Environmental Management and Biodiversity Conservation of Forests, Woodlands, and Wetlands of the Rufiji Delta and Floodplain

Implementation of the Rufiji Forest Action Plan

With Special Emphasis on Community Based Natural Resources Management and a Case study of Ngumburuni Forest

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REMP MUMARU

Rufiji Environment Management Project

RUFIJI DISTRICT COUNCIL

Rufiji District Council

Technical Report No. 45
Oct 2003

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[1] The Rufiji District Council implements Rufiji Environment Management Project with technical assistance from IUCN – The World Conservation Union, and funding from the Royal Netherlands Embassy.

Rufiji Environment Management Project – REMP

Project Goal
To promote the long-term conservation through 'wise use' of the lower Rufiji forests, woodlands and wetlands, such that biodiversity is conserved, critical ecological functions are maintained, renewable natural resources are used sustainably and the livelihoods of the area's inhabitants are secured and enhanced.

Objectives

- To promote the integration of environmental conservation and sustainable development through environmental planning within the Rufiji Delta and Floodplain.

- To promote the sustainable use of natural resources and enhance the livelihoods of local communities by implementing sustainable pilot development activities based on wise use principles.

- To promote awareness of the values of forests, woodlands and wetlands and the importance of wise use at village, district, regional and central government levels, and to influence national policies on natural resource management.

Project Area
The project area is within Rufiji District in the ecosystems affected by the flooding of the river (floodplain and delta), downstream of the Selous Game Reserve and also including several upland forests of special importance.

Project Implementation
The project is run from the district Headquarters in Utete by the Rufiji District Administration through a district Environmental Management Team coordinated by the District Executive Director. The Project Manager is employed by the project and two Technical Advisers are employed by IUCN.
Project partners, particularly NEMC, the Coast Region, RUBADA, The Royal Netherlands Embassy and the Ministry of Natural Resources and Tourism, collaborate formally through their participation in the Project Steering Committee and also informally.

Project Outputs
At the end of the first five –year phase (1998-2003) of the project the expected outputs are:
An Environmental Management Plan: an integrated plan for the management of the ecosystems (forests, woodlands and wetlands) and natural resources of the project area that has been tested and revised so that it can be assured of success - especially through development hand-in-hand with the District council and the people of Rufiji.

Village (or community) Natural Resource Management Plans: These will be produced in pilot villages to facilitate village planning for natural resource management. The project will support the implementation of these plans by researching the legislation, providing training and some support for zoning, mapping and gazettement of reserves.

Established Wise Use Activities: These will consist of the successful sustainable development activities that are being tried and tested with pilot village and communities and are shown to be sustainable

Key forests will be conserved: Forests in Rufiji District that have shown high levels of plant biodiversity, endemism or other valuable biodiversity characteristics will be conserved by gazettement, forest management for conservation, and /or awareness-raising with their traditional owners.

Summary

Natural forests cover approximately the half of the Tanzanian national territory and most of them are rich in vegetation types. Yet, the decrease in this forest cover started several decades ago. Droughts, but also fires and illegal exploitation are the main reasons for this degradation. For a long time the Tanzanian forest policy has been focusing both on strict conservation and production. But the results of this policy have shown its limits. In the nineties, a world-wide trend to promote systems of local management involving rural communities was developed, most often under the leadership of international donors. In eastern and southern African countries, and particularly in Tanzania, this trend was expressed by a flurry of new forest acts facilitated by the development of more democratic systems.

It is up to the District Council to enforce the new laws in Rufiji where over exploitation and deforestation are becoming a worrying issue. Promoted by the IUCN Rufiji Environment Management Project (REMP), a Forest Action Plan, approved by the Council in April 2003, aims to help the District to improve forest management with special emphasis on the communities' participation, in order to reverse the trend of over exploitation and destruction. The Council decided to start the implementation of the plan by transferring the management of the Ngumburuni District Forest Reserve to the adjacent communities. This operation required an inventory of the resource and a study of the human context.

The Ngumburuni forest 165 km South of Dar es Salaam, covers an area of 10 000 ha (including the 3000 to 4000 ha District Reserve) to the northeast of Ikwiriri. It is mainly composed of primary and secondary (or disturbed) coastal forest. Yet, it is interspersed with Miombo and woodland patches. Ngumburuni still contains high biodiversity value areas, constituting a unique habitat for rare, endemic or threatened species. But over harvesting has severely diminished the forest capital and the average basal area is one of the lowest in Rufiji. The forest is criss-crossed by many trails and logging sites can be found even in the deepest parts. Other activities like charcoal burning or agriculture also damage it.

But Ngumburuni is also a place where the neighbouring communities find basic livelihoods. People of six villages, Mangwi, Mkupuka, Muyuyu Umwe Centre, North and South used to harvest timber, firewood, edible plants or building materials in the forest. Most of them are aware of the bad condition of the forest and they often maintain that Ngumburuni is threatened with becoming an open woodland. Nevertheless, opinion is divided about the establishment of a participatory management. Some stakeholders are doubtful about the real will of the District Council to empower the communities. Some others think that it will be difficult for them to succeed where the authorities failed. Yet, many people are convinced that they must seize this opportunity and manage their natural resources themselves. In fact, no significant obstacle should hamper the implementation of a community-based (or a joint) forest management. The national and local institutional tools are now operational. But it will be indispensable to develop confident relationships between the communities and the District authorities.

After two discussion rounds with the different stakeholders, the current report also proposes a framework for the development of a management plan, which will take into account the results of the forest analyses, the human context and the demands and the expectations of the communities.

The main unifying threads are:

- combining the necessary conservation and improvement of the coastal forest and the communities' legitimate demand for livelihoods;
- encouraging current and new non-timber activities;
- stopping the most damaging uses;
- empowering the communities for crucial issues like guarding, managing village areas, etc.

These proposals are accompanied by a time frame planning the next steps of the process up to the start of the management plan enforcement, by September 2004. A crucial item pointed out is the

search for financial support, which has already begun since REMP successfully applied to Switzerland for financial aid. Yet, these encouraging results will need intensive follow-up by the District.

It could be one of the major lessons learnt from this study: the pilot role of the District Council must increase. Indeed, other forests need action (Ruhoi, Utete, Kichi Hills…) and the authorities must now find their own way to further the Forest Action Plan, which has hardly started. It is not too late. This study proposes elements of methodology, but the key words should be dynamism and initiative. Initiative for making a credible workplan, for finding funds but also for developing the indispensable relationship of trust with the communities who will, from now on, be partners impossible to ignore.

Muhtasari

Misitu ya asili inafunika karibu nusu ya Tanzania, na mingi ina utajiri wa uoto mbalimbali. Hata hivyo kupungua kwa maeneo yaliyofunikwa na misitu hii kumeanza miaka mingi iliyopita. Ukame, moto na uvunaji holela/haramu ni baadhi ya sababu za uharibifu wa misitu. Kwa miaka mingi, Sera ya Taifa ya Misitu imekuwa ikisisitiza na kutia mkazo uhifadhi na uzalishaji wa misitu. Lakini matokeo ya Sera hii yameonyesha ufinyu kama siyo mapungufu. Miaka ya tisini (kuanzia 1990), mfumo wa dunia wa ushirikishwaji jamii katika usimamizi ulianzishwa kupitia wahisani wa kimataifa. Katika nchi za Mashariki na Kusini mwa Afrika, hasa Tanzania, mtazamo huu ulijionyesha kwa kuwa na sheria za misitu zilizotungwa kwa kufuata mifumo ya demokrasia.

Ni jukumu la Halmashauri ya Wilaya ya Rufiji kutumia sheria hizi Wilayani hasa ukizingatia ukweli kuwa uvunaji holela na ukataji wa misitu ni suala la kutisha sana Wilayani. Kupitia Mradi wa Usimamizi wa Mazingira Rufiji (MUMARU) uliyoanzishwa na shirika la usimamizi wa mazingira duniani (IUCN), Mpango wa Usimamizi wa Misitu wilaya ya Rufiji ulipitishwa na Baraza la Waheshimiwa madiwani mwezi Aprili 2003. Dhumuni kuu la mpango huu ni kusaidia Wilaya katika kuboresha usimamizi wa misitu hasa kuzingatia ushirikishwaji wa jamii kwa lengo la kupunguza mwelekeo wa uvunaji uliyokithiri na uharibifu wa misitu. Halmashauri imeshaanza kutekeleza mpango huu wa Wilaya kwa kukabidhi jukumu la usimamizi wa Msitu wa Ngumburuni (msitu wa Halmashauri) kwa jamii inayozunguka msitu huu. Shughuli hii ilihitaji utafiti wa kuelewa raslimali ya msitu na kujua mahusiano ya kibinadamu na raslimali hizi.

Msitu wa Ngumburuni upo kilomita 165 kusini mwa Da es Salaam, una eneo la hekta 10,000 (inajumuisha hekta 3000 hadi 4000 za msitu wa serikali ya mitaa) kwa upande wa kazikazini-Mashariki mwa Ikwiriri. Msitu huu wa Kanda ya Pwani una maeneo yenye miti ya asili ambayo haijaharibiwa (ina misitu ya awali "Primary forest") sana na sehemu zingine msitu una maeneo yaliyoharibiwa, una miti inayomea/ kuchipua kwa upya baada ya kukatwa/kuharibiwa (Secondary forest). Aidha msitu huu una mabaki ya maeneo yenye miti ya Miombo na vifufutu/ uwanda wa vichaka,manyasi na miti mikubwa ya hapa na pale. Ngumburuni bado ina maeneo yenye bioanuai ya dhamani kubwa ambayo hulea aina mbalimbali ya viumbe hai. Baadhi ya viumbe hivi aidha si rahisi kupatikana au vinapatikana sehemu hii tu, ama vipo katika hatari ya kutoweka. Hata hivyo uvunaji uliyokithiri umepunguza sana mtaji wa msitu huu hasa ukiangalia idadi ya aina ya miti kwa eneo (hekta) ni wa kiwango cha chini sana ukilinganisha na misitu yote Wilayani Rufiji. Msitu una vinjia/mapito mengi na uvunaji wa miti hufanyika hadi katika miteremko mikali mno. Shughuli zingine kama vile uchomaji wa mkaa na kilimo zinachangia pia kuharibu msitu huu.

Hata hivyo, Ngumburuni ni mahali ambapo jamii inayozunguka hujipatia vyanzo vya maisha yao. Watu wa vijiji sita vya Mangwi, Mkupuka, Muyuyu, Umwe Kati, Kaskazini na kusini huvuna mbao/ magogo, kuni, mazao ya msitu yanayoliwa na nguzo za kujengea katika msitu huu. Watu wengi wanaelewa kuwa hali ya msitu ni mbaya. Aidha wengine wanafikia kusema kuwa Ngumburuni inatishia kuwa uwanda wenye miti ya hapa na pale. Hata hivyo watu hutofautiana katika mtizamo wa mawazo kuhusu uanzishwaji wa usimamizi shirikishi wa jamii. Wengine wanahofu kuhusu utayari wa halmashuri kutoa madaraka kwa jamii. Wengine wanahisi kuwa ikiwa halmashauri kama serikali imeshindwa, basi ni vigumu kwa jamii kufanikiwa. Hata hivyo watu waliowengi wanasema, ni vyema kutumia mwanya huu waliopewa ili wa simamie maliasili zao wenyewe. Kusema kweli hakuna kikwazo cha kutishia utekelezaji wa usimamizi wa msitu ama kijamii au kwa njia ya ubia. Vitendea kazi vya kitaifa na kiasasi vimeanza kutumika. Lakini ni muhimu sana kuunda mahusiano yenye kuaminika na thabiti kati ya jamii na utawala wa Wilaya.

Baada ya mizunguko miwili ya mazungumzo na wadau mbalimbali, taarifa hii ya sasa inapendekeza muundo wa kutengeneza mpango wa kusimamia msitu huu. Mpango huu utilie maanani matokeo ya utafiti wa awali, wa kuelewa kwa undani msitu na mahusiano yake na jamii husika, hususani mahitaji na matarajio yao kwa ujumla. Masuala muhimu ya kuzingatia ili kuwa na mafanikio mema ni:

- Kuoanisha mambo muhimu ya uhifadhi na uboreshaji wa msitu wa pwani na haki ya kisheria na mahitaji ya jamii kimaisha.

- Kuhamasisha shughuli za sasa na zitakazobuniwa ambazo hazina athari kwa msitu (hazihusiani na mbao, magogo n.k)

- Kusimamisha kabisa matumizi ambayo yanazidi uharibifu

- Kuwapa uwezo jamii kwa masuala yenye tija hususani ulinzi/ doria na usimamizi wa eneo la kijiji husika n.k

Mapendekezo haya yanafuatana na rasimu ya mpango wa kazi wa kuendelea na hatua zingine za kufuatwa hadi kufikia utekelezaji na usimamizi wa mpango ifikapo mwezi Septemba 2004. Suala muhimu lililojitokeza ni utafutaji wa msaada wa fedha.Hili limeshaanzwa kufanyiwa kazi kupitia mradi wa MUMARU ambao umeshaomba fedha kutoka mfuko wa msaada wa fedha nchini Swizalend. Hata hivyo matokeo haya yanayotia moyo yanahitaji ufuatiliaji wa Karibu wa Wilaya.

Ingelikuwa moja ya masuala makuu ya kujifunza kutokana na utafiti huu: Jukumu hili la mfano katika halmashauri ya Wilaya ni lazima liongezeke. Kweli, misitu mingine bado inahitaji kutendewa kazi (Misitu ya Ruhoi, Utete, Vilima vya Kichi.) na mamlaka ya Wilaya ni lazima sasa kutafuta njia yao ya kuendeleza zaidi mpango wa usimamizi wa misitu Wilayani, ambao kwa uhakika tunaweza kusema bado haujaanza kutekelezwa. Haina maana kuwa shughuli hii imechelewa, ila utafiti huu unapendekeza njia ya kiutendaji.Hata hivyo neno kuu liwe kuuendeleza na kuuanzisha. Kuuanzisha kwa kuunda mpango wa utekelezaji wenye tija kwa kutafuta fedha na pia kuendeleza mahusiano yenye uwazi na uaminifu kwa jamii ambao watakuwa wabia, hivyo si vyema kuwapuuza kuanzia sasa na kuendelea.

Acknowledgements

This work was conducted between May and September 2003 as part of my training period at ENGREF, the French Institute of Forestry, Agricultural and Environmental Engineering under the supervision of Georges Smektala.

I would like to thank the entire REMP-IUCN staff in Utete and Dar es Salaam and the Rufiji District Council and technical staff for their help and kindness during the making of this study.

Mr Richard Elibariki, a free-lance forester with many years of experience on participatory forest management in Rufiji, Ms Rose Hogan REMP Technical Adviser and Mr Mohamed L. Chande, District Lands Natural Resources and Environment Officer provided guidance and essential backstopping to the process. The field team with Mr Jonas Nambua, Assistant Forest Officer, Mr Revocatus X. L. Nandi, Land Use Plan Officer and Mr Hadji Mkungula, Assistant Game Officer and resource persons Mr Athman Ngwele and Mr Rachidi Meza from the local communities, endured with me the hardships of the fieldwork in the forest.

Thanks are due to Stéphanie Duvail from CEH Wallingford/IRD for having accorded the first priority to the geometric correction and georeferencing of the aerial photographs of Ngumburuni.

I also wish to present very, very special thanks to Olivier Hamerlynck for his confidence, his always relevant pieces of advice and the discovery of the coastal forest of eastern Africa. Maybe one day, somewhere else on the Earth…

Lastly, I do not want to forget Pat Viollier for revising the English.

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List of Abbreviations

C.B.F.M.:	Community Based Forest Management
D.F.A.P.T.F.:	District Forest Action Plan Task Force
ENGREF:	The French Institute of Forestry, Agricultural and Environmental Engineering
F.B.D.:	Forest and Beekeeping Division
G.I.S.:	Geographic Information System
G.P.S.:	Global Positioning System
GTZ:	Gesellschaft für Technische Zusammenarbeit
IUCN:	The World Conservation Union
J.F.M.:	Joint Forest Management
N.T.S.P.:	National Tree Seeds Project
P.F.M.:	Participatory Forest Management
REMP:	Rufiji Environment Management Project
RUBADA:	Rufiji Basin Development Authority
Tsh:	Tanzanian shilling: 1030 Tsh = 1 $ (August 2003)
WWF:	The World Wide Fund

1 Introduction

Tanzania has a wealth of natural forests ranging from mangroves to mountain and dry forests. More than 50 % of the country is covered with forests or woodland, which play a significant role in the national economy, but also in the daily lives of many rural communities. Former forest policies mainly focused on the preservation of the natural resources from exploitation and the exclusion of people from protected forests, meanwhile overlooking the vital needs of the local communities. Yet, the 2002 new Forest Act, taking note of the failures of these policies, promotes participatory management.

The Rufiji District, the southernmost of the six districts in the Pwani (Coast) region, is at the heart of these new orientations. Indeed, the exploitation of the important forest resources has been conducted as a mining operation in Rufiji and almost all the forest are overharvested. Some valuable species are commercially extinct. In 2003, the District Council approved a Forest Action Plan promoted by the IUCN Rufiji Environment Management Project (REMP). This Plan aims to improve the management of the forests and to stop their destruction all over the District with special emphasis on community based management, according to the spirit of the new law.

The District Council put a high priority on the Ngumburuni forest in order to start the implementation of the Plan, with the idea that this study case could become a model for similar management transfers elsewhere in Rufiji. Indeed, Ngumburuni includes a District Forest Reserve which the foresters have failed to control. In contrast, the forest still harbours exceptional biodiversity and in 2002 the finding of a population of the *puguensis* race of the Pale-breasted Illadopsis is one of the most significant ornithological discoveries made in Tanzania over the past 5 years. As some forest-adjacent communities asked to start a community based management system, the Council decided to survey the forest in close collaboration with the surrounding villages. Thus, this study, commissioned both by REMP and the Rufiji District Council, aims to develop a method of establishing a management plan and learning lessons from this pilot operation, to carry out a first assessment of the Forest Action Plan implementation.

After a presentation of the national and local context and of the methodology, the current report will set out the results and analysis of the inventory of the Ngumburuni forest in order to describe the forest, its potential and physical constraints. Then, we will study the human context, i.e. the history of the forest, its perception by the different stakeholders, the wishes and expectations of the adjacent communities and their degree of motivation for a community based or a joint forest management.

The outcome of these analyses, aiming also to verify the feasibility of a collaborative management process, will be the establishment of the framework of a management plan based on the main results and the recommendations and claims of the stakeholders. This part will be completed by the proposal of a program and a time frame to bring the operation to a successful conclusion.

Finally, we will learn the lessons of this case study and develop proposals in order to help the District Council to further the Forest Action Plan. By reviewing all the planned actions proposed in the operational matrix, we will pinpoint the constraints and weaknesses and make suggestions in order to facilitate its implementation.

2 Context of the Study

2.1 Tanzania and Rufiji District: a general overview

2.1.1 A brief presentation of Tanzania

The United Republic of Tanzania is the largest country in Eastern Africa with a land area of 945 000 km^2. It is located between latitudes 1^o 00' S and 11^o 48' S and longitudes 29^o 30' E to 40^o 30' E (Sayer *et al.*, 1992; Collective, 1998). Tanzania shares borders with eight countries: Malawi and Mozambique in the south; Burundi, Congo (D.R.C.), Rwanda and Zambia in the west; Kenya and Uganda in the north. The eastern side is the Indian Ocean coastline (about 1000 km).

The climatic conditions range from coastal to alpine deserts on Mount Kilimanjaro. The coastal area experiences a tropical climate and is influenced by two monsoon winds: the south-east monsoon blowing northwards from March to September and bringing heavy intermittent rains; from December to March the north-east monsoon blows southwards and brings the hottest temperatures. The rainfall is generally erratic and varies from 400 mm in the central regions to 2500 mm in the highlands (Collective, 1998).

According to the 1988 census, a population of 22 to 23 million was recorded. As the population grows by 2,8 to 3 % annually, we can now expect a total population of 35 million. Over 80 % of the Tanzanians are living in rural areas and most of them depend on land and natural resources for subsistence. The quality and the availability of arable land explain for the most part the internal population distribution. Obviously, population growth will increase pressure on land and natural resources. Agriculture and livestock keeping are still traditional and mainly extensive and the practice is not about to change. As the soils are generally naturally poor (they are typical tropical soils with low nutrient content), they become quickly exhausted, increasing land requirement. Agriculture mainly produces food crops and moreover, the production of export crops (sisal, cashew nuts,…) dropped due to unfavourable international market conditions.

The country is divided into administrative regions, twenty on the mainland and five in Zanzibar, which has a special status and its own government. These regions are further divided into districts. Politically, the districts are governed by two entities. The Central Government is represented at this level by a District Commissioner who is the chief spokesman and in charge of all government matters. There is also a local political entity, which is the District Council, i.e. the assembly of councillors elected from each ward. The District Executive Director is the spokesman of the Council and the head of all the civil servants working within (Collective, 1997).

Several standing committees and technical departments help the District Council to build and execute its policy.

Figure 1: Location map of Tanzania (doc. S.C.P.M.E.).

2.1.2 Profile of the Rufiji District

Rufiji is one of six districts in the Pwani region. The headquarters are in Utete, located about 200 km south of Dar es Salaam. It is divided into 91 registered villages, 19 wards and 6 divisions. Each village has its own government. The wards are run by the ward development committees headed by their respective councillors. They also have executive officers. At the division level there are divisional officers (Collective, 1997).

Figure 2: Location of the Rufiji District on the Tanzanian political map (Doc. Blay-Foldex).

The Rufiji District covers an area of 13 339 km^2. Thirty eight percent of that area is covered by registered Forest Reserves (1668 km^2) and the Selous Game Reserve (3436 km^2). The Rufiji River, the largest in Tanzania and the fifth in Africa for the flow (900 m^3/s), runs west – east to the Indian Ocean and cuts the territory of the district into two (Collective, 1997). There are also 13 lakes and several swamp areas.

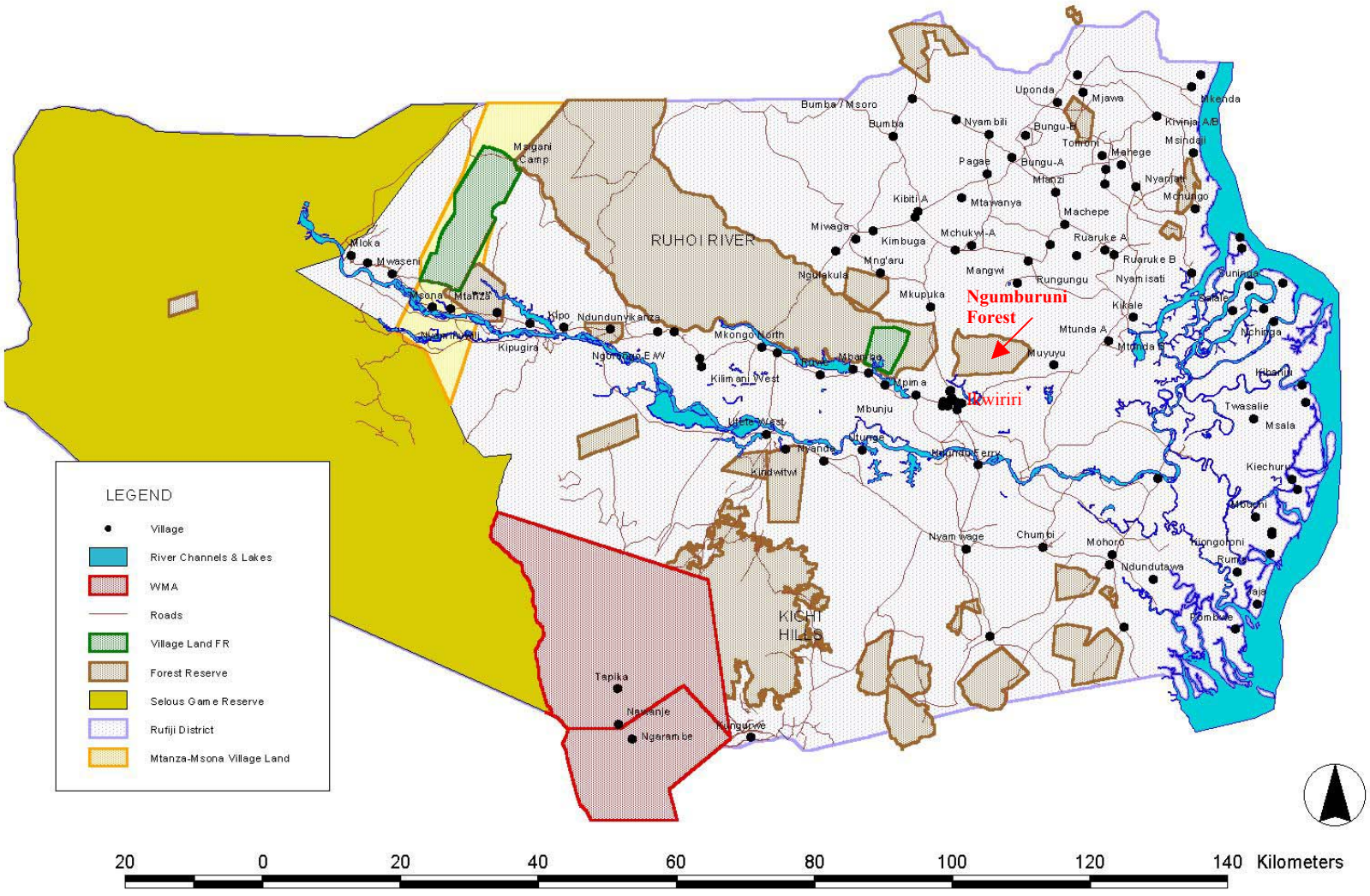


Figure 3: Landscape designations in Rufiji District (REMP).

The rainfall pattern is characterised by the two seasons described above. The average annual rainfalls vary from 850 mm at Utete to 1000 mm at Mohoro. There is a slight variation of temperature between the delta and the inland areas, because of the stabilising influence of the sea. The average temperature varies from 24°C in June to 28 °C between December and February.

The current population, according to the 2002 census is about 203,000 persons. It seems that there are more women than men. The major ethnic group is the Wandengereko. Other groups are also represented: Wanyagatwa, in the delta, Wamatumbi around the Kichi and the Matumbi Hills and Wapogo and Ngindo from neighbouring districts (Collective, 1997). The main economic activities in the District are fishing and subsistence agriculture and many of the field operations are done manually. The local populations have no tradition of keeping cattle and the presence of the tse-tse is not encouraging them to begin animal husbandry, except for poultry. Yet, recently, livestock keepers have been coming from the northern regions of Tanzania, attracted by the large grassland areas. At the most recent count (August 2003), there were 11,000 heads of cattle in the District, to be compared with a few hundred before 2002. There is also an unofficial economy and illegal logging is probably an important part of it, as it can be guessed considering the high number of lorries crossing Utete, Ikwiriri or Kibiti. Be that as it may, the Rufiji District is one of the less developed in Tanzania on criteria such as standard of living or access to services and basic amenities.

2.2 A flurry of forest reforms, with special emphasis on participatory management, in Eastern and Southern Africa

In spite of the fact that involving people in forest management has become common all over the world for a long time, participatory forest management in Africa has been slow to evolve. In the early nineties, Gambia was almost the only country which had proclaimed it as a national priority. But from 1995 to 2000, new forestry acts had been promulgated in many African countries, and particularly in Zanzibar, South Africa, Malawi, Zambia, Lesotho and Mozambique. From 2000 to 2003, Kenya, Uganda, Tanzania, Namibia and Swaziland joined the movement. In fact, nowadays, more than forty new national forest policies make participatory forest management an objective in Africa (Alden Wily, 2000).

This reform wave originates in recent political changes. Indeed it occurs as east and southern African countries become more democratic, adopt more liberal economic strategies and new devolution rules. These forestry reforms have also been favoured by the promulgation of new land tenure laws clarifying the legal status of the land property. Yet, the incentive role of international donors, and particularly the World Bank, must also be emphasized. Indeed, the development of participatory management is linked to the criticism of the governmental action and the emergence of the structural adjustment, promoted by liberal ideas of the main international donors (Buttoud, 2001). At the same time, the citizens are more and more demanding of an important role in managing the natural resources that they can find around their villages.

Effective participatory management mainly consists of the transfer of the management to the adjacent communities relieving the authorities of their responsibilities concerning the results (Buttoud, 2001).

There are three main types of participatory forest management (Alden Wily, 2001):

- Joint Forest Management (J.F.M.) or co-management. This system consists in sharing the managerial powers, the use rights and the benefits between the foresters and the communities. In practice, the agreement can vary from passive cooperation to active management partnership. It depends on the degree of confidence between the authorities and the communities, but also on the real will to empower these communities;
- Designated Management (first type of Community-Based Forest Management – C.B.F.M.). The community is empowered as the only manager of the forest, even if it is a Local or National Government Reserve. The management entity generally operates with a

management plan agreed with the authorities. But the Government stays the owner of the forest;

- Owner Management (second type of Community-Based Forest Management – C.B.F.M.). In that case, the community is not only the manager of the forest but also the owner. This system is being widely established with respect to those forests which are not forest reserves.

Of course, each country is following its own way and we can now find a large diversity of management regimes. Thus, Lesotho and South Africa return the national forests to their original owners, hoping at the same time that they will contract specialised agencies to manage the more commercial and valuable ones. Uganda, Ethiopia or Niger have made the choice of developing P.F.M. in their most valuable forest reserves. Tanzania has made the main experiences in currently unreserved areas (Alden Wily, 2001). In that sense, the Ngumburuni operation, promoting a management transfer, could become a reference at least in Rufiji and maybe in the country.

Much is expected from these new policies, maybe too much, and the donors supported it with important funds. Today, we can say that the various experiences have not always lived up to the expectations. To be efficient, participatory management must be implemented in favourable socio-political conditions. Particularly, the devolution laws must be really able to empower the communities (Buttoud, 2001). And sometimes things do not go as planned. For example, in the Dwesa-Cwebe Forest Reserve in the former Transkei region of the Eastern Cape (South Africa), the question of who has the power over decision-making is not solved, despite seven years of negotiations. This relative failure originates in the weakening of traditional leadership. Indeed its traditional authority over the allocation of land and resources has been challenged. On the other hand, the new community institutions lack local legitimacy (Anonymous, 2003).

This example demonstrates that successful management needs more than so-called democratic institutional community structures. In Tanzania, this pattern of potential conflict can arise because the democratic structures have been imposed by the Government. Obviously, in Zimbabwe, Rwanda or Burundi, a similar risk exists, increased by the currently tense political situation. Fortunately, success stories also exist, for example in Namibia where four national forest reserves have been demarcated to be transferred to the neighbouring communities. Some other examples can be found in Tanzania or in Uganda (Alden Wily, 2000). In fact, successful participatory forest management needs strong support from both government and really empowered communities (Anonymous, 2003).

In the case of Ngumburuni, after having studied the forest and the human context, we will analyse a list of criteria to verify that these supports exist and that the main conditions for a successful transfer of management are verified (cf. chapter III.3).

2.3 Tanzanian forestry resources and new policy

2.3.1 Tanzania is rich in vegetation types

Estimates for closed forests in Tanzania vary from about 9000 km^2 to 16,000 km^2 according to the different authors (Sayer *et al.*, 1992). But the whole country is reputed to be covered by 400,000 km^2 of various woodland types, *i.e.* almost the half of the national area. In fact, the real surface is not well known, but it is probably decreasing because of fires, droughts and unplanned exploitation.

Yet, Tanzania is still acknowledged for its forest richness. The main forest types are varied as they include montane forests, lowland forests, coastal forests, woodlands, thickets and bushlands, mangroves and swamps (Holmes, 1995). The woodlands (Miombo) and the coastal forests will be defined in the next chapters. The coastal forests, which are very important ecologically, are now greatly depleted, degraded and fragmented. All mangroves are legally protected nevertheless they

are threatened too by overharvesting, conversion to agricultural land, salt production pans and prawn farming.

In fact, most forests have been significantly exploited in a recent past. Encroachment, often for shifting cultivation, overharvesting, often illegal, and burning are the more damaging factors. In many places intensive pit-sawing has replaced mechanical logging. We will see that it is the case in Ngumburuni in particular.

Timber, of legal or illegal origin, is most often exported, particularly and recently to east Asian countries. But a local market also exists, particularly for furniture. But it is not really organised and local high value products could be more developed. Firewood and charcoal demands are also increasing with the demographic growth. Obviously, more or less all of Tanzania depends on forest resources for cooking. Firewood accounts between 90 and 92 % of the total energy used in Tanzania and for around 95 % of the total wood products consumed in the country (Milledge, 2003). It is likely to continue in the foreseeable future.

2.3.2 Institutional framework of the Tanzanian forestry sector

"*The forests of Tanzania are covered by laws passed, or inherited and accepted, by the National Assembly. These laws are published by the Government Printer, Dar es Salaam as Chapters, Supplements, Orders or Notices which, until revoked or amended, remain the primary legislative control of the woody vegetation of the country*" (Holmes, 1995).

Until recently, these Tanzanian forest laws, often inherited from the colonial period, essentially promoted the state management or in some cases the management by district authorities (like for example in Ngumburuni). Indeed, historically, Tanzania had a former tradition of strict conservation as it is proved by the numerous national parks (11), game reserves (16) and the extensive forest reserves network (Sayer *et al.*, 1992). Some productive forests exist too. But this policy is not very efficient in many cases because it is inhibited by shortages of staffs and implementation funds. Surveillance of large territories is indeed quite difficult for reduced teams and the people living in the neighbourhood do not feel involved in the management and are tempted to get what they can in the public domain.

Yet, in 1999, Tanzania radically changed the legal status of the land common laws. The new act recognizes the common laws and allows people to get, own and transfer land rights and to gazette title deeds (Alden Wily, 2000). This major political change favours the new forest strategies aiming to allow the communities to create their own forest reserves. This first step was followed by a second one. Indeed, the new 2002 Forest Act (passed by Parliament in April 2002) designates community-based forest management as a major objective, also facilitated by the new land acts. In fact, as noted in I.2, it is a regional tendency and Malawi, Lesotho, Uganda or Mozambique, for example, voted similar laws. The Forest Act of 2002, which replaced the Forest ordinance of 1957, the Grass Fire Ordinance of 1943 and the Export of Timber Ordinance of 1953 (amended in 1989), and the National Forest Programme (2001-2010) are currently the main instruments to implement the Tanzanian forest policy.

Community – based management is now developing in Tanzania and this new strategy is also favoured by existing local power structures. Indeed, the management by a community is based on the hypothesis that social control is more efficient than administrative control (Babin *et al.*, 1998). As mentioned in I.2, to be effective, this principle must be supported by a real decentralisation and a real will to empower the communities. In Tanzania, where the Government was omnipresent during several decades, particularly the seventies and the eighties, it was not obvious. In fact, the Tanzanian community – based forest management finds its origin in a successful recovery of forests by thirteen communities (1991 – 1995). Initially, the Government planned to class them as national forest reserves. But the local populations were determined to get all they could before losing them. Incursions and damages were increasing and outsiders took part in it too. Eventually, in view of stopping the decline of the forests, the Government resolved to entrust their management

to the communities. The villagers quickly succeeded in banning the damaging practices that they considered essential for their livelihoods only a short time before (Alden Wily, 2000). In Tanzania, the community-based management can be regulated by these village authorities. The local governance can indeed promulgate by-laws, registered by the District and applicable to everybody. Through this legal mechanism, the communities can seal their own forest rules and power structures into the law. It includes the right to lay down fines to offenders, to collect royalties and control their use. But as a counterpart, the community is officially responsible for the management of its forest.

2.3.3 The forestry sector under pressure in Rufiji

The forestry sector in Rufiji District is well described in the Forest Action Plan (2002). Through a bibliographical analysis, this paragraph just aims to extract the main lines. In Rufiji, the term "forest" refers to both woodland (Miombo and open woodland) and "real" forest. Rufiji has woodlands, coastal forests (cf. III.1.) and also mangroves and tidal forests in the delta. According to the Forest Action Plan, there are 18 forest reserves in the Rufiji District.

Name	Area (ha)	Status
Ruhoi	**68633**	**Encroached, over exploited**
Mangrove	53255	Contains 14357 ha of non-forested land
Tamburu	5997	Probably encroached and over exploited
Katundu	5631	Under increasing exploitation
Mtanza	4926	Encroached, over exploited
Namakuttwa-Nyamuete	4700	Protected but starting to be encroached
Rupiage	4118	Under increasing exploitation
Ngumburuni	**3104**	**Encroached, over exploited**
Kiwengoma	3104	Protected
Mtita	**2998**	**Over exploited**
Ngalakula	**2399**	**Encroached, over exploited**
Mohoro	2349	Probably encroached and over exploited
Kipo	1749	Encroached
Kikale	988	Encroached
Kingoma	988	Probably encroached
Mchungu	949	Under increasing exploitation
Utete	900	Under increasing exploitation
Muhoro river	49	Status unknown
Total	166837	

Table 1: Forest reserves in Rufiji District, surface areas and status (Forest Action Plan, 2002)

The four forests written in bold type belong to the District authorities. Only the two forests written in italics have management plans.

Over the last decade, the Rufiji forests have come under increasing exploitation. As shown in table 1, about 54 % of the total forest reserves area is overharvested. We will see that it is particularly the case in Ngumburuni. The commercial demand of timber and charcoal is the main factor explaining this situation, because of the relative proximity of Dar es Salaam. For example, the quantities of charcoal produced and traded from Rufiji have been multiplied by 2,3 during the past ten years, in spite of a decrease in the mid nineties. Even in the local or national reserves, the weak human and financial capacities of the Forest Departments do not allow them to control illegal logging or charcoaling with sufficient efficiency (the District has only 2 to 3 forest officers without means). Moreover, the situation of the forests reserves ruled by the District is ambiguous because it is difficult to find the right balance between the necessity of conservation and the need of royalties, which is by far the main motivation of the District policy. We can note that 60 % (150 M Tsh – 146 000 $) of revenue generated locally by Rufiji District comes from the forest. In addition, 7 % (88 M Tsh – 85 000 $) of central government forest revenue (7 % of the royalties) comes from Rufiji

District. Every year, 10 000 m^3 of hardwood are exported from the District. It is important to know these figures before proposing a community-based management process.

Presently, forestry in Rufiji is of a mining type (the illegal one, but also the legal one). Target species are logged out one by one until they become commercially extinct. Precious species such as Mninga (*Pterocarpus angolensis*) are still being harvested, but most often under the recommended diameter. The seed sources are disappearing and the regeneration is threatened too.

The conversion of some parts of the forests to cultivation is also increasing. Yet, for the moment, the land pressure stays relatively reasonable compared with some other African regions (in Rwanda or in Madagascar for example). But the settlers generally clear large areas because they do shifting cultivation most often. As the soil is quite poor, they give up their fields a few years after coming. Those fields quickly become woodlands or grasslands and have little chance of again becoming a closed forest. This issue could be partly solved by conserving seeding trees, but we note that it has never been done.

2.4 The Rufiji Environment Management Project promoter of the Forest Action Plan

The Rufiji Environment Management Project (REMP) is a IUCN project and it aims to "*promote the long-term conservation through wise use of the lower Rufiji forests, woodlands and wetlands, such that biodiversity is conserved, critical ecological functions are maintained, renewable natural resources are used sustainably and the livelihoods of the area's inhabitants are secured and enhanced*" (Hogan *et al.*, 1999).

The main REMP objectives are (Hogan *et al.*, 1999):

- to promote the integration of environmental conservation and sustainable development through environmental planning within the Rufiji delta and floodplain;
- to improve the natural resources management in the district, and to promote their sustainable use with special emphasis on the community-based management;
- to promote awareness of the values of forests, woodlands and wetlands and the importance of wise use at village, district, regional and central government levels, and to influence national policies on natural resources management.

An E.M.T. (Environmental Management Team), coordinated by the District Executive Director and linked to the District Administration, runs the Project from the District headquarters in Utete. Financing is given by the Dutch government through the IUCN regional office in Nairobi, Kenya.

The main outputs of the projects should be environmental management plans and among them, documents dealing with the forest conservation. As said in the previous paragraphs, wood resources management is particularly problematical in Rufiji. That is why a Forest Action Plan was designed in view of improving this management according to the REMP principles and the local and national laws.

The Forest Action Plan (2002) includes eleven key-activities. They aim to improve the general forest management in the District and to reverse the trend of overharvesting and destruction. They are briefly summarized here below:

1**. Demarcation of forest boundaries and definition of management responsibility and legal status**. It supposes a participatory mapping of the forest and it aims to clearly know the resource, the stakeholders and their wishes about the management.

2. **Adoption of zoning and harvesting plans**, including conservation areas, restrictions on the harvest of certain species, recommendations for exploiting the other ones (minimum diameters,…).

3. **Defining and controlling charcoal production areas**. The villagers should be involved in licensing and monitoring this activity.

4. **Revitalizing and initiating collaborative forest management arrangements**. The District has an active role to play in it by supporting the village committees and helping them for mobilising funds.

5. **Effective law enforcement and revenue collection**. Some efforts should be made at the District level to improve the situation. Some simple measures should be taken: hammering logs in the field, mobile check points, etc.

6. **Consolidating the "whole tree" licensing system in the district**, instead of licensing on the basis of logs. This measure aims to reduce wood waste.

7. **Adopting a moratorium on Mkongo harvesting and other depleted species**. Such a measure should be adopted until these species achieve again some convincing level of regeneration.

8. **Promotion of *Afrormosia angolensis* from class V to class II**, because of its high quality and an increasing demand for export. Some other species should also be promoted. It would contribute to loosening the pressure on more depleted species.

9. **Improving the revenue retention scheme at district level**. In fact, these measures aim to strengthen the District forestry budget and consequently its action capacities.

10. **Revenue generation from the seeds**. This activity could be a real opportunity, as it should be supported by the National Tree Seed Project which facilitates the collection and marketing of the seeds.

11. **Promoting the planting of indigenous tree species**, for replenishment of harvested zones for example. Village wood lots could also be created.

The present study fits into this process and aims to facilitate its implementation. The management transfer of one of the planned forest will be done according to these principles while, at the same time training a team of District officers. This team will be responsible for the next management transfer operations.

3 Problem Analysis and Methodology

3.1 Objectives and problem analysis

This study aims mainly to start the implementation of the Rufiji Forest Action Plan, with special emphasis on the community-based natural resources management aspects and to formulate some propositions to facilitate and further this plan. Indeed, as we shall note in Chapter IV, its implementation has hardly begun. For a start, the Rufiji District has put a high priority on the Ngumburuni forest as a pilot area where participatory forest management, including the development of a management plan, is going to be tried out. Ngumburuni has been chosen because the District did not succeed in controlling it, because of its exceptional biodiversity and the high level of current threats and also because some adjacent villages declared themselves in favour of participatory management. In addition, as the human context is relatively complex, this operation could become a model for other management transfers in the District. That is why one of the main goals of this work is to design a simple method to develop such an operation, easy to replicate in other forests. Thus, the present report will set out the study of the Ngumburuni forest and of its human context, the framework of the management plan and the lessons learnt from it.

This work has been realised with the permanent collaboration and under the responsibility of the Lands, Natural Resources and Environment department of the Rufiji District, which was asking for methodology. The Rufiji Environmental Management Project (REMP), promoter of this process, supplied our team with intellectual and logistical support.

3.2 Context and brief description of the Ngumburuni forest

As already noted, in order to start the implementation of the Forest Action Plan, REMP and the District chose the Ngumburuni forest as a pilot area. Indeed, the interest of this forest has been well known for a long time. Before the First World War, the German colonial authorities already demarcated a forest reserve there. Nowadays, the Ngumburuni Forest Reserve is managed in theory by the Rufiji District. But in fact, it is daily damaged by illegal activities.

We have not restricted ourselves to study only the reserve, but we have also surveyed the forest beyond these historical boundaries, which are in fact unmarked. Indeed, the villages' activities concern this total area. Thus, the surveyed area covers about 10 000 ha. According to the assertions of most of the stakeholders, we shall call "Ngumburuni" the entire surveyed area and not only the District Forest Reserve.

Physically, the Ngumburuni forest is a mosaic of several wood patches which can be easily distinguished in the field:

- the coastal forests which are very dense and contain a rich biodiversity (with rare and endemic species);
- the Miombo which are wooded savannas where *Julbernardia sp.*, *Brachystegia sp.* and *Pterocarpus angolensis* are dominant;
- the woodlands which are also savannas but with smaller and scarcer trees, more shrubs and an abundance of grasslands;
- the riverine forests on the floodplain along the river beds.

These ecological units will be defined and described in chapter III, but we can give briefly some descriptive elements. The transition between the different patches is generally sharp and abrupt. Yet the different ecological units share an important number of species. Commercial timber wood species used to be abundant in Ngumburuni such as *Milicia exelsa* (Mvule), *Dalbergia melanoxylon* (Mpingo), *Pterocarpus angolensis* (Mninga) or *Khaya anthotheaca* (Mkangazi). But nowadays all the commercial species are over-harvested and trees of more than 30 cm in diameter are scarce. This observation alone may justify the implementation of a management plan.

The forest is surrounded by 4 main villages (Mkupuka, Mangwi, Nyamtimba, Muyuyu) and the Ikwiriri township.

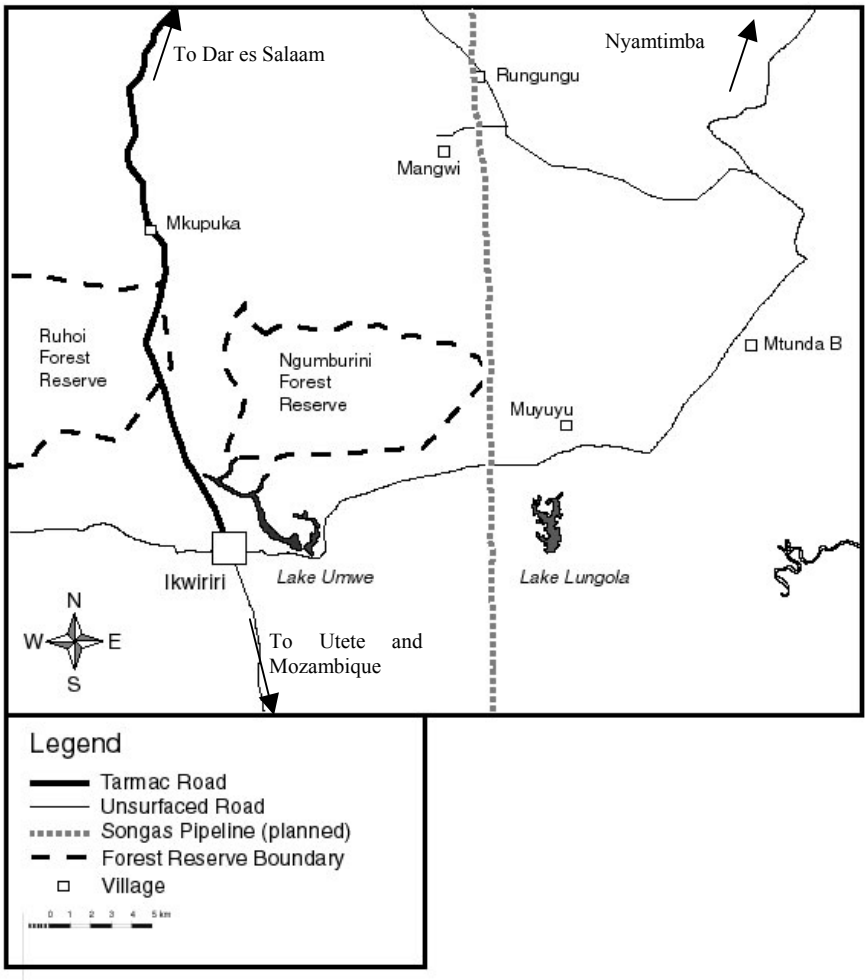


Figure 4: A rough location map of the Ngumburuni Forest Reserve and of the different neighbouring villages (O. Hamerlynck, REMP - 2003)

3.3 Materials and Methods

The study has been realised according to the following time frame, in order to carry out four main steps: to know the Ngumburuni forest; to know the stakeholders and to debate with them about the management; to propose a framework for the management plan; to learn the lessons from this case in order to further the Rufiji Forest Action plan.

Period	Action
28th of April – 12th of May	Installation, bibliography, first visit in Ngumburuni forest, elaboration of the work plan.
13th of May – 20th of June	Inventory and description of the Ngumburuni forest.
21st of June – 29th of June	Mapping the forest – designing the inquiries and preparation of the awareness meetings.
30th of June – 20th of July	Inquiries among the different stakeholders. Awareness meetings.
21st of July – 27th of July	Collecting more information, particularly in the Forest and Beekeeping Division (Ministry of natural resources and Tourism - Dar es Salaam).
28th of July – 10th of August	Data analysis and elaboration of the framework of the forest management plan
11th of August – 2nd of September	Second round of meetings in the villages, adoption of a time frame for the next steps of the process. Visit of other forests and reflection about the Rufiji Forest Action Plan.
3rd of September – 30th of September	Writing of the report.

Table 2: Time frame of the study

3.3.1 Bibliography and first contact with the forest

An abundant literature is available about the participatory management of natural resources and about the coastal forests ecosystems. The REMP library contains a lot of books about these topics and the first task was to study this bibliography. It has been completed by search of documents in Dar es Salaam and of websites. Thereafter, a first contact mission was organised in Ngumburuni forest and in Ikwiriri and Muyuyu. Its main goals were:

- to get a first general view of the forest;
- to organise the team for the inventory and the inquiries;
- to get into contact with the leaders of the forest-adjacent villages;
- to establish an initial timeframe.

3.3.2 Description – inventory of the Ngumburuni forest

3.3.2.1 Objectives of the inventory

The technical study of the forest aims to:

- delimit the different ecological areas, with particular attention on the rich coastal forests;
- characterize the main forest stands;
- identify suitable areas for conservation, timber wood harvesting but also for plantations and non-timber activities;

- identify a possible ecological corridor for the fauna (particularly elephants and birds);
- draw forest maps.

3.3.2.2 The work to do

The first task was the demarcation of the surveyed area on a Landsat image, after the first discussions with the communities. Thereafter, we used geo-referenced aerial photography prepared by Dr. Stéphanie Duvail from CEH Wallingford/IRD.

The inventory has been made with sample plots in order to determine the different ecological areas and the different stand types. A sampling team was formed with agents of the District Lands, Natural Resources and Environment Office: Mr Jonas Nambua, Assistant Forest Officer, Mr Revocatus X. L. Nandi, Subject-matter Specialist on Land Use Planning (from the agricultural department) and Mr Hadji Mkungula, Assistant Game Officer. Two knowledgeable villagers (Mr Athman Ngwele and Mr Rachidi Meza) joined the team. Their intimate knowledge of the forest and its tree species (vernacular names) was essential. I was the sixth member and the coordinator of the field team. Mr Richard Elibariki, free-lance forest engineer, joined the field team during the two first days to provide help with the identification of the tree species.

3.3.2.3 Materials and equipments

The basic equipment used during the inventory was:

- a G.P.S. GARMIN 12 for locating the sample plots in the field;
- a SUUNTO clinometer for measuring the height of trees;
- a tape measure for measuring the circumference of the trees at breast height (1,30 m);
- a Landsat image of the forest with a longitude – latitude grid;
- forms for filling in the data;
- chalks for marking the trees;
- 15 meters long ropes for materializing the sample plots.

3.3.2.4 The inventory method

a) Sampling

A systematic sampling has been used because it is easy to implement in the field.

b) Number of sample plots

In order to calculate the number of sample plots, we used the following formula:

$$n = T^2.cv^2/e^2$$

T is given by the Student table for a probability level of 0,95: T = 2.

To get cv and e, we used the results from inventory carried out in similar conditions (particularly the same area for the sample plots) in Miombo of Kiketo District. Since there are no other data for the other forest types, we consider that these figures are valid for them (following the example of Malimbwi, 2000). They showed that the sampling error of mean basal area per hectare ranged from 7,7 to 9,8 % and that of volume from 8,6 to 12,5 %. Given time constraint of the training period it will be considered logical to reduce slightly the number of sampling spots by increasing the error to 15 %. This level of precision is within acceptable limits for such natural forests. Taking an average coefficient of variation, cv, of estimated volume of 0,5 like in Kiketo, the number of sample plots in Ngumburuni will be:

$$n = 4 \times 0,25 / 0,0225 = 44$$

c) Size and shape of sample plots
The sample plots were circular with a radius of 15 m. Their area covered 0,071 ha. For the study of regeneration, we used a reduced concentric sample plot with a radius of 5 m.

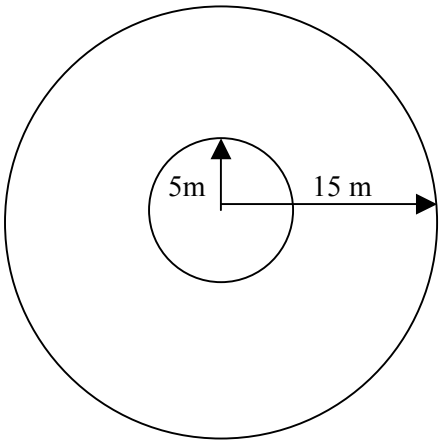


Figure 5: Size and shape of a sample plot.

d) Recorded tree variables
- species names (vernacular and botanical);
- DBH (at 1,30 m);
- number of stems;
- total height of three sample trees representative of the plot;
- presence and names of poles and regeneration stems (DBH < 20 cm);
- identification and diameter of stumps;
- nature of the soils, according to a superficial observation.

e) Layout of sample plots
The plots were laid out in the field with the G.P.S. (WGS 84 system). After sampling in the forest they have been loaded in a computer and laid out on the maps.

3.3.3 Mapping the Ngumburuni forest

The base for mapping the forest were 4 scenes of a 1:50,000 aerial photography done by REMP in June 1999. These were geometrically corrected and geo-referenced in the WGS 84 system by Dr. Stéphanie Duvail from CEH Wallingford/IRD. The different vegetation units can be distinguished on it thanks to the contrast. During the inventory, we could first draw a rough map of the forest comparing the image and the vegetation patches where the sample plots were laid out. After having refined this first draft in the office, we went back into the field to determine the nature of some other points and to precise the demarcation of the different patches. We also discussed the current forest uses with the villagers who worked with us. The main trails and settlements were recorded in the G.P.S. too. Eventually, all the data were downloaded in a computer using the MAPMAKER G.I.S.

With MAPMAKER, we drew maps showing the ecological units, the main forest stands and the management objectives and suggested forest uses. These maps will be saved on CDs in order to be used by the District staff during the following steps of the process.

3.3.4 Study of the human context and start of the participatory process

3.3.4.1 Objectives and target groups for interviews

At first, the interviews and meetings aimed to explain the process to the communities and to understand the history of the forest, its perception by the different stakeholders and the interactions

between the forest and the different villages or human groups around it. Particularly, it is useful to understand what they are thinking about the current situation and uses of the forest and what their wishes are for the future management. Another objective was to start to define with the villagers the new boundaries of the future managed forest. We have also discussed the main management, use and guarding rules that they would implement if they were the managers.

During the mission carried out in the beginning of May and during the inventory we identified a list of stakeholders for interviews. They have been classed in three groups: economic operators, forest-adjacent communities and Authorities (political leaders and civil servants). These three categories will be detailed in chapter III.2.

In principle, the villages which could be involved in the management plan are: Muyuyu, Ikwiriri (Umwe), Mkupuka, Mangwi, Nyamtimba and their associated sub-villages. The final list was also discussed with the communities.

3.3.4.2 Participatory methodologies for the interviews and meetings

The inquiries were implemented in two main ways. At first we used semi-directive questionnaires, letting people express what they had to say on several themes linked to the forest management. Thereafter or with specialised people, we asked more closed questions in order to precise the issues. The themes of the inquiries were chosen according to the recommendations of the Forest Action Plan of Rufiji (cf. appendix n° 6).

The following table suggests some participatory methods to facilitate obtaining information on the main forest issues.

Process easier methods	Issues
Transect walks	Condition, problems and future of the forest.
Social mapping	Who lives in the forest?
Time lines	History of the forest.
Participatory mapping	Do the communities know the current boundaries? Where should the new boundaries be?
Ranking	Least + most damaging uses.
Visioning / drawing the ideal scenario	How the forest should be managed in the future?
Role play	How the forest should be managed in the future?
Seasonal calendar of forest uses	Forest uses, pressure from destructive activities.

Table 3: Participatory methods used in order to obtain information

3.3.5 Data analysis and proposal of a management framework

In collaboration with all the stakeholders, the aim was to develop the framework of a management plan, including multiple choices and possibilities and which can be finalised by the communities and the forest service of the District.

The first task was the analysis of the data collected in the forest in order to map the different ecological areas and the main stands types. These maps were the basis for the discussions with the stakeholders and thereafter for developing the plan. We also calculated different parameters like basal areas and wood volumes and evaluate (qualitatively) the biodiversity, especially in the coastal forests. But in order to characterize the forest with practical criteria, we also compared these results with those used by the forest-adjacent communities.

Thereafter, the inquiries were also sorted through. Indeed, we had to specify the perception of the forest by the different stakeholders, the current uses, the wishes about future management, etc. We prioritised a descriptive analysis rather than developing a statistical one, probably less adapted to

our purpose.

These results, both from the forest analysis and the inquiries, were compared with criteria permitting to formulate an opinion about the feasibility of a Participatory Forest Management (Chapter III.3). Then, the framework of the management plan was developed using mainly the propositions, observations and wishes of the different stakeholders, but also the recommendations of the Forest Action Plan and of the community-based forest management guidelines (Collective, 2001 a). As much as possible, we have proposed several options for the different themes evoked in the plan, and particularly for the possible uses of the various identified ecological units. A map of the management objectives and of the uses has been proposed. The principle was not to dictate what should be done but to give the decision makers enough elements and proposals to make their own choices, with full knowledge of the constraints and assets of their ecological and human environment.

Lastly, we also drew up a programme, including a time frame, in order to bring the process to a successful conclusion. Of course, this programme was discussed with the communities during the meetings of the end of August.

3.3.6 Lessons of this study and some proposals to further the Rufiji Forest Action Plan

The last part of the work is a reflection about the Forest Action plan itself. As the Ngumburuni operation is one of the first actions planned in this document, we have used this experience to assess the first steps of its implementation and to propose some elements to facilitate further initiatives.

At first, we reviewed all the planned actions of the operational matrix proposed in the Forest Action Plan. After thorough discussions with the District staff, we established an evaluation of what has started or what has already been done.

But we also pinpointed the constraints, weaknesses and bottlenecks. That is why a second step was devoted to make some proposals in order to facilitate the implementation of the Plan. The Ngumburuni experience, but also the visit of other forests and interviews of various people in the District or in Dar es Salaam were used for this task.

4 Development of the Ngumburuni forest management plan

4.1 Main features and description of the Ngumburuni forest

4.1.1 A piece of the ecologically rich East African coastal region

The Ngumburuni forest covers about 10,000 ha to the northeast of Ikwiriri township, 165 kilometres south of Dar es Salaam. The official Forest Reserve, declared in German colonial times, is supposed to cover only 3000 to 4000 ha (the figures vary from one document to another but the outline of the reserve as shown on the official topographic maps covers 4545 ha). Ngumburuni suffers from overharvesting and most of commercial timber species are about to disappear. The threat is increasing because some parts of the forest are being cleared for cultivation, mainly by people originating from Muyuyu village. Moreover, a new bridge has been built over the Rufiji river, close to the southern part of Ikwiriri. Undoubtedly, it will increase the traffic on the road leading to Dar es Salaam. The export of timber and charcoal from the forests south of the river will increase, and Ngumburuni is also affected because of its closeness to Ikwiriri. As we will see in the following paragraphs, the Ngumburuni forest is a rich area from an ecological point of view and many people get cash income from its natural resources. That is why this forest has been designated as a pilot area for the implementation of the Rufiji Forest Action Plan.

4.1.1.1 Defining the coastal forests

The eastern African coastal forests, which are sometimes called “forests of Zanzibar – Inhambane regional mosaic” (White, 1983), stretch from the South of Somalia to Mozambique. Formerly, this several hundred kilometres wide strip followed the Indian Ocean coast. Nowadays, the coastal forests are quite fragmented and hardly cover 3000 km^2, half of the estimated extent being in Mozambique.

Basically, the coastal forests show dense closed canopy tree stands but they do not encompass the halophytic mangrove forests. There are several differences between the wide spread “miombo” woodlands and the coastal forests. In the first case, the tree crowns may touch but they generally do not overlap as they do in the second one. In woodlands, grasses are well developed while they are sparse or absent in coastal forests, but a shrub and liana layer is normally present (Burgess *et al.*, 2000).

In Ngumburuni, as commonly in Rufiji, the coastal forests and the miombo and woodlands are juxtaposed in a kind of patchwork. Water is probably the key to explaining such a configuration. The drainage capacity of soils is also a factor. In the coastal plains of eastern Africa, there are about 12 soil types supporting coastal forests. They range from “sandy soils with imperfect drainage”, “loams with imperfect drainage”, “loams with moderately good drainage”, “loams with imperfect drainage” and “clays with imperfect drainage” (Burgess *et al.*, 2000). In Ngumburuni, most of the soils are sandy and they are obviously not really suitable for agriculture because the farmers abandon them after two or three years. This sand comes from the post Karoo mainly marine - but also fluviatile and more recent - sediments (Karoo is the geological period during which the first marine incursions occurred in Gondwanaland – 290 M.Y.A – 180 M.Y.A.).

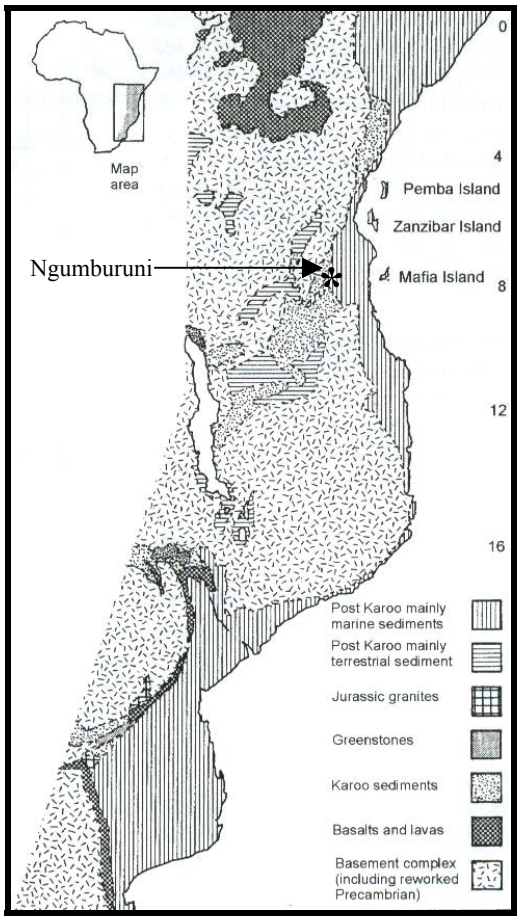


Figure 6: Surface geology of the east African coastal region (Burgess et al., 2000)

The coastal forests seem to be well adapted to the variable rainfall regime, which can be found in Rufiji. Average annual rainfall varies from 900 mm to 1400 mm. But there are significant daily, monthly and annual fluctuations in rainfall. The climate can be characterised by these very variable rainfall patterns, combined with incident sunlight and high temperature with little seasonal or annual variations. The coastal forests are obviously able to withstand severe water stresses.

From an ecological point of view, the coastal forests are very rich. The literature records at least 484 different tree species. The level of plant species endemism is high (several hundreds of endemic plant species). They have been listed amongst the world's 25 biodiversity hotspots. This could be explained by their adaptation to the climatic variations. Some people suggest that coastal forests may be partial relics of the former pan-African tropical forest, fragments of a formerly contiguous lowland refugium centre for ancient species (Burgess *et al.*, 2000).

For many years, several species of mammals (bats, shrews, rodents) and birds have been known to be endemic in the coastal forests. Frequently, elephant-shrews cross the trails and several species of birds are confined to these particular ecological areas. The Ngumburuni forest is also a corridor for elephants, and especially the Ruhoi River valley. Indeed, many tracks can be found. During the inventory, we also observed many monkeys: black and white *Colobus*, baboons, vervets, blue or Syke's monkey.

4.1.1.2 Defining the Miombo woodlands

Miombo woodlands are widespread in central, eastern and southern Africa. They belong to the savannah ecosystems but, when they are mature and undisturbed, they look like close deciduous non-spinescent woodlands (Campbell, 1996). Miombo is dominated by three main genera: *Brachystegia* (21 species are represented all over the Miombo African area), *Julbernardia* and *Isoberlinia*. In Rufiji, the third genus is rather scarce, but *Pterocarpus angolensis* was once common. These genera belong to the legume family. The ground is most often covered with grass varying from sparse to dense. A shrub layer is generally present and is also variable in density and composition. With such a structure, it is not surprising that fires are one of the main characteristic features of Miombo woodlands, unlike the coastal forests which fire cannot penetrate. Miombo generally occur on nutrient-poor soils with a rainfall range from 650 to 1400 mm (Campbell, 1996). When the soils are richer and/or the climate drier, Miombo are replaced by open woodlands like *Acacia* savannahs.

Obviously, faunal richness is lower in the Miombo woodlands than in the coastal forests. It is probably a consequence of the extreme harshness of the dry season (Campbell, 1996). But there are herbivores specific to the Miombo regions and they have a distinctive avifauna (Grey Tit, Miombo Rock Thrush). In fact, in a patched structure like Ngumburuni, the diversity of wildlife in Miombo woodlands may be enhanced by overlapping with coastal forests zones.

Human population density is still quite low in the Miombo regions. The density of livestock is low too. But at present, these densities are increasing and particularly in Tanzania where agricultural encroachments are spreading. For the time being the pressure remains moderate in Rufiji. Nevertheless, the Miombo woodlands are modified by people who get a large range of products from food and medicines to timber wood there. In Ngumburuni human pressure is likely to increase because of the closeness to several villages, to Ikwiriri township and to one of the main Rufiji roads.

4.1.1.3 Defining the riverine forests

Riverine forests develop along the course of the rivers, i.e. mainly the Ruhoi River in Ngumburuni, where they form strips generally characterized by a closed canopy. The structure is similar to the structure of the coastal forests and these two types share a lot of species. But, in riverine forests the species composition depends both on the interval between flooding events and the dynamics of areas drying up following changes in the river course (Burgess *et al.*, 2000). The riverine forests are important for the biodiversity and even in the dry season, the permanent pools are frequented by the elephants or the buffalos, for example. They are also nesting places for the birds.

Photo No. 1 to 7: Biodiversity in Ngumburuni. 1: Black and white Colobus; 2: Elephant-shrew (photo Tanzanian Forest Conservation Group); 3: East Coast Akalat, a rare vulnerable endemic bird (photo O. Hamerlynck- REMP); 4: Baboon; 5: Dense coastal forest; 6: Elephant skull; 7: Dense Miombo.

4.1.2 Results of inventory and description of the forest

4.1.2.1 Data analysis

In order to facilitate the study of the forest, we have calculated several parameters in terms of stocking, basal area and volume per hectare based on the 44 plots measured.

a) Height / diameter and volume equations

As the volume equations require height estimation for each tree, we have calculated height / diameter equations using the sample trees for each ecological unit, Miombo and coastal forests (Table 4). The calculation is explained in Appendix n° 1.

Ecological unit	Height / diameter equation	R^2	Standard error	N° of observations
Miombo	**ln(H) = 0.722 + 0.590ln(DBH)**	0.61	0.17	35
Coastal forest	**ln(H) = 1.187 + 0.548ln(DBH)**	0.42	0.23	84

Table 4: Height / diameter equations used in Ngumburuni forest

The single tree volumes were calculated using the following equations, determined by Sokoine University, Morogoro (Malimbwi**,** 2000):

Ecological unit	Equation
Miombo	$V = 0.00001 . DBH^{2,032} . H^{0,66}$
Coastal forests	**V = f . SBH . H**

Table 5: Single tree volumes equations

V = tree volume (m^3)
DBH = diameter at breast height (cm)
SBH = tree cross sectional area at breast height (m^2)
H = tree height (m)
F = form factor = 0.5

b) Stand parameters

The stand parameters, stocking, basal area and volume per hectare, are shown in the following table. The basal areas and the volumes have been calculated both for all species and for the commercial species. The calculation is developed in Appendix n° 1.

Ecological units	Statistical calculations.	Stocking (stems/ha)	Basal area (m^2/ha)	Volume (m^3/ha)	Commercial Basal area (m^2/ha)	Commercial Volume (m^3/ha)
Miombo	Average	96	10.4	106.4	3.3	40.1
	Standard deviation	60	6.2	65.1	3.3	47.0
Coastal forest	Average	127	11.7	146.5	2.8	34.1
	Standard deviation	48.9	6.1	89.6	3.2	41.8

Table 6: Stand parameters in the main ecological units of the Ngumburuni forest.

We can compare these stand parameters with those found in other forests of the Rufiji district (Malimbwi**,** 2000):

Ecological unit	Name of forest	Basal area (m^2/ha)	Volume (m^3/ha)
Miombo	Utete	12	107
	Weme	12.5	105
	Mbunju	13	127
	Ngumburuni	**10.4**	**106.4**
Coastal forest	Utete	9	85
	Weme	17	139
	Kichi	20	172
	Ngumburuni	**11.7**	**146.5**

Table 7: Comparison of the stand parameters in Ngumburuni and in four other forests of the Rufiji District

We can note that in Ngumburuni, the basal area is not very high, neither for Miombo nor for coastal forests. Generally, it is admitted that the basal area in Miombo hardly exceeds 15 m^2/ ha (Malimbwi**,** 2000), but in Ngumburuni, we can find the lowest value in the District. The basal area of commercial species is also very low. These observations are indications of overharvesting. On the other hand, we can note that the volumes per hectare in Ngumburuni are not so low, compared to the values in other forests. It can mainly be explained by a more important average height of the trees, which is an indicator of the good productivity of the site.

c) Species composition

A total of 124 tree species were identified in the 44 sample plots (including regeneration and future stems). We have also recorded 7 species of shrubs and 2 of lianas without especially looking at them). Appendix n° 2 shows the list of these species and their vernacular names (mainly in Kiswahili and Kidengereko). For 68 species of trees (and 2 of shrubs), the botanical names were identified with the help of Mr Athman Ngwele and Mr Richard Elibariki and of several books and reports (Mbuya *et al.*, 1994, Beentje, 1994, Palgrave**,** 2002, Malimbwi**,** 2000). The distribution of these species in the different ecological units is shown in Table 8.

Localisation of the trees	Number of tree species
In miombo	29
In coastal forests	54
In riverine forests	4
In coastal forests and in miombo	29
In coastal forests and in riverine forests	4
In coastal forests, in riverine forests and in miombo	4

Table 8: Localisation of the different tree species

It is interesting to note that the coastal forest and the miombo share 33 species. Although they are arranged in quite distinct patches, they influence each other. Obviously, the biodiversity of miombo is increased by the contiguous coastal forest patches. As expected, the three genera *Julbernardia*, *Brachystegia* and *Pterocarpus* are present in the Ngumburuni miombo but are not especially dominant in the surveyed plots. *Markhamia*, *Afrormosia* or *Acacia* are well represented, too.

In coastal forests, the biodiversity varies from one place to another. In fact, some places are obviously

secondary forests, maybe former agricultural encroachments now overgrown with a typical coastal forest vegetation.

d) Timber species

The following table shows the timber species found both in coastal forest and Miombo patches. A total of 21 timber species were recorded in the inventory.

Name of species (scientific)	Name of species (vernacular)	Class
Afrormosia angolensis	Mmangangwaru	V
Afzelia quanzensis	Mkongo	II
Albizia versicolor	Mtanga	III
Amblygonocarpus andongensis	Nyamakwenge	V
Baphia kirkii	Mtasi	III
Bombax rhodognaphalon	Msufi Pori / Mkunya	IV
Brachystegia spiciformis	Myombo	III
Cordyla africana	Mndundu	IV
Dalbergia melanoxylon	Mpingo	I
Hymenaea verrucosa	Mnangu	V
Julbernardia globiflora	Mtondoro	III
Markhamia lutea	Mpugupugu	II
Markhamia obtusifolia	Mtaranda / mtalawanda	II
Millettia stuhlmannii	Mpangapanga / mnyamwea	II
Newtonia sp.	Mdadarika	II
Pterocarpus angolensis	Mninga	II
Sclerocarya birrea	Mngongo	V
Sterculia appendiculata	Mkweanyani / ngude	V
Tamarindus indica	Mkwaju	V
Trichilia emetica	Mlopolopo	V
Xeroderris stuhlmannii	Mnondondo	V

Table 9: List of timber species identified in the 44 sample plots

They constitute an average of 25 % of the total stocking in Ngumburuni (stems with a diameter exceeding 20 cm) as it is shown by figure 7.

Photo No. 8: Mkongo (Afzelia quanzensis).

Photo No. 10: Mninga (Pterocarpus angolensis).

Photo No. 9: Mvule (Milicia excelsa) commercially extinct in Ngumburuni.

Photo No. 11: Mnangu (Hymenaea verrucosa).

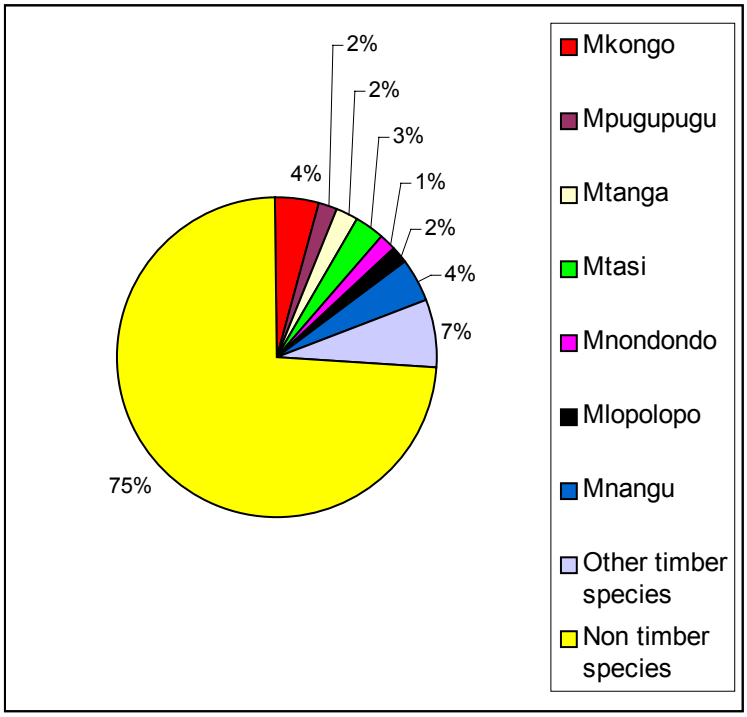
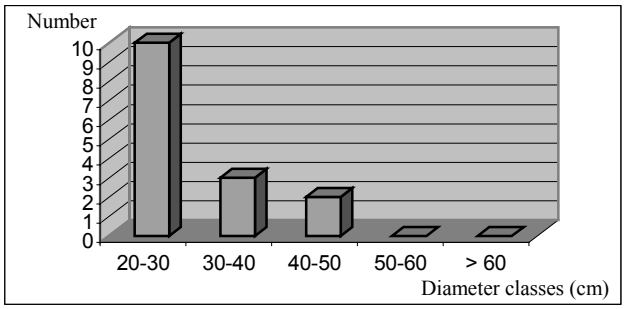


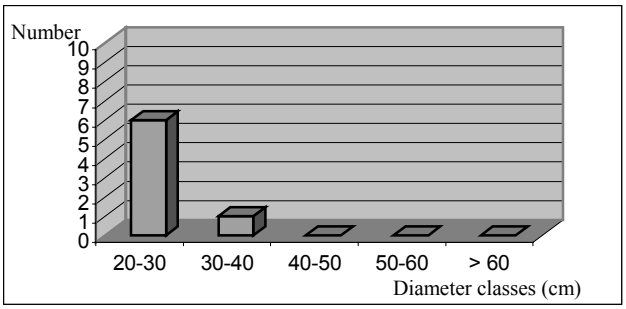
Figure 7: Distribution of the different timber species found in the Ngumburuni forest (number of trees in the 44 sample plots)

During the inventory, no mature Mpingo (*Dalbergia melanoxylon*) was found in the sample plots. This first class species was only present in the form of regeneration stems and only in one plot. The two more numerous timber species are Mkongo (*Afzelia quanzensis*) and Mnangu (*Hymenaea verrucosa*). Mkongo has been found mainly in the coastal forest plots. Mnangu is present in Miombo, riverine or coastal forest plots.

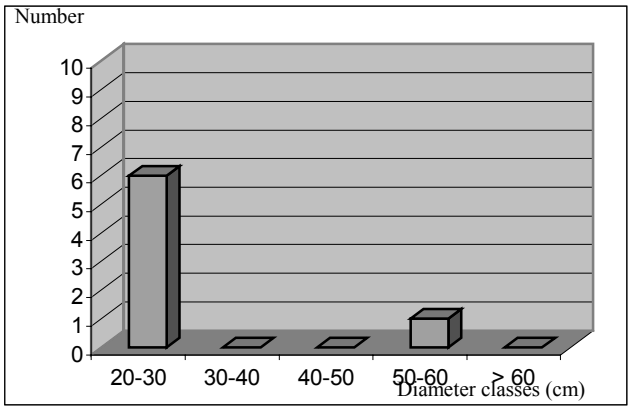
As it is suggested on the following graphs, the large diameter timber trees have become very scarce in the Ngumburuni forest.



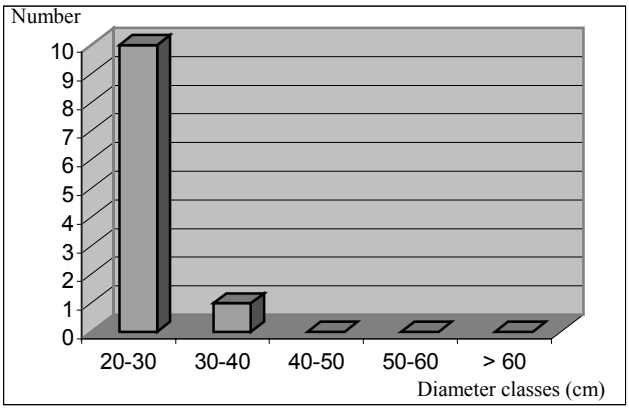
a) Mkongo (*Afzelia quanzensis*)



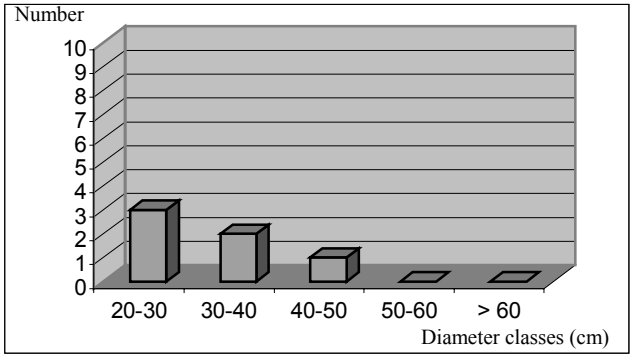
b) Mpugupugu (*Markhamia lutea*)



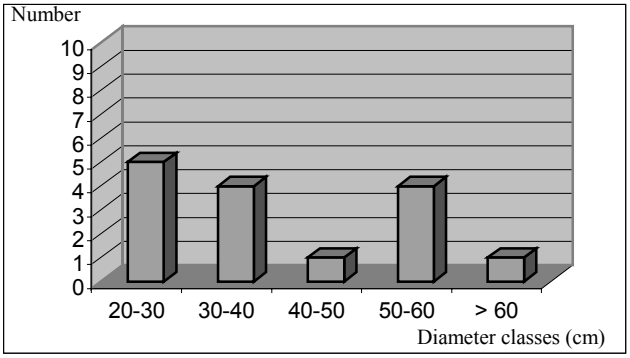
c) Mtanga (*Albizia versicolor*)



d) Mtasi (*Baphia kirkii*)



e) Mlopolopo (*Trichilia emetica*)



f) Mnangu (*Hymenaea verrucosa*)

Figure 8: Distribution of the most abundant timber trees stems by diameter classes, in the 44 sample plots

We can note that the graphs show a general negative exponential distribution as expected for a natural forest with an active regeneration. We can also note that the stems with a diameter exceeding 50 cm are scarce, except for Mnangu. For the main timber species it is obvious that overharvesting is responsible for this situation. These observations are confirmed by a more complete study of the size distributions of all the timber species (number of stems and volumes per hectare) in the Miombo patches and in the costal forest, shown in table 10 and 11.

We have also analyzed the regeneration of the timber species in reduced size sample plots (5 m radius), by noting presence or absence. Tables 10 and 11 give the percentage of plots where regeneration or/and future stems have been found. We must precise that the regeneration is often governed by the presence of seeding trees close by, but also by the local ecological conditions, particularly the light. In addition the existence of seedlings does not guarantee a fully-grown future without any human intervention. Nevertheless, if regeneration is present, we can consider that the concerned species stand a good chance of being well-represented in the future.

In Miombo, Mpugupugu (Markhamia lutea) regeneration and future stems are present in 54,5 % of the sample plots. The percentage is 27.3 % for Mnangu (Hymenaea verrucosa) and Mtondoro (Julbernardia globiflora), 18,2 % for Mtanga (Albizia versicolor) and Mpangapanga (Millettia stuhlmannii) and only 9,1 % for Mkongo (Afzelia quanzensis). We have not found any regeneration for 7 Miombo timber

species and among them Mninga (Pterocarpus angolensis). Yet, we had found a beautiful stand of young Mninga in the northeastern part of the Ruhoi floodplain. Unfortunately, they were all cut just after the inventory (cf. appendix n° 3). We can also confirm that the first class species Mpingo (Dalbergia melanoxylon) is likely to disappear because its regeneration has become very scarce. These high value species are really threatened in Ngumburuni and they are likely to be at least commercially extinct.

In coastal forest patches, the more represented regenerations are Mpugupugu (*Markhamia lutea*) with 18,5 %, Mnangu (*Hymenaea verrucosa*) and Mtasi (*Baphia kirkii*) with 14,8 % and Mtanga (*Albizia versicolor*) with 11,1 %. We can still note that the Mkongo regeneration is also low in coastal forest (presence in only 7,4 % of the surveyed plots). In fact, even if Mkongo is one of the best-represented species, the diameters are generally quite low. Almost all the big Mkongo trees have been cut. A few Mninga regenerations exist, but probably without any future because it is typical Miombo species. Regeneration or future stems cannot be found for 7 species.

Name of species (scientific)	Name of species (vernacular)	Rege. Level *	20-30 cm class		30-40 cm class		40-50 cm class		50-60 cm class		> 60 cm class	
			N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)
Afrormosia angolensis	Mmangangwaru	0	2.6	1.06								
Afzelia quanzensis	Mkongo	9.1	1.3	0.51								
Albizia versicolor	Mtanga	18.2	1.3	0.44					1.3	4.14		
Amblygonocarpus andongensis	Nyamakwenge	0							1.3	3.06		
Baphia kirkii	Mtasi	0	2.6	0.72								
Brachystegia spiciformis	Myombo	0			1.3	1.4						
Hymenaea verrucosa	Mnangu	27.3							1.3	3.54		
Julbernardia globiflora	Mtondoro	27.3			1.3	0.83					1.3	10.14
Markhamia lutea	Mpugupugu	54.5	1.3	0.29								
Millettia stuhlmannii	Mpangapanga	18.2	1.3	0.69								
Pterocarpus angolensis	Mninga	0			1.3	1.54						
Sclerocarya birrea	Mngongo	0			1.3	0.79						
Tamarindus indica	Mkwaju	9.1										
Xeroderris stuhlmanii	Mnondondo	0					2.6	4.21	2.6	6.62		

Table 10: The distribution of timber tree species by size classes in the Miombo patches (*Frequency of the regeneration and poles of the timber species in the 44 sample plots -%)

Name of species (scientific)	Name of species (vernacular)	Rege. Level *	20-30 cm class		30-40 cm class		40-50 cm class		50-60 cm class		> 60 cm class	
			N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)	N (/ha)	V (m3/ha)
Afrormosia angolensis	Mmangangwaru	0	0.5	0.22	0.5	0.48						
Afzelia quanzensis	Mkongo	7.4	3.7	1.79	1.6	1.42	1	2.02				
Albizia versicolor	Mtanga	11.1	2.6	0.95								
Baphia kirkii	Mtasi	14.8	3.7	1.7	0.5	0.64						
Bombax rhodognaphalon	Msufi Pori	0					1	1.85				
Cordyla africana	Mndundu	0			0.5	0.72						
Hymenaea verrucosa	Mnangu	14.8	1	0.49	1.05	1.05	0.5	1.35	1.6	5.67	0.5	2.34
Markhamia lutea	Mpugupugu	18.5	2.6	0.91	0.5	0.72						
Markhamia obtusifolia	Mtaranda	3.7	0.5	0.33								
Newtonia sp.	Mdadarika	0	0.5	0.37								
Pterocarpus angolensis	Mninga	3.7										
Sterculia appendiculata	Mkweanyani	0							0.5	1.46		
Tamarindus indica	Mkwaju	0	0.5	0.14	1.6	2.5						
Trichilia emetica	Mlopolopo	7.4	1.6	0.68	1	1.06	0.5	1.05				
Xeroderris stuhlmannii	Mnondondo	0			0.5	0.62						

Table 11: The distribution of timber tree species by size classes in the Coastal forest patches (*Frequency of the regeneration and poles of the timber species in the 44 sample plots -%).

4.1.2.2 Map and description of the forest

The following description is based on the maps of the forest and on the observations made during the inventory and the transects carried out thereafter. Figure 9 is a map showing the different ecological units and the vegetation types. Figure 10 shows the main stands types. The nomenclature of this map has been established by comparing the communities' perceptions and descriptions of the different parts of the forest, the basal area in the 44 sample plots and our own observations. For example, the"primary coastal forest" corresponds to places where the villagers say that "the canopy is closed", where "they can not see the sky", etc. Generally, the basal area is superior to 15 m^2/ha there. "Secondary or disturbed coastal forests" are places where the trees have small sizes, the canopy is open and where many tracks of exploitation can be found. There is also the same type of differences between dense Miombo, where big trees are still present (Basal area > 8 m^2/ha) and disturbed Miombo where they are scarce and where charcoal kilns and many stumps can be found.

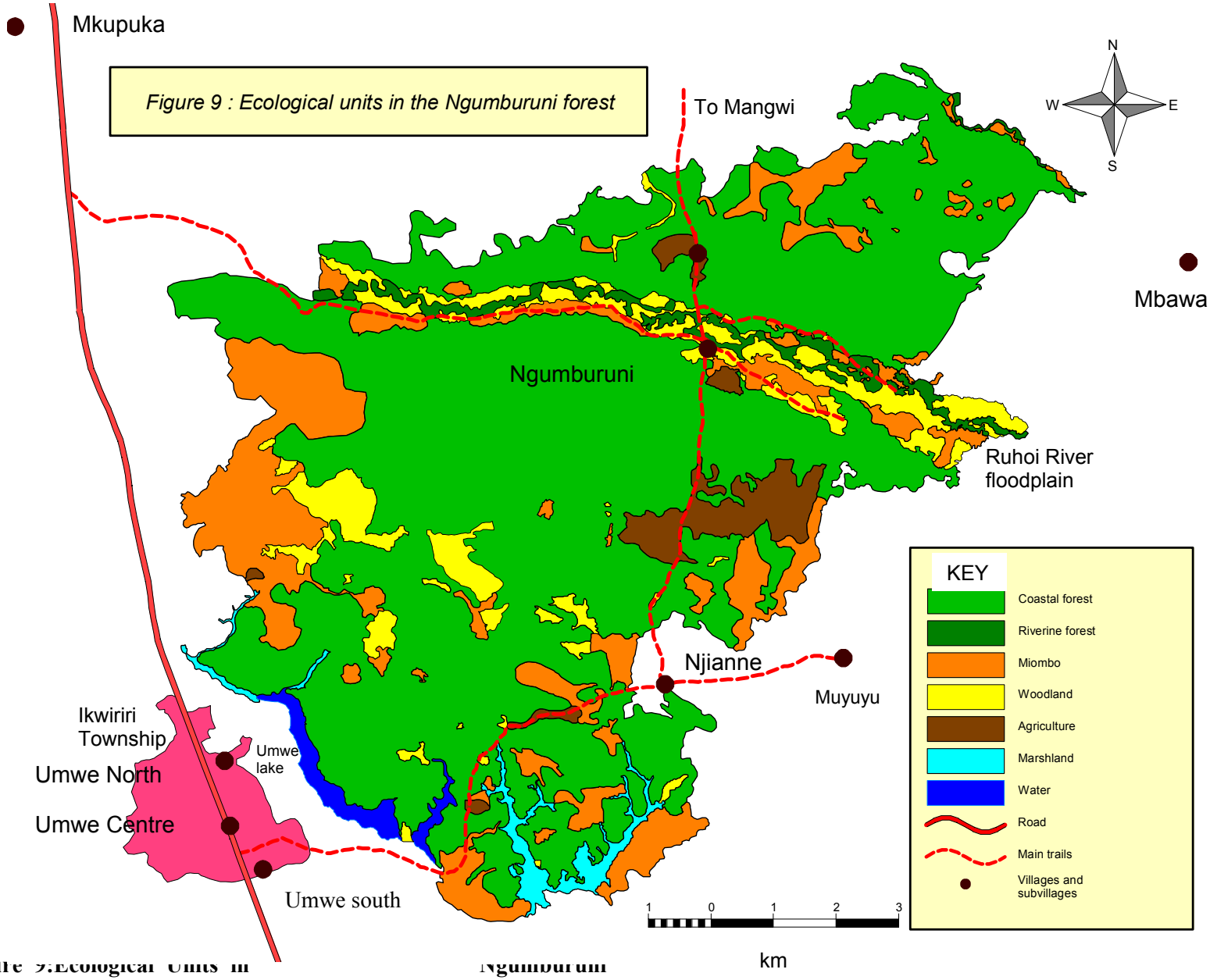


Figure 9: Ecological Units in Ngumburuni Forest

From the north to the south we can divide the forest into four main parts.

The northern part, north of the Ruhoi river floodplain, is mostly coastal forest. The richest part, with high biodiversity value, is in the east (see the primary coastal forest patch on figure 10 and the forms of SP11, SP12, SP14 and SP15 in appendix n°1). Valuable species can be found there: Mkongo (*Afzelia quanzensis*), Mnangu (*Hymenaea verrucosa*), Mdadarika (*Newtonia sp*.), Mtanga (*Albizia versicolor*) or Mmangangwaru (*Afrormosia angolensis*). In that area the average basal area is more than 15 m^2/ha, reaching 20 m^2/ha in some places and the volumes range from 170 m^3/ha to 236 m^3/ha, but the stand is mainly constituted by a high density of relatively young trees. However some of them are quite big (for example, in SP11, a 60.5 cm diameter *Hymenaea verrucosa*). The west part is more disturbed, with secondary forests and important Miombo and woodlands areas overlapping. Close to the Mangwi trail, about 35 ha have been cleared for agriculture. Shifting cultivation is practiced in this encroachment.

The Ruhoi river floodplain stretches all along the south of this part. It is mostly Miombo interspersed with patches of poorer woodland and grassland and with strips of riverine forest along the drainage lines, where the groundwater table is high over a long period. On the edge of the floodplain the Miombo consists of a relatively high density of commercial species: Mpangapanga (*Millettia stuhlmannii*), Mninga (*Pterocarpus angolensis*), Mtondoro (*Julbernardia globiflora*) and Mkongo (*Afzelia quanzensis*). The basal areas recorded there are close to 12 m^2/ha and the volumes exceed 145 m^3/ha in some places. The riverine forest strips really look like coastal forests and have more or less the same structure. Species such as Mkongo, Mnangu (*Hymenaea verrucosa*) or Mtasi (*Baphia kirkii*) are frequent in those strips.

The central part of the forest corresponds approximately to the forest reserve. The northern and eastern areas are covered with tall primary coastal forest (cf. figure 10). The average basal area is close to 14 m^2/ha, reaching 20 m^2/ha in some places. The highest volumes have been recorded there with a maximum of about 290 m^3/ha. In fact, the basal area should reach and exceed those values everywhere in that part, but most of the large diameter high value trees have been harvested. Many stumps can be found and the forest is criss-crossed by many logging trails. Excessive logging has opened the canopy in many places and lianas are invading the gaps. Grasses are growing in some places too. This hinders regeneration, makes the forest more prone to fires and eventually favours its transformation into woodland. This phenomenon is particularly obvious in the southern area of this central part of the forest. From west to east, the coastal forests are interspersed with patches of Miombo and woodlands, sometimes of very poor biodiversity. In addition, in the west part, and above all in the east part, recent and former agricultural encroachments have totally cleared about 280 ha of the forest.

The fourth part of the forest is the southern one, to the east of Umwe Lake. The area adjoining the lake is covered with coastal forest where the basal area can reach 17 m^2/ha, but is generally lower than in the other parts of the forest. While the lake is a natural barrier against loggers, pit-sawing sites can be found in that area.

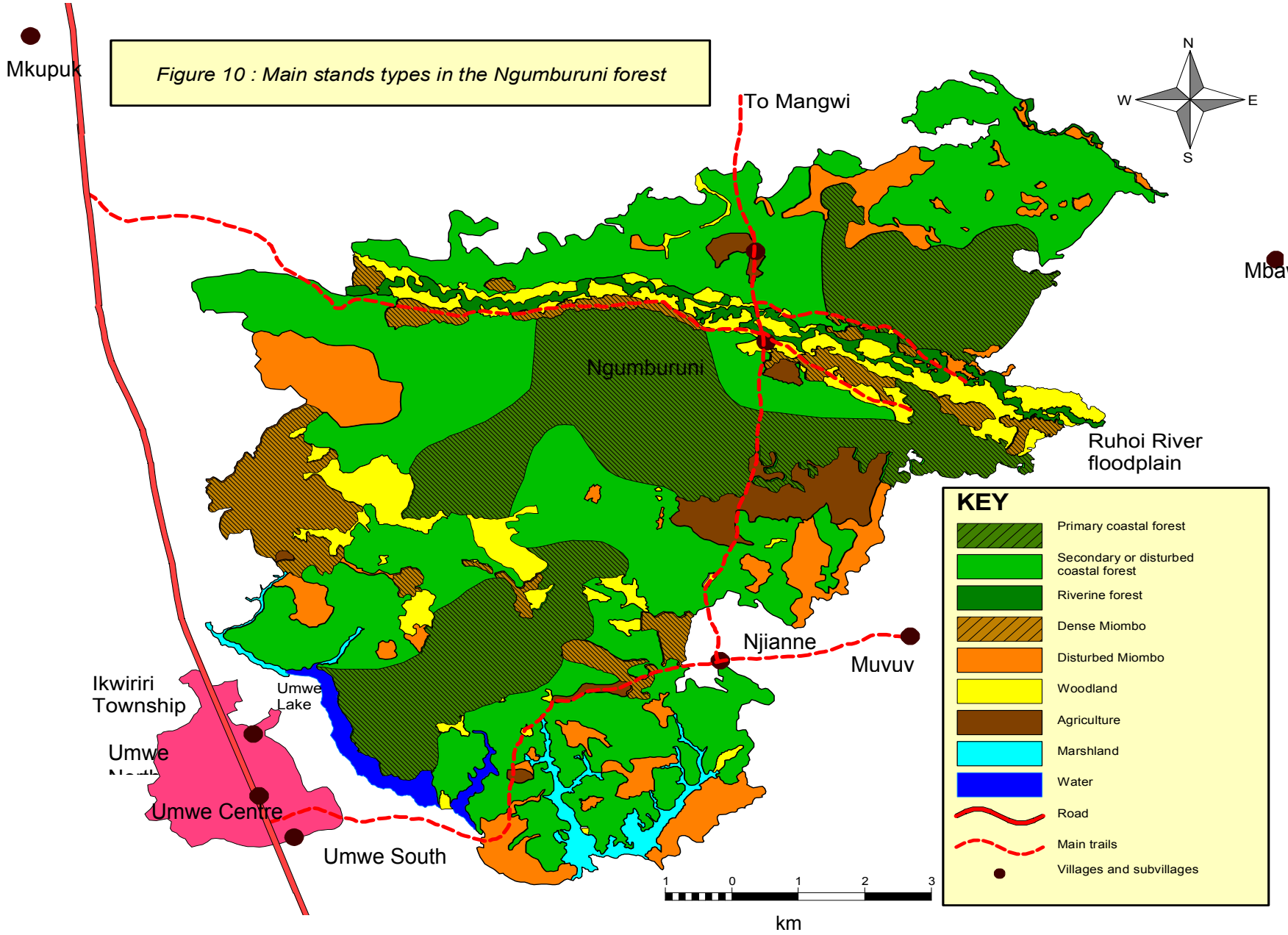


Figure 10 : Main stands types in the Ngumburuni forest
Mkupuk
To Mangwi
N
W
E
S
Mbawa
Ngumburuni
Ruhoi River floodplain
Njianne
Muvuv
Ikwiriri Township
Umwe Lake
Umwe
Umwe Centre
Umwe South
KEY
Primary coastal forest
Secondary or disturbed coastal forest
Riverine forest
Dense Miombo
Disturbed Miombo
Woodland
Agriculture
Marshland
Water
Road
Main trails
Villages and subvillages
1 0 1 2 3
km

In fact, the entire southern area is quite heterogeneous, including Miombo patches, wetlands and swamps. Some agricultural encroachments also stretch along the Ikwiriri – Muyuyu trail. But that heterogeneity makes this area very interesting, with a high biodiversity value, particularly because of the wetlands. With the G.I.S., we have measured the different areas for each ecological unit. The results are shown in the following table.

	North of the Ruhoi River	Ruhoi River floodplain	South of the Ruhoi River	Total
Primary coastal forest Areas (ha)	537.32	-	2106.54	***2643.86***
Secondary or disturbed coastal forest areas (ha)	1439.99		3125.06	***4565.05***
Dense Miombo Areas (ha)	13.84	217.25	459.35	***690.44***
Disturbed Miombo Areas (ha)	176.88	12.87	698.87	***888.62***
Woodlands Areas (ha)	11.13	376.79	293.79	***681.71***
Riverine forest Areas (ha)	12.57	235.55	-	***248.12***
Agricultural encroachments (ha)	34.40	16.26	279.85	***330.51***
Total (ha)	***2226.13***	***858.72***	***6963.46***	**10,048.31**

Table 12: Areas of the different patches included in the main stands types map of the Ngumburuni forest

4.1.2.3 Discussion and general analysis of the situation of the forest

The parameters analysed in the previous paragraphs, the observations and the discussions with villagers and different stakeholders show that the main problem of the Ngumburuni forest is excessive logging. During the inventory, we found between 30 and 40 pit-sawing sites. We personally caught two logging teams in the act. All the valuable species are heavily overharvested. Most of them such as Mninga (*Pterocarpus angolensis*) and Mkongo (*Afzelia quanzensis*) are now exploited while immature. The average diameter of many stumps is about 30 cm, which is now the harvesting diameter. Yet, recommended DBH of harvesting for Mkongo (*Afzelia quanzensis*), Myombo (*Brachystegia spiciformis*) or Mninga (*Pterocarpus angolensis*) could be set at 60 cm. For Mpangapanga (*Millettia stuhlmannii*) or Mpingo (*Dalbergia melanoxylon*), 40 cm could be permitted as a minimum harvesting size, as these trees are generally naturally small sized (Malimbwi**,** 2000). To dispose of the wood, illegal loggers are now trading the small diameter logs as off-cuts, i.e. that they are the branches of trees harvested previously instead of freshly cut tree-trunks.

In addition, the pit-sawing places show a high wastage of timber. For example, the stump heights exceed most often 15 cm, reaching 1 m in some places and they are not necessarily belonging to buttressed tree species.

The analysis of the main stand parameters, and especially the basal area, shows that they are among the lowest in the Rufiji District, mainly because of the elimination of the more interesting big trees. But now, the elimination of the small trees, which has seriously begun, will have long-term impacts. The normal rotation times of the main species are no longer respected. Some species can disappear because in addition, the heavy impact exploitation creates large gaps in which lianas and grasses are growing, hampering regeneration. But some places are still of very high biodiversity value, particularly the north-eastern part, the central part and the south-western part of the forest.

Another threat is the encroachment by agriculture. In the east central part of the reserve, a first agricultural area was cleared in the sixties but was reversed during Ujamaa (a collectivisation policy period) (Collective, 2002). Nowadays it is mainly a poor woodland. Recently the forest attracted new settlers and other encroachments occurred, mainly close to the main trails. Although this illegal occupation is increasing, it has not reached alarming proportions for the moment.

Charcoal burning is another damaging activity. In Ngumburuni, as in many other forests, charcoal is produced through the traditional earthmound kilns. It is generally admitted that these kilns are inefficient and that the charcoal recovery rate ranges between 10 and 15 percent on weight basis (Collective, 2001 b). For the moment, the kilns are mainly built in Miombo areas and around them the charcoal burners make large harvesting gaps. We found several of them during the inventory. The different shapes of the kilns show that the charcoal burners come from different regions of Tanzania and not only from the Rufiji District.

All these activities are most often illegal although some logging licenses are issued by the District authorities. The exploitation is made easier by the important trail network criss-crossing the forest in all directions. In addition, a new wooden bridge is being built over the Ruhoi river and will favour communications between the northern and southern parts of the forest.

More generally we can conclude that the Ngumburuni forest still harbours important biodiversity, and constitutes a unique habitat for rare or threatened species. During the Songas pipeline survey *Afromomum orientale*, a plant endemic to Rufiji and Mkuranga Districts and two orchids, *Microcoelia exilis* and *Microcoelia megalorrhiza*, were found (Songas, 2003). Moreover it is a fauna corridor from Selous Game Reserve to Coastal areas, as it is proved by the numerous animal prints and dungs we have found during the inventory. Ngumburuni is a shelter for elephants, antelopes and Black-and-white *Colobus*, for example. Exceptional biodiversity is present for birds (Boswell *et al*., 2002) with the discovery of the second known population of the *puguensis* race of the Pale-breasted Illadopsis, the presence of red-listed species such as Southern Banded Snake Eagle and East Coast Akalat, occurrence of the rare African Pitta and a host of East Coast Biome species such as Tiny Greenbul, Fisher's Greenbul, Little Yellow Flycatcher, Chestnut-fronted Helmet Shrike, Uluguru Violet-backed Sunbird, Kretschmer's Longbill, Brown-breasted Barbet, and Black-breasted Starling. The very recent discovery of the dragonfly *Teinobasis alluaudi* in the Ruhoi floodplain is exciting, as it is only the second record of for the African mainland (Clausnitzer, 2003).

But Ngumburuni is also a place where many people find basic livelihoods and where outside stakeholders make money, to such extent that the forest capital is really threatened by overharvesting.

4.1.3 Orientations suggested by the data analysis and the in field observations

The last remarks of the previous paragraph suggest that a balance must be found between the necessary conservation of the high biodiversity areas and a sustainable management of the other places and particularly the Miombo and woodlands.

a) Conservation and improvement of the coastal forests

For the coastal forests, conservation and improvement should be the basic rules. Conservation does not necessarily signify any human intervention or a hypothetical return to the climax. Regeneration cutting is conceivable for very mature trees. In natural forests, the windfall naturally contributes to the regeneration. So it is not a heresy to cut big old trees even in the coastal forests, provided that it is done with low impact and with the certainty that regeneration does exist or will appear.

In the most damaged areas enrichment plantations of local species could improve the situation. Some places should probably be totally closed to logging because they have already been overharvested and no more big size tree can be found there.

b) Encouraging non-timber activities

In the coastal forests patches (but also in Miombo), non-timber uses can be encouraged and alternative livelihoods developed. We can think about beekeeping, mushroom harvesting and even tourist activities, for example, close to Umwe lake.

c) Stopping the most damaging uses

The agricultural encroachments and charcoal burning should be stopped. We can admit that the existing agricultural settlements can be kept, but new ones must be banned. The former agricultural encroachments could be replanted as forest, perhaps using quick growing species to settle incomes on the villagers involved in the management process. A mixture of species with existing ones is conceivable, for example in poor woodland areas.

In the miombo areas, an appropriate management, including sustainable harvesting of high value species and strict control of the loggers, should be implemented under supervision of the communities.

All these propositions, just sketched here on a technical basis, must now be confronted with the different stakeholders' point of view.

4.2 Analysis of the human context

As proposed in chapter II, we visited all the surrounding villages. After arrival, we met the political leaders - Divisional Secretaries, Village Councillors and Ward Officers - to introduce and explain the process, according to the governmental and District policy and the REMP principles. We also explained the aim of our survey during the first month and that it allowed us to say that the forest is ecologically rich. Briefly, we presented the main results and the first draft of the map. Thereafter, we conducted interviews in order to understand the human background and the different interest flows between the various stakeholders and the forest itself. This work was based upon the principle: "to inform people, to be informed by people" (D'Arcy, 1993). The analysis of the human context results both from these inquiries and the awareness meetings we organised in each village.

4.2.1 Brief social overview and identification of the different stakeholders

During the forest inventory, we identified the villages, which could be involved in the future forest management. They are located on the following map.

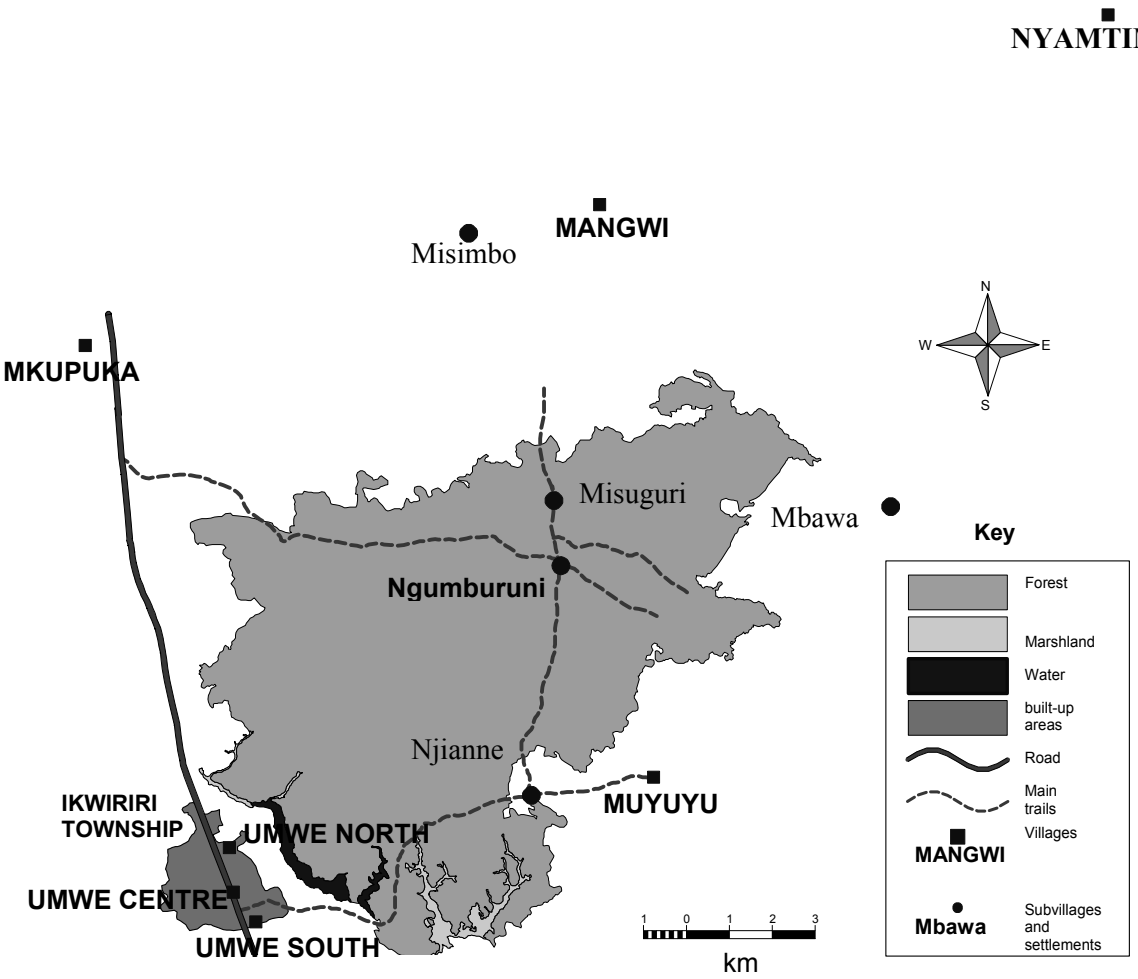


Figure 11: Location of the villages and settlements

Only Umwe, North (1564 hab., 372 households), Centre (1946 hab., 468 households) and South (3159 hab., 742 households), Mkupuka (376 hab.), Nyamtimba (2000 hab.), Muyuyu (2344 hab.) and Mangwi (about 2000 hab.) are villages with a government and a chairman. Ngumburuni and Njianne, Mbawa, Misimbo are sub-villages respectively of Muyuyu, Nyamtimba and Mangwi.

Umwe North, Centre and South are subdivisions of Ikwiriri and constitute the eastern part of the city. Ikwiriri is a typical Ujamaa creation. Indeed, from 1967 (Arusha Declaration), hundreds of artificial village communities have been created according to the Chinese collectivist model. These populations' groupings aimed to make access to the basic amenities easier. Consequently, most of Ikwiriri people come from other places, particularly from the Rufiji River floodplain.

The current economic activity is shared among traders, transporters, craftsmen and small industries (sawmills). Obviously, the unofficial economy is important too and many charcoal burners, medicine men or peasants sell their production in small markets or on the roadside. The Ikwiriri people's way of life is close to a usual East African urban one and the forest does not appear to them as a vital source of livelihoods. On the other hand, they are aware that they can get benefits out of it.

The people of the small surrounding villages have a different perspective. They depend more on the forest for their livelihoods and an important part of their food, medicines or building materials derives directly from Ngumburuni. In fact, the closer they are, the more concerned they feel. In Ngumburuni and Misuguri settlements, we can find the people living the most in harmony with the forest. It provides them with food, medicines, building poles, palms and spiritual values. They are

Muslims, but Tambiko leaders can be found among them (cf. 4..2.2.1.) and even their graveyards are hidden in the deep forest.

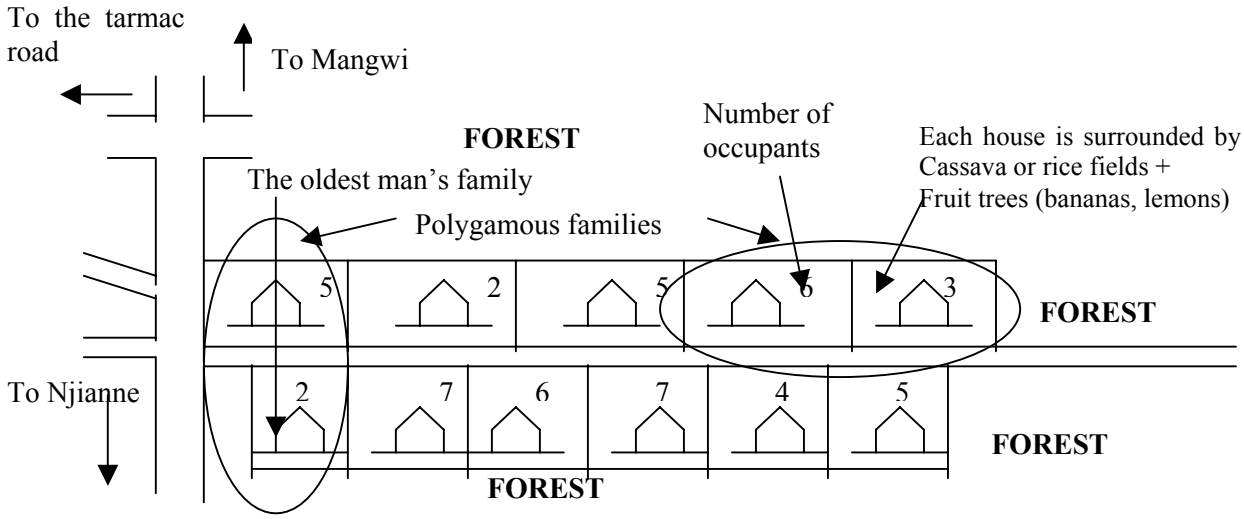


Figure 12: Spatial organisation of an ancient inside-forest settlement: Ngumburuni.

The standard of living is generally lower in the small villages, where people are mostly farmers, than in Ikwiriri. In addition, there are also differences between them. For example, there are primary schools in Muyuyu and Mbawa, but not in Njianne. But, with a masjid and a store, Njianne is a bit more developed than Ngumburuni or Misuguri, which are agricultural settlements located inside the forest. The poverty level globally follows this village hierarchy, but there are also differences among the people inside the villages.

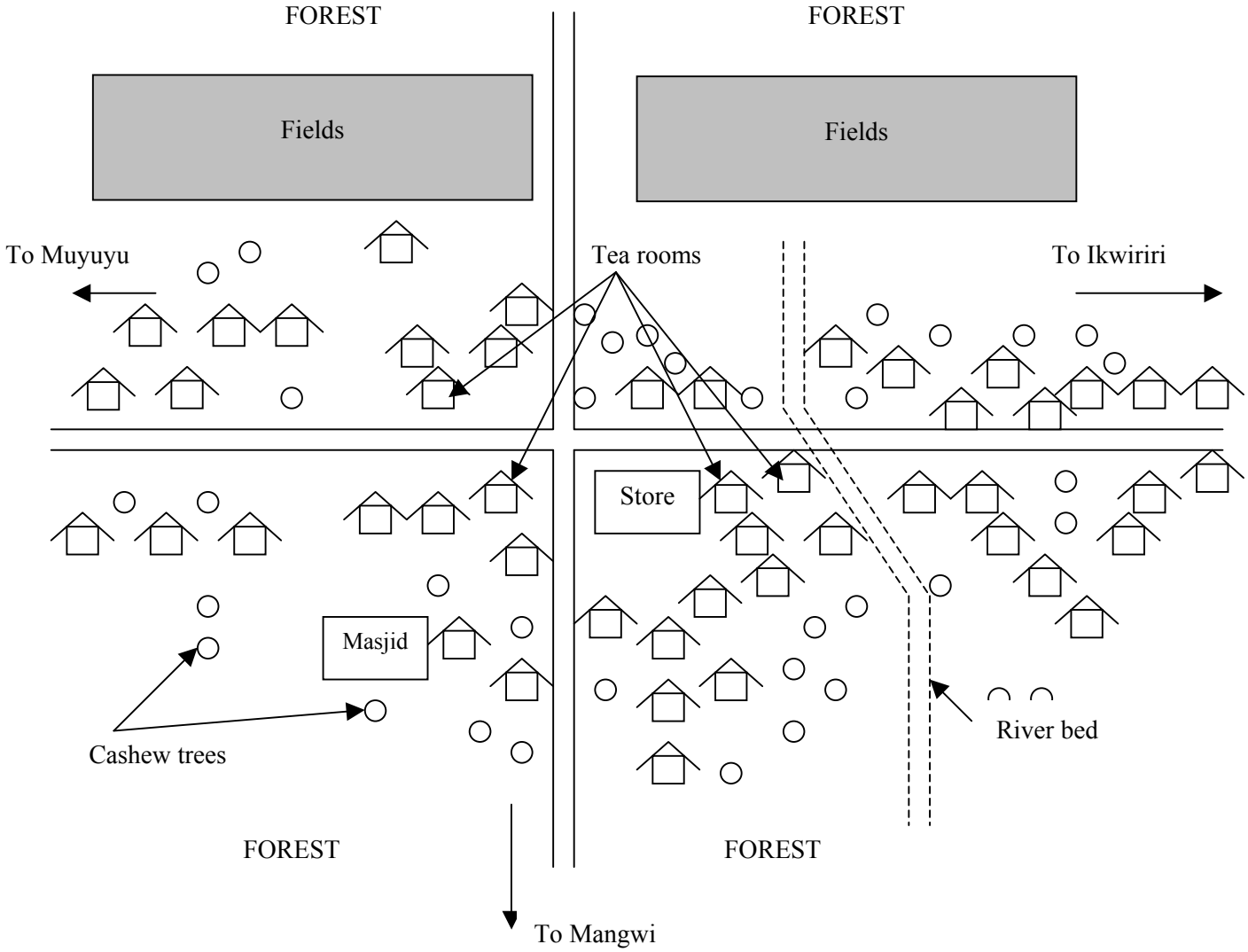


Figure 13: Spatial organisation of a recent forest-adjacent sub-village - Njianne

In these various places and also in Ikwiriri township, the different categories of stakeholders have been identified. They can be classed in three groups: economic operators, forest-adjacent communities and authorities (political leaders and civil servants).

The following figure shows roughly their relationships with the Ngumburuni forest.

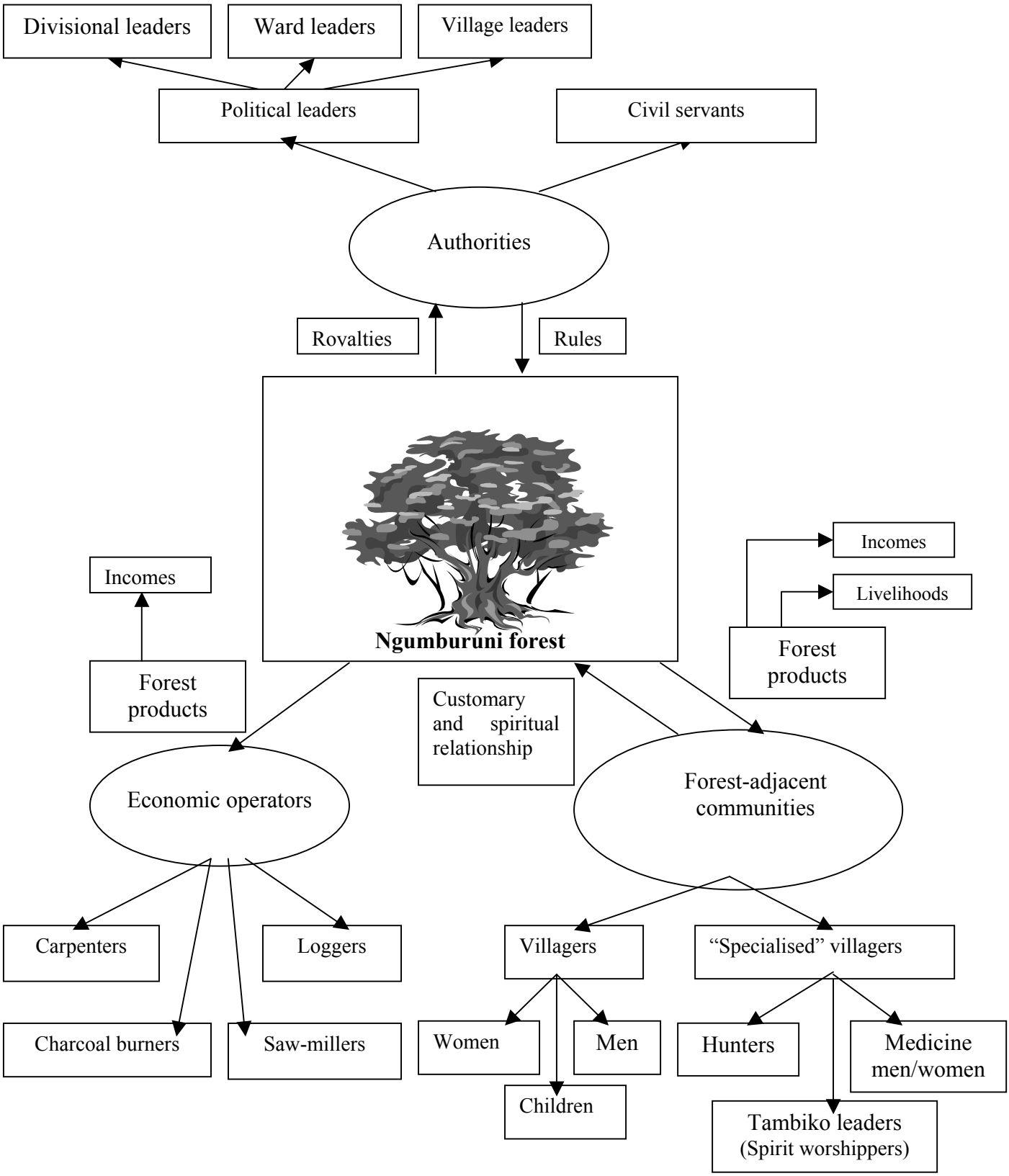


Figure 14: The different stakeholders and their relationships with the forest

Among these stakeholders, 183 persons were interviewed in all the communities. We chose them after consultations held with the village councils. In addition, we did our best to meet all the social categories: poor and richer strata, old, middle and young people for both genders. In many cases, we succeeded but it was sometimes difficult to get information from the women because of the

Muslim context. Nevertheless, we met 47 women and some of them were really interested in the process. The following table shows the distribution of the various interviewed people.

	Ngumburuni	Njianne	Umwe North	Umwe centre	Umwe South	Ikwiriri	Mkupuka	Muyuyu	Nyamtimba-Mbawa	Mangwi-Misimbo
Villagers (men)	2	4			3		12	5		4
Villagers (women)		5	2	4			6	11		
Villagers (children)							4			6
Tambiko leaders	1				3					
Medicine men						1				
Hunters								1		
Divisional leaders						1			1	1
Ward leaders									5	1
Village leaders			12 (8 m., 4 w.) *	17 (15 m., 2 w.) *	12 (10 m., 2 w.) *		10 (7 m., 3 w.) *	1	3 (men)	14 (6 m., 8 w.) *
Civil servants						1				
Poles cutters			15							
Loggers						6				
Saw-millers						2				
Carpenters						5				
Charcoal burners						1	1			
Total	3	9	29	21	18	17	33	18	9	26

Table 13: The number of interviewed stakeholders and their living places (* m.: men; w.: women)

4.2.2 Perception and current uses of the forest by the different stakeholders

4.2.2.1 A place of taboos and spiritual events: the history of the Ngumburuni forest

At first, we can note that many people know a few scraps of the forest history. But very few can tell the entire story. According to the different interviews, before the German colonization, the forest was in the influence area of the Zanzibar Arabian power. The Arabians used to harvest gum copal in the forest and probably ivory too. They were also slaves traders and captured some of them in that area.

During this period and after, during the German colonialization, three main chiefs ruled the forest. Some of their names have been conserved. So in the 18th century, Nyasinda ruled the area located north of the Ruhoi river. Another one, Mwamiya, ruled the southern part. From Mbawa to Kikale, the area was ruled by a third one called Mkali. All the surveyed area seems to be called Ngumburuni but, formerly, the forest was also called Makotwa (maybe a local chief's name). Other families, the Magombo, the Msuko and the Kimbanga ruled the forest, perhaps in the beginning of the 20th century. During that period, the forest was closed and contained many big trees. People needed the chiefs' permission to cut a tree. In fact, the chiefs allowed or forbade the different activities in the forest.

The German colonial authority began the demarcation of the reserve and it was finalised by the British. Yet, traditional chiefs still ruled the forest during the colonial period. There was a kind of agreement between them and the colonial authorities. For example, they collected the taxes in the

name of the colonial power. Nevertheless, the loggers had to get permission from the forest authority before working, especially during the British period. The traditional power ended after independence. Then, Ngumburuni became a national forest reserve. During the seventies, the District got the control of the forest.

During the history of the forest, several settlements appeared inside and close to the forest. Misimbo, for example, was created at the end of the 18th century. The settlement called Ngumburuni is probably very ancient too.

Other settlements formerly existed, especially before Ujaama, as it is proved by the presence of big mango trees and of former agricultural encroachments in several places. On the contrary, Njianne is recent. It was created in 1968. The people came from Ndundu (in the Rufiji River floodplain), but nowadays, they administratively depend on Muyuyu. The main event, which increased the human pressure, was the creation of Ikwiriri township during the Ujaama period.

Ngumburuni has also always been a place of legends and spiritual activities. According to these legends, a spirit, called Mchela, lives in the deepest parts of the forest. Formerly, Mchela was a good spirit. People could pray him for recovery, rainfall or good harvests. For the time being, many people don't practice and Mchela is not well regarded any more, people fear him. In fact, formerly, to go into the forest was regarded as dangerous. Giant snakes and mysterious orchards were supposed to exist there. If somebody ate the fruits, he was definitely lost. Yet, there was a medicine to treat this kind of event, but the Tambiko leaders had also to beg the spirit who confused the people. Sometimes, if you were lost, you only had to turn your shirt inside out to remember your way. In other places, if you cut a tree, it never fell. In fact, there were many taboos in the forest and the local people used to respect them. But, nowadays, the outsiders cut trees even in the Tambiko sites and nothing happens. So it encourages the local people to do the same thing.

Formerly, the Tambiko spiritual activities took place in three main sites: Nyaugali, Kwa Mzungu and Kwa Munboka. These sites are supposed to be still active. At the end of each year, the people practiced Tambiko ceremonies in view of being protected during the following year. During these ceremonies, the people washed themselves with special forest plants and they often gave perfumed objects to the divinities. Even nowadays, some particular families are enabled to implement these Tambiko practices and sometimes, small temples can be found around the big trees. Indeed, the Tambiko is preferably practiced in non-disturbed parts of the forest, where big trees can be found. In fact, for the Tambiko leaders, the forest is not only a natural resources reservoir, but also a kind of living temple. Tambiko leaders can also help people at home. Then, the ceremonies are called Mbungi and Likwa. Their duration is about two or three days. They use drums, local beer and dances.

But obviously, the Ujaama and the development of other religions have diminished the number of people practicing Tambiko or believing in it. The spiritual dimension of the forest still exists, but it is not as essential as it was a few decades ago. So, unfortunately, the forest is less respected. Unplanned harvesting began just after independence and has always increased since that date.

4.2.2.2 The forest is a source of incomes and livelihoods for the forest-adjacent communities

All forest communities use the forest, but to various degrees. People living inside or very close consider that it is an important part of their livelihoods (between 20 and 30 % and maybe more in dry years like 2003). For people living in Ikwiriri Township, it rather appears as an occasional or complementary source of revenue and they harvest wild fruits or plants more rarely. There are also gender differences. Indeed, women and men generally use the forest in different ways and women avoid going into the deepest parts of the forest. In fact, the more lucrative activities are done by men: commercial harvesting of timber and poles, charcoaling. Women rather deal with useful domestic activities: collection of fruits, edible plants, fuel-wood, weaving and dying materials. Yet, some activities are shared by both men and women, like medicine or mushroom collection. Tambiko is also practiced by both of them (it depends on the ceremony). For shifting cultivation, the forest is cleared by men but cultivation in itself is done by both of them. The children often fish

in the rivers and harvest fruits. They also collect gum for making balls.

Timber (for canoes or carpentry), off-cuts, charcoal are mainly traded. Poles, building and roofing materials are produced for both commercial and domestic goals. Fuel-wood, weaving and dying materials, mushrooms, edible plants and fruits are exclusively intended for domestic use. We can also note that the women from Mkupuka exploit clay for pottery in the forest.

Hunting (antelopes and small mammals) and fishing in the Ruhoi River or in small swamps within the forest are complementary protein resources for the local communities. Medicine collection is also an important activity. Some Umwe South people consider that about 30 % of their medicine needs come from the forest. In addition, it is a source of income for medicine men and women, who sell the medicines in small shops, particularly in Ikwiriri, but also in Dar es Salaam. One of them, interviewed in Ikwiriri, explained that he uses many forest shrubs and trees species – between 25 and 30 - for medicine (leaves, barks or roots). The lowest price for one treatment being 1000 Tsh (about 1 $) and the most expensive 128,000 Tsh (124 $) for a spirit affectation, we can guess that, with an average of three patients per day, it is a lucrative business.

Forest uses	**Gender**		**For home use only**	**For sale**	**Both**	**Trend in use, according to the interviewees: Increasing (I); Decreasing (D); Stable (S)**
	Men	**Women**				
Timber	x			x		I
Charcoal burning	x	(x)		x		I
Building poles collection	x				x	I
Roofing materials collection	x	x			x	I
Fuel-wood collection		x	x			I
Wild honey collection	x		x			D
Beekeeping	x	x			x	S
Weaving and dying materials	x		x			S
Fruits, mushrooms and edible plants collection	x	x	x			S
Medicine collection	x	x			x	S
Clay for pottery		x			x	S
Shifting cultivation	x	x	x			I
Settlements in the forest	x	x	x			S
Hunting	x				x	S
Firing for hunting and clearing skidding areas	x				x	I
Tambiko and ritual uses	x	x	x			D

Table 14: Synthesis of the forest uses by the forest-adjacent communities

4.2.2.3 The forest is a source of raw materials for economic operators

As explained in chapter I, the Rufiji forests are under increasing pressure. This is particularly due to the development of small industries and of commercial harvesting of various wood materials. Around Ngumburuni, we have identified five main types of activities using trees. For the time being, their exploitation is of a mining type.

Table 15: The different trees species used by the economic operators around Ngumburuni

(*the canoe data come from Hamerlynck, 2003)

Tree species	Sawmills	Poles	Pit-sawyers	Charcoal	Canoes *
Maemba (*Mangifera indica*)					x
Mbebeti (*Albizia sp.*)				x	
Mfuru (*Vitex doniana*)					x
Mhanga		x			
Mkatitu		x			
Mkongo (*Afzelia quanzensis*)	x	x	x		x
Mkuruti			x	x	
Mkwaju (*Tamarindus indica*)				x	
Mlopolopo (*Trichilia emetica*).	x		x		
Mmangangwaru (*Afrormosia angolensis*)	x		x		
Mnangu (*Hymenaea verrucosa*)	x		x	x	
Mndototo (*Lettowianthus stellatus*)		x			
Mndundu (*Cordyla africana*)	x		x		
Mneke (*Pteleopsis myrtifolia*)				x	
Mninga (*Pterocarpus angolensis*)	x		x		x
Mningahoka (*Apodytes dimidiata*)		x			
Mpangapanga (*Millettia stuhlmannii*)	x		x		
Mpilipili (*Sorindeia madagascariensis*)		x	x		
Mpuya (*Bersama abyssinica*)		x			
Msekeseke (*Swartzia madagascariensis*)	x		x		
Msufipori (*Bombax rhodognaphalon*)					x
Msweli (*Grewia sp.*)		x			
Mtabwe (*Grewia trichocarpa*)		x			
Mtanga (*Albizia versicolor*)	x				
Mtasi (*Baphia kirkii*)		x			
Mtete (*Hymenocardia ulmoides*)		x			
Mtondoro (*Julbernardia globiflora*)	x		x	x	
Mtopetope (*Annona senegalensis*)		x			
Mvule (*Milicia exelsa*)	x		x		x
Mwakala		x			
Myombo (*Brachystegia spiciformis*)				x	

Economically, the main activity is the production of sawn wood. Several economic operators share this market. The most important are the four sawmills located in Ikwiriri. But there are also small ones around the forest. According to the interviews, they use eleven species of trees. Mninga and Mvule used to be particularly appreciated for furniture, but as they are now forbidden in Rufiji, the saw-millers have recently developed the exploitation of other species, for example Mtondoro or Mpangapanga. But it is quite sure that a black market exists for Mninga and Mvule. The sawmillers explain that these logs come from other regions, but they probably buy some coming from Ngumburuni forest, although they are almost commercially extinct. Mkongo has also been an alternative since the middle nineties. In Ikwiriri, it is mainly used for windows by the carpenters. Mkongo is still present in Ngumburuni, but the big sized stems are scarce.

The forest is also an income source for the unemployed young people of the surrounding villages. Many of them have become illegal pit-sawyers. Indeed, as they have seen the outsiders cutting many trees without noticeable problems, they joined in the movement. As shown in table 15, they

add harvesting pressure on the same species as the sawmills. During our transect walks (appendix n° 3), we have found a Mninga stand that was entirely cut. About ten trees were waiting for skidding. The maximum diameter was 39 cm. We caught two loggers in the act and we asked them if they were aware of the District initiative aiming to forbid Mninga harvesting. They said that they were aware, but they added that they continue this activity because, first and foremost, they are struggling for survival. The forest appears to them as a means of short-term poverty alleviation. They also specified that in the Kibiti and Jaribu-Mpakani check-points, the traders are allowed to pass with furniture made from Mninga wood. The pit-sawyers mainly sell the planks to the local carpenters in Ikwiriri and they scarcely deal with the saw-millers. They can saw from 5 to 10 planks per week. The planks are 6-8 feet long x 6 inches wide x 2 inches thick. One Mkongo plank is sold 1500 Tsh (1,5 $) maximum. Other species planks are sold from 800 to 1200 Tsh (0,78 to 1,17 $). They claim that the average diameter of the trees they harvest ranges from 30 to 40 cm. But in reality, many of them also cut smaller trees and sell them as so-called off-cuts, i.e. as branches of trees felled in the past.

Another category of beneficiaries is the pole harvesters. In fact everybody is likely to cut poles in the forest to build his own house, because the traditional building technique implies the erection of a pole substructure (cf. photo No. 14).

But this activity has become a commercial and lucrative one. The poles are sold:

- by pieces for the big ones: 150 – 200 Tsh (0,15 – 0,20 $) each;
- by batches of 25 – 30 poles for the small ones: 300 – 400 Tsh (0,30 – 0,40 $) for a batch.

The interviewed pole harvesters told us that each of them sells an average quantity of 15-20 poles per week. With the population growth, particularly in Ikwiriri, the commercial demand for poles is increasing and becomes a threat to the forest. Indeed, the poles are not only cut among the shrub species but also among the regeneration stems of tree species. Fortunately, we can note in table 15 that the more precious species are not cut for poles, yet with the surprising exception of Mkongo (*Afzelia quanzensis*).

Photos No. 12 and No. 13: The two main manual sawing methods used in Ngumburuni. The second one is a pit-sawing site.

Photo No. 14: A traditional house in Mkupuka, with a pole stock.

Photo No. 15: A charcoal burner with a bag sold 2000 Tsh (1,94 $). Behind him, a small size kiln.

Charcoaling is also a widespread activity around Ngumburuni. The charcoal burners generally work in Miombo and not in the coastal forest patches. But, they mainly use species like Mtondoro (*Julbernardia globiflora*), Mnangu (*Hymenaea verrucosa*) or Mkuruti, which are timber species too. They perceive the forest as a mining source of raw materials and, consequently, their activity is particularly destructive. A charcoal-burning site generally becomes an open woodland.

The charcoal burners use several sizes of earth kilns. For example, a small one needs 4 trees (30 cm diameter) and gives 14 bags. It takes one week to produce this quantity. A larger one needs 35 trees and gives 100 bags. The production time is one month. The prices of the bags are:

- 1000 Tsh (0,97 $) in the field;
- 1800 – 2000 Tsh (1,75 – 1,94 $) on the tarmac roadside.

In fact, their profit margin is very low. A study carried out in Ikwiriri (Kaale *et al.*, 2000) showed that for people producing and selling their charcoal themselves, average monthly profit excluding their labour cost was around 62,000 Tsh (60,20 $). For those only selling in retail, their average monthly profit was 15,300 Tsh (14,85 $). Surely, this activity provides some money to people with few alternative sources of income, but it does not really help poverty alleviation and it is most damaging to the forest. But the wholesalers trading big quantities of charcoal in Dar es Salaam with important profit margins, are the main winners of this business

We also mention canoe-making because it is a vital item in the Rufiji people's livelihoods and because some of the interviewed stakeholders told us that this activity still exists in Ngumburuni. But it has probably become marginal because it is now very difficult to find the preferred species for canoes with a sufficient diameter. Canoes are now made from less adequate species (table 15), which have a much lower duration of use (Hamerlynck, 2003).

We can also add that the forest provides the adjacent communities with non-material values. We already noted that it was the case for Tambiko spiritual activities, but neither can the ecological values be disregarded. Many stakeholders are aware of the importance of the forest for issues like fauna, water and more generally "mazingira" (environment). The following figure aims to summarize all these observations.

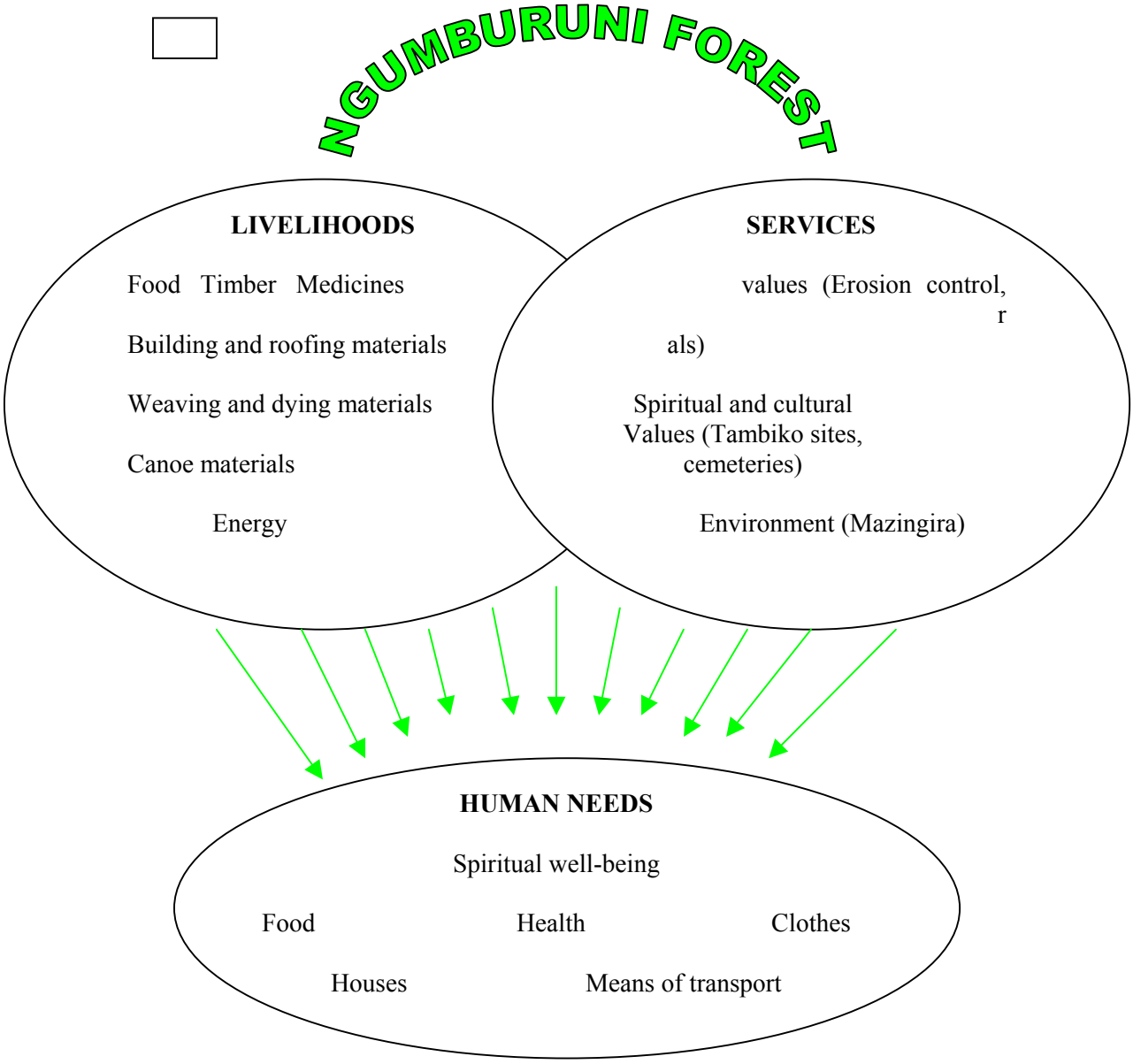


Figure 15: All-encompassing diagram showing the goods and services provided by the Ngumburuni forest

4.2.2.4 The forest is a source of royalties for the District

As noted in 2.3.3, the forestry sector provides the District with most of its revenue. Obviously, Ngumburuni and the other District Forest Reserves are actually perceived by the foresters as a source of income. This income is generated by the licenses and the fines, mainly collected in several checkpoints located along the tarmac road leading to Dar es Salaam. Yet, due to the poor human capacities to manage the forest, the District resolved to transfer the management of the forest either partly or totally. Indeed, with increased community involvement the management will not be as bad as it was up to now. But for the moment, the District foresters are a bit doubtful about the capacity of the communities. In fact, the lack of trust is shared between the District and the communities.

4.2.2.5 The perception of the current management

Only the leaders are currently aware that a part of the forest is, at least theoretically, managed by the District. Nobody among the villagers and only 50 % of the economic operators can say who is the manager. Nevertheless a few more people know that a forest reserve exists but only the leaders can approximately locate the boundaries and very few of them can draw a rough map of the forest reserve. Yet, the northern boundary is better known because it is materialized by a main trail.

Generally speaking, most of the stakeholders actually have a bad image of the management by the authorities. Their general feeling about this management is that it is a repressive but ineffectual one. When you ask the people what the words “environment” and “natural resources” (respectively mali asili and mazingira in Kiswahili) or “protection of nature” (Uhifadhi wa pori) mean to them, they generally answer in terms of forbidding, conservation without any use or fines given by the foresters. They are even more bitter since they consider that mali asili is a gift of God and that, therefore, they must at least be part of the management and also get benefits.

But many of them are aware that it is necessary to implement a protection policy and a management plan including the forest itself and the fauna, because they are convinced that Ngumburuni is threatened. Simply, they are very doubtful about the capacity of the authorities to succeed in implementing management decisions and the all-repressive policy is less and less accepted. The participants in the transect walks, in particular, were very clear about that (appendix n^{o} 3).

4.2.2.6 III.2.2.6. The stakeholders perceive the forest to be in a bad condition

All the stakeholders maintain that the forest has significantly changed over the past few decades. Before, the canopy was totally closed. Currently, the canopy is open and many trucks cross the forest thanks to the numerous trails. Shrubs, lianas and small trees are more numerous. According to a villager, “formerly, Ngumburuni was cold and wet, now it is hot and dry”. Consequently, many animals have left. Particularly, the number of elephants has diminished. Liechtenstein’s Hartebeest (Kongoni) and waterbucks were also more abundant a few decades ago.

Most of the interviewed people are actually aware that excessive logging has increased for 15 years and that the forest is overharvested. It is now difficult to find big trees. Formerly, they were abundant. Precious species like Mvule or Mpingo were particularly numerous. But, they have practically disappeared, sometimes since the eighties (Mpingo for example). The sawmillers confirm that the main commercial species logs arriving from Ngumburuni in the sawmills have a smaller diameter than before. Most of the big trees are now from other species. Mkongo is still available but the diameters are small too.

According to the various stakeholders, the most damaging causes for all these changes are:

- excessive logging (and truck traffic inside the forest);
- commercial harvesting of poles;
- charcoaling;

- fires;
- shifting cultivation (in addition, the average productivity duration of this kind of fields doesn't exceed 2 or 3 years, according to them);
- harvesting of immature trees, sold as so-called off-cuts;
- lack of a harvesting plan.

In contrast, they consider that the least damaging uses are:

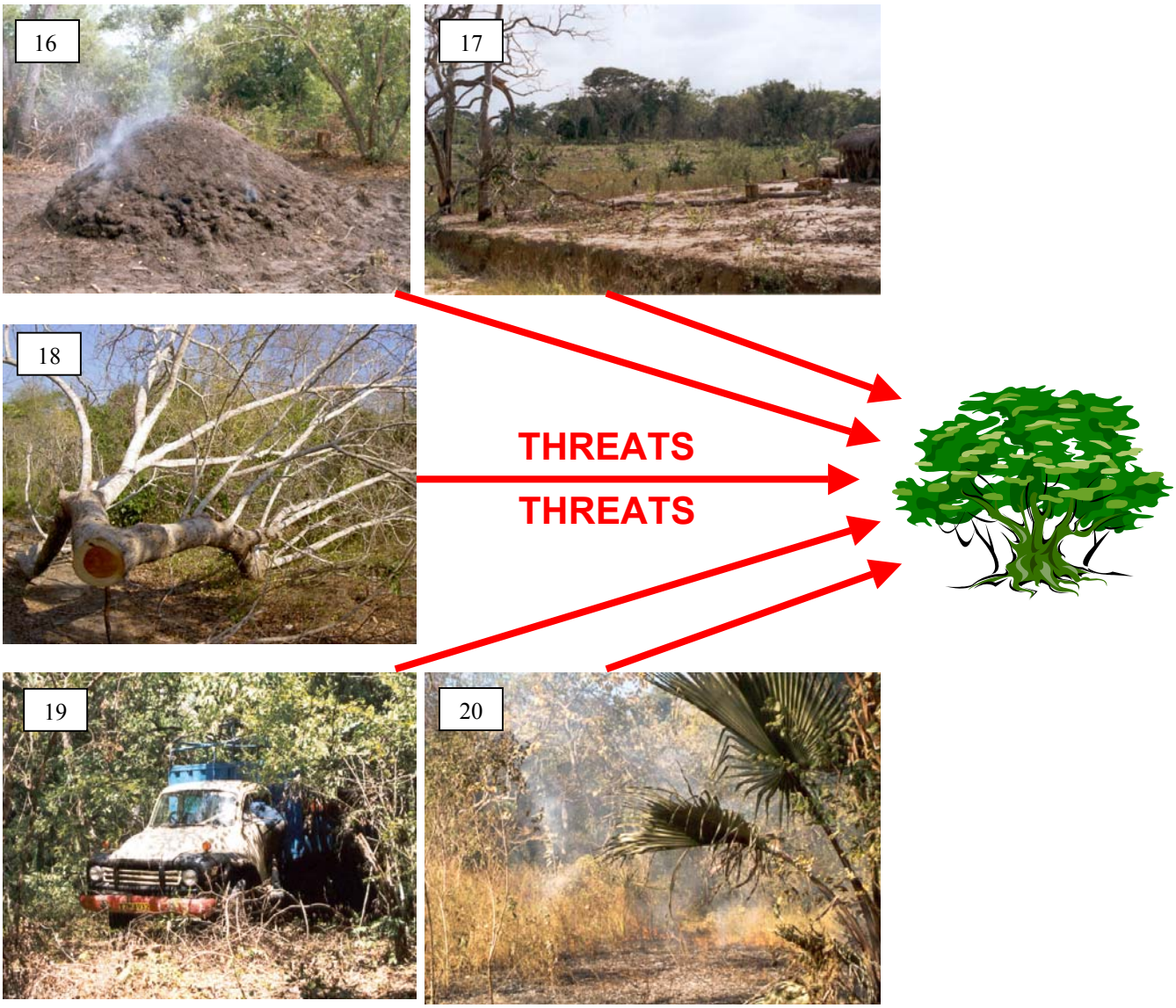
- collection of weaving and dying materials;
- collection of building and roofing materials for local domestic use;
- collection of fuel-wood;
- hunting, because it is only done by local people and it remains reasonable for the moment;
- collection of edible fruits and plants;
- collection of medicine;
- collection of mushrooms.

All the interviewees express a pessimistic feeling about the future of the forest. Most people are afraid it will become "an open woodland" or even "a desert" if nothing serious is done. Year after year, logging and fires change the aspect of the forest and it will increasingly become fragmented. Fire is a natural part of the Miombo ecosystem, but if repeated during the late dry season, human-induced fires severely damage trees and hinder regeneration. Some of the more precious species, like Mpingo (*Dalbergia melanoxylon*), are particularly fire-sensitive. The fires are started both by the hunters and the loggers, respectively in view of driving game and clearing the skidding areas. In any case, it could exhaust the forest resources and the communities would have more problems making a living. The modest economic operators, like carpenters, think that maybe after ten years, the currently used species will become as scarce as Mninga is today. They fear that it will be more and more difficult to find wood.

The Ujamaa operation, the industrialisation (creation of sawmills, development of the wood market in Dar es Salaam) and the increasing population in Ikwiriri are considered to be the fundamental causes of all these disruptions. But, with common sense, the villagers think that the main reason is poverty. Poor people cut trees in view of making some money for their essential needs, especially in dry years, like 2003. So they think that they have their own responsibility in the demise of the forest, but with differences among the local communities: Ikwiriri people are indicated as the most active users of the forest (by the other villagers, but also often by themselves).

Yet, more than 90 % of the interviewed people are convinced that the outsiders damage the forest most. It is thought that they could easily get the legal permission from the District and even unofficially from the local communities' leaders (who are paid for that, according to several interviewees). Even if local people admit that many of them also use the forest, they maintain that by far the main part of the benefits go to outsiders, especially logging companies coming from Dar, where they can sell the timber with a high added value. The local people mainly contribute manpower but for very low salaries.

Local people hope that the worst can be avoided, but they think that their influence to prevent destruction is rather limited. At least, awareness must be raised with the villagers and all the communities must join to manage the forest.



Photos No. 16 to 20: The most damaging activities, according to the stakeholders. 16: A charcoal earth mound kiln; 17: Agricultural clearing; 18: Overharvesting and wasting wood (an immature felled Mkongo – Afzelia quanzensis); 19: Truck traffic inside the coastal forest; 20: One of the numerous fires in the dry season.

4.2.3 Overview of the main trading networks of the forest products

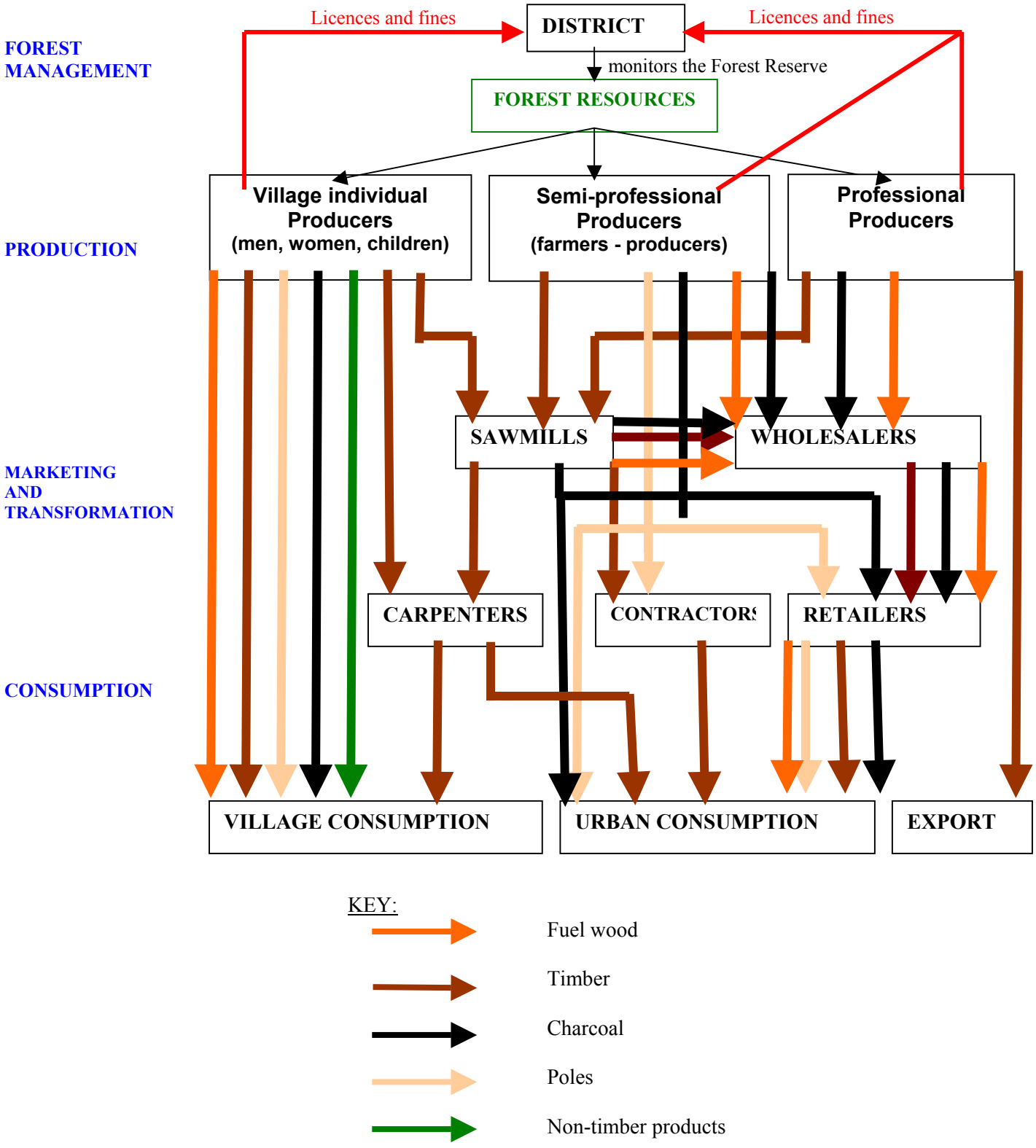


Figure 16: Main trading networks of the Ngumburuni products

In fact, the District controls only the Forest Reserve. In this area, at least theoretically, all the products must be the object of a license there and especially timber. In the surrounding areas, access is free. But in practice, most of the inside-forest activities shown in figure 16 are done in illegally. Most of the stakeholders are aware of this and put up with it. Consequently, if the District really wants to change things, it will have to act at each level and not only depend on the communities to improve management.

4.2.4 The wishes and suggestions of the different stakeholders for the management

4.2.4.1 Discussion about the boundaries of the community-based managed forest

According to all the stakeholders the boundary issue is delicate. The general opinion is that all the surrounding villages should be party to agreement on external and possible internal boundaries: Mangwi (+Misimbo), Mkupuka, Muyuyu (+ Njianne, Misuguri and Ngumburuni), Nyamtimba (+ Mbawa), Umwe (N,S and C + Mparange).

Most of the villagers think that the entire surveyed area should be included in the future community-based managed reserve, and not only the current District reserve. Yet, Umwe North and Centre object to including the east part of Umwe Lake, which is included in the future Ikwiriri extension project (cf. III.2.4.1.). Another problem will be the Mbawa people's claim to keep the northeastern part of the forest for their exclusive use. In addition, many farmers ask for the need of cultivation areas to be taken into account.

4.2.4.2 What kind of organisation should be the manager of the forest ?

The most often-proposed management system is based upon two levels of authority. According to 80 % of the stakeholders, each village must create its own forest committee. Another proposal is to use the recently created environmental committees and to empower them with forest affairs. Above them, an intervillage committee, composed of representatives of each village committee, should control the entire forest and manage the relationships between the different groups of stakeholders. Consequently, the villagers suggest to divide the forest into demarcated areas, each one managed by one village committee, under the coordination of the intervillage authority. The village governments will have to empower the management entities so that they will be able to operate easily.

The issue of a joint management system (communities + District) stays open. Most of the stakeholders think that technical and financial supports are essential and that improved communication between the communities and the authorities is necessary to implement efficient forest management. In addition, they feel inexperienced in forestry and they need training. The communities remain suspicious of the authorities and they fear that a huge part of the benefits will elude them. The sharing of the benefits will be the key-issue if a joint management system is decided for part of the forest.

The composition of the different committees is also an issue. At first, there is a gender problem. Most of the interviewed women want an equal representation with the men and some of them are already volunteers, even for scouting. But in a traditional Muslim society, the practical implementation of this legitimate claim is not obvious. In addition, men are supposed, even by women, to know most about the forest, because they work there more often. A second issue is the representation of the economic operators involved in the forest exploitation, particularly the sawmillers. Opinions are divided. Fifty percent of the people think that it could be a good thing to involve them in the management process, at least because they know the wood market. The others think that the sawmillers will just have to respect the by-laws decided by the communities for the forest management. But the wood demand exists and this reality must be taken in account. Yet, we can note that Ngumburuni is only one of their wood sources (5 %, for example for one of the

interviewed sawmills). The danger is that harmful practices and the harvesting of forbidden species will simply move to the villages with the least effective management.

Finally, a way of monitoring the progress of the communities in managing the forest must be found. Most of the interviewed people think that it must be done by the communities themselves and that the District services will just be needed for technical advice during the first years of the process. But they will need to decide on simple and practical indicators.

4.2.4.3 Protection and guarding issues

A crucial issue in the future management plan is the guarding, and more generally the protection of the forest. Indeed, in view of stopping unplanned harvesting, a surveillance system must be implemented. This is a challenge in itself, because many stakeholders, local or outsiders, got into the habit of using the forest without any wisdom.

Of course, the involvement of communities is essential, mainly because they are well placed to do it and also because there is no other realistic solution. Most of the villagers suggest organising patrols, with voluntary scouts chosen in each village. It is also conceivable to create checkpoints around the forest. The scouts must be sufficiently empowered to apprehend offenders and levy fines. According to the majority of interviewed people, the village governments should fix the fine levels at the intervillage management committee's suggestion. They view the scouts' task as essentially repressive, stating that if offenders fail to pay the fines, they have to be taken to the police or to court. However, alternative solutions should be considered. For example, offenders could be involved in plantations. If well trained, the scouts could also play an educational role.

Yet, to be efficient, the scouts must be supported. First, they need training and basic equipment. In addition most of the interviewed people think, logically, that they must be paid, at least because of the time spent and the risks incurred. We can add that this is also a good way to avoid corruption. Maybe in the end, the necessary funds can be generated by the forest revenue, but an initial investment is probably indispensable.

Their action must also be supported by the formulation of by-laws, defining clearly the rules, the forbidden and authorised activities. The necessity of a harvesting plan for the commercial trees species is particularly emphasized. With strong enough by-laws and regular patrols, it will be possible to establish a moratorium on the most threatened species. Information boards for public and users can also strengthen the surveillance task.

Yet, even if an efficient control system is created, a political problem, well highlighted during the transect walks (appendix n^{o} 3), remains. Indeed, if the authorities do not play the game and let smugglers pass through the checkpoints carrying furniture made from forbidden species, the surveillance work will be severely hampered. This fundamental issue is well explained in the Rufiji Forest Action Plan (2002).

Name of volunteer	Sex	Name of the village
Likasugana Ally Sobo	M	Umwe South
Halima Mohamed mkumba	F	Mkupuka
Omary Shamte Ngaima	M	Mkupuka
Hussein Said Kiboko	M	Mkupuka
Zainabu Omary Ndundu	F	Mkupuka
Amina Ally Mapande	F	Muyuyu
Rashid Salumu Meza	M	Ngumburuni (Muyuyu)
Hamisi Mohamed Mkingiye	M	Umwe North

Table 16: The first volunteers for scouting, after the July 2003 meetings

Note that women are well represented

4.2.4.4 Alternative uses and non-timber activities

As mentioned in 4.2.2.2., forest-adjacent communities already have non-timber activities in Ngumburuni. But, presently, they are more a livelihood source at subsistence level rather than a real means for making money. Yet, with regard to protection of the forest, the development of a sustainable extraction of those non-timber products could contribute to the conservation. Indeed, this kind of activity is a possible alternative to the other destructive exploitation methods.

Most of the interviewed people are mainly interested in beekeeping. Some of the villagers have already tried it or occasionally harvested wild honey. Three producers groups are supported by the District beekeeping development service (Ikwiriri) in the Ngumburuni neighbourhood, in Mtunda and Muyuyu. But, generally, the people have no experience and they need training to implement it on a large scale. In addition, they raise several problems:

- the lack of funds for the starting investments;
- the low selling prices;
- a gender problem: the women are not always allowed by their husbands to develop beekeeping, in spite of this they are very interested;
- fires hamper the beekeeping development. The hives are burnt, bees are killed and the favourable environment is destroyed.

People are also interested in edible plants and mushrooms collection. But, the limit for developing those activities is their seasonal nature and they think that it is only adequate for their own consumption. Medicine collection can also be developed. But in view of generating revenues, it could be better to emphasize the harvesting of materials used for handcrafts (weaving and dying materials for example). Hunting is a prized activity and it needs to be planned and better organised.

We have also asked their opinion about new kinds of activities like butterfly farming but they have never heard about it. On the other hand most of the interviewed people think that it is conceivable, and interesting, to promote a tourist activity in the forest. Indeed, they are aware of the Ngumburuni ecological richness and they are convinced that vision tourism could be implemented. The numerous populations of birds, elephants and monkeys and the relative proximity of Dar es Salaam are favourable elements. It could be a good source of income and encourage the forest-adjacent communities to take care of the forest. Yet, this kind of initiative can be hampered by such issues as the Ikwiriri extension project (cf. III.2.5.1). Indeed, if Umwe lake is included in an urban area, it will be an attraction loss. People are not experienced in organising tourist activities, but they claim to be ready to welcome tourists. This would probably require investment into a forest canopy walkway as has been done in Uganda and elsewhere, training of local guides, etc.

4.2.4.5 Tree Plantations

Most of interviewed villagers think that plantations could be implemented, under the supervising of the management committee(s), for everybody's benefit. Some of them have already tried teak or cashew trees plantations. But they would rather try local species like Mkongo or Mninga, for example. The committee(s) should allocate some plantation areas to each village. The degraded woodlands and former agricultural encroachments can also get an increased value in this way. It could compensate for the harvesting reduction in other parts of the forest

The main difficulty, as for the other activities, will be to find an initial investment. Indeed people are ready to prepare the fields and to supply the manpower, but they must buy seeds or seedlings. Solutions can be found using logging taxes and fines. They can also force the loggers to give the committee the off-cuts they do not need. Selling these off-cuts, the villagers would make money for plantation investment. Some people think about involving private operators. Another issue is that you should allow several decades before getting benefits out of the plantations. Fast growing species should be chosen if this problem was considered as a major one (cf. 4.4.5.7).

4.2.5 Analysis of the constraints likely to hamper the implementation of the community-based management

4.2.5.1 The Ikwiriri extension project

Umwe North and Centre's leaders exposed the Ikwiriri extension project wich concerns the part of the forest located east of Lake Umwe. The G.P.S. coordinates of the extension show that it overlaps with 696 ha of the forest (mainly coastal forest). In addition, Lake Umwe and its connected marshlands would be included in this area. This extension aims to provide Ikwiriri with new settlement and agricultural zones.

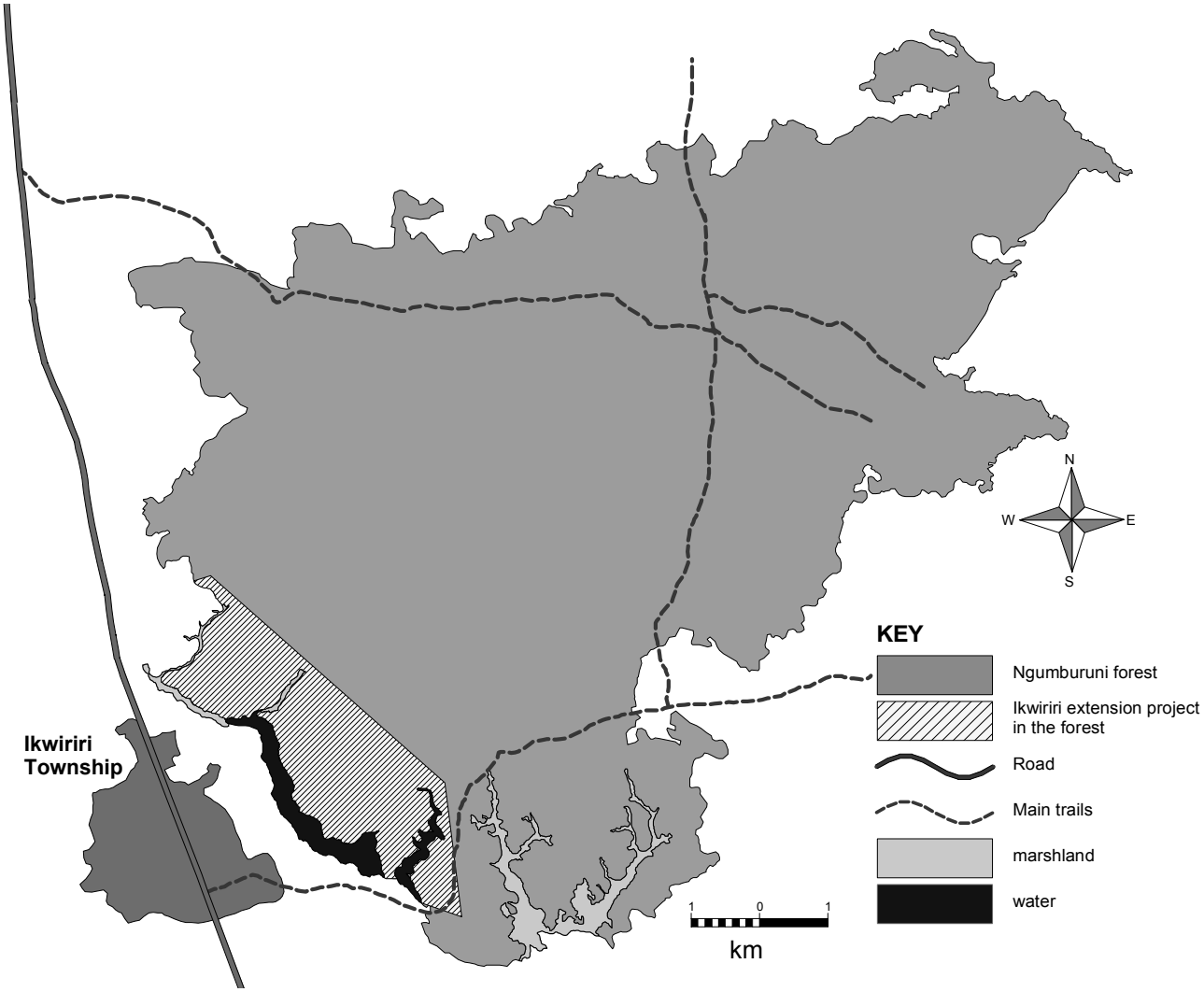


Figure 17: Overlap between the Ikwiriri extension project and the Ngumburuni forest

In Umwe Centre, the project was presented only as a possible extension. But, in Umwe North the discussion was almost aggressive. They fear that the new forest management process can obstruct the extension of Umwe North for a bit less than 5 km in an easterly direction. They add that they don't want to walk long distances to reach their future fields.

This project may be worrying for the environment near Ikwiriri. Indeed, it would be a very damaging attack on the forest biodiversity. In addition, if the Umwe Lake and its connected wetlands were included in a settlement and agricultural area, they would become a sewer before long. It is also important to mention that should that part of the forest be sacrificed, the natural barrier that Lake Umwe constitutes will be lost and access by Ikwiriri township dwellers to the

remaining forest will increase. Lastly, we must mention the ratification by Tanzania of the Biodiversity Agreement, and of the high ecological interest of the coastal forests, which are one of the 25 hotspots in the world. In fact there should be further loss of coastal forest anywhere in East Africa.

Obviously, this project was designed on a geometrical basis, witjout any considerations for environmental values. It can (and must) be modified through a joint reflection on land use planning and involve a wide stakeholder community. Other less destructive (and quite more lucrative) alternatives are surely conceivable for the Ikwiriri influenced forest area. And at least, a serious and exhaustive environmental impact study should be carried out as it has been done for the pipeline project (cf. 4.2.5.2.). Anyway, this issue will have to be strongly taken into account in the next negotiations rounds, without losing sight of the existence, particularly in Umwe North, of a lobby defending this extension project and presenting it as a crucial item for the future.

4.2.5.2 Constraints induced by the big infrastructures projects

a) The Songas pipeline

The Songas (a private Canadian company) pipeline will conduct natural gas from Songo Songo island to a power plant in Dar es Salaam. The pipeline corridor on the main land is about 203 km long, extending from Somanga Fungu seashore to Wazo Hill Cement Factory. It is set to pass through the northeastern part of the forest, as shown on the following map.

An environmental impact study has been made, including recommendations for diminishing the impact of the project, particularly on high biodiversity value areas like Ngumburuni (Songas, 2003). This document advises to clear the vegetation in a strip of only about 15 – 20 m of the right-of-way, especially on the edge of the Ruhoi floodplain where the orchids occur. It also advises that, during construction, used lubricants, chemicals, machinery parts, plastic bottles and tins should be disposed off safely away from all habitats along the corridor. This issue must not be underestimated as hundreds of workers will be involved in the construction.

The construction roads and trails will also probably facilitate access to the eastern part of the forest and, consequently, it could increase the pressure on the natural resources, particularly timber.

The future forest management entity will have to take into account a particularly crucial item: the fires. If they damage the habitat, they can also cause havoc to the pipeline and the environment in case there are any accidental gas leaks (Songas, 2003). This event is very unlikely, but it may happen.

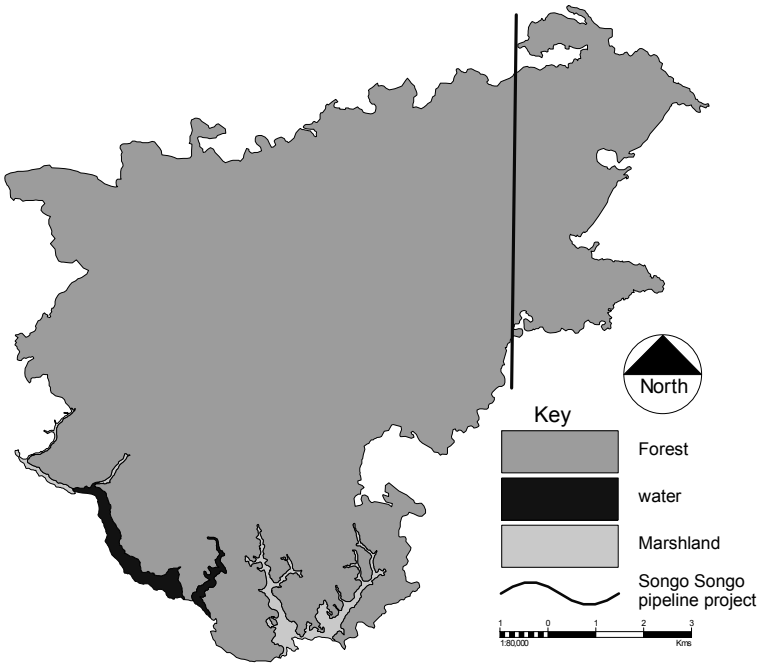


Figure 18: Position of the future Songas pipeline within the Ngumburuni forest

b) The new bridge over the Rufiji River

The new bridge, located a few kilometers south of Ikwiriri township, is likely to change the communication flow between the southern regions and Dar es Salaam. Life in Ikwiriri is likely to change too. Particularly, it could increase the population even more and, consequently, the pressure on the forest (confirming the Ikwiriri extension project lobby's opinion). Also it cannot be excluded that more illegal loggers or settlers coming from south of the River join in the pressures on Ngumburuni.

4.2.5.3 The forest-adjacent communities internal constraints

During the meetings and the interviews, we particularly strove to determine the degree of acceptability of the process of participatory forest management and to assess the people's motivation level for it. We questioned both leaders and villagers and, generally, the first reactions of almost each of them were tinged with suspicion. But after a first round of explanations, the opinions became full of nuances. And after three weeks of meetings (July 2003), we could draw up the following table.

Table 17: Community-based management process acceptance for all villages

(1: acceptance without major remarks; 2: acceptance with major remarks; 3: acceptance with doubts; 4: acceptance with unwillingness; 5: rejection)

Names of The villages	Degree of Acceptance	Details and observations
Muyuyu	1	In general, they agree with the process, but they have some issue with regard to the way they will be empowered. They are not trained for surveillance and they don't know how to formulate by-laws.
Umwe North	4	The proposals for a community-based forest management process were very negatively received. They think that they cannot get any land ownership except from RUBADA (Rufiji Basin Development Authority). So they don't believe that the District can give them the forest to be managed. They want to favour the development of Ikwiriri township, also to the East of Lake Umwe (cf. 4.2.4.1.). They plan to clear a big collective farm in the southern part of the forest (in fact, on both sides of the lake). They know that the District is controlling the forest, but they think that it has already failed. The council seems to be influenced by a few people involved in the agricultural development. We must add that they often talk about cash changing hands.
Umwe Centre	2	In general, they agree, but as Umwe North, they think about the extension of Ikwiriri in an easterly direction. The women don't seem to receive information from the men. In fact, all the councillors seem to agree with the chairman's points of view. They don't dare to express their own opinions. But, actually, they are aware of the condition of the forest and they are convinced that better management is indispensable. They also have some ideas for community-based management.
Umwe South	3	They do not really show that they are concerned by the process. Nevertheless, in general, they agree, but they mainly consider the potential benefits issues.
Mkupuka	3	In Mkupuka, there is a general feeling of fear of what could happen if the new management system was implemented. Nevertheless some people can see the interest of the process and in fact, they don't want to be left out of it. But they are doubtful about the means. The women are more aware of the benefits they can get from the forest (they gave the example of clay collection for pottery). Indeed, the women seem to take part in the forest activities more than in other villages (even charcoaling). Mkupuka people are not sure to be able to manage the forest efficiently, but some of them are already volunteering for guarding and patrolling. But they want the District to train them. Eventually, we can note it is relatively easy to assemble the Village Council.
Mangwi - Misimbo	3	The influence of the Divisional and Ward authorities are very much appreciated in that community. We could not meet the village councillors without them. But these leaders really agree with the process. The problem is that we could not really get the opinion of the villagers. Some of them are obviously waiting to meet the other villages before taking a firm decision. There are several levels of understanding: the older people seem to be more enthusiastic than the young. They can positively influence the process. The women able to speak are those involved in the

Names of The villages	Degree of Acceptance	Details and observations
		village government and they don't really make a choice.
Nyamtimba-Mbawa	5	The leaders (divisional secretary, ward staff and village councillors) appreciate the process. But there is a big misunderstanding between them and Mbawa villagers. The biggest doubts come from the youngest people. The older ones are more interested in participatory forest management. It seems that there is a political conflict for the leadership. The confidence between the chairman and the Mbawa villagers seems to be very poor. They feel negative about the administrative initiatives, especially village legislation. In addition they think they are outside the forest and that they are not concerned by the management. We can also note that no women were present. Thereafter, during a second meeting, the Mbawa people told us that they did not agree with the process. The conflict between the generations seems to be evident.

As shown in this table, Nyamtimba-Mbawa and Umwe North are the most problematic communities. Muyuyu and Umwe Centre are the most interested and the most aware of the forest issues. Between these two extremes, the other communities are rather in an expectant position. In particular, Mkupuka people feel that they are a bit out of the process and they want to know what the other villages are thinking about it. In fact, they fear to get only a very small part of the forest to manage. Nevertheless, they want to be part of the management process because most of them use the forest. But these opinions are not fixed and a few weeks after our meetings, we can note that the debate is going on within the villages and particularly in Mbawa where a more favourable position seems to appear.

4.2.6 Orientations suggested by the human context analysis

a) A need of intensive follow-up

Everybody, even the more sceptical people, is aware that the forest is in a bad condition and that it is really threatened if nothing is done. But, at this stage in the process, many people are still doubtful about the genuine commitment of the District to implement community-based management and to share the benefits. So the first recommendation could be to operate the process continuously in the next months in view of minimizing the awareness intervals among the different stakeholders and among the villagers. Village assemblies must be organised to give them more clarification and to remove any ambiguity. Some people from the REMP pilot villages (Another REMP activity) could be involved in awareness meetings, because they are already experienced in natural resources management.

b) The new management must allow the communities to make a livelihood and benefits

Through better management, people are mainly looking for secured livelihoods and the generation of benefits. The conservation of some ecologically rich parts of the forest is necessary, according to them, but a crucial item for its implementation will be to compensate for the illegal, but lucrative logging activity. Obviously, non-timber activities will not be sufficient, at least because they will concern less people than logging. A joint forest management system could be implemented, at least for the forest reserve, but the majority of the villagers is doubtful about the District's will to share the benefits with them.

c) The forest should be shared in village management areas

For the management in itself, the generally proposed system is a forest divided into village areas, managed by village committees, with an intervillage entity supervising the entire forest. The reflection about the management system should be developed around these proposals. But it must also include the necessity of specific activities areas (beekeeping, logging, plantation, conservation areas, etc.).

d) Guarding the forest will be a crucial item
Control and guarding will be crucial issues for the success of the process. The role of the scouts and the different rules must be formulated in by-laws. And information to the communities should be permanent (posters and signals inside the forest, involvement of the public in committee meetings, etc.). So, a basic investment is needed, at least to start the implementation of the management plan.

4.3 Discussion on the conditions for successful implementation of the participatory management in Ngumburuni

In a publication prepared for the seminar "Sustainable livelihoods in forestry" (Oxford, April 1999), the World Bank gave the conditions for a successful participatory forest management (World Bank, 1999). This paragraph aims to review these different key issues and to analyse them in the particular context of Ngumburuni described in III.1 and III.2. Indeed, as the World Bank is a potential supporter of the Ngumburuni process (cf. III.5 and IV), it will be interesting to estimate the level of tallying with the criteria of this institution.

4.3.1 At the political and institutional level

4.3.1.1 Is there a governmental will to experiment new forest policies and a political stability associated with confidence in the governmental structures?

As noted in Chapter I, Tanzania has started implementing a new forest policy (Forest Act, 2002). One of the most important parts of this new act deals with the participatory forest management and defines a legal framework to enforce it. Participatory management is also a key issue of the Rufiji Forest Action Plan, written with the help of REMP and approved by the District Council. As, in addition, the Land Act and the village political practices (possibility of formulating by-laws, etc.) are favourable, we can say that the political will and means really exist, even at the District level.

Political stability is also present in Tanzania, especially in comparison with most of the neighbouring countries. But, paradoxically, the level of confidence between the communities and the "authorities" is, in general, not very high. The explanation is probably historical and the Ujaama period has left its mark on the populations. This issue is not insoluble but the local authorities must make the effort to meet the communities as much as needed, to explain their new approach and raise their awareness on the potential of community involvement in forestry.

4.3.1.2 Does an institutional framework exist and are the forest authorities available?

As already noted, the new Forest Act and, locally, the Forest Action Plan are strong institutional tools. The main problem is probably the forest staff. They are totally aware of the condition of the forest and of its importance for the local communities. In addition, they generally agree with the new forest policy. They have been well supported by the first phase of REMP and could benefit from the second phase. But there is a lack of means, particularly financial, and consequently a lack of dynamism. Financial support will be a crucial condition for the success of the process. On the other hand, forestry staff are not very numerous and not especially trained for this new forestry approach. This lack of human resources and capacity will probably be the main weakness for the implementation of the Forest Action Plan.

4.3.1.3 Does coordination between the donors exist?

Several donors are involved in forestry development (Netherlands, Switzerland, Finland, Denmark, Norway and, of course the World Bank). There is no special coordination between them, but the Forest and Beekeeping Division (F.B.D.) is in charge of the contacts and the follow-up of these issues. Yet, basically, as environment is within the mandate of local government, the District staff must take the follow-up of the Rufiji forest affairs in hand.

4.3.2 At the social level

4.3.2.1 Are the stakeholders clearly identifiable? Have they got a common perception of the forest natural resources, at least partly?

Chapter 4.2 has shown the diversity of the stakeholders. Most of them have been identified. They are involved in the current forest activities to a variable degree, but generally, they consider that Ngumburuni is an important source of livelihood. Yet, there is a difference of perception between Ikwiriri (Umwe) people, who have a quasi-urban way of life, and the forest-adjacent villages. Umwe people are more worried about income issues than the others. But, almost all of the stakeholders are convinced that the forest is in bad condition, even if some of them, particularly in Umwe, wish to extend the agricultural encroachments.

4.3.2.2 Does a confidence exist between the forest users? Are they volunteers for the participatory management?

For the time being, there is no major conflict between the users about the forest and the level of confidence is not bad. The main problem comes from Mbawa sub-village which remains very doubtful about the process. There is a difference of opinion between them and the major village (Nyamtimba), where the authorities are rather favourable to the development of a management plan. The origin of this issue is obviously an internal power conflict. So we can hope that it will be solved.

Nevertheless, the demarcation of internal boundaries and the formulation of restricting by-laws could cause tensions among the communities. The general meeting planned for the end of September 2003 can contribute to alleviate the possible misunderstandings.

4.3.2.3 Are the communities able to formulate access and harvesting rules without being thwarted by the authorities?

As already noted, in Tanzania the local communities are enabled to formulate by-laws and this power is particularly well-adapted for a community-based forest management. But an important work of awareness raising and provision of information must still be done to facilitate the acceptance of the new system by the populations and the leadership.

The District authorities are totally involved in the process and they probably want to try sincerely to implement the process. Nevertheless, they will have to change some of their opinions, firmly rooted in their mind. Indeed, it will not be easy to give up a police attitude and to empower the communities without any ambiguity. They must also play the game and try to improve the law enforcement, particularly at the road checkpoints, where a stricter control of the wood transport should be carried out (especially with regard to ‘off-cuts’ of species that cannot be harvested such as Mninga).

4.3.2.4 Are the forest users ready to decrease timber harvesting before the start of the new management?

This issue has not been really discussed. It seems very difficult to stop these practices without guarding the forest, especially in this drought year. It is understandable that the people try to compensate for the lack of crops by harvesting timber. The District has forbidden the exploitation in Ngumburuni until a new management system is implemented but that is a decision that exists on paper only.

4.3.2.5 Do village organisations already exist?

Each village is governed by a Council enabled to formulate by-laws and to create committees. Some quite effective environment management committees have recently been constituted in the REMP pilot villages. Discussions about the creation of such committees have begun in the Ngumburuni-adjacent villages. Environment committees would be adequate because their mandate would be larger than the one of simple forest committees. Indeed, their mandate could include wildlife management, tourism and agricultural issues. In fact the Village Councils (and the Village Assembly) would remain the decision-makers. The environment committees would be their

technical branch, especially in charge of the management of the natural resources, including the forest.

The experience of the pilot villages is likely to be successfully reproduced around Ngumburuni, However, the real challenge will be to organise an inter-village committee, that would be representative of the various wishes concerning the uses of the forest and be able to enforce the commonly agreed rules.

4.3.3 At the forestry level

4.3.3.1 Are the stakeholders aware that the forest is threatened and that a management has become necessary?

Most of the stakeholders, villagers, authorities and economic operators, are convinced that the natural resources, wood, fauna, habitats, have decreased in Ngumburuni. They are aware that charcoaling, excessive (legal and illegal) harvesting, etc. are the most damaging uses. That is why they, in general, have a pessimistic opinion about the future of the forest. Nevertheless, some of the villagers think that appropriate management could improve the condition of the forest. Since the first round of meetings in July, the idea of a C.B.F.M. has gained ground among the communities.

4.3.3.2 Is the forest small enough to allow the users to know the boundaries, the forest itself and its potentials?

With an area of 10 000 ha, the forest is well-grasped by most of the stakeholders. But, paradoxically, very few of them have a precise idea of the external boundaries which should be demarcated. In this report we propose to include the entire surveyed area, but of course, the decision will be taken by the communities and the District.

On the other hand, the villagers have a good knowledge of the natural resources and of their uses. They will probably be able to formulate appropriate rules. Yet, the main challenge for hem will be to consider the forest not only as a source of income and benefits, but also as a common heritage which they must manage in a sustainable way, i.e. to reconcile their legitimate livelihood aspirations and the necessary conservation of this heritage.

4.3.4 By way of conclusion: is participatory management possible in Ngumburuni?

According to this short analysis, no major obstacle should hamper the implementation of a community-based (or a joint) forest management in Ngumburuni. The political and institutional tools exist and the communities are now convinced of the necessity of changing the rules if they want to continue to benefit from their environment. Nevertheless, we have also pointed out some issues which must be solved for a successful implementation of the process. One of the most important is probably the establishment of trusting relationships between the communities and the authorities. The proposals for the development of the future management plan will take into account the conditions and observations mentioned previously.

4.4 Framework for the development of the management plan

In accordance to the spirit of the participatory process, this framework does not aim to formulate the Ngumburuni forest management plan. The formulation of the management plan is first and foremost the task of the forest user communities, supported by technical backstopping by the District Council staff. For successful implementation it is essential that the communities can make their own choices. Still, in order to make informed decisions they need to have full knowledge of the facts. Therefore, the main goal here is to provide the decision-makers that will be appointed by the communities with a framework for the development of the management plan. This framework is constructed on the basis of the results of the previous analyses during the fieldwork in the area over the past months. Particular attention has been paid to the incorporation of the observations, remarks and wishes expressed by the communities. The framework also incorporates the recommendations of the Rufiji Forest Action Plan as approved by the Rufiji District Council and of the Community-based forest management guidelines developed by the Ministry of Natural

Resources and Tourism.

The main principles for formulating the management plan should be simplicity and conciseness, because it must be a document of action, implemented by people not particularly experienced in forestry. Therefore in the present document we examine a range of management possibilities, in view of providing the stakeholders with a maximum of elements to base their decisions on. But it should be borne in mind that the final plan will have to be brief and easy to implement. Nevertheless, the outline of the framework can, and probably should, be used for the writing of the operational management plan.

This document covers the entire forest and woodland area surveyed during the participatory forest management process (see map).

4.4.1 Background and management objectives

The plan must include a first part describing the background: the forest, the communities and the uses. It should also state the management objectives. For the descriptive part all the elements provided in chapters 4.1 and 4.2 of the current report can be used. In this section, we will just expose the information that is likely to facilitate the formulation of the purposes of putting the forest under management.

As a result of the discussions with the different stakeholders, it appears clearly that the communities have expectations about benefits and livelihood support from the forest. The analyses of the state of the forest and of the interviews with stakeholders has shown that the management will have to combine conservation objectives with sustainable production objectives. Consequently, the main management objectives are likely to be found among the following wider themes:

- establishment of the forest ownership and demarcation;
- protection and conservation (of the coastal forest patches, in particular);
- production for livelihood support;
- generation of financial benefits;
- regulation of the forest use in order to ensure sustainability.

4.4.2 Scenarios for the management system

Two general options have been discussed with the stakeholders: a community-based forest management (C.B.F.M.) and a joint forest management (J.F.M.). The choice will be made after a round of negotiations, but basically, there are three possibilities:

- a C.B.F.M. for the entire forest and woodland block;
- a J.F.M. for the entire forest and woodland block;
- a mixed system with areas under C.B.F.M. and others under J.F.M. as suggested in the Rufiji District Forest Action Plan.

Indeed, the current situation of Ngumburuni does not leave the District Council with any other option but to share the management and therefore the benefits with the local stakeholders. In fact, for the District Council, the choice can be summarised with a quip: either to accept (for example) 20 % of the benefits in the case of a joint management or to lose 100 % of the benefits in a few years if no management is implemented.

Even if J.F.M. is considered the preferred option by the District, it is not well received by the communities. From the stakeholder analysis it is clear that the communities do not have confidence in the management capacity of the authorities. The experience elsewhere in Tanzania also suggests that J.F.M. has been less successful than C.B.F.M.

The advantages and drawbacks of the three main management systems can be summarised as follows:

Table 18: Comparison of the advantages / drawbacks of C.B.F.M., J.F.M. and a mixed system

	Advantages	Drawbacks
C.B.F.M. for the entire forest and woodland block	• The responsibility is not shared. • The communities feel really empowered. • The communities get all the benefits.	• Conservation may be more problematical: what immediate benefits can the communities derive from it? • The communities need more training and support.
J.F.M. for the entire forest and woodland block	• The management will benefit from the authority of the District. • The communities will benefit from the forestry experience of the District staff. • The conservation of the protected areas should in theory be more effective.	• The communities may not feel sufficiently empowered. They would probably believe that the District wants to own a larger chunk of forest at their expense. • Difficulties for sharing benefits and duties.
Mixed system C.B.F.M. + J.F.M.	• The conservation of the protected J.F.M. areas should be more effective. • The communities will manage and benefit from their own forest areas. • The communities will benefit from the forestry experience of the District staff.	• Risk of confusion: who will appear as the real manager ? • Difficulties for sharing benefits and duties in the J.F.M. areas.

In fact, the choice among these options will mostly depend on the degree of confidence, which will be established between the District authorities and the villagers and maybe between the villagers themselves. It should be noted that under full implementation of the District Forest Action Plan the role of the communities in forest management should expand considerably in the District thus liberating the forest officers from some of their current tasks. This could make their supportive role more effective and result in an increased presence in the field, thus increasing the confidence of the communities in their management capacity. The next round of participatory meetings will be crucial in determining a management system that is in accordance with the will of the communities and that specifies the role and the duties of each party.

Whatever the choice may be, the management authority will most probably have to be exercised at two levels, according to the recommendations of most of the villagers. Thus, each village should appoint its own environment committee, for example through election by the Village Assembly and with endorsement by the Village Council. The composition of the Village Environment Committee will have to be defined carefully, so that the sub-villages, especially those located inside or close to the forest, will be adequately represented. Lessons on this can be drawn from the REMP experience in the pilot villages. As a rule a minimum quota of women representatives should also be guaranteed, this in accordance with the legitimate request of most of the women interviewed. The women are important stakeholders and users of the forest and they are to be given management responsibility.

The responsibilities and powers of the Village Environment Committees, with regard to forest issues should be defined and the relationship of the committees to their respective Village Councils clearly stated. The frequency of the meetings, the quorum (at least 50 %), and the best way to record minutes, will also need to be determined.

As seven villages (Mangwi, Mkupuka, Muyuyu, Nyamtimba, Umwe Centre, North and South) are

involved in the participatory forest management process, a supervising and coordinating committee is indispensable. Its main goal will be to harmonize the actions of all the Village Environment Committees and to keep a general overview on all the forest management. This inter-village (or ecosystem management) committee should also be more powerful in dealing with the relationships with the different authorities and outside stakeholders. It should be composed of representatives elected by each Village Environment Committee. If a joint management option is chosen, representatives of the District should also be members. Some functions (guarding for example), should be handled by the Village Environment Committees so it needs setting out in the plan how these will report to the inter-village committee.

For efficient management the coordination between the different entities is essential. Also, reporting will be crucial. Thus, the Village Environment Committees should periodically report in writing to the Village Councils and to the inter-village committee (which, district-wide, could be formed by groups of villages using the same functional ecosystem unit, e.g. a lake or a forest rather than the more administrative ward structure). In the case of a J.F.M., copies of reports should also go to the District foresters. Even in the case of C.B.F.M. an information flow from the communities to the District technical staff would be preferable. Communication on matters on mutual interest should be organised at the inter-village committee level and special meetings could be set up especially for it.

At each level, record books should be used to store the information, decisions and events dealing with the forest management and other environmental issues. For example, likely record books will include minutes, offences and fines, and have receipt, permit, patrol and account books.

The following figure summarises (in a non-exhaustive way) what could be the Ngumburuni forest management system.

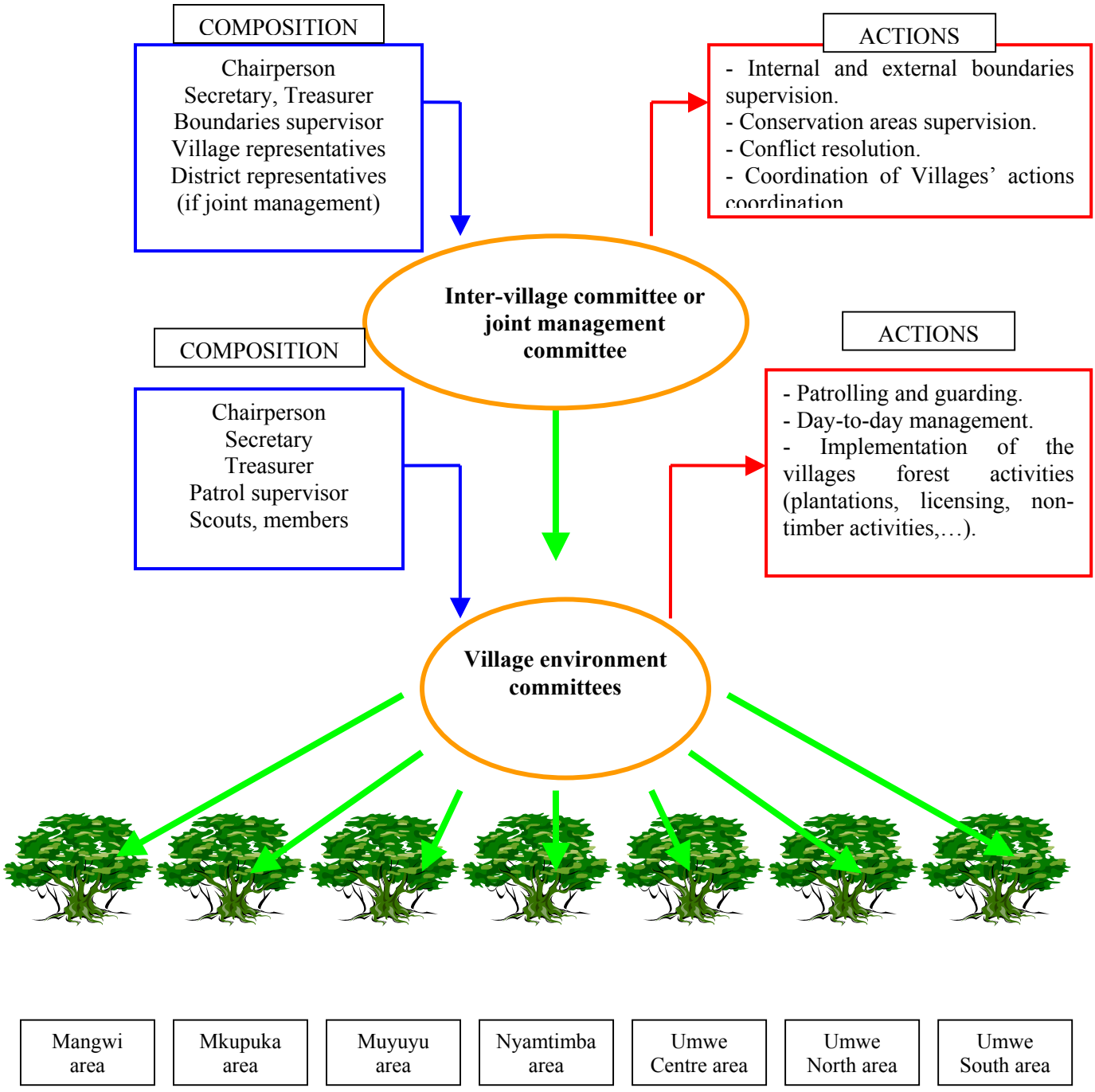


Figure 19: A possible Ngumburuni management diagram, based upon most of the stakeholders' requests

A crucial item in the implementation of the management will be the financial management. The plan must clearly set out how it expects any funds to be handled. As shown in figure 17, this will be the function of the treasurers. But their task should be based upon precise guidelines mentioning:

- who will levy fines and fees;
- who will hold the money;
- where the money will be kept safely;
- to whom and how often all funds received must be reported;
- the list of permitted expenditure.

Maximum transparency should be the fundamental rule of the financial management and any villagers should be able to access the record books if they would request it. The money from forest management may be spent on items directly linked to the forest issues (guarding or planting trees for example). But, as requested by the people, there must also be some direct benefits so that the forest contributes to poverty alleviation.

4.4.3 Demarcation and supervision of the boundaries

According to the different meetings in the villages, the establishment of the boundaries will not be an easy process and disputes are likely to arise. Basically, it will need joint meetings in the field involving all the neighbouring communities. This work will be facilitated by the use of a GPS, the map included in this report and its digital formats (with the help of the District staff) which can become the Geographic Information System (GIS) of the area.

The first task will be to demarcate the external boundaries. We have noted during the interviews that a majority suggests including the entire surveyed area as the basic management unit. However, as a prerequisite, the issue of the proposed extension of Ikwiriri (Umwe North) to the East of Lake Umwe will have to be resolved. This first step is crucial and an agreement must be reached by all parties, otherwise the unresolved problems will arise again later.

The second step will be the demarcation of internal management boundaries. Indeed, as the forest is likely to be managed on a village basis, it will be indispensable to fix the boundaries between the different village areas. Each village should be responsible for agreeing its own boundaries, but of course, in agreement with the neighbours. If some areas are under joint forest management, their boundaries must be demarcated in common with the District. It could also be useful to precisely demarcate the existing in-forest and near-forest settlements. Forcibly removing them should be avoided because their inhabitants have been living in those places for a long time and their knowledge and continuous presence will be useful for the management. Nevertheless, it will be essential to agree with the farmers on the limits beyond which their cropping activities will be banned. Special areas, particularly the plantation sites, should also be carefully demarcated.

Inside the village areas, sub-divisions corresponding to management zones (conservation areas, various use areas, etc.) will have to be defined. The purpose of each area will be precisely and carefully described.

In practice, marking the boundaries should be done for example by painted markings on trees. Each sign will have to be recorded by GPS and eventually downloaded in the digital map file, so that it will be possible to join a thorough and comprehensive printed map to the management plan. The best way to organise and supervise the work is to appoint a boundary supervisor, as suggested in figure 1.

Those initial demarcations will have to be regularly maintained and controlled. This will be the function of the scouts, under the responsibility of the boundary supervisor.

Yet, those boundaries need to be officially recognized. According to the usual gazettement process, after the village level agreement, the villagers will have to send their proposal to the District

Council who will submit it to the Ministry of Natural Resources and Tourism for approval. This process is likely to be long and can take several months. The committee Chairman and the District staff will have to keep a careful eye on the unfolding of the process. As the experience in other parts of the District has shown excessive delays lead to discouragement and loss of momentum, detrimental to the management. The swift approval of the bylaws proposed by the communities is probably the most crucial step.

4.4.4 Protection, guarding and enforcement of rules

The most crucial item for the success of the management plan is the protection of the forest. Most of the interviewed people suggest organising patrol teams, with voluntary scouts selected in each village. During the surveys some volunteers have already proposed their services and local knowledge of the area, the tree species and their uses was often very impressive. Guarding is essential but it must be supported by clearly formulated rules.

According to the C.B.F.M. guidelines, we can divide those rules in three categories.

Access rules. This category will aim to define who may use the forest. In particular, the communities will have to decide if outsiders will be allowed or not to enter the forest, and if yes, under which conditions and for which uses. All this without losing sight of the current bad condition of the forest, caused by its effectively open access nature. They will also have to decide if each village must exclusively use its own managed area or if access to the other parts can be permitted. Perhaps such inter-village access could be limited to a restricted set of activities which would require the permission of the inter-village committee.

Uses rules. Their main goal is to set out the authorised, restricted and forbidden uses. In addition, the plan must specify the uses permitted only on licenses with fees, those permitted on the issue of domestic user permits and those freely allowed for community members. Table 2 can assist in the communities' choice as it makes an assessment of the potential forest uses and of their effects, according to the elements presented in the analyses in the full survey report.

Other rules. For example, rules in order to reduce the fires. Fires should be strictly controlled and totally banned in some places, especially in the secondary coastal forest patches. Special rules could also be formulated for hunting or tourism if necessary. A decision should be also taken about charcoal burning. As noted in the full report, this is a very destructive activity. At least, if it is not possible to totally forbid it, the rules should specify the authorised species (avoiding the more valuable ones) and ban this activity in the more sensitive parts of the forest.

Table 19: List of the potential uses, ranking their effects on the forest

Potential Forest uses	Should be stopped because highly damaging	Could be sustained if limited	Could be increased because less damaging	Indifferent
Timber	x (in coastal forest patches)	x (in Miombo patches)		
Charcoal burning	x			
Settlements in the forest	x			
Shifting cultivation	x			
Fuelwood collection		x		
Beekeeping			x	
Wild honey collection			x	
Fruits, mushrooms and edible plants collection			x	
Building poles collection		x		

Potential Forest uses	Should be stopped because highly damaging	Could be sustained if limited	Could be increased because less damaging	Indifferent
Roofing materials collection		x (if palms)		x (if thatching materials)
Weaving and dying materials			x	
Medicine collection		x (roots and barks)		x (leaves)
Hunting		x		
Firing for hunting and clearing skidding areas	x			
Clay for pottery		x		
Tourism		x (has not been tried)		
Butterfly farming			x (has not been tried)	
Tambiko and ritual uses				x

Rules will be respected only if information and awareness raising are efficient, but also if the punishments are a sufficient deterrent. So the plan must set out what will be the punishments placed upon the offenders. The most common idea, suggested by a majority of interviewed people is to give them fines. The rates should be fixed by the management committees, under the control of the Villages Councils. A harmonization is necessary at the inter-village level.

However, poverty is surely one of the main causes for offences. From the villagers' point of view, poverty is an every day and short-term issue and vital needs often lead simple people to be offenders. Consequently, to send offenders consistently to the police or to the District Court, as it is often suggested, is not a very constructive solution. That is why the plan should probably emphasize non-financial punishments. For example, the offenders could be required to plant trees or to maintain trails in the forest. This kind of sanction has also the advantage of being educational. Anyway, the full punishment outlay must be clearly described in the plan so that the scouts and the management authorities can apply them without any ambiguity. The bylaws formalising these arrangements need to be approved by the District Council.

As protection is usually the heaviest task of C.B.F.M., the plan must also set out how it must be organised and carried out. At first, the scouts must be appointed, after election or on a voluntary basis. The management committee must decide the extent and duration of their mandate, the limits of their action and how to check on their performance (and consequently, how to deal with scouts who abuse of their status, or on the contrary, how to reward them for a beneficial intervention). The size and the frequency of the patrols should also be made explicit.

Yet, even if an efficient protection is carried out, the inter-village committee will have to draw the authorities' attention to illegal practices which they fail to effectively stamp out (e.g. wood smuggling, so-called off-cuts that in fact newly felled trees). The inter-village committee can put pressure on the District and or National authorities so that they will join in the hunt and efficiently apprehend and deal with the persistent offenders.

4.4.5 Development of forestry actions

This part of the plan will list and describe any actions aiming to rehabilitate the forest and to

develop its potential. Many possibilities are presented here, often suggested by the analysis of the stakeholder interviews, but they are also based on the results of the forest inventory work. The communities and the District forest office will have to choose their own priorities among those listed and probably to improve, adapt and mature them.

According to the objectives given, the main lines of thinking proposed for the development of forestry actions will try to combine the necessary conservation of the richest parts of the forest with the legitimate expectations of the stakeholders. Thus, if some suggestions are likely to add constraints to the villagers' habits, some others will try to compensate for such constraints by providing alternatives. Proposals such as the as creation of plantations, harvesting plans for the species that are still available or the development of non-timber activities, will clearly aim to bring benefits to the communities.

4.4.5.1 Conservation zones and restoration of disturbed areas

Effective Joint Forest Management agreements between communities and District could be particularly appropriate for the conservation of the high biodiversity value areas (the highest quality coastal forest patches). Indeed, the alliance between the communities' in-field control and the official authority of the District, always respected even if it is denigrated, should be efficient.

Non-destructive activities and low-impact rules

Considering the high ecological value of the coastal forests, it would be the best if only non-destructive activities were allowed inside. But such a rule would be a real constraint for the communities, because the coastal forest represents 72 % of the forest area. The plan must define conservation areas, yet harvesting mature Mnangu (*Hymenaea verrucosa*) could be allowed inside on the previously described basis. The harvesting should follow low impact exploitation rules, for example:

- to use the existing trails as much as possible;
- to fell the trees in a direction which limits the damages;
- to prohibit fuel deposits
- to prohibit pit-sawing in the conservation areas.

Favouring regeneration

Subject to these precautions, the exploitation of a small number of very mature trees (about 2 stems/ha) could also favour the regeneration without disturbing the ecosystems too much. In fact, harvesting in those area must be organised as a real silvicultural operation. The notion of conservation, accepted with difficulty by the communities, could be thus well thought of, especially since the conservation areas can also be used for non-timber activities.

Restoration and enrichment planting

In the secondary or disturbed coastal forest, restoration can be considered. Enrichment planting could be part of the solution and a percentage of the income could be devoted to it. Enrichment planting has commonly been used for increasing the timber volume and the economic value of the secondary forests. The conditions for a successful operation include the provision of adequate light conditions, proper supervision and maintenance. Enrichment planting can be in lines or in patches. Scattered single seedlings or saplings must be avoided because they are generally suppressed by competition (Anonymous, 2002 c). Local high value species should be chosen for enrichment planting. For example, reintroducing Mvule (*Milicia exelsa*) could be interesting because, formerly, this species used to be abundant in Ngumburuni. So the site is favourable and Mvule can grow both in Miombo and in coastal forest. In addition, in favourable circumstances it is an evergreen tree, which will have a beneficial effect on the ecosystem. Unfortunately it does not have a rapid growth in height. Mkongo (*Afzelia quanzensis*) is also an adequate species. In addition, we can note that, as Mkongo is still well represented in Ngumburuni, it will be essential to keep mature trees for seeding.

4.4.5.2 Maintenance of a fauna corridor

The Ruhoi River floodplain is not favourable for flood cultivation, because the water, which has a geothermic origin, is too salty. In fact, this area should be conserved, and particularly the riverine forest strips. Indeed, those riverine forests are shelters for birds and they contain a high biodiversity. Medicines and edible fruits are collected there. Most of the Ngumburuni timber tree species are represented in the strips. In addition, this floodplain is a natural corridor for the fauna, particularly the elephants and the buffalos. But, in order to be efficient in the long term, this corridor must have a continuation in the neighbouring Ruhoi Forest Reserve and on towards the Selous Game Reserve. The maintenance of favourable conditions for wildlife migration can both increase the touristic values and the potential for bushmeat harvesting. With the increasing traffic on the main coastal road Dar es Salaam Mtwara there will be an increase in accidents caused by collisions between migrating wildlife and transport vehicles. A study on the creation of a passage for the animals, preferably below the road on both sides of the Ruhoi floodplain (north and south) should be accorded a high priority. This tunnel should be linked to the Ngumburuni and Ruhoi forests by well- maintained forest corridors that are attractive to migrating animals. Examples exist in South Africa and Zimbabwe.

4.4.5.3 Fire control, fire management

A moratorium on fires in the forest areas

Fires early in the dry season (which burn at relatively low temperature) and on a rotational basis e.g. every 3 or 4 years for a specific patch are acceptable and some typical Miombo species like Mninga (*Pterocarpus angolensis*) have developed with fires as part of their natural ecosystem. The thick bark of Mninga, which looks like a crocodile skin, is a natural protection against fire. But if repeated all along the dry season and every year, the fires hamper the regeneration by destroying saplings, and they undervalue the wood because they cause flaws in it. Periods of around three or four years without fire should be the rule in Miombo and inspiration could be taken from the fire management in the Selous Game Reserve.

The secondary and disturbed coastal forests are also prone to fire but they must absolutely be protected against it. Care should be taken to avoid spreading of controlled fires from the Miombo to the forest. Prevention and early stoppage of fires are also essential to the development of non-timber activities like beekeeping.

Information, control and surveillance are the keys

It would be the best if the management committee could impose a total fire ban, at least during the first five years of the implementation of the plan. An awareness campaign on the benefits of stopping the unregulated use of fire is important.

4.4.5.4 A wise and controlled timber activity

As noted by all the stakeholders, unplanned timber harvesting is currently one of the most damaging activities in Ngumburuni. This paragraph aims to determine the timber harvesting potential and to give recommendations, based on technical elements, to the decision-makers.

First of all, it is important to agree on the Minimum harvesting DBH (Diameter at Breast Height, 1.3m above the ground) of the timber species recorded during the Ngumburuni inventory. They are given in Table 3. The proposed diameters have been determined by comparing the official recommendations given by the Forest Rules, which have been considered as a minimum level, and the results and data of the REMP technical report dealing with other Rufiji forests (Malimbwi, 2000). Malimbwi's recommendations are often stricter than the Forest Rules, particularly concerning the naturally small size species (*Millettia stuhlmannii, Dalbergia melanoxylon, Markhamia lutea*). For these he recommends to consistently adopt 40 cm. Considering the deteriorated condition of the forest they are the only realistic option. For example, Government's recommendation (Forest Rules) for Mpingo is 20 cm and Malimbwi's one is 40 cm. In such a case, we have adopted the second diameter for our study.

Table 20: Minimum felling DBH for the main commercial tree species (Forest rules – Government notices n° 462 and 463 – 1996; Malimbwi, 2000)

Name of species (vernacular)	Name of species (scientific)	Minimum harvesting DBH (cm)
Mdadarika	*Newtonia sp.*	50
Mkongo	*Afzelia quanzensis*	60
Mkwaju	*Tamarindus indica*	60
Mkweanyani / Ngude	*Sterculia appendiculata*	50
Mlopolopo	*Trichilia emetica*	40
Mmangangwaru	*Afrormosia angolensis*	50
Mnangu	*Hymenaea verrucosa*	50
Mndundu	*Cordyla africana*	50
Mngongo	*Sclerocarya birrea*	50
Mninga	*Pterocarpus angolensis*	60
Mnondondo	*Xeroderris stuhlmanii*	60
Mpangapanga / Mnyamwea	*Millettia stuhlmannii*	40
Mpingo	*Dalbergia melanoxylon*	40
Mpugupugu	*Markhamia lutea*	40
Msufi Pori / Mkunya	*Bombax rhodognaphalon*	60
Mtanga	*Albizia versicolor*	50
Mtaranda / Mtalawanda	*Markhamia obtusifolia*	40
Mtasi	*Baphia kirkii*	50
Mtondoro	*Julbernardia globiflora*	40
Myombo	*Brachystegia spiciformis*	40
Nyamakwenge	*Amblygonocarpus andongensis*	50

Using the distribution of timber tree species by size classes and the frequency of the regeneration in the 44 sample plots, we have drawn up the list of the species, which do not qualify for harvesting under the following criteria:

- less than 1 harvestable stem/ha (according to the minimum DBH shown in previous table 3)
- absence of regeneration in at least 90 % of the sample plots.

The results are shown in the Table 21.

Table 21: Timber species that do not qualify for harvesting in Ngumburuni

Name of species (vernacular)	Name of species (scientific)	Justification
Mdadarika	*Newtonia sp.*	No harvestable size, no regeneration
Mkongo	*Afzelia quanzensis*	No harvestable size, but if protected, good potential for the future
Mkwaju	*Tamarindus indica*	No harvestable size and only few regeneration stems in Miombo
Mkweanyani / Ngude	*Sterculia appendiculata*	To few mature trees, no regeneration
Mlopolopo	*Trichilia emetica*	To few mature trees and only few regeneration stems, but if protected, good potential for the future
Mmangangwaru	*Afrormosia angolensis*	No harvestable size, no regeneration
Mndundu	*Cordyla africana*	No harvestable size, no regeneration
Mngongo	*Sclerocarya birrea*	No harvestable size, no regeneration
Mninga	*Pterocarpus angolensis*	No harvestable size, no regeneration, endangered and forbidden by District rules
Mnondondo	*Xeroderris stuhlmannii*	No harvestable size, no regeneration
Mpangapanga / Mnyamwea	*Millettia stuhlmannii*	No harvestable size

Name of species (vernacular)	Name of species (scientific)	Justification
Mpingo	*Dalbergia melanoxylon*	No harvestable size, no regeneration, endangered, likely to be commercially extinct
Mpugupugu	*Markhamia lutea*	No harvestable size
Msufi Pori / Mkunya	*Bombax rhodognaphalon*	No harvestable size, no regeneration
Mtaranda / Mtalawanda	*Markhamia obtusifolia*	No harvestable size and only few regeneration stems
Mtasi	*Baphia kirkii*	No harvestable size, but if protected, good potential for the future
Myombo	*Brachystegia spiciformis*	No harvestable size, no regeneration
Nyamakwenge	*Amblygonocarpus andongensis*	No regeneration

The results speak volumes about the exhausted condition of the forest. Indeed, only three species qualify for harvesting: Mnangu (*Hymenaea verrucosa*), both in Miombo woodland and coastal forests, Mtanga (*Albizia versicolor*) and Mtondoro (*Julbernardia globiflora*) in Miombo. The first one is in class V and the two others are in class III. Nevertheless, three other species have a good potential for the future: Mtasi (*Baphia kirkii*), Mkongo (*Afzelia quanzensis*) and Mlopolopo (*Trichilia emetica*). If they are protected during the implementation of this plan, they could qualify for harvesting in the next one. An inventory, targeting these species in particular, should be done at the end of this planning period to evaluate the harvesting possibilities. Their regeneration should be protected by management intervention such as fire protection.

Consequently, in this framework document we only propose a harvesting plan for the three qualified species. Since there are no growth and yield data for the different forest types in Rufiji (Malimbwi, 2000), we have chosen to develop a harvesting plan by annual cuts using area control. The annual cut is calculated as:

AC = A / R

AC: annual cut (ha/year)
A: area (ha)
R: Rotation age (years); R = 30

The lack of data led us to adopt a hypothetical rotation age of 60 years assumed in 30 years (1/2 rotation age) felling cycles for both Miombo and coastal forests. This hypothesis, which seems credible, is generally used by the foresters working in Rufiji (Malimbwi, 2000). Table 22 shows the area for each vegetation type and the annual cut calculated with the previous formula.

Table 22: Annual cuts in each vegetation unit

Vegetation type	Area (ha)	Annual cut (ha/year)
Coastal forest	7208.91	240
Miombo	1579.06	53

Each year, Mtanga (*Albizia versicolor*) and Mtondoro (*Julbernardia globiflora*) will be harvested in Miombo in 53 ha areas. Mnangu (*Hymenaea verrucosa*) will be harvested in 240 ha areas only in coastal forest patches, which are the natural ecosystem of this species. Mnangu is also present in Miombo, but the inventory results show that only one diameter class is well represented. Consequently, Table 23 shows the allowable cuts for those three timber species.

Table 23: Harvesting plan for the qualified timber species

Species name	Rotation age (years)	Minimum felling DBH (cm)	Allowable cut			
			Stocking (stems/ha) *	Stems/annual cut	Volume (m^3/ha) *	Volume/annual cut (m^3)
Mnangu (*Hymenaea verrucosa*)	60	50	2.1	504	8.01	1922
Mtondoro (*Julbernardia globiflora*)	60	40	1.3	69	10.14	537
Mtanga (*Albizia versicolor*)	60	50	1.3	69	4.14	219

According to the recommendations of the Rufiji Forest Action Plan, it will be in the interest of the management committee to impose full-tree licensing, i.e. to sell the permits on the basis of the full-tree volume. Consequently, the income potentially generated by licensing the three qualified species can be calculated on the basis of the official Forest Rules fees (Anonymous, 2001 a).

Table 24*:* Income per year likely to be generated by the full-tree licensing

Name of species	Class	Fee per cubic metre Tsh ($)	Volume/annual cut (full tree licensing) m^3	Annual Income Tsh ($)
Mnangu (*Hymenaea verrucosa*)	V	10,000 (9.70)	1922	19,220,000 (18,643)
Mtondoro (*Julbernardia globiflora*)	III	30,000 (29.10)	537	17,190,000 (15,627)
Mtanga (*Albizia versicolor*)	III	30,000 (29.10)	219	6,570,000 (6373)
Total				42,980,000 (41,728)

The potential annual income, reaching almost 43 MTsh, is not exceptional, but, if judiciously used, it could help the communities to equip themselves with basic amenities. Of course, it can also help them to control and manage the forest in a sustainable way, with the hope that more species will qualify for harvesting in the next plan. If the species are adequately protected during the present one that hope is not vain.

Indeed, the implementation of such a restricted harvesting plan implies that the committees strictly manage the logging activity. They must have their own hammer and provide the guards with the means to organise an efficient control of the harvested species and volumes.

4.4.5.5 Pole harvesting

The collection of poles is part of the day-to-day life of the forest-adjacent communities. Nevertheless, this activity should respect several rules. At first, the harvesting of valuable tree species should be totally prohibited, because it threatens the regeneration and thus the future value of the forest. Therefore, the plan will have to mention that the collection of poles will be limited to non-valuable tree and shrub species. This activity should also be banned from the conservation areas.

The issue of the commercial harvesting stays open. The communities will have to decide if they want to maintain this possibility. If yes, they will have to fix fees payable on these products and to strictly control the species harvested. But, for the use of poles for local consumption, it would be

preferable to maintain this activity as free of charge, as it has been asked by a majority of the interviewees.

4.4.5.6 Energy issues

Limiting fuel-wood collection in the conservation areas
Fuel wood collection should be avoided in the conservation areas. This measure should be easy to implement as the women, who collect the most of the firewood, generally avoid going into the deepest parts of the forest, which have the biggest conservation potential. Dry wood collection can be allowed elsewhere, particularly in Miombo and this activity should remain free of charge for the local communities. The collection of firewood contributes to the reduction of the fire hazard and therefore contributes to managament.

Development of alternatives
The plan should propose innovation and diversification for the fuel-wood supply issue. Thus, progressively, alternative solutions can complete the fuel-wood collection in the forest with the aim of diminishing the pressure on the natural resource. A first solution could be to progressively cut down the senile cashew trees, which are abundant around the forest. These can then be used for firewood. They could be replaced by fast growing fuel-wood species like for example *Cassia siamea*.

We have estimated the area to be planted for satisfying different percentages of the communities' need for fuel-wood.

a) Estimate of the total need for fuel-wood
The total population of the seven villages is about 13,400. As it grows by 2.2 % annually (Collective, 2001 g), we can expect a population of 17,000 by 2014 (for a management plan 2004 – 2014). The average annual consumption of fuel wood *per capita,* determined in Ikwiriri, is 523 kg (Collective, 2001 g). Then the total annual need for fuel wood in 2014 will be 17,000 x 523 = 8,891,000 kg.

b) Estimate of the quantity of fuel-wood produced by *Cassia siamea*
When we studied a *Cassia siamea* planted forest in Cameroon, we determined that an average of 3,5 trees of 4 metres high could produce a 40 kg bundle of fuel-wood (branches only). This quantity represents 2,5 – 3 days of consumption for a family of ten persons (Durand *et al.,* 2003).

c) Calculation of the area to be planted
If the communities want to satisfy 2 % of their fuel-wood need from the *Cassia* plantations, this will represent 177,820 kg, i.e. 4445 x 40 kg bundles. This quantity can be provided by 3,5 x 4445 = 15,557 trees. If the density of plantation is at least 300 stems per hectare, the annual cut area will be 15,557 / 300 = 52 ha. With a rotation of 5 years, the total planted area would need to be 260 ha.

This calculation has been made for several percentages:

Table 25: Percentages of the fuel wood supply for various planted areas of Cassia siamea

Planted area (ha)	Percentage of the fuel wood consumption
260	2
650	5
1300	10

As shown in Table 25, plantations can satisfy only a small part of the fuel-wood needs. Non-timber branches of the exploited trees can also be used. Indeed they are often abandoned in the forest. The harvesting rules formulated in the plan could force the loggers to put the off-cuts at the communities' disposal.

An agreement concerning the sawmill residues could also be attempted by the inter-village committee. These residues are already used in Ikwiriri. The quantities, produced by three sawmills, and consumed by the township for fuel wood and charcoal production are respectively 1193 t and 612 t (Collective, 2001 g). If all the sawmills are involved and if a precise agreement is formulated between them and the communities, the residues can significantly contribute to the energy supply.

As suggested in table 18, charcoal burning should be prohibited in all of the managed forest. As a compensation, charcoal areas can be demarcated in each village, but outside of the managed block. Indeed, open Miombo and woodlands are available around each village. Nevertheless, this activity should follow strict rules:

- to be forbidden for outsiders;
- the most valuable timber species should be avoided;
- the charcoal burners must avoid to clear their entire working area and particularly, they must conserve seeding trees.

4.4.5.7 The multi-purpose role of plantations

Plantations are part of the strategy for helping the communities appropriate the new management system. They can be considered as compensations for the constraints caused by the creation of conservation areas.

Preference for local species

The species to be used should have a traditional economic value or be suitable for existing or potential activities. In addition, these species should be adapted to the local environment and able to tolerate the unfavourable conditions which can be found in the degraded areas. The main targeted uses will be: timber, poles and fuel wood production and restoration of degraded areas. As noted in most of the interviews, the communities have a preference for planting local species. In view of spreading the harvesting periods, it could be judicious to create mixed plantations using different species, for example:

- Mtanga (*Albizia versicolor*), which is a fast growing species and can be exploited for poles (after three years) or timber (after forty years);
- Mkangazi (*Khaya anthotheca*), characterised by a medium growing speed;
- Mkongo (*Afzelia quanzensis*) a high value species for the long term.

Other species like Mpingo (*Dalbergia melanoxylon*), Mninga (*Pterocarpus angolensis*) or Mvule (*Milicia excelsa*) have been successfully planted in the neighbouring region of Lindi (Milledge *et al*., 2003). In Rufiji, several successful experiments have been carried out, particularly for Mkongo. For example, in Ikwiriri, 1000 stems have been planted in the college and more than 50% have survived, without particular care. The seeds are easy to collect and Mkongo seeding trees are relatively abundant in and around Ngumburuni.

Cassia siamea for fire-wood and reforestation

Non-local species such as *Cassia siamea* can also be accepted because it is multi-purpose. We have already mentioned the interest for fuel-wood, but it can also produce poles and it is well adapted for the reforestation of cleared areas (Collective, 1989 b). In addition, it is a fast growing species. A plantation already exists between Umwe South and the forest.

As a guide, we can give the selling prices of several tree seeds (Anonymous, 1999 b):

- Mkongo (*Afzelia quanzensis*): 6000 Tsh/kg (5,80 $); 1 kg can give 260 seedlings;
- Mvule (*Milicia excelsa*): 36 000 Tsh/kg (35 $);
- Mtanga (*Albizia versicolor*): 8400 Tsh/kg (8,15 $);
- *Cassia siamea*: 7200 Tsh/kg (7 $); 1 kg can give 28 000 seedlings;

Location of the plantations

Plantations, particularly of the timber species, could be implemented in the agricultural encroachments located in the eastern part of the forest. These cover a total area of 251 ha and, because of the exhaustion of the soils, only a small surface is used for cultivation nowadays. *Cassia siamea* would be a good solution for the reforestation of the woodlands located in the western part of the forest, where about 245 ha are available. Providing alternative areas outside the forest could also be important for developing productive plantations. The communities will have to make a choice among these various possibilities. But the main issue will probably be the necessary basic investment. Planting trees is expensive and part of the forest revenue should be used for planations.

Photos No. 21 and 22: Mkongo seeds ("lucky beans"). They used to be sold as ornaments (necklaces) and charms. In South Africa, they are called Mkehli (betrothed girl) by the Zulu, for those black seeds, with their orange aril suggest a maiden's red-ochred head-dress, which used to be worn in the period prior to marriage (PALGRAVE, 2002).

Photo No. 23: A twenty year old Cassia siamea plantation in Umwe South.

4.4.5.8 The place of non-timber activities in the management plan

a) Development of beekeeping

Beekeeping is one of the most promising non-timber activities and its development has been suggested by many interviewees. The context is favourable and the Rufiji production of honey has significantly increased over the past 3 years:

- 2000 – 2001: 9 tons;
- 2001 – 2002: 9,8 tons;
- 2002 – 2003: 25 tons.

A beekeeping development project, managed by the District, aims to help Rufiji people to start beekeeping, in view of poverty alleviation. It targets especially the young people and the women. It supports 44 beekeeping groups all over the District. In addition, they organise training sessions to initiate people.

For the time being, beekeepers produce three types of honey: Miombo (where species like Mtondoro – *Julbernardia globiflora* - or *Acacia sp.* are favourable), mangrove and floodplain. But, according to the Forest and Beekeeping Division (F.B.D. – Ministry of Natural Resources and Tourism) it is possible to produce honey in all parts of the forest, including coastal forest patches. Moreover, the costal forests are particularly favourable to this production because various flowers can be found almost throughout the year. Thus, it could be interesting to create a specific label "coastal forest honey" as such labelling already exists, for example for mangrove honey. This could also increase its 'green' appeal in European and American markets.

The honey is consumed locally and it is also sent to Kibaha and Dar-es-Salaam for export. At present, the prices of honey range from 15,000 Tsh (14.60 $) to 25,000 Tsh (24.20 $) for 20 lts. The prices of beeswax range from 1000 to 2000 Tsh (0.97 to 1.90 $) per kg. The prices depend on the market demand, and this market seems to be reliable, even for beeswax for which there is a real unsatisfied commercial demand (F.B.D.).

The wholesalers can collect the honey directly in the villages, if the quantity is significant. But if the local producers pack their honey, they can sell it at least 2000 Tsh per litre and, of course, get more income. But it is necessary to find a basic investment to buy the jars and, in addition, the quality must be impeccable. On an other hand, the making of hives is very easy. The villagers can group themselves in producers' organisations. Such structures exist all over the country (example in Kibondo) and some of them can be found in Rufiji. The official policy encourages the creation of these organisations.

Therefore, beekeeping should be a good alternative if a reliable market is guaranteed. This activity is less tiring for the people and non destructive for the forest. In addition, the new Beekeeping Act (Anonymous, 2002 b) allows the creation of beekeeping forest reserves and the National Beekeeping Policy document (Anonymous, 1998 b) introduces the notion of api-agro-forestry. If the communities decide on the creation of such beekeeping reserves they will have to demarcate them and to formulate the uses rules in by-laws, approved by the District.

This activity could be carried out in the conservation areas which would be better protected by the status of beekeeping protected forest. This association could be an argument and an asset for a good acceptance by the communities of the notion of conservation.

Photo No. 24: a low-cost hive under a Mkwaju (Tamarindus indica).

b) Development of traditional activities

The forest provides the communities with livelihood support through edible fruits, plants and roots, mushrooms, medicines, etc. To encourage and develop these activities can help the communities to better conserve and appropriate the forest. Indeed, the abundance of harvestable products is directly linked to the biodiversity.

The management plan will have to mention the favourable areas, especially in the coastal forests. The harvesting of non-timber forest products should remain free of charge for the domestic uses and fees should be payable only for commercial exploitation, except perhaps for medicines. Indeed medicine-men or -women would simply pass on the resulting price rise to their patients. Such a measure could have negative social impacts.

The management plan should also be the opportunity to rehabilitate the image of the natural forest products. Indeed, some highly palatable products are already actively exploited, but many others are only harvested during times of hardship and some are regarded as "poor-men's food" (Burgess *et al.*, 2000). Therefore, the plan should propose practical measures to strengthen the knowledge, the information and the awareness about the use of plants, roots, barks, fruits and mushrooms.

Photo No. 25: Edible mushrooms are abundant in Ngumburuni (O. Hamerlynck).

c) Development of new activities

During the interviews, we discussed possible non-traditional activities and the communities generally showed interest, particularly in tourism. Developing tourism has recently become a priority in Rufiji District and the recommendations of the technical report of the Rufiji Tourism Development Workshop (August 2003) clearly includes forest discovery. The conservation areas could be an opportunity of developing such an activity. Many trails already exist but they need maintenance. In addition, reception infrastructures would be necessary.

Another alternative non-timber activity is butterfly farming. Indeed, it is already suited as an income-earning venture for forest-adjacent communities in several countries like Costa-Rica, which exports around $ 1million worth of live butterflies a year, or Kenya (Gordon *et al*., 2003). A reliable project also exist in Tanzania, in Muheza District (Tanga Region). It is expected that the villagers would earn at least 100 million Tsh (97,000 $) a year when the project reaches its peak (Libongi, 2003). This is because scarce butterflies, especially those endemic in the coastal forests, are in big demand in Europe and the U.S.A.

This activity requires little investment, simple equipment and materials. Necessities are locally available and the basic skills are easily learned (Gordon *et al*., 2003). In addition this activity can be linked to conservation because it depends directly on forest resources for both butterflies and foodplants. Generating curiosity, it can also contribute to develop ecotourism. Such an activity should be explicitly mentioned in the management plan.

Lastly, we can also think about gum copal collection. Gum copal is the resin from Mnangu (*Hymenaea verucosa*) and it has been harvested for a long time, particularly during the Arabian period. It was mainly traded via Zanzibar to the Arabic countries and India. Modern Tanzania exported about 350 t of copal a year around 1950. In Mkupuka, we met people who used to harvest this gum. It was used to make varnish and incense. Nowadays, it is exclusively harvested for local uses, because of the development of synthetic resins (Burgess, 2000). But some companies, particularly in Europe, are looking for this natural gum for high quality traditional varnishes and lacquers. The marketing potential of this product should be studied in more detail, as Mnangu are abundant in Ngumburuni.

4.4.6 Zoning the forest

After the choice and the definition of the forestry actions, it will be useful to include an action map in the management plan. Of course, this report does not aim to draw this map, but we are going to suggest some management areas likely to satisfy the main claims and wishes of all the stakeholders, taking the noted condition of the forest into account.

Table 26: Matching forestry actions and uses to parts of the forest

Actions and authorised activities	**AREA 1 Conservation**	**AREA 2 Improvement of coastal forests**	**AREA 3 Sustainable exploitation of Miombo**	**AREA 4 Plantations**
Timber harvesting	X Only Mnangu	X Only Mnangu	X Mtondoro and Mtanga	X Planted species
Pole collection		X	X	X
Roofing materials collection			X	
Fuel-wood collection			X	X
Fruits, mushrooms and edible plants collection	X	X	X	
Weaving and dying materials collection	X	X	X	
Medicine collection	X	X	X	
Wild honey collection	X	X	X	
Beekeeping	X	X	X	
Agriculture		X Only in pre-existing areas	X Only in pre-existing areas	
Hunting		X	X	X
Clay for pottery		X	X	
Tourism	X	X	X	
Butterfly farming	X Caterpillars and foodplants collection	X Caterpillars and foodplants collection		
Tambiko uses	X	X	X	

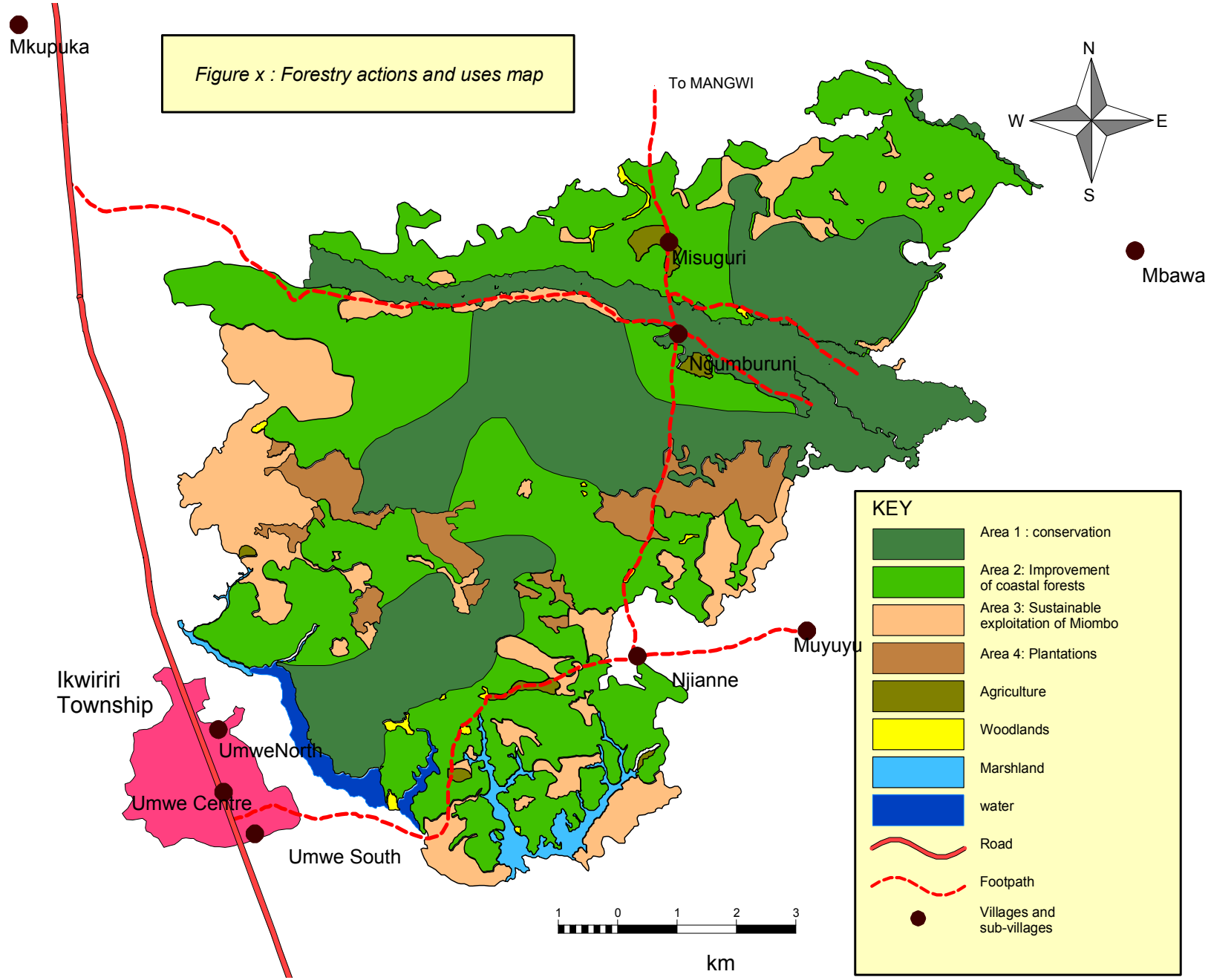


Figure x : Forestry actions and uses map
Mkupuka
To MANGWI
N
W
E
S
Mbawa
Misuguri
Ngumburuni
Muyuyu
Njianne
Ikwiriri
Township
UmweNorth
Umwe Centre
Umwe South
1 0 1 2 3
km
KEY
Area 1 : conservation
Area 2: Improvement of coastal forests
Area 3: Sustainable exploitation of Miombo
Area 4: Plantations
Agriculture
Woodlands
Marshland
water
Road
Footpath
Villages and sub-villages

4.4.7 Management monitoring and assessment

A crucial item for the success of the management will be the capacity of the communities (and of the District foresters in case of J.F.M.) to know at various stages of its enforcement if this management is working or not. This assessment requires practical indicators. Some of them are suggested in the following table.

Table 27: Practical indicators of Management success (according to Anonymous, 2002 c)

Items to assess	Indicators
Demarcation of the forest and of the management units	• Boundaries visible and known.
Improvement of the condition of the forest; Conservation	• Cases of illegal felling decreasing. • Undergrowth appearing. • New tree seedlings increasing. • No new in-forest dwellers. • Fauna frequenting increasing.
Efficiency of guarding	• Number of fires decreasing. • Number of sanctioned offences • Cases of illegal felling decreasing. • Respect of the minimum harvesting diameters.
Development of plantations	• Number of hectares. • Quality of the plantations.
Development of non-timber activities	• Number of hives increasing. • New activities implementation.

The plan must also mention the list of the persons responsible for collecting the information, making and issuing the assessment. A time frame must also be included. As a guide, we can propose a first assessment after two or three years, another one after five years and lastly one at the end of the planning period of 10 years. Finally, the possibility of amending the plan on the basis of the assessments must be incorporated.

4.4.8 Time frame

This important part of the plan will set target dates for decisions and actions. These dates should be realistic and not over-ambitious. The time frame can be divided in two or three parts, for example:

- immediate actions (during the first year);
- medium-term actions (3-5 years);
- long-term actions (> 5 years).

Among the immediate actions, we can mention the organisation of guarding, the first meetings, the creation of record books, the formulation of by-laws, etc.

Towards the end of the plan, a simplified inventory, targeting the most promising species like Mtasi (*Baphia kirkii*), Mkongo (*Afzelia quanzensis*) and Mlopolopo (*Trichilia emetica*), should be planned. Indeed, if the communities succeed in protecting them during the implementation of this plan, these species could qualify for harvesting in the next one. The time frame must mention this inventory and the expenditure for must also be planned.

4.5 Next steps and time frame to bring the process to a successful conclusion

A second round of meetings with the communities was held at the end of August 2003. The aim was to present the main results of the study and to explain to each community the others' points of view. We also discussed a time frame for the next steps of the process (cf. table 27). The main immediate result of these discussions was a general agreement for a meeting involving all the communities and the District in early October 2003. The main goals of this meeting would be:

- to favour the exchange of ideas among the different communities;
- to inform the communities more precisely about the content of a management plan. The management plan framework part of the present report (III.4) will be translated into Kiswahili and given to them before the meeting;
- to assist the communities with the establishment of the committees;
- to establish a consensual time frame for the next steps of the process on the basis of the proposals given in table 28.

Table 28: Proposed operational matrix for the next steps of the implementation of the Ngumburuni management process

Objectives	Actions	Responsible actors	Time frame
Choice of the management system	Negotiation between the villages and the District. Decisions at the village government level.	Village leaders Village assemblies Ward leaders Divisional leaders District administration	September - October 2003
Establishment of the Committee(s)	Selection of the members and definition of how the committee(s) will operate.	Village councils Village assemblies District administration	November 2003
Search for financial support	Presentation of the file to the Ministry and the donors (first contacts in September). As soon as the committee is constituted, they can apply to a forest fund managed by IUCN Netherlands (liaise with IUCN Tanzania office).	District administration Management committee(s)	September – December 2003
Demarcation of the boundaries and registration of the management area	Negotiation between the different communities. Negotiation between the communities and the District. Ground survey and marking of the boundaries within and around the forest (using paint on trunks, if necessary with different colours for the different zones). Recording the boundaries in the G.I.S. *The District needs to make a register for the different types of managed forests.*	Village councils Village assemblies Management committee(s) District administration Forest and Beekeeping Division (Ministry)	December 2003 – June 2004

Objectives	Actions	Responsible actors	Time frame
	Start-up of the awareness campaign and of the forest surveillance.		
Preparation of the management plan document	Choice of the management objectives and priorities. Identification of the immediate actions Writing of the management plan using the proposed framework.	All the communities Management committee(s) District administration	February – March 2004
Development of by-laws and management agreements	Writing the by-laws and agreements. Submission to District committee of works, economy and environment and later to full Council for approval.	Management committee(s). Village councils. Ward committees	March – April 2004
Implementation and monitoring	Enforcement of the management plan directives and by-laws.	Management committee(s) Village councils. District administration	By September 2004 (until September 2014 or 2019 ?)

A crucial item pointed out in this matrix is the search for financial support. Indeed, we mentioned several times that the start of the management plan would need such support. REMP has already taken the initiative by applying to the N.C.C.R.-P.A.M.S. fund (Switzerland) for financial aid. This has been successful and $ 30,000 will be available in 2004 for both Ngumburuni and another ecosystem-based environmental management project around Lake Zumbi. In addition, Rufiji is among the 16 Tanzanian districts chosen for implementing a World Bank supported C.B.F.M. initiative.

Yet, these encouraging results will need some backstopping and intensive follow-up by the District, especially with the Forest and Beekeeping Division. The role of the District must increase, particularly because REMP I will come to a close at the end of September 2003. The second phase is not expected before the early 2005. The District and the communities will have to take the process in hand and they will be responsible for a wise use of the funds.

5 Lessons Learned from the study and some proposals to further the Forest Action Plan implementation

The Rufiji Forest Action Plan was approved by the District Council in April 2003. But the draft had been circulating since March 2002. This chapter aims to assess the first steps of its implementation and to formulate some proposals to facilitate it. For the time being, the main achievement is the start of the recommended collaborative forest management process in Ngumburuni. To date no other forest management transfer from local government to communities has been initiated by the District. REMP, WWF and the Mangrove Management Project had worked on C.B.F.M. and J.F.M. with pilot communities before the approval of the Forest Action Plan. That is why the first results of the present Ngumburuni process are a useful contribution to a reflection on the Forest Action Plan implementation.

5.1 First evaluation of the operational action plan matrix implementation

The Forest Action Plan contains an operational matrix pinpointing the activities to be carried out, assigning tasks to responsible stakeholders and proposing a timeframe. The following table takes stock of the implementation of the planned actions.

The main general conclusion is that it is very little has been implemented and even less at the proper initiative of the District without REMP support. An excuse may be that it is difficult to correctly implement the operational matrix with the current District staff. The District Forest Office considers that about ten foresters would be needed to effectively implement the Forest Action Plan. Part of the solution could be to create a forest task force by assembling the District staff and the staff of the Mangrove Management Project, which operates in the District (based in Kibiti) but is more or less autonomous at present. Nevertheless, some of the proposed actions are really easy to carry out, such as the opening of a village forest register and starting an awareness campaign promoting village forest registration.

Table 29: Assessment of implementation of the Forest Action Plan operational matrix in August 2000

Objectives	Planned Actions	Evaluation
To have clearly defined management responsibility, legal and management status for all the forests in Rufiji District	• Defining management responsibility, legal and management status for all the forests in the district. • Earmarking forests for protection and utilization purposes (appendix 3 of the Forest Action Plan).	• REMP, with support from IRD is improving the maps of the Rufiji forests (to be completed before the end of 2003). • It is up to the District to exploit and update the existing documents (lists). These tasks are not particularly difficult and should be done before the end of 2003.
To adopt zoning and harvesting plans for the forests in the district in order to enhance forest protection and systematic utilization of forest resources	• Effective law enforcement in protected areas. • Harvesting to be allowed only in those forests which are earmarked for collaborative forest management. • Involving villagers in the licensing and monitoring processes with clear benefit sharing mechanisms. • Enacting a district by-law on minimum harvestable diameters for different species in the district	• No evolution for the effective law enforcement. It is now necessary to draw up a patrolling program. • A reflection about clear benefit-sharing mechanisms has just begun for Ngumburuni. The results could be used for other places. • For enacting a district by-law on minimum harvestable diameters, the table 19 in III.4 of this report can be used.
To revitalize and introduce new collaborative Forest Management initiatives in the district for effective participation of local communities in forest management	• Approving by-laws for existing CBFM initiatives • Introducing new areas for C.B.F.M. • Revitalizing village level forest committees • Adopting an elaborate system of benefit sharing and compensating local patrol men • Awareness raising and close follow up with technical advice • Applying for financial support from the World Bank's initiative on Participatory Forest Management	• Ngumburuni is the first experience of a control transfer from a local government forest reserve, theoretically managed by the District to the communities. • Some village forest reserves and their by-laws have been approved recently by the District. • Kipo and Mmaru villagers have asked the District to start a C.B.F.M. process. The District will have to carry out a fast diagnosis of these forests. • Rufiji is among the 16 districts chosen for implementing a World Bank supported CBFM initiative. But lobbying must be carried out. Contacts must be developed with several possible partners and also with the central administration, particularly with Mr Felician Kilihama, who co-ordinates all the financial forest issues.

Objectives	Planned Actions	Evaluation
To improve forest law enforcement and revenue collection situation in the district	• Adopting a systematic harvesting plan which allows check-points and foresters to rotate in the field • Capacity building by increasing manpower and transport facilities. • Restricting licensing to specific days in a week • Hammering of logs and scaling to be done in the field • Introduction of new check-points • Promotion of law enforcement through village level scouts under collaborative forest management • Frequent checks from the FBD	• District foresters have got a car (shared with other departments) since last year. They can also use the cars of the Mangrove Management Project. Some REMP vehicles should be available after the end of the current phase of the project provided that the forest department draws up a convincing workplan. • The foresters have got hammers, but hammering in the field is still the exception rather than the rule. • There are only three foresters in the District staff. The District has applied for additional staff, but, under structural adjustment, it is not easy to obtain. • Promotion of law enforcement through village level scouts will be tried in Ngumburuni. But a sustainable financial mechanism for the long-term payment of their expenses must be guaranteed.
To consolidate the system of issuing licenses on whole trees in order to minimize wastes in the field.	• Adopting and sticking to the new system in the district as a rule • Introducing an immediate by-law which bans the trade in off-cuts in the district	• The basic rules exist, but nothing has been implemented and no by-law has been formulated.
To adopt a moratorium on depleted species in the district in order to allow for their regeneration	• Liaising with the FBD in relation to the proposed species • Adopting the moratorium • Adopting an implementation strategy that would ensure that the suspension is effective	• A moratorium on Mninga and Mvule has already been in force for a long time (though implementation is less than perfect). • But for the moment, no further reflection has been initiated on other species. Yet, Mkongo should urgently be included.
To promote *Afrormosia angolensi*s from class V to class II for improved revenue collection and	• Liaising with the FBD on the proposal • Promoting the species into a higher class • Monitoring revenue collection from the species	• A letter has been send to National Forest Director in view of promoting several species, including *Afrormosia angolensis* and *Combretum imberbe*.

Objectives	Planned Actions	Evaluation
regulated harvesting	after its promotion	
To generate some revenues for the district by selling its valuable tree seeds to the National Tree Seeds Project (NTSP).	• Registering good stands of trees with the N.T.S.P. • Facilitate the collection and marketing of seeds in collaboration with the N.T.S.P.	• For the moment, no contact with N.T.S.P. • It could be particularly interesting for Mkongo. • Information should be obtained by District staff for Mvule, Mpingo, Mninga or Mkangazi. Indeed, these species have already been tried for plantations. • But in view of developing seeds selling, it is necessary to find valuable stands, to ask the NTSP to officially record them and to protect them.
To promote the planting of indigenous tree species in the district	• Identifying suitable species for regeneration • Introducing farm and village level nurseries • Provision of technical advice	• The District has already begun to promote Mkongo. Several plantations have been implemented. • But it must not rule out the possibility of planting other species, for example fuel wood.
To develop guidelines for sustainable agricultural practices in the district	• Commissioning a multi-disciplinary team of consultants for the task • Introduction and adoption of improved agroforestry practices • Adopting a taungya system on the mangroves on experimental basis • Establishing hazardous slopes for cultivation in the district	• Something has been done for rice cultivation in the mangroves (a kind of taungya). But deforestation is going on. • Soil conservation measures should be studied. • There is still little interaction or collaboration between the forest and agricultural departments
To implement an elaborate monitoring system for harvesting of forest products in the district	• Updating the established data base regularly • Including harvested areas in the database • Adopting a systematic harvesting system	• Nothing has been done. Even the 2002 data have not been entered into the Forest Action Plan database.

5.2 Proposals to facilitate the implementation of the Forest Action Plan

5.2.1 Development of new forest management initiatives

5.2.1.1 Duration of the forest action plan

As we can predict from the Ngumburuni process, the implementation of a participatory management process is quite long and can take several years. Consequently, the duration of the current action plan should be at least 10 or 15 years. Yet, there is no deadline for implementation in the Forest Action Plan and it could be useful to fix one. Indeed, it would force the District to elaborate a work plan. Intermediary evaluations should be carried out, for example, every three or four years. At the end of the plan, a major review should be carried out, taking into account the successes and failures of the past implementation period.

5.2.1.2 Other forests need management

At the end of this first action plan, the effective or potential managers of all the Rufiji forests should have been identified and recorded. It is compulsory according to the new Forest Act and the District must enforce it. It must be done simply and at low cost, on a register with simple descriptions and, if possible, rough maps (sketches) and identification of the villages involved. This system exists in other districts (Babati for example). A workplan should be prepared by the District, planning intervention zones and defining priorities, with a timetable and provisional expenditures.

Besides Ngumburuni, we visited three other forests which should be included in the District priorities. The most interesting one is located on the Kichi Hills (cf. figure 3 in chapter I). This coastal forest covers an area of about 23,000 ha (probably the largest patch in the whole of Tanzania). In some parts is still well stocked. According Malimbwi (2000), the average stocking is about 2940 stems/ha and the average basal area 20 m^2/ha. Eight potential timber species can be found there. Big Mvule (*Milicia excelsa*) can also be found, but without regeneration and sufficient stocking (Malimbwi, 2000). This forest also has a high biodiversity value and many endemic species of dragonflies, amphibians, birds and mammals (bush-babies, elephant-shrews) can be found in it (Perkin & Hamerlynck, 2001).

Recently, this rich coastal forest was proposed to become a protected forest reserve and WWF worked on the project for several years. But the District authorities were not associated and internal WWF conflicts and external political ones hamper the unfolding of this initiative. In addition an all-weather road was built by the Selous Game Reserve, through the richest part of the forest, without any environmental impact study. This in spite of the fact that the Selous Game Reserve receives substantial support from donors such as WWF and GTZ, the German technical cooperation. The road facilitates the coming of new settlers, clearing large parts of the primary and secondary forest, and of course of loggers. During our visit, we have found four pit-sawing places. Nevertheless, the Kichi Hill forest is likely to be gazetted in September 2003. We can hope that a management plan will be developed thereafter and that the District authorities will join more closely in the process.

Utete Forest Reserve (900 ha) and Katundu Forest Reserve (5631 ha) form a single forest block, close to the administrative centre of the District. The block is also one of the most overharvested. Many trails criss-cross it and the traffic of loggers' trucks is constant. A great number of charcoal burners are active within the reserves, which are within walking distance of the foresters' offices. This forest block is now intensively exploited and of course without any harvesting plan. An effort should be made to elaborate a restoration and management plan for this forest which stays useful for Utete. In addition, firewood and charcoal plantations could usefully replace the sterile cashew stands between Utete and the forest reserves.

With an area of about 79,000 ha, the Ruhoi Forest Reserve is the largest in Rufiji. Theoretically, it

is a local government forest reserve managed by the District Council, but the impression is that there is no difference in the management of Ruhoi forest and the woodlands surrounding it. Indeed, it seems to be overexploited and, in addition, large and recent agricultural encroachments have appeared in several places within the reserve.

Yet, this forest is an important shelter for the fauna moving from the Selous Game Reserve to the coastal zones. Especially important are the coastal forest strips along drainage lines and on the edges of the Ruhoi River floodplain. Consequently, it is a vital place for the preservation of the corridor already evoked in the study of Ngumburuni. For such a large forest, the only solution is certainly a community-based management process involving all the surrounding villages. The forest should be divided into village areas and controlled by local scouts. If this project exists one day, a collaboration between Ruhoi and Ngumburuni management committees would be desirable, particularly concerning the fauna issues.

Photo No. 27: The Ruhoi Forest Reserve is mostly covered with closed woodland.

Photo No. 26: Coastal forest relics in Ruhoi Forest Reserve (Sterculia appendiculata and Afzelia quanzensis).

Photo No. 28: Logs in the overharvested Utete Forest reserve.

Photo No. 29: High biodiversity value coastal forests on the Kichi Hills.

5.2.1.3 Some methodological elements for the development of other management plans

For the other forests, it would be best if a complete study could be carried out. But, because of the lack of means, the next surveys will probably have to be simpler than the survey carried out in Ngumburuni. Nevertheless, they must include the following themes:

- the knowledge of the forest (condition, potential, constraints,…);
- the knowledge of the forest-adjacent communities (relationships with the forest, wishes, conflicts);
- the framework of the management plan to guide the communities in the elaboration of their own one.

The results of inventories by Malimbwi (2000) could be a good basis for developing harvesting plans in several Rufiji forests. Even if the sample plots have not always been very numerous, the results can be used and completed. The following table shows the surveyed forests and the number of sample plots studied by the Sokoine University team.

Table 30: Rufiji forests surveyed by REMP and number of recorded sample plots (Malimbwi, 2000)

Name of forest	Surveyed Area (ha)	Number of sample plots
Utete	23,981	68
Weme	3437	61
Mtanza	47,234	28
Kichi	23,057	28
Mbunju	6153	58

A rough map of the forest can be hand-drawn using aerial photography or a Landsat image and the G.P.S. points. It is generally sufficient, at least for the discussions with the stakeholders. Of course, it would be ideal if the District could train one or two foresters or other staff for the use of Mapmaker software, which is relatively simple. Some of them have already got notions about it. The essential item thereafter is the precise and reliable demarcation of the boundaries in the field.

Lastly, the other communities will be able to benefit from the Ngumburuni experience and meetings between the management committees should be organised.

5.2.2 The pilot role of the District must increase

As mentioned in table 29, the role of the District Lands, Natural Resources and Environment Office is central for the implementation of the Forest Action Plan, especially as the first phase of REMP ends in September 2003. They must particularly emphasize the development of management plans all over the District. Some documents and data already exist, it is up to the staff to update and exploit them. These first steps will not be very costly.

Another crucial item is effective law enforcement. For the time being, the results are not very convincing. The main reason is obviously the lack of staff and means, but also perhaps a lack of flexibility and administrative habits. To deal with a new forest policy, new practices should be introduced. To improve law enforcement, District foresters' patrols should be increased. But as the forest human capacity is low, expanded patrols could be organised involving other department officers (wildlife, fisheries even agricultural officers). But at first, a patrolling plan, with a timetable and a provisional budget must be drawn up.

5.2.3 Financial aspects

We can regret that the Forest Action Plan does not suggest any elaborate financial mechanism. In fact, it supposes that internal solutions must be found by the District and that the District will agree to invest a part of or its entire forest revenue in forestry action. Yet, these two points are not self-evident.

The implementation of the Forest Action Plan supposes the mobilisation of important funds. For example, according to the F.B.D., no C.B.F.M. has been implemented in Tanzania without the support of a donor. We can guess that it will be the same in Rufiji. As noted for Ngumburuni, a significant basic investment is necessary, at least to start the process. As things stand, it is unrealistic to think that it could be provided by the District. In addition, there is a political issue. While the Central Government wants the District authorities to enforce the new Forest Act, at the same time, it asks the District Lands, Natural Resources and Environment Office to provide it with more timber royalties. Consequently, there are mainly two solutions to improve this situation and to stand a chance of succeeding in implementing the Action Plan.

The first one is to improve the revenue collection at the District level and to reserve (a part of) the benefits for the implementation of the new policy. This recommendation is clearly and precisely mentioned in the Forest Action Plan, with practical solutions (cf. table 29). New practices, like full tree licensing or tree seeds selling, should be quickly undertaken.

The second solution is of course to mobilise external financial support. The biodiversity, ecosystem function and economic values of the Rufiji Forests make this a realistic view. As mentioned in table 29, Rufiji is among the 16 districts chosen for implementing a World Bank supported CBFM initiative. And for Ngumburuni, REMP has got a fund from the Swiss Development Aid. But lobbying with other organisations and sources must be carried out by the District. Contacts must be developed with other possible partners and particularly IUCN Netherlands, which manages a tropical forest fund. The District administration can liaise with them not only for the Ngumburuni operation, but also for others, provided that they make a credible workplan before and that they make it clear that the communities are clearly in the driver's seat.

In both cases, the key words should be initiative and dynamism. The Forest Action Plan is ambitious, but it meets the spirit of the new law. REMP has provided the bricks, it is now up to the local authorities to build the wall by mobilizing the forces extant in the local communities.

6 Conclusion

The establishment of a management plan for the Ngumburuni forest and the empowerment of the adjacent communities constitute one of the first operations among those designated as priorities by the Rufiji District Forest Action Plan. At this stage of the process, we can conclude that the first results are encouraging. No major obstacle should hamper the implementation of participatory management in Ngumburuni. The communities are convinced of the necessity of taking in hand their environment in order to continue to benefit from its resources. In addition, a favourable institutional framework was developed a few years ago.

Nevertheless, achieving the possible will not be easy. A significant number of issues must be solved: the choice of the management system, the demarcation of the forest boundaries, the awareness of the villagers and maybe the most important, the establishment of confidence between the authorities and the communities, including the finding of benefit-sharing arrangements in case of joint management. As the proposed plan recommends, a strictly controlled and restricting timber harvesting plan must be accompanied by adequate and judiciously studied compensatory measures. In fact, a subtle balance must be found between the requirement of conservation of the most valuable sites and the necessity for the resource-adjacent communities to continue to benefit from the forest that represents a significant part of their livelihoods. In addition, the District Council will have to avoid the obstructions to village empowerment which delayed the approval of other, similar operations (the Matumbi Hills and REMP Village Forest Reserves).

All these observations were taken into account in the proposed framework for the management plan. For example, it attaches the utmost importance to the development of plantations and non-timber activities. They will not be miraculous solutions, but they will be able to contribute to adequate acceptance of the process by the villagers. However, it will be necessary to find funds to support the process, even if we can expect that the management will generate benefits likely to be invested in forest actions. The search has already successfully begun, but it needs follow-up. Thus, for the Ngumburuni operation, but also for all the actions planned in the Rufiji Forest Action Plan, the leading role of the District Council and of its technical staff must increase. We have made proposals in that sense, knowing that it will not be obvious under structural adjustment.

Moreover, the effective enforcement of the Plan by the District authorities needs to be strongly embedded in a genuine resolve for action at Central Government level. Formulating the new Forest Act was a first step. Writing a local Forest Action Plan was a second one. But they will not change things significantly if the commitment of the local authorities, supported without any ambiguity by the Central Government, is not strong enough.

But it is not too late. Implementation of the Rufiji Forest Action Plan is starting and the Ngumburuni forest can become a showcase for the new policy of the District Council, provided that dynamism and initiative do not falter when facing the obstacles.

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8 Appendices

List of Appendices

Appendix 1: Analysis of Forest Inventory Data

Sample plot n° : SP1 **X =** 505996 **Y =** 9127996

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mbelebele	*Holarrhena pubescens*	110	35.0	14	0.0963	23	1.11
Mkibu	*Dombeya rotundifolia*	86	27.4		0.0589	20	0.59
Mkongo	*Afzelia quanzensis*	75	23.9		0.0448	19	0.42
Mpilipili	*Sorindeia madagascariensis*	92	29.3		0.0674	21	0.70
Mnangu	*Hymenaea verrucosa*	95	30.2	22	0.0718	21	0.76
Mndototo	*Lettowianthus stellatus*	100	31.8	22	0.0796	22	0.87
Mpilipili	*Sorindeia madagascariensis*	90	28.6		0.0645	21	0.66
Msufi Pori	*Bombax rhodognaphalon*	138	43.9		0.1515	26	1.97
Mkibu	*Dombeya rotundifolia*	78	24.8		0.0484	19	0.46
Total					**0.6831**		**7.55**
Commercial species					**0.2681**		**3.15**

Number of stems : 9

Regeneration : Mpilipili (*Sorindeia madagascariensis*)

Number of future stems : Mpilipili (*Sorindeia madagascariensis*)

Nature of the soil : Loam

Sample plot n° : SP2 **X =** 504560 **Y =** 9128000

Ecological unit : Coastal forest

Name of specie (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mkarango / Mtindili		265	84.4	32	0.5588	37	10.41
Mnangu	*Hymenaea verrucosa*	180	57.3		0.2578	30	3.88
Kilonzimwitu		106	33.7		0.0894	23	1.01
Mnabia		70	22.3		0.0390	18	0.35
Mtondodeka		75	23.9		0.0448	19	0.42
Mlopolopo	*Trichilia emetica*	98	31.2	30	0.0764	22	0.83
Mkongodeka		72	22.9		0.0413	18	0.38
Mtunda	*Manilkara sansibarensis*	80	25.5		0.0509	19	0.49
Mnabia		84	26.7		0.0561	20	0.56
Mtunda	*Manilkara sansibarensis*	77	24.5	32	0.0472	19	0.45
Mbebeti	*Albizia sp.*	106	33.7		0.0894	23	1.01
Mbebeti	*Albizia sp.*	93	29.6		0.0688	21	0.72
Total					**1.4200**		**20.49**
Commercial species					**0.3343**		**4.71**

Number of stems : 12

Regeneration : Mpingwi
Kipinga
Kikobati
Mbunduwakutu
Mnyambara

Number of future stems :

Nature of the soil : sandy

Sample plot n° : SP3 **X =** 503115 **Y =** 9128008

Ecological unit : Coastal forest

Name of specie (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mnuso		82	26.1		0.0535	20	0.52
Mnuso		100	31.8	32	0.0796	22	0.87
Mkangaviko		253	80.5	39	0.5094	36	9.25
Mbebeti	*Albizia sp.*	131	41.7		0.1366	25	1.73
Mkuruti		85	27.1		0.0575	20	0.57
Mbebeti	*Albizia sp.*	87	27.7		0.0602	20	0.61
Mbebeti	*Albizia sp.*	103	32.8		0.0844	22	0.94
Mmangaosungu		92	29.3	20	0.0674	21	0.70
Mmangaosungu		82	26.1		0.0535	20	0.52
Mmangaosungu		71	22.6		0.0401	18	0.36
Total					**1.1421**		**16.08**
Commercial species					**0.0000**		**0**

Number of stems : 10

Regeneration : Mngongoro (*Monanthotaxis buchananii*)
Kikobati
Mkuruti
Mhanga
Mambaato (*Grewia goetzeana*)

Number of future stems :

Nature of the soil : Loam / sandy

Sample plot n° : SP4 **X =** 501675 **Y =** 9127984

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtunda	*Manilkara sansibarensis*	73	23.2	18	0.0424	18	0.39
Mlopolopo		139	44.2		0.1538	26	2.01
Mnangu	*Hymenaea verrucosa*	185		31		31	4.16
Mnangu	*Hymenaea verrucosa*	63	20.1		0.0316	17	0.27
Mnangu	*Hymenaea verrucosa*	90	28.6			21	
Mungwai		130	41.4		0.1345	25	1.69
Mungwai		130	41.4	18	0.1345	25	1.69
Mlopolopo	*Trichilia emetica*	74	23.6		0.0436	19	0.40
Total					**0.8771**		**11.29**
Commercial species					**0.5657**		**7.51**

Number of stems : 8

Regeneration : Mpingwi
Mbelete (*Teclea simplicifolia*)
Kobati
Mbelete (*Teclea simplicifolia*)
Kobati

Number of future stems :

Number of stumps : 1 (Mkongo - *Afzelia quanzensis*)

Nature of the soil : sandy

Sample plot n° : SP5 **X =** 500223 **Y =** 9127998

Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m2)	Volume (m3)
Mkongodeka		94	29.9	14	0.0703	15	0.60
Total					**0.0703**		**0.60**
Commercial species					**0.0000**		**0.00**

Number of stems : 1

Regeneration : Mnyalanyai
Mtondoro (*Julbernardia globiflora*)
Mnangu (*Hymenaea verrucosa*)
Mwaiji

Number of future stems :

Nature of the soil : Sandy

Sample plot n° : SP6 **X =** 505996 **Y =** 9127996

Ecological unit : Coastal forest

Name of specie (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mkundekunde	*Senna sp.*	65	20.7	15	0.0336	17	0.29
Mbunduwakutu		72	22.9		0.0413	18	0.38
Mkongodeka		64	20.4		0.0326	17	0.28
Mhanga		143	45.5	39	0.1627	27	2.16
Mkuruti		122	38.8	20	0.1184	24	1.44
Mkongodeka		176	56.0		0.2465	30	3.67
Total					**0.6351**		**8.21**
Commercial species					**0.0000**		**0**

Number of stems : 6

Regeneration : Mtete (*Hymenocardia ulmoides*)
Mtete (*Hymenocardia ulmoides*)
Mnuso
Mpojoa
Mbelete (*Teclea simplicifolia*)
Mbelete (*Teclea simplicifolia*)
Mbelete (*Teclea simplicifolia*)

Number of future stems : Kinuso cha mkunguti

Nature of the soil : Sandy

Sample plot n° : SP7 **X =** 501681 **Y =** 9129442

Ecological unit : Riverine forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mnangu	*Hymenaea verrucosa*	88	28.0	15	0.0616	20	0.63
Mnangu	*Hymenaea verrucosa*	89	28.3		0.0630	20	0.65
Mkuruti		70	22.3		0.0390	18	0.35
Mkuruti		95	30.2	15	0.0718	21	0.76
Mnangu	*Hymenaea verrucosa*	95	30.2		0.0718	21	0.76
Mnangu	*Hymenaea verrucosa*	97	30.9		0.0749	21	0.80
Mkuruti		63	20.1		0.0316	17	0.27
Mtasi	*Baphia kirkii*	76	24.2		0.0460	19	0.43
Mkongo	*Afzelia quanzensis*	63	20.1		0.0316		0.27
Mkuruti		73	23.2		0.0424	18	0.39
Mkuruti		101	32.1		0.0812	22	0.89
Mkongo	*Afzelia quanzensis*	65	20.7		0.0336	17	0.29
Mkuruti		85	27.1		0.0575	20	0.57
Mnangu	*Hymenaea verrucosa*	86	27.4	17	0.0589	20	0.59
Total					**0.7649**		**7.65**
Commercial species					**0.4414**		**4.42**

Number of stems : 14

Regeneration : Mtunda (*Manilkara sansibarensis*)
Mkonge (*Milletia dura*)
Mkonge (*Milletia dura*)
Mkonge (*Milletia dura*)
Mkonge (*Milletia dura*)

Number of future stems : Mtunda (*Manilkara sansibarensis*)
Mkongo (*Afzelia quanzensis*)

Nature of the soil : Sandy / Loam

Sample plot n° : SP8 **X =** 503115 **Y =** 9129454

Ecological unit : miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mninga	*Pterocarpus angolensis*	125	39.8	18	0.1243	18	1.20
Mpangapanga	*Milletia stulhmanii*	90	28.6	22	0.0645	15	0.54
Mtondoro	*Julbernardia globiflora*	97	30.9		0.0749	16	0.65
Mtondoro	*Julbernardia globiflora*	272	86.6	25	0.5887	29	7.91
Total					**0.8524**		**10.31**
Commercial species					**0.8524**		**10.31**

Number of stems : 4

Regeneration : Mpugupugu (*Markhamia lutea*)
Kipungu
Mpome (*Commiphora ugogensis*)
Mnyakara
Mtondoro (*Julbernardia globiflora*)

Number of future stems : Mtopetope (*Annona senegalensis*)

Nature of the soil : Sandy

Sample plot n° : SP9 **X =** 504549 **Y =** 9129453

Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m^2)	Height (calculated m)	Volume (m^3)
Mlambunju	*Commiphora sp.*	67	21.3		0.0357	13	0.27
Mtopetope	*Annona senegalensis*	78	24.8	12	0.0484	14	0.38
Mneke	*Pteleopsis myrtifolia*	105	33.4	17	0.0877	16	0.79
Mwembe ngongo		176	56.0	20	0.2465	22	2.76
Mtonga	*Strychnos spinosa*	94	29.9		0.0703	15	0.60
Mngongo	*Sclerocarya birrea*	95	30.2		0.0718	15	0.62
Total					**0.5605**		**5.42**
Commercial species					**0.0718**		**0.62**

Number of stems : 6

Regeneration :
Mpangapanga (*Milletia stuhlmanii*)
Mtondoro (*Julbernardia globiflora*)
Mpangapanga (*Milletia stuhlmanii*)
Mkibu (*Dombeya rotundifolia*)
Mkibu (*Dombeya rotundifolia*)

Shrubs : Mpakacha (*Deinbolia borbonica*)
Number of future stems :

Nature of the soil : Loam

Sample plot n° : SP10 **X =** 505997 **Y =** 9129446

Ecological unit : Coastal forest (secondary)

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mpome	*Commiphora ugogensis*	122	38.8	17	0.1184	24	1.44
Mtunda	*Manilkara sansibarensis*	96	30.6	14	0.0733	21	0.78
Total					**0.1918**		**2.22**
Commercial species					**0.0000**		**0**

Number of stems : 2

Regeneration : Mpambalaya
Mkandabia
Mnangu (*Hymenaea verrucosa*)

Shrubs : Mpakacha (*Deinbolia borbonica*)
Msisi ngololo

Number of future stems :

Nature of the soil : Loam / Sandy

Sample plot n° : SP11 **X =** 507456 **Y =** 9129448

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtasi	*Baphia kirkii*	90	28.6	30	0.0645	21	0.66
Mtasi	*Baphia kirkii*	71	22.6		0.0401	18	0.36
Mnabia		130	41.4	27	0.1345	25	1.69
Mngwai		131	41.7		0.1366	25	1.73
Mkongo	*Afzelia quanzensis*	86	27.4		0.0589	20	0.59
Mnangu	*Hymenaea verrucosa*	190	60.5	32	0.2873	31	4.46
Mnuso		85	27.1		0.0575	20	0.57
Mtunda	*Manilkara sansibarensis*	81	25.8		0.0522	19	0.51
Mnangu	*Hymenaea verrucosa*	158	50.3		0.1987	28	2.79
Mkongo	*Afzelia quanzensis*	105	33.4		0.0877		0.98
Mkongo	*Afzelia quanzensis*	97	30.9		0.0749	21	0.80
Total					**1.1927**		**15.15**
Commercial species					**0.8120**		**10.65**

Number of stems : 11

Regeneration : Mnyambara
Mtunda (*Manilkara sansibarensis*)
Mkahamba
Mnyambara
Matakogambuya

Number of future stems : Mnuso
Mnuso

Nature of the soil : sandy

Sample plot n° : SP12 **X =** 508893 **Y =** 9129452

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mkongo	*Afzelia quanzensis*	103	32.8	32	0.0844	22	0.94
Mkongo	*Afzelia quanzensis*	144	45.8		0.1650	27	2.20
Mkongo	*Afzelia quanzensis*	78	24.8		0.0484	19	0.46
Mkongo	*Afzelia quanzensis*	65	20.7		0.0336	17	0.29
Mnuso		133	42.3	30	0.1408	26	1.80
Mdadarika	*Newtonia sp.*	91	29.0	32	0.0659	21	0.68
Mnabia		128	40.7		0.1304	25	1.63
Mnabia		101	32.1		0.0812	22	0.89
Mlopolopo	*Trichilia emetica*	88	28.0		0.0616	20	0.63
Mnuso		65	20.7		0.0336	17	0.29
Mkuruti		66	21.0		0.0347	17	0.30
Mkuruti		123	39.2		0.1204	24	1.47
Mkuruti		120	38.2		0.1146	24	1.38
Mkuruti		82	26.1		0.0535	20	0.52
Mnuso		161	51.2		0.2063	28	2.92
Msweli	*Grewia sp.*	64	20.4		0.0326	17	0.28
Total					**1.4070**		**16.68**
Commercial species					**0.4590**		**5.20**

Number of stems : 16

Regeneration :
Mkahamba
Mnyanyati
Mlopolopo (*Trichilia emetica*)
Nyakahamba (*Antidesma venosum*)
Mtiriri

Number of future stems :
Mkalioto
Mtabwe (*Grewia trichocarpa*)
Mnuso
Mnuso
Mtabwe (*Grewia trichocarpa*)
Mlopolopo (*Trichilia emetica*)

Number of stumps :
Mkongo (*Afzelia quanzensis*) (2)
Mtasi (*Baphia kirkii*) (3)

Nature of the soil : Sandy / Loam

Sample plot n° : SP13 **X =** 510342 **Y =** 9130868

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtasi	*Baphia kirkii*	77	24.5	18	0.0472	19	
Mtanga	*Albizia versicolor*	69	22.0	22	0.0379	18	
Mtanga	*Albizia versicolor*	66	21.0		0.0347	17	
Mohoro	*Pseudolachnostylis maprouneifolia*	63	20.1	13	0.0316	17	0.27
Mohoro	*Pseudolachnostylis maprouneifolia*	86	27.4		0.0589	20	0.59
Mohoro	*Pseudolachnostylis maprouneifolia*	73	23.2		0.0424	18	0.39
Total					**0.2526**		**2.33**
Commercial species					**0.1197**		**1.09**

Number of stems : 6

Regeneration : Mkonge (*Milletia dura*)
Mtete (*hymenocardia ulmoides*)
Mtasi (*Baphia kirkii*)

Number of future stems : Mtanga (*Albizia versicolor*)
Mtete (*hymenocardia ulmoides*)
Mkonge (*Milletia dura*)
Mtasi (*Baphia kirkii*)
Mtasi (*Baphia kirkii*)
Mohoro (*Pseudolachnostylis maprouneifolia*)

Shrubs : Nyepagamba

Number of stumps :

Nature of the soil : sandy

Sample plot n° : SP14 **X =** 508890 **Y =** 9130879

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mneke	*Pteleopsis myrtifolia*	91	29.0	26	0.0659	21	0.68
Mneke	*Pteleopsis myrtifolia*	63	20.1		0.0316	17	0.27
Mneke	*Pteleopsis myrtifolia*	64	20.4		0.0326	17	0.28
Mneke	*Pteleopsis myrtifolia*	67	21.3		0.0357	18	0.31
Mpugupugu	*Markhamia lutea*		21.3		0.0357		0.31
Mmangangwaru	*Afrormosia angolensis*		23.9		0.0448		0.42
	Albizia versicolor	80	25.5		0.0509	19	
Mneke	*Pteleopsis myrtifolia*	144	45.8	27	0.1650	27	2.20
Mpugupugu	*Markhamia lutea*	65	20.7		0.0336	17	0.29
Mkombasiko	*Crossopteryx febrifuga*	68	21.6		0.0368	18	0.33
Mndototo	*Lettowianthus stellatus*	91	29.0		0.0659	21	0.68
Total					**0.5985**		**6.26**
Commercial species					**0.1650**		**1.51**

Number of stems : 11

Regeneration : Mnungu (*Zanthoxylum chalybeum*)
Mtanga (*Albizia versicolor*)
Mpugupugu (*Markhamia lutea*)
Mkabusi (*Rytigynia uhligii*)
Mkibu (*Dombeya rotundifolia*)

Number of future stems : Mnangu (*Hymenaea verrucosa*)
Mtejateja
Mtete (*hymenocardia ulmoides*)

Shrubs : Mpakacha (*Deinbolia borbonica*)

Nature of the soil : sandy / loam

Sample plot n° : SP15 **X =** 507418 **Y =** 9130905

Ecological unit : coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mnondondo	*Xeroderris stuhlmanii*	113		21	0.1016	23	
Msufi pori	*Bombax rhodognaphalon*	126	40.1		0.1263	25	1.57
Mtanga	*Albizia versicolor*	68	21.6		0.0368	18	0.33
Mtumba	*Lannea schweinfurthii*	132	42.0	27	0.1387	25	1.76
Mohoro	*Pseudolachnostylis maprouneifolia*	118	37.6		0.1108	24	1.32
Mtimbo		93	29.6		0.0688	21	0.72
Msibondo		77	24.5		0.0472	19	0.45
Mtanga	*Albizia versicolor*	71	22.6		0.0401	18	0.36
Mkwaju	*Tamarindus indica*	63	20.1		0.0316	17	0.27
kikomopende		107	34.1		0.0911	23	1.03
Mndototo	*Lettowianthus stellatus*	74	23.6		0.0436	19	0.40
Mkwaju	*Tamarindus indica*	107	34.1		0.0911	23	1.03
Mndototo	*Lettowianthus stellatus*	74	23.6		0.0436	19	0.40
Mohoro	*Pseudolachnostylis maprouneifolia*	112	35.7		0.0998	23	1.16
Total					**1.0711**		**11.99**
Commercial species					**0.4276**		**4.74**

Number of stems : 14

Regeneration : Mkonge (*Milletia dura*)
Mtabwe (*Grewia trichocarpa*)
Mtete (*hymenocardia ulmoides*)
Mkonge (*Milletia dura*)
Mbelebele (*Holarrhena pubescens*)

Shrubs: Kinyunde (*Cynometra suahilensis*)

Number of future stems : Mkonge (*Milletia dura*)
Mtete (*hymenocardia ulmoides*)
Mtabwe (*Grewia trichocarpa*)

Nature of the soil : Loam / Sandy

Sample plot n° : SP16 **X =** 505998 **Y =** 9130900

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtasi	*Baphia kirkii*	115	36.6	21		24	1.24
Mtasi	*Baphia kirkii*	74	23.6		0.0436	19	0.40
Mtasi	*Baphia kirkii*	89	28.3	19	0.0630	20	0.65
Mneke	*Pteleopsis myrtifolia*	63	20.1		0.0316	17	0.27
Mkuruti		69	22.0		0.0379	18	0.34
Mneke	*Pteleopsis myrtifolia*	120	38.2		0.1146	24	1.38
Mneke	*Pteleopsis myrtifolia*	76	24.2		0.0460	19	0.43
Total					**0.4419**		**4.71**
Commercial species					**0.2119**		**2.29**

Number of stems : 7

Regeneration : Mbunduwakutu
Mtabwe (*Grewia trichocarpa*)
kiingiri

Number of future stems : Mtete (*hymenocardia ulmoides*)
Mtete (*hymenocardia ulmoides*)
Mtunda (*Manilkara sansibarensis*)
Mtasi (*Baphia kirkii*)

Shrubs : Mpwekanyati
Msekea

Nature of the soil : Loam

Sample plot n° : SP17 **X =** 504563 **Y =** 9130893

Ecological unit : Coastal forest (secondary)

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mpugupugu	*Markhamia lutea*	63	20.1	13	0.0316	17	0.27
Mneke	*Pteleopsis myrtifolia*	71	22.6	13	0.0401	18	0.36
Mulaula	*Voacanga africana*	76	24.2	13	0.0460	19	0.43
Mulaula	*Voacanga africana*	70	22.3		0.0390	18	0.35
Total					**0.1567**		**1.41**
Commercial species					**0.0316**		**0.27**

Number of stems : 4

Regeneration : Mpojoa
Mulaula (*Voacanga africana*)
Mpambalaya
Nyakahamba

Number of future stems : Mpambalaya
Mpojoa

Shrubs : Mpakacha (*Deinbolia borbonica*)

Nature of the soil : Sandy

Sample plot n° : SP18 **X =** 501662 **Y =** 9130890

Ecological unit : Woodland

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtondoro	*Julbernardia globiflora*	160	50.9	20	0.2037	21	2.19
Myombo	*Brachystegia spiciformis*	89	28.3	17	0.0630	15	0.53
Total					**0.2668**		**2.72**
Commercial species					**0.2668**		**2.72**

Number of stems : 2

Regeneration :
Mtaba (*Ximenia caffra*)
Mnondura
Mtaba (*Ximenia caffra*)
Mnondura

Number of future stems :
Myombo (*Brachystegia spiciformis*)
Mtondoro (*Julbernardia globiflora*)
Kipomu
Accacia sp.
Mnungamo

Shrubs : Msekea

Nature of the soil : Sandy

Sample plot n° : SP19 **X =** 500266 **Y =** 9130857

Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtumba	*Lannea schweinfurthii*	105	33.4	22	0.0877	16	0.79
Mkolowa	*Accacia sp.*	110	35.0	20	0.0963	17	0.88
Mtumba	*Lannea schweinfurthii*	130	41.4		0.1345	19	1.32
Myombo	*Brachystegia spiciformis*	120	38.2	25	0.1146	18	1.09
Mtogo	*Diplorynchus condilocarpon*	118	37.6		0.1108	17	1.05
Mnondura		70	22.3		0.0390	13	0.30
Mmangangwaru	*Afrormosia angolensis*	94	29.9		0.0703	15	0.60
Mkolowa	*Accacia sp.*	83	26.4		0.0548	14	0.45
Total					**0.7080**		**6.48**
Commercial species					**0.1849**		**1.69**

Number of stems : 8

Regeneration : Mtopetope (*Annona senegalensis*)
Mtesa
Mnondura
Mpangapanga (*Millettia stuhlmannii*)
Mhiru (*Vangueria infausta*)

Number of future stems : Mhiru (*Vangueria infausta*)
Mnondura

Nature of the soil : sandy / loam

Sample plot n° : SP20 **X =** 508809 **Y =** 9132524

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mneke	*Pteleosis myrtifolia*	95	30.2	20	0.0718	21	0.76
Mneke	*Pteleosis myrtifolia*	117	37.2	22	0.1089	24	1.30
Mnondura		109	34.7	22	0.0945	23	1.08
Mneke	*Pteleosis myrtifolia*	75	23.9		0.0448	19	0.42
Mfuru	*Vitex doniana*	123	39.2		0.1204	24	1.47
Mfuru	*Vitex doniana*	93	29.6		0.0688	21	0.72
Mfuru	*Vitex doniana*	78	24.8		0.0484	19	0.46
Total					**0.5577**		**6.21**
Commercial species					**0.0000**		**0**

Number of stems : 7

Regeneration : Mbigicho (*Gardenia ternifolia*)
Mnungu (*Zanthoxylum chalybeum*)
Mnyanyati / Mpwangati
Mpugupugu (*Markhamia lutea*)
Mtanga (*Albizia versicolor*)

Number of future stems : Mninga (*Pterocarpus angolensis*)
Mneke (*Pteleosis myrtifolia*)

Shrubs: Kinyunde (*Cynometra suahilensis*)

Nature of the soil : Loam

Sample plot n° : SP21 **X =** 510365 **Y =** 9132349
Ecological unit : Riverine forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mbigicho	*Gardenia ternifolia*	96	30.6	21	0.0733	21	0.78
Mnee	*Syzygium guineense*	74	23.6	22	0.0436	19	0.40
Mnee	*Syzygium guineense*	104	33.1	18	0.0861	22	0.96
Myengawa	*Kigelia africana*	148	47.1		0.1743	27	2.36
Mbigicho	*Gardenia ternifolia*	88	28.0		0.0616	20	0.63
Mbigicho	*Gardenia ternifolia*	84	26.7		0.0561	20	0.56
Mbigicho	*Gardenia ternifolia*	117	37.2		0.1089	24	1.30
Mnee	*Syzygium guineense*	119	37.9		0.1127	24	1.35
Mnee	*Syzygium guineense*	76	24.2		0.0460	19	0.43
Mnee	*Syzygium guineense*	64	20.4		0.0326	17	0.28
Mnee	*Syzygium guineense*	90	28.6		0.0645	21	0.66
Mnee	*Syzygium guineense*	108	34.4		0.0928	23	1.06
Mnee	*Syzygium guineense*	179	57.0		0.2550	30	3.83
Mnee	*Syzygium guineense*	188	59.8		0.2813	31	4.34
Mfuru	*Vitex doniana*	66	21.0		0.0347	17	0.30
Total					**1.5234**		**19.24**
Commercial species					**0.0000**		**0.00**

Number of stems : 15
Regeneration : Mkonge (*Millettia dura*)
Mbigicho (*Gardenia ternifolia*)
Mnee (*Syzygium guineense*)
Mbukuli
Number of future stems : Mkonge (*Millettia dura*)
Mbigicho (*Gardenia ternifolia*)
Mbigicho (*Gardenia ternifolia*)
Mtomondo (*Rauvolfia caffra*)
Liana : Ngombere
Nature of the soil : Clay / Loam

Sample plot n° : SP22 **X =** 507312 **Y =** 9127984

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mkuruti		75	23.9		0.0448	19	0.42
Mkuruti		104	33.1	32	0.0861	22	0.96
Mohoro	*Pseudolachnostylis maprouneifolia*	92	29.3	22	0.0674	21	0.70
Mkuruti		75	23.9		0.0448	19	0.42
Mkuruti		97	30.9	27	0.0749	21	0.80
Mnuso		167	53.2		0.2219	29	3.21
Mtopetope	*Annona senegalensis*	75	23.9		0.0448	19	0.42
Mtopetope	*Annona senegalensis*	63	20.1		0.0316	17	0.27
Total					**0.6161**		**7.19**
Commercial species					**0.0000**		**0**

Number of stems : 8

Regeneration : Mtete (2) (*Hymenocardia ulmoides*)
Mkatitu (2)
Mkingili
Mpome (*Commiphora ugogensis*)
Mningahoka (kifukura Nyoka) (2) (*Apodytes dimidiata*)
Mnyambara

Nature of the soil : sandy

Sample plot n° : SP23 **X =** 508465 **Y =** 9126674

Ecological unit : coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mndototo	*Lettowianthus stellatus*	108	34.4	31	0.0928	23	1.06
Mpilipili	*Sorindeia madagascariensis*	82	26.1		0.0535	20	0.52
Mpilipili	*Sorindeia madagascariensis*	99	31.5		0.0780	22	0.85
Mdimupori	*Suregada zanzibariensis*	292	92.9	33	0.6785	39	13.32
Mpilipili	*Sorindeia madagascariensis*	120	38.2		0.1146	24	1.38
Mpilipili	*Sorindeia madagascariensis*	99	31.5	25	0.0780	22	0.85
Mpome	*Commiphora ugogensis*	99	31.5		0.0780	22	0.85
Mpilipili	*Sorindeia madagascariensis*	75	23.9		0.0448	19	0.42
Mpome	*Commiphora ugogensis*	90	28.6		0.0645	21	0.66
Mndototo	*Lettowianthus stellatus*	132	42.0		0.1387	25	1.76
Mpilipili	*Sorindeia madagascariensis*	84	26.7		0.0561	20	0.56
Total					**1.4774**		**22.23**
Commercial species					**0.0000**		**0**

Number of stems : 11

Regeneration : Mkingili (5)
Mbunduwakutu (2)
Mtete (*Hymenocardia ulmoides*)
Mpugupugu (*Markhamia lutea*)
Kipinga

Nature of the soil : Sandy / loam

Sample plot n° : SP24 **X =** 507441 **Y =** 9126557

Ecological unit : Totally destroyed woodland

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m^2)	Height (calculated m)	Volume (m^3)
none							
Total					**0.0000**		**0.00**
Commercial species					**0.0000**		**0.00**

Number of stems : 0

Regeneration :
Mfuru (*Vitex doniana*) (18)
Mpugupugu (*Markhamia lutea*) (10)
Mulaula (*Voacanga africana*) (6)
Mkwanga (*Acacia tortilis*) (1)

Nature of the soil : Sandy

Sample plot n° : SP25 **X =** 504585 **Y =** 9126548

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mwakala		113	36.0		0.1016	23	1.19
Mneke	*Pteleosis myrtifolia*	187	59.5	32	0.2783	31	4.28
Mndototo	*Lettowianthus stellatus*	158	50.3		0.1987	28	2.79
Mndototo	*Lettowianthus stellatus*	77	24.5		0.0472	19	0.45
Mndototo	*Lettowianthus stellatus*	124	39.5		0.1224	25	1.50
Mneke	*Pteleosis myrtifolia*	134	42.7	36	0.1429	26	1.83
Mneke	*Pteleosis myrtifolia*	110	35.0		0.0963	23	1.11
Mnabia		79	25.1		0.0497	19	0.48
Mneke	*Pteleosis myrtifolia*	155	49.3	34	0.1912	28	2.65
Total					**1.2281**		**16.27**
Commercial species					**0.0000**		**0**

Number of stems : 9

Regeneration : Mtasi (*Baphia kirkii*) (2)
Mkongo (*Afzelia quanzensis*) (1)
Msweli (*Grewia sp. ?*) (1)
Mkolekole (4)
Mkingili (2)
Kinganambele (2)

Nature of the soil : sandy / loam

Sample plot n° : SP26 **X =** 503103 **Y =** 9126556

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtasi	*Baphia kirkii*	68	21.6		0.0368		0.33
Mtete	*Hymenocardia ulmoides*	74	23.6	18	0.0436	19	0.40
Mmangwangwaru		102	32.5		0.0828	22	0.91
Mneke	*Pteleosis myrtifolia*	113	36.0	28	0.1016	23	1.19
Msweli	*Grewia sp.*	65	20.7		0.0336	17	0.29
Mndototo	*Lettowianthus stellatus*	139	44.2		0.1538	26	2.01
Total					**0.4522**		**5.13**
Commercial species					**0.1196**		**1.24**

Number of stems : 6

Regeneration : Mtaranda (*Markhamia obtusifolia*)
Mnyambara
Mohoro (*Pseudolachnostylis maprouneifolia*)
Mtasi (*Baphia kirkii*)
Mtabwe (*Grewia trichocarpa*)

Number of future stems : Mohoro (*Pseudolachnostylis maprouneifolia*)
Mtasi (*Baphia kirkii*)
Mkuruti
Mtete (*Hymenocardia ulmoides*)

Nature of the soil : Sandy

Sample plot n° : SP27 **X =** 501665 **Y =** 9126553

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mndototo	*Lettowianthus stellatus*	160	50.9		0.2037	28	2.88
Mndototo	*Lettowianthus stellatus*	67	21.3		0.0357	18	0.31
Mndototo	*Lettowianthus stellatus*	130	41.4		0.1345	25	1.69
Mpugupugu	*Markhamia lutea*	120	38.2	21	0.1146	24	1.38
Mkwaju	*Tamarindus indica*	103	32.8		0.0844	22	0.94
Mkwaju	*Tamarindus indica*	116	36.9		0.1071	24	1.27
Mpambalaya		136	43.3		0.1472	26	1.90
Mndundu	*Cordyla africana*	120	38.2	27	0.1146	24	1.38
Mndototo	*Lettowianthus stellatus*	80	25.5		0.0509	19	0.49
Mndototo	*Lettowianthus stellatus*	148	47.1	23	0.1743	27	2.36
Mneke	*Pteleosis myrtifolia*	141	44.9		0.1582	26	2.08
Total					**1.3252**		**16.69**
Commercial species					**0.4207**		**4.97**

Number of stems : 11

Regeneration : Mkabusi (*Rytigynia uhligii*)
Mhiru (*Vangueria infausta*)
Mtabu
Mpingwi

Number of future stems : Mtabu

Shrubs : Mpakacha (*Deinbolia borbonica*)

Nature of the soil : Loam / sandy

Sample plot n° : SP28 **X =** 500233 **Y =** 9126545

Ecological unit : Woodland

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m^2)	Height (calculated m)	Volume (m^3)
Muungo	*Acacia nilotica*	65	20.7	10	0.0336	12	0.25
Muungo	*Acacia nilotica*	94	29.9	12	0.0703	15	0.60
Muungo	*Acacia nilotica*	82	26.1	11	0.0535	14	0.43
Total					**0.1574**		**1.28**
Commercial species					**0.0000**		**0.00**

Number of stems : 3

Regeneration : Mnywamaji (*Laprothamnus zanguebaricus*)
Msegese (*Piliostigma thonningii*)
Kiingiri

Nature of the soil : Clay / loam

Sample plot n° : SP29 **X =** 498759 **Y =** 9126541

Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circ. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mneke	*Pteleosis myrtifolia*	163	51.9	23	0.2114	21	2.29
Mnondondo	*Xeroderris stuhlmannii*	140	44.6	17	0.1560	19	1.58
Nyamakwenge	*Ablygonocarpus andongensis*	166	52.8	22	0.2193	21	2.39
Total					**0.5867**		**6.27**
Commercial species					**0.3753**		**3.98**

Number of stems : 3

Regeneration : Mpugupugu (*Markhamia lutea*)
Mtopetope (*Annona senegalensis*)
Mkibu (*Dombeya rotundifolia*)

Future stems : Mpugupugu (*Markhamia lutea*)
Mpugupugu (*Markhamia lutea*)
Mtopetope (*Annona senegalensis*)

Shrubs : Msekea
Mpakacha (*Deinbolia borbonica*)

Nature of the soil : Loam / sandy

Sample plot n° : SP30 **X =** 498781 **Y =** 9125113

Ecological unit : Woodland

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
none							
Total					**0**		**0**
Commercial species					**0**		**0**

Number of stems : 0

Regeneration : Mtopetope (*Annona senegalensis*)
Mpugupugu (*Markhamia lutea*)
Mninga (*Pterocarpus angolensis*)
Mneke (*Pteleosis myrtifolia*)
Future stems : Mninga (*Pterocarpus angolensis*)
Mpingo (*Dalbergia melanoxylon*)
Shrubs : Msekea
Nature of the soil : Loam

Sample plot n° : SP31 **X =** 500218 **Y =** 9125121

Ecological unit : Coastal forest (secondary)

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Muukurio	*Lannea humilis*	63	20.1	18	0.0316	17	0.27
Mkibu	*Dombeya rotundifolia*	80	25.5		0.0509	19	0.49
Mpugupugu	*Markhamia lutea*	63	20.1	16	0.0316	17	0.27
Mkibu	*Dombeya rotundifolia*	63	20.1		0.0316	17	0.27
Mulaula	*Voacanga africana*	63	20.1	17	0.0316	17	0.27
Mpingo	*Dalbergia melanoxylon*	130	41.4		0.1345	25	1.69
Mpugupugu	*Markhamia obtusifolia*	86	27.4		0.0589	20	0.59
Mneke	*Pteleosis myrtifolia*	69	22.0		0.0379	18	0.34
Mkombasiko	*Crossopteryx febrifuga*	67	21.3		0.0357	18	0.31
Mpome	*Commiphora ugogensis*	106	33.7		0.0894	23	1.01
Total					**0.5336**		**5.51**
Commercial species					**0.0904**		**0.86**

Number of stems : 10

Regeneration : Mpilipili (*Sorindeia madagascariensis*)
Mnungu (*Zanthoxylum chalybeum*)
Mneke (*Pteleosis myrtifolia*)
Mtopetope (*Annona senegalensis*)
Mpugupugu (*Markhamia lutea*)
Mtiriri

Number of future stems : Mtopetope (*Annona senegalensis*)
Mneke (*Pteleosis myrtifolia*)
Mtabwe (*Grewia trichocarpa*)
Mulaula (*Voacanga africana*)
Mtaranda (*Markhamia obtusifolia*)

Nature of the soil : sandy

Sample plot n° : SP32 **X =** 501671 **Y =** 9125104

Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Kiombo		82	26.1		0.0535	14	0.43
Kiombo		70	22.3		0.0390	13	0.30
Mtanga		188	59.8	26	0.2813	23	
Mndototo	*Lettowianthus stellatus*	72	22.9		0.0413	13	0.32
Mohoro	*Pseudolachnostylis maprouneifolia*	122	38.8	18	0.1184	18	1.14
Mohoro	*Pseudolachnostylis maprouneifolia*	65	20.7		0.0336	12	0.25
Mtumba	*Lannea schweinfurthii*	217	69.1	21	0.3747	25	4.58
Mkongodeka		72	22.9		0.0413	13	0.32
Mpumbili		67	21.3		0.0357	13	0.27
Mfuru pori		70	22.3		0.0390	13	0.30
Mtonga / Kiburuta	*Strychnos spinosa*	76	24.2		0.0460	13	0.36
Total					**1.1037**		**11.48**
Commercial species					**0.2813**		**3.23**

Number of stems : 11

Regeneration : Mkibu (*Dombeya rotundifolia*)
Mpugupugu (*Markhamia lutea*)
Matakoyambuya
Mnungu (*Zanthoxylum chalybeum*)

Shrubs : Mpakacha (*Deinbolia borbonica*)
Msekea

Nature of the soil : Loam

Sample plot n° : SP33 **X =** 503153 **Y =** 9125110

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mnangu	*Hymenaea verrucosa*	115	36.6	21	0.1052	24	1.24
Mtete	*Hymenocardia ulmoides*	86	27.4		0.0589	20	0.59
Mbebeti	*Albizia sp.*	156	49.7		0.1937	28	2.70
Mwakala		174	55.4		0.2409	30	3.56
Mkweanyani / ngude	*Sterculia appendiculata*	158	50.3	39	0.1987	28	2.79
Mndundu	*Cordyla africana*	197	62.7	25	0.3088	32	4.89
Mangauzungu		66	21.0		0.0347	17	0.30
Mbunduwakutu		70	22.3		0.0390	18	0.35
Total					**1.1798**		**16.42**
Commercial species					**0.6127**		**8.91**

Number of stems : 8

Regeneration : Mtabwe (*Grewia trichocarpa*)
Msweli (*Grewia sp.*)
Mnyambara
Kipungu

Number of future stems : Mndototo (*Lettowianthus stellatus*)
Kinyomwile
Mlopolopo (*Trichilia emetica*)

Shrubs : Msekea
kinyunde (*Cynometra suahilensis*)

Nature of the soil : sandy

Sample plot n° : SP34 **X =** 504569 **Y =** 9125094

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtiriri		130	41.4	20	0.1345	25	1.69
Mlopolopo	*Trichilia emetica*	113	36.0		0.1016	23	1.19
Mtete	*Hymenocardia ulmoides*	78	24.8	22	0.0484	19	0.46
Mbunduwakutu		63	20.1		0.0316	17	0.27
Mnangu	*Hymenaea verrucosa*	153	48.7		0.1863	28	2.57
Mkuruti		76	24.2		0.0460	19	0.43
Mkuruti		78	24.8		0.0484	19	0.46
Mkuruti		120	38.2	37	0.1146	24	1.38
Mkongodeka		75	23.9		0.0448	19	0.42
Mlopolopo	*Trichilia emetica*	63	20.1		0.0316	17	0.27
Total					**0.7877**		**9.14**
Commercial species					**0.3195**		**4.02**

Number of stems : 10

Regeneration : Mtunda (*Manilkara sansibarensis*)
Mnangu (*Hymenaea verrucosa*)
Mpojoa
kipungu
Nyakahamba (*Antidesma venosum*)

Shrubs : Mpakacha (*Deinbolia borbonica*)

Nature of the soil : sandy

Sample plot n° : SP35 **X =** 506021 **Y =** 9125104

Ecological unit : miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mohoro	*Pseudolachnostylis maprouneifolia*	95	30.2	15	0.0718	15	0.62
Mohoro	*Pseudolachnostylis maprouneifolia*	93	29.6		0.0688	15	0.59
Mnabia		160	50.9	24	0.2037	21	2.19
Mlundikafuru		66	21.0		0.0347	12	0.26
Mlundikafuru		76	24.2	12	0.0460	13	0.36
Mtanga	*Albizia versicolor*	74	23.6			13	0.34
Mkongo	*Afzelia quanzensis*	79	25.1		0.0497	14	0.40
Total					**0.5182**		**4.75**
Commercial species					**0.0932**		**0.73**

Number of stems : 7

Regeneration : Mkongo (*Afzelia quanzensis*)
Mhiya (2)
Mtanga (*Albizia versicolor*)
Mkwaju (*Tamarindus indica*) (3)
Mtanga (*Albizia versicolor*)
Mkundekunde (*Senna sp.*)
Mikoche (*Hyphaene compressa*) (4)

Nature of the soil : Loam

Sample plot n° : SP36 **X =** 507405 **Y =** 9125101

Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mkwanga	*Acacia tortilis*	102	32.5	14	0.0828	16	0.74
Mneke	*Pteleosis myrtifolia*	63	20.1		0.0316	12	0.23
Mohoro	*Pseudolachnostylis maprouneifolia*	67	21.3	14	0.0357	13	0.27
Total					**0.1501**		**1.23**
Commercial species					**0.0000**		**0.00**

Number of stems : 3

Regeneration : Mneke (*Pteleosis myrtifolia*) (10)
Mpugupugu (*Markhamia obtusifolia*) (3)
Mngwai (7)
Msegese (*Piliostigma thonningii*)
Lianas : Mkwezingura (2)
Nature of the soil : Loam / sandy

Sample plot n° : SP37 **X =** 504559 **Y =** 9123668

Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mnondondo		165		25		21	2.36
Mtasi	*Baphia kirkii*	72	22.9			13	0.32
Mtasi	*Baphia kirkii*		20.4		0.0326	12	0.24
Mulaula	*Voacanga africana*	102	32.5	16	0.0828	16	0.74
Mulaula	*Voacanga africana*	82	26.1		0.0535	14	0.43
Mpugupugu	*Markhamia lutea*	63	20.1			12	0.23
Mohoro	*Pseudolachnostylis maprouneifolia*	142	45.2	16	0.1605	20	1.64
Mkulo	*Trichilia dregeana*	175	55.7		0.2437	22	2.72
Mpome	*Commiphora ugogensis*	78	24.8		0.0484	14	0.38
Total					**0.9110**		**9.05**
Commercial species					**0.3221**		**3.14**

Number of stems : 9

Regeneration : Mnangu (*Hymenaea verrucosa*)
Mtomoni / Mtogo (*Diplorynchus condilocarpon*)
Future stems : Mtabu
Mpugupugu (*Markhamia lutea*)
Mnangu (*Hymenaea verrucosa*)
Shrubs : Msekea
Nature of the soil : sandy

Sample plot n° : SP38 **X =** 503128 **Y =** 9123667
Ecological unit : Miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mndototo	*Lettowianthus stellatus*	75	23.9		0.0448	13	0.35
Mnangu		176	56.0	23		22	2.76
Mtete	*Hymenocardia ulmoides*	75	23.9		0.0448	13	0.35
Mkomampembe		90	28.6	13	0.0645	15	0.54
Mohoro	*Pseudolachnostylis maprouneifolia*	75	23.9		0.0448	13	0.35
Mohoro	*Pseudolachnostylis maprouneifolia*	88	28.0		0.0616	15	0.51
Mtogo / Mtomoni	*Diplorynchus condilocarpon*	109	34.7		0.0945	17	0.86
Mkulo	*Trichilia dregeana*	94	29.9	19	0.0703	15	0.60
Mkulo	*Trichilia dregeana*	70	22.3		0.0390	13	0.30
Mnondondo	*Xeroderris stuhlmannii*	144	45.8		0.1650	20	1.70
Mtogo / Mtomoni	*Diplorynchus condilocarpon*	177	56.3		0.2493	22	2.80
Mnondondo	*Xeroderris stuhlmannii*	177	56.3		0.2493	22	2.80
Mtete	*Hymenocardia ulmoides*	75	23.9		0.0448	13	0.35
Mneke	*Pteleosis myrtifolia*	99	31.5		0.0780	16	0.68
Mneke	*Pteleosis myrtifolia*	71	22.6		0.0401	13	0.31
Mneke	*Pteleosis myrtifolia*	93	29.6		0.0688	15	0.59
Total					**1.6060**		**15.84**
Commercial species					**0.6608**		**7.25**

Number of stems : 16

Regeneration :
Mtabwe (*Grewia trichocarpa*)
Mtabwe (*Grewia trichocarpa*)
Mnangu (*Hymenaea verrucosa*)
Mnangu (*Hymenaea verrucosa*)
Mnangu (*Hymenaea verrucosa*)
Mpugupugu (*Markhamia lutea*)

Number of future stems:
Mtete (*Hymenocardia ulmoides*)
Mneke (*Pteleosis myrtifolia*)
Mneke (*Pteleosis myrtifolia*)
Mkulo (*Trichilia dregeana*)
Mngongoro (*Monanthotaxis buchananii*)

Nature of the soil: Loam / sandy

Sample plot n° : SP39 **X =** 501666 **Y =** 9123667

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mwakala		93	29.6	20	0.0688	21	0.72
Mnungu	*Zanthoxylum chalybeum*	92	29.3		0.0674	21	0.70
Mkombasiko	*Crossopteryx febrifuga*	95	30.2		0.0718	21	0.76
Mtiriri		297	94.5	21	0.7019	40	13.91
Mtete	*Hymenocardia ulmoides*	92	29.3		0.0674	21	0.70
Mnepa / Mneke	*Pteleopsis myrtifolia*	100	31.8	22	0.0796	22	0.87
Mndototo	*Lettowianthus stellatus*	96	30.6		0.0733	21	0.78
Total					**1.1302**		**18.45**
Commercial species					**0.0000**		**0**

Number of stems : 7

Regeneration : Mpuya (*Bersama abyssinica*)
Mtabwe (*Grewia trichocarpa*)
Mbelebele (*Holarrhena pubescens*)
Mtabwe (*Grewia trichocarpa*)
Mkundekunde (*Senna sp.*)
Mnangu (*Hymenaea verrucosa*)

Future stems : Nyakahamba (*Antidesma venosum*)

Shrubs : Mpakacha (*Deinbolia borbonica*)

Nature of the soil : Sandy / Loam

Sample plot n° : SP40 **X =** 500231 **Y =** 9123648

Ecological unit : miombo

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mtopetope	*Annona senegalensis*	120	38.2	16	0.1146	18	1.09
Mmangangwaru	*Afrormosia angolensis*	63	20.1		0.0316	12	0.23
Mbula / mula		176	56.0	24	0.2465	22	2.76
Ngwai / Mgombakilanga		79	25.1		0.0497	14	0.40
Ngwai / Mgombakilanga		74	23.6		0.0436	13	0.34
Ngwai / Mgombakilanga		194	61.8		0.2995	23	3.49
Mohoro	*Pseudolachnostylis maprouneifolia*	183	58.3	20	0.2665	23	3.03
Total					**1.0519**		**11.33**
Commercial species					**0.0316**		**0.23**

Number of stems : 7

Regeneration : Mhiru (*Vangueria infausta*)
Mbula
Mtanga (*Albizia versicolor*)
Future stems : Mtanga (*Albizia versicolor*)
Lianas : Mkwezingura
Nature of the soil : Loam

Sample plot n° : SP41 **X =** 498805 **Y =** 9123678

Ecological unit : Coastal forest (secondary)

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
	Acacia sp.	116	36.9	24	0.1071	24	1.27
Mneke	*Pteleopsis myrtifolia*	73	23.2	22	0.0424	18	0.39
Mneke	*Pteleopsis myrtifolia*	65	20.7	20	0.0336	17	0.29
Total					**0.1831**		**1.95**
Commercial species					**0.0000**		**0**

Number of stems : 3

Regeneration : Kipinga

Future stems : Mneke (*Pteleopsis myrtifolia*)
Mpugupugu (*Markhamia lutea*)
Mpugupugu (*Markhamia lutea*)
Mtete (*Hymenocardia ulmoides*)
Mhiru (*Vangueria infausta*)

Shrubs : Mpakacha (*Deinbolia borbonica*)
Msekea

Nature of the soil : Sandy

Sample plot n° : SP42 **X =** 500230 **Y =** 9122235

Ecological unit : coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mneke	*Pteleopsis myrtifolia*	184	58.6	34	0.2694	30	4.11
Mtunda	*Manilkara sansibarensis*	74	23.6		0.0436	19	0.40
Mkongodeka		63	20.1	16	0.0316	17	0.27
Mkuruti		130	41.4	24	0.1345	25	1.69
Mkongodeka		68	21.6		0.0368	18	0.33
Mkongodeka		85	27.1		0.0575	20	0.57
Mneke	*Pteleopsis myrtifolia*	133	42.3		0.1408	26	1.80
Mtasi	*Baphia kirkii*	73	23.2		0.0424	18	0.39
Mkuruti		110	35.0		0.0963	23	1.11
Mkongodeka		107	34.1		0.0911	23	1.03
Mkongodeka		110	35.0		0.0963	23	1.11
Mkongodeka		145	46.2		0.1673	27	2.24
Total					**1.2075**		**15.04**
Commercial species					**0.0424**		**0.39**

Number of stems : 12

Regeneration : Mbelebele (*Holarrhena pubescens ?*)
Mtabwe (*Grewia trichocarpa*)
Mbebeti (*Albizia sp.*)
Mkuruti

Number of future stems : Mtasi (*Baphia kirkii*)
Mkongodeka
Shrubs : Mpakacha (*Deinbolia borbonica*)
Nature of the soil : Sandy

Sample plot n° : SP43 **X =** 501679 **Y =** 9122207

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mkongo	*Afzelia quanzensis*	94	29.9		0.0703	21	0.74
Mtete	*Hymenocardia ulmoides*	67	21.3		0.0357	18	0.31
Mtete	*Hymenocardia ulmoides*	63	20.1		0.0316	17	0.27
Mneke	*Pteleopsis myrtifolia*	67	21.3	15	0.0357	18	0.31
Mkolowa	*Acacia sp.*	83	26.4	13	0.0548	20	0.54
Muumburu		102	32.5		0.0828	22	0.91
Total					**0.3110**		**3.09**
Commercial species					**0.0703**		**0.74**

Number of stems : 6

Regeneration : Muungoma (*Acacia sp.*)
Mtete (*Hymenocardia ulmoides*)
Mtabwe (*Grewia trichocarpa*)
Mtete (*Hymenocardia ulmoides*)

Number of future stems : Mtete (*Hymenocardia ulmoides*)
Mulaula (*Voacanga africana*)
Mulaula (*Voacanga africana*)

Nature of the soil : Loam / Sandy

Sample plot n° : SP44 **X =** 504553 **Y =** 9122218

Ecological unit : Coastal forest

Name of species (vernacular)	Name of species (scientific)	circumf. (cm)	DBH (cm)	Height (m)	Section (m2)	Height (calculated m)	Volume (m3)
Mkongo	*Afzelia quanzensis*	129	41.1	25	0.1324	25	1.66
Mndototo	*Lettowianthus stellatus*	75	23.9		0.0448	19	0.42
Mnabia		103	32.8	29	0.0844	22	0.94
Mndototo	*Lettowianthus stellatus*	76	24.2		0.0460	19	0.43
Mndototo	*Lettowianthus stellatus*	96	30.6		0.0733	21	0.78
Mkongo	*Afzelia quanzensis*	65	20.7		0.0336	17	0.29
Mtaranda	*Markhamia obtusifolia*	88	28.0		0.0616	20	0.63
Mkongo	*Afzelia quanzensis*	88	28.0	15		20	0.63
Total					**0.5378**		**5.77**
Commercial species					**0.2893**		**3.21**

Number of stems : 8

Regeneration : Mtabu
Mtiriri
Mulaula (*Voacanga africana*)

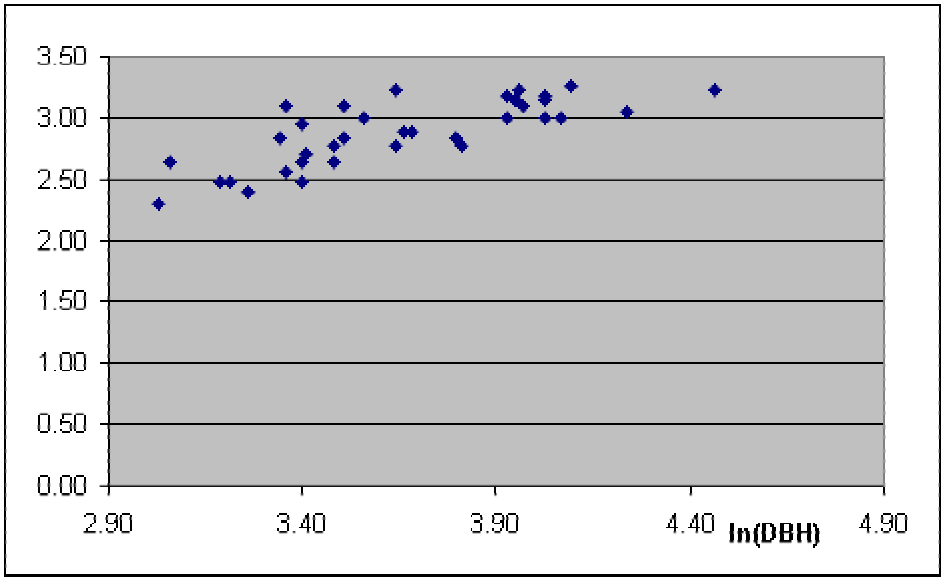
Future stems : Mkongo (*Afzelia quanzensis*)
Mtaranda (*Markhamia obtusifolia*)
Mtaranda (*Markhamia obtusifolia*)
Mnongoro (*Monanthotaxis buchananii*)

Shrubs : Mpakacha (*Deinbolia borbonica*)
Shingororo

Nature of the soil : Sandy

Calculation of the Height / Diameter Equation for the Miombo and Woodland Patches

cir. (cm)	DBH (cm)	Height (m)	ln(DBH)	ln(H)
94	29.9	14	3.40	2.64
125	39.8	18	3.68	2.89
90	28.6	22	3.36	3.09
272	86.6	25	4.46	3.22
78	24.8	12	3.21	2.48
105	33.4	17	3.51	2.83
176	56.0	20	4.03	3.00
160	50.9	20	3.93	3.00
89	28.3	17	3.34	2.83
105	33.4	22	3.51	3.09
110	35.0	20	3.56	3.00
120	38.2	25	3.64	3.22
65	20.7	10	3.03	2.30
94	29.9	12	3.40	2.48
82	26.1	11	3.26	2.40
163	51.9	23	3.95	3.14
140	44.6	17	3.80	2.83
166	52.8	22	3.97	3.09
188	59.8	26	4.09	3.26
122	38.8	18	3.66	2.89
217	69.1	21	4.24	3.04
95	30.2	15	3.41	2.71
160	50.9	24	3.93	3.18
76	24.2	12	3.19	2.48
102	32.5	14	3.48	2.64
67	21.3	14	3.06	2.64
165	52.5	25	3.96	3.22
102	32.5	16	3.48	2.77
142	45.2	16	3.81	2.77
176	56.0	23	4.03	3.14
90	28.6	13	3.36	2.56
94	29.9	19	3.40	2.94
120	38.2	16	3.64	2.77
176	56.0	24	4.03	3.18
183	58.3	20	4.06	3.00



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.78157
R Square	0.61085
Adj. R Square	0.59906
Standard Error	0.16797
Observations	35

Height / diameter equation:

ln(H) = 0,722 + 0,590ln(DBH)

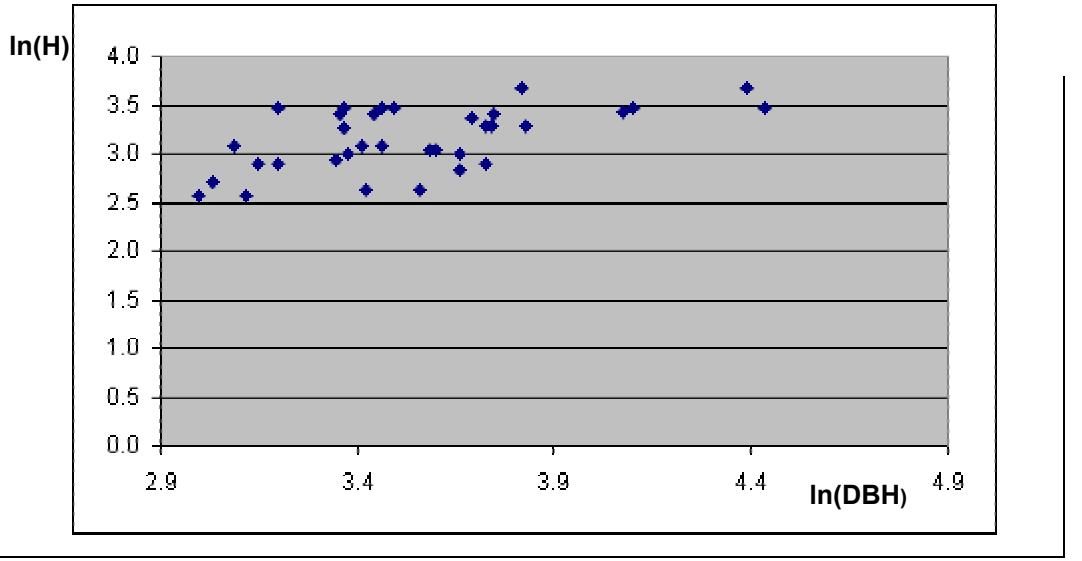
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.461446	1.461446	51.80047	2.9905E-08
Residual	33	0.931029	0.028213		
Total	34	2.392475			

	Coeff	*St. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95%*	*Upper 95%*
Intercept	0.72223	0.300871	2.400471	0.022172	0.11010482	1.334357	0.110105	1.334357
X Variable 1	0.59017	0.082	7.197254	2.99E-08	0.42334224	0.757001	0.423342	0.757001

Calculation of the Height / Diameter Equation for the Coastal Forest Patches

cir. (cm)	DBH (cm)	Height (m)	ln (DBH)	ln(H)
110	35.0	14	3.6	2.6
95	30.2	22	3.4	3.1
100	31.8	22	3.5	3.1
265	84.4	32	4.4	3.5
98	31.2	30	3.4	3.4
77	24.5	32	3.2	3.5
100	31.8	32	3.5	3.5
253	80.5	39	4.4	3.7
92	29.3	20	3.4	3.0
73	23.2	18	3.1	2.9
185	58.9	31	4.1	3.4
130	41.4	18	3.7	2.9
65	20.7	15	3.0	2.7
143	45.5	39	3.8	3.7
122	38.8	20	3.7	3.0
122	38.8	17	3.7	2.8
96	30.6	14	3.4	2.6
90	28.6	30	3.4	3.4
130	41.4	27	3.7	3.3
190	60.5	32	4.1	3.5
103	32.8	32	3.5	3.5
133	42.3	30	3.7	3.4
91	29.0	32	3.4	3.5
77	24.5	18	3.2	2.9
69	22.0	22	3.1	3.1
63	20.1	13	3.0	2.6
91	29.0	26	3.4	3.3
144	45.8	27	3.8	3.3
113	36.0	21	3.6	3.0
126	40.1	29	3.7	3.4
132	42.0	27	3.7	3.3
115	36.6	21	3.6	3.0
89	28.3	19	3.3	2.9
63	20.1	13	3.0	2.6
71	22.6	13	3.1	2.6



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.649326
R Square	0.421624
Adjusted R Square	0.414571
Standard Error	0.232018
Observations	84

Height / diameter equation :

ln(H) = 1,187 + 0,548ln(DBH)

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.217908	3.217908	59.77638	2.37E-11
Residual	82	4.414259	0.053832		
Total	83	7.632167			

	Coeff	*St. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95%*	*Upper 95%*
Intercept	1.187091	0.250805	4.733124	9.12E-06	0.68816	1.686022	0.68816	1.68602218
X Variable 1	0.548458	0.070938	7.731519	2.37E-11	0.40734	0.689576	0.40734	0.68957581

cir. (cm)	DBH (cm)	Height (m)	ln (DBH)	ln(H)
76	24.2	13	3.2	2.6
95	30.2	20	3.4	3.0
117	37.2	22	3.6	3.1
109	34.7	22	3.5	3.1
104	33.1	32	3.5	3.5
92	29.3	22	3.4	3.1
97	30.9	27	3.4	3.3
108	34.4	31	3.5	3.4
292	92.9	33	4.5	3.5
99	31.5	25	3.5	3.2
187	59.5	32	4.1	3.5
134	42.7	36	3.8	3.6
155	49.3	34	3.9	3.5
68	21.6	20	3.1	3.0
74	23.6	18	3.2	2.9
113	36.0	28	3.6	3.3
120	38.2	21	3.6	3.0
120	38.2	27	3.6	3.3
148	47.1	23	3.9	3.1
63	20.1	18	3.0	2.9
63	20.1	16	3.0	2.8
63	20.1	17	3.0	2.8
115	36.6	21	3.6	3.0
158	50.3	39	3.9	3.7
197	62.7	25	4.1	3.2
130	41.4	20	3.7	3.0
78	24.8	22	3.2	3.1
120	38.2	37	3.6	3.6
93	29.6	20	3.4	3.0

cir. (cm)	DBH (cm)	Height (m)	ln (DBH)	ln(H)
297	94.5	31	4.5	3.4
100	31.8	22	3.5	3.1
116	36.9	24	3.6	3.2
73	23.2	22	3.1	3.1
65	20.7	20	3.0	3.0
184	58.6	34	4.1	3.5
63	20.1	16	3.0	2.8
130	41.4	24	3.7	3.2
94	29.9	16	3.4	2.8
67	21.3	15	3.1	2.7
83	26.4	13	3.3	2.6
129	41.1	25	3.7	3.2
103	32.8	29	3.5	3.4
88	28.0	15	3.3	2.7
88	28.0	15	3.3	2.7
95	30.2	15	3.4	2.7
86	27.4	17	3.3	2.8
96	30.6	21	3.4	3.0
74	23.6	22	3.2	3.1
104	33.1	18	3.5	2.9

Appendix 2: List of Species

In alphabetical order of the vernacular names

TREES

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Kiingiri			miombo - coastal forest
Kikobati			coastal forest
Kikomopende			coastal forest
Kilonzimwitu			coastal forest
Kinganambele			coastal forest
Kinuso cha mkunguti			coastal forest
Kinyomwile			coastal forest
Kiombo			miombo
Kipinga			coastal forest
Kipomu			miombo
Kipungu			miombo
Kobati			coastal forest
Mambaato	*Grewia goetzeana*		coastal forest
Mangauzungu			coastal forest
Matakoyambuya			miombo - coastal forest
Mbebeti	*Albizia sp.*		coastal forest
Mbelebele	*Holarrhena pubescens*		coastal forest
Mbelete	*Teclea simplicifolia*		coastal forest
Mbigicho	*Gardenia ternifolia*		coastal forest - riverine forest
Mbukuli			riverine forest
Mbula / mula / mbura			miombo
Mbunduwakutu			coastal forest
Mdadarika	*Newtonia sp.*	II	coastal forest
Mdimupori	*Suregada zanzibariensis*		coastal forest
Mfuru	*Vitex doniana*		miombo - coastal forest - riverine forest
Mfuru pori			miombo
Mhanga			coastal forest
Mhiru	*Vangueria infausta*		miombo - coastal forest
Mhiya			miombo
Mikoche	*Hyphaene compressa*		miombo
Mkabusi	*Rytigynia uhligii*		coastal forest
Mkahamba			coastal forest
Mkalioto			coastal forest
Mkandabia			coastal forest
Mkangaviko			coastal forest
Mkarango / Mtindili			coastal forest
Mkatitu			coastal forest
Mkibu	*Dombeya rotundifolia*		miombo - coastal forest
Mkingili			coastal forest
Mkolekole			coastal forest
Mkolowa	*Acacia sp.*		miombo - coastal forest
Mkomampembe			miombo
Mkombasiko	*Crossopteryx febrifuga*		coastal forest
Mkonge	*Millettia dura*		riverine forest - coastal forest
Mkongo	*Afzelia quanzensis*	II	miombo - coastal forest - riverine forest
Mkongodeka			miombo - coastal forest

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Mkulo	*Trichilia dregeana*		miombo
Mkundekunde	*Senna sp.*		miombo - coastal forest
Mkuruti			coastal forest - riverine forest
Mkwaju	*Tamarindus indica*	V?	miombo - coastal forest
Mkwanga	*Acacia tortilis*		miombo
Mkweanyani / ngude	*Sterculia appendiculata*	V?	coastal forest
Mlambunju	*Commiphora sp.*		miombo
Mlopolopo	*Trichilia emetica*	V	coastal forest
Mlundikafuru			miombo
Mmangangwaru	*Afrormosia angolensis*	V	miombo - coastal forest
Mmangaosungu			coastal forest
Mnabia / Mlabia			miombo - coastal forest
Mnangu	*Hymenaea verrucosa*	V	miombo - coastal forest - riverine forest
Mndototo	*Lettowianthus stellatus*		miombo - coastal forest
Mndundu	*Cordyla africana*	IV	coastal forest
Mnee	*Syzygium guineense*		riverine forest
Mnepa / Mneke	*Pteleopsis myrtifolia*		miombo - coastal forest
Mngongo	*Sclerocarya birrea*	V	miombo
Mngongoro	*Monanthotaxis buchananii*		miombo - coastal forest
Mngwai			miombo - coastal forest
Mninga	*Pterocarpus angolensis*	II	miombo - coastal forest
Mningahoka (kifukura Nyoka)	*Apodytes dimidiata*		coastal forest
Mnondondo	*Xeroderris stuhlmannii*	IV?	miombo - coastal forest
Mnondura			miombo - coastal forest
Mnongoro	*Monanthotaxis buchananii*		coastal forest
Mnungamo			miombo
Mnungu	*Zanthoxylum chalybeum*		miombo - coastal forest
Mnuso			coastal forest
Mnyakara / mwakala			miombo
Mnyambara			coastal forest
Mnyanyati / Mpwangati			coastal forest
Mnywamaji	*Laprothamnus zanguebaricus*		miombo
Mohoro	*Pseudolachnostylis maprouneifolia*		miombo - coastal forest
Mpambalaya			coastal forest
Mpangapanga / mnyamwea	*Millettia stuhlmannii*	II	miombo
Mpilipili	*Sorindeia madagascariensis*		coastal forest
Mpingo	*Dalbergia melanoxylon*	I	miombo - coastal forest
Mpingwi / kipingwi			coastal forest
Mpojoa			coastal forest
Mpome	*Commiphora ugogensis*		miombo - coastal forest
Mpugupugu	*Markhamia lutea*	II	miombo - coastal forest
Mpumbili			miombo
Mpuya	*Bersama abyssinica*		coastal forest
Msegese	*Piliostigma thonningii*		miombo
Msibondo			coastal forest
Msufi Pori / Mkunya	*Bombax rhodognaphalon*	IV	coastal forest
Msweli	*Grewia sp. ?*		coastal forest
Mtaba	*Ximenia caffra*		miombo
Mtabu			miombo - coastal forest
Mtabwe	*Grewia trichocarpa*		miombo - coastal forest

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Mtanga	*Albizia versicolor*	III	miombo - coastal forest
Mtaranda / mtalawanda	*Markhamia obtusifolia*	II	coastal forest
Mtasi	*Baphia kirkii*	III	miombo - riverine forest - coastal forest
Mtejateja			coastal forest
Mtesa			miombo
Mtete	*Hymenocardia ulmoides*		miombo - coastal forest
Mtimbo			coastal forest
Mtiriri			coastal forest
Mtogo / Mtomoni	*Diplorynchus condilocarpon*		miombo
Mtomondo	*Rauvolfia caffra*		riverine forest
Mtondoro	*Julbernardia globiflora*	III	miombo
Mtonga / Kiburuta	*Strychnos spinosa*		miombo
Mtopetope	*Annona senegalensis*		miombo - coastal forest
Mtumba	*Lannea schweinfurthii*		miombo - coastal forest
Mtunda	*Manilkara sansibarensis*		coastal forest - riverine forest
Mulaula	*Voacanga africana*		miombo - coastal forest
Muukurio	*Lannea humilis*		coastal forest
Muumburu			coastal forest
Muungo	*Acacia nilotica*		miombo
Muungoma	*Acacia sp.*		coastal forest
Mwaiji			coastal forest
Mwakala			coastal forest
Mwembe ngongo			miombo
Myengawa / mtandi / mwegea	*Kigelia africana*		riverine forest
Myombo	*Brachystegia spiciformis*	III	miombo
Ngwai / Mgombakilanga			miombo
Nyakahamba	*Antidesma venosum*		coastal forest
Nyamakwenge	*Amblygonocarpus andongensis*	V?	miombo

SHRUBS

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Kinyunde	*Cynometra suahiliensis*		coastal forest
Mpakacha	*Deinbolia borbonica*		miombo - coastal forest
Mpwekanyati			coastal forest
Msekea			miombo - coastal forest
Msisi ngololo			coastal forest
Nyepagamba			coastal forest
Shingororo			coastal forest

LIANAS

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Mkweringura / Mkezingata			miombo
Ngombere / Ngombera			riverine forest

In alphabetical order of the scientific names

TREES

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Muungo	*Acacia nilotica*		miombo
Mkolowa	*Acacia sp.*		miombo - coastal forest
Muungoma	*Acacia sp.*		coastal forest
Mkwanga	*Acacia tortilis*		miombo
Mmangangwaru	*Afrormosia angolensis*	V	miombo - coastal forest
Mkongo	*Afzelia quanzensis*	II	miombo - coastal forest - riverine forest
Mbebeti	*Albizia sp.*		coastal forest
Mtanga	*Albizia versicolor*	III	miombo - coastal forest
Nyamakwenge	*Amblygonocarpus andongensis*	V?	miombo
Mtopetope	*Annona senegalensis*		miombo - coastal forest
Nyakahamba	*Antidesma venosum*		coastal forest
Mningahoka (kifukura Nyoka)	*Apodytes dimidiata*		coastal forest
Mtasi	*Baphia kirkii*	III	miombo - riverine forest - coastal forest
Mpuya	*Bersama abyssinica*		coastal forest
Msufi Pori / Mkunya	*Bombax rhodognaphalon*	IV	coastal forest
Myombo	*Brachystegia spiciformis*	III	miombo
Mlambunju	*Commiphora sp.*		miombo
Mpome	*Commiphora ugogensis*		miombo - coastal forest
Mndundu	*Cordyla africana*	IV	coastal forest
Mkombasiko	*Crossopteryx febrifuga*		coastal forest
Mpingo	*Dalbergia melanoxylon*	I	miombo - coastal forest
Mtogo / Mtomoni	*Diplorynchus condilocarpon*		miombo
Mkibu	*Dombeya rotundifolia*		miombo - coastal forest
Mbigicho	*Gardenia ternifolia*		coastal forest - riverine forest
Mambaato	*Grewia goetzeana*		coastal forest
Msweli	*Grewia sp. ?*		coastal forest
Mtabwe	*Grewia trichocarpa*		miombo - coastal forest
Mbelebele	*Holarrhena pubescens*		coastal forest
Mnangu	*Hymenaea verrucosa*	V	miombo - coastal forest - riverine forest
Mtete	*Hymenocardia ulmoides*		miombo - coastal forest
Mikoche	*Hyphaene compressa*		miombo
Mtondoro	*Julbernardia globiflora*	III	miombo
Myengawa / mtandi / mwegea	*Kigelia africana*		riverine forest
Muukurio	*Lannea humilis*		coastal forest
Mtumba	*Lannea schweinfurthii*		miombo - coastal forest
Mnywamaji	*Laprothamnus zanguebaricus*		miombo
Mndototo	*Lettowianthus stellatus*		miombo - coastal forest
Mtunda	*Manilkara sansibarensis*		coastal forest - riverine forest
Mpugupugu	*Markhamia lutea*	II	miombo - coastal forest
Mtaranda / mtalawanda	*Markhamia obtusifolia*	II	coastal forest
Mkonge	*Millettia dura*		riverine forest - coastal forest
Mpangapanga / mnyamwea	*Millettia stuhlmannii*	II	miombo
Mngongoro	*Monanthotaxis buchananii*		miombo - coastal forest
Mnongoro	*Monanthotaxis buchananii*		coastal forest
Mdadarika	*Newtonia sp.*	II	coastal forest
Msegese	*Piliostigma thonningii*		miombo
Mohoro	*Pseudolachnostylis maprouneifolia*		miombo - coastal forest

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Mnepa / Mneke	*Pteleopsis myrtifolia*		miombo - coastal forest
Mninga	*Pterocarpus angolensis*	II	miombo - coastal forest
Mtomondo	*Rauvolfia caffra*		riverine forest
Mkabusi	*Rytigynia uhligii*		coastal forest
Mngongo	*Sclerocarya birrea*	V	miombo
Mkundekunde	*Senna sp.*		miombo - coastal forest
Mpilipili	*Sorindeia madagascariensis*		coastal forest
Mkweanyani / ngude	*Sterculia appendiculata*	V?	coastal forest
Mtonga / Kiburuta	*Strychnos spinosa*		miombo
Mdimupori	*Suregada zanzibariensis*		coastal forest
Mnee	*Syzygium guineense*		riverine forest
Mkwaju	*Tamarindus indica*	V?	miombo - coastal forest
Mbelete	*Teclea simplicifolia*		coastal forest
Mkulo	*Trichilia dregeana*		miombo
Mlopolopo	*Trichilia emetica*	V	coastal forest
Mhiru	*Vangueria infausta*		miombo - coastal forest
Mfuru	*Vitex doniana*		miombo - coastal forest - riverine forest
Mulaula	*Voacanga africana*		miombo - coastal forest
Mnondondo	*Xeroderris stuhlmannii*	IV?	miombo - coastal forest
Mtaba	*Ximenia caffra*		miombo
Mnungu	*Zanthoxylum chalybeum*		miombo - coastal forest

SHRUBS

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Kinyunde	*Cynometra suahiliensis*		coastal forest
Mpakacha	*Deinbolia borbonica*		miombo - coastal forest

List of species in each ecological unit

TREES

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Kikobati			coastal forest
kikomopende			coastal forest
Kilonzimwitu			coastal forest
Kinganambele			coastal forest
Kinuso cha mkunguti			coastal forest
Kinyomwile			coastal forest
Kipinga			coastal forest
Kobati			coastal forest
Mambaato	*Grewia goetzeana*		coastal forest
Mangauzungu			coastal forest
Mbebeti	*Albizia sp.*		coastal forest
Mbelebele	*Holarrhena pubescens*		coastal forest
Mbelete	*Teclea simplicifolia*		coastal forest
Mbunduwakutu			coastal forest
Mdadarika	*Newtonia sp.*	II	coastal forest
Mdimupori	*Suregada zanzibariensis*		coastal forest
Mhanga			coastal forest
Mkabusi	*Rytigynia uhligii*		coastal forest
Mkahamba			coastal forest
Mkalioto			coastal forest
Mkandabia			coastal forest
Mkangaviko			coastal forest
Mkarango / Mtindili			coastal forest
Mkatitu			coastal forest
Mkingili			coastal forest
Mkolekole			coastal forest
Mkombasiko	*Crossopteryx febrifuga*		coastal forest
Mkweanyani / ngude	*Sterculia appendiculata*	V?	coastal forest
Mlopolopo	*Trichilia emetica*	V	coastal forest
Mmangaosungu			coastal forest
Mndundu	*Cordyla africana*	IV	coastal forest
Mningahoka (kifukura Nyoka)	*Apodytes dimidiata*		coastal forest
Mnongoro	*Monanthotaxis buchananii*		coastal forest
Mnuso			coastal forest
Mnyambara			coastal forest
Mnyanyati / Mpwangati			coastal forest
Mpambalaya			coastal forest
Mpilipili	*Sorindeia madagascariensis*		coastal forest
Mpingwi / kipingwi			coastal forest
Mpojoa			coastal forest
Mpuya	*Bersama abyssinica*		coastal forest
Msibondo			coastal forest
Msufi Pori / Mkunya	*Bombax rhodognaphalon*	IV	coastal forest
Msweli	*Grewia sp. ?*		coastal forest
Mtaranda / mtalawanda	*Markhamia obtusifolia*	II	coastal forest
Mtejateja			coastal forest
Mtimbo			coastal forest
Mtiriri			coastal forest
Muukurio	*Lannea humilis*		coastal forest
Muumburu			coastal forest

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Muungoma	*Acacia sp.*		coastal forest
Mwakala			coastal forest
Nyakahamba	*Antidesma venosum*		coastal forest
Mwaiji			coastal forest
Mbigicho	*Gardenia ternifolia*		coastal forest - riverine forest
Mkuruti			coastal forest - riverine forest
Mtunda	*Manilkara sansibarensis*		coastal forest - riverine forest
Mkonge	*Millettia dura*		coastal forest - riverine forest
Kiombo			miombo
Kipomu			miombo
kipungu			miombo
Mbula / mula / mbura			miombo
Mfuru pori			miombo
Mhiya			miombo
Mikoche	*Hyphaene compressa*		miombo
Mkomampembe			miombo
Mkulo	*Trichilia dregeana*		miombo
Mkwanga	*Acacia tortilis*		miombo
Mlambunju	*Commiphora sp.*		miombo
Mlundikafuru			miombo
Mngongo	*Sclerocarya birrea*	V	miombo
Mnungamo			miombo
Mnyakara / mwakala			miombo
Mnywamaji	*Laprothamnus zanguebaricus*		miombo
Mpangapanga / mnyamwea	*Millettia stuhlmannii*	II	miombo
Mpumbili			miombo
Msegese	*Piliostigma thonningii*		miombo
Mtaba	*Ximenia caffra*		miombo
Mtesa			miombo
Mtogo / Mtomoni	*Diplorynchus condilocarpon*		miombo
Mtondoro	*Julbernardia globiflora*	III	miombo
Mtonga / Kiburuta	*Strychnos spinosa*		miombo
Muungo	*Acacia nilotica*		miombo
Mwembe ngongo			miombo
Myombo	*Brachystegia spiciformis*	III	miombo
Ngwai / Mgombakilanga			miombo
Nyamakwenge	*Amblygonocarpus andongensis*	V?	miombo
Kiingiri			miombo - coastal forest
Matakoyambuya			miombo - coastal forest
Mhiru	*Vangueria infausta*		miombo - coastal forest
Mkibu	*Dombeya rotundifolia*		miombo - coastal forest
Mkolowa	*Acacia sp.*		miombo - coastal forest
Mkongodeka			miombo - coastal forest
Mkundekunde	*Senna sp.*		miombo - coastal forest
Mkwaju	*Tamarindus indica*	V?	miombo - coastal forest
Mmangangwaru	*Afrormosia angolensis*	V	miombo - coastal forest
Mnabia / Mlabia			miombo - coastal forest
Mndototo	*Lettowianthus stellatus*		miombo - coastal forest

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Mnepa / Mneke	*Pteleopsis myrtifolia*		miombo - coastal forest
Mngongoro	*Monanthotaxis buchananii*		miombo - coastal forest
Mngwai			miombo - coastal forest
Mninga	*Pterocarpus angolensis*	II	miombo - coastal forest
Mnondondo	*Xeroderris stuhlmannii*	IV?	miombo - coastal forest
Mnondura			miombo - coastal forest
Mnungu	*Zanthoxylum chalybeum*		miombo - coastal forest
Mohoro	*Pseudolachnostylis maprouneifolia*		miombo - coastal forest
Mpingo	*Dalbergia melanoxylon*	I	miombo - coastal forest
Mpome	*Commiphora ugogensis*		miombo - coastal forest
Mpugupugu	*Markhamia lutea*	II	miombo - coastal forest
Mtabu			miombo - coastal forest
Mtabwe	*Grewia trichocarpa*		miombo - coastal forest
Mtanga	*Albizia versicolor*	III	miombo - coastal forest
Mtete	*Hymenocardia ulmoides*		miombo - coastal forest
Mtopetope	*Annona senegalensis*		miombo - coastal forest
Mtumba	*Lannea schweinfurthii*		miombo - coastal forest
Mulaula	*Voacanga africana*		miombo - coastal forest
Mfuru	*Vitex doniana*		miombo - coastal forest - riverine forest
Mkongo	*Afzelia quanzensis*	II	miombo - coastal forest - riverine forest
Mnangu	*Hymenaea verrucosa*	V	miombo - coastal forest - riverine forest
Mtasi	*Baphia kirkii*	III	miombo - riverine forest - coastal forest
Mbukuli			riverine forest
Mnee	*Syzygium guineense*		riverine forest
Mtomondo	*Rauvolfia caffra*		riverine forest
Myengawa / mtandi / mwegea	*Kigelia africana*		riverine forest

SHRUBS

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Kinyunde	*Cynometra suahiliensis*		coastal forest
Mpwekanyati			coastal forest
Msisi ngololo			coastal forest
Nyepagamba			coastal forest
Shingororo			coastal forest
Mpakacha	*Deinbolia borbonica*		miombo - coastal forest
Msekea			miombo - coastal forest

LIANAS

Name of species (vernacular)	Name of species (scientific)	Class	Ecological unit
Mkweringura / Mkezingata			miombo
Ngombere / Ngombera			riverine forest

Appendix 3: Transect Walks Report

TRANSECT WALKS REPORT

I. FOREWORD

For two days in July 2003, we conducted transect walks with villagers from Umwe South, Njianne, Ngumburuni and Mkupuka (first day) and from Mangwi-Misimbo, Umwe Centre, Umwe North and Muyuyu (second day). These transects aimed:

- to observe together with villagers the real situation of the forest : how it is exploited, and what kind of uses are most damaging, particularly the fires ;
- to collect their opinions, views and recommendations about the possible sustainable ways to use, secure and protect the forest ;
- to begin a reflection about the future management of the forest and the main constraints.

II. UNFOLDING OF THE TRANSECT WALKS

First stopover : in a coastal forest patch.

According to the villagers this patch (photo n° 1) is a secondary forest but, formerly, it was very dense. Obviously, it was already disturbed. The canopy is open in several places and some trails cross it. Some of the trees species, Mbebeti (*Albizia sp.*), Mlopolopo (*Trichilia emetica*) or Mkuruti, have been harvested and big trees are scarce. In that kind of forest the villagers used to collect medicines, edible fruits and fuel wood. They think that it is worth a try to improve and conserve those coastal forests but they ask about the means (technical and financial) to do so.

Second stopover : in a Miombo patch.

On the left edge of the Ruhoi River floodplain, this part of the forest is mostly Miombo, with Mninga (*Pterocarpus angolensis*), Mnangu (*Hymenaea verrucosa*), Mtasi (*Baphia kirkii*) or Mtumbatumba (*Lannea schweinfurthii*). In that area the valuable species are heavily overexploited. Hunters and loggers set fires for driving game and clearing the skidding areas, respectively. According to the villagers, this part of the forest is really threatened with becoming an open woodland. Yet, it is mostly used by the communities, for fuel wood or building and roofing materials collection.

Third stopover : An illegal logging area

During the transect, we found about ten cut down immature Mninga (*Pterocarpus angolensis*). All the surrounding area had been burnt for clearing. The average diameter of these trees is about 30 cm. The minimum harvesting diameter recommended by the official Forest Rules is 45 cm and the sustainable harvesting diameter is rather around 60 cm (Hamerlynck, 2003). In addition, the heartwood, the only one commercially valuable, is even smaller. The observations made during this transect walk also revealed wasteful practices, because most of the loggers are inexperienced : trees cut at 50 cm to 1 m height, split logs, etc. In view of facilitating logs smuggling, they are traded as off-cuts, which are not subject to licensing. The biggest ones are slightly burnt so that they cannot be recognized by the forest officers in the checkpoints. No big valuable trees will be found for decades, even more so because fires hinder regeneration. All the participants were very dismayed and they agreed that this illegal harvesting does them harm. They had the feeling that someone had stolen their future benefits.

Fourth stopover : two illegal loggers caught in the act on their pit-sawing place

During the transect, two illegal loggers, coming from Mkupuka, were caught in the act. The participants asked them if they were aware that the District already took initiatives to stop them harvesting Mninga. They answered that they knew that. They carry on exploiting Mninga because in the Kibiti and Jaribu-Mpakani checkpoints, the traders are allowed to pass with furniture made from Mninga. They agreed that these trees were immature, but they added that, as they were unemployed and as the climate was not favourable for cultivation this year, they had no other choice to earn their living. According to the participants, this poverty argument is difficult to dispute.

Fifth and last stopover : another pit-sawing place

During this five hundred meters transect, we discovered three active pit-sawing sites. It gave the participants a good idea of what happens all over the forest. During the inventory, we found more than forty of them. Some outside loggers sometimes stay six months in the forest, exploiting several sites.

III. CONCLUSIONS FROM THE TRANSECT WALKS

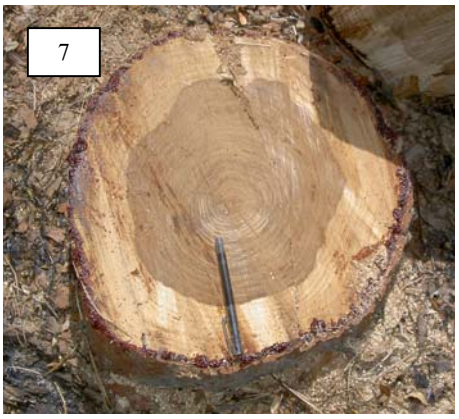
- The participants realised the forest is in a truly bad condition. They also saw the impact from overharvesting. They had already heard about those issues, but having seen the threats themselves, they will be able to testify and to increase public awareness.

- They emphasized the main forest management dilemma: how to reconcile the poverty of the surrounding villagers and the constraints of forest management?

- They also emphasized the gaps in the District management, and particularly the control issues at Kibiti checkpoint.

- They were convinced of the necessity of securing the forest so that the next generations could also benefit from it. They think that the restoration of the most degraded areas could be a good initiative.

- Lastly, they added that, for the success of the process, it would be necessary to find support and particularly a basic investment, at least initially.



1 : Participants discussing the condition of a disturbed coastal forest.
2 : Crossing the Miombo.
3 : Palms used for covering the roofs of the traditional houses.
4 : A young Mninga (*Pterocarpus angolensis*) tested in order to know the thickness of the sapwood.
5 – 6 : young Mninga felled along the transect.
7 : A young Mninga stump (the diameter is 39 cm).
8 : An old Mpingo log (*Dalbergia melanoxylon*). This first class species is now commercially extinct in Ngumburuni.
9 : A pit-sawing place and two young illegal loggers caught in the act. They come from one of the surrounding villages.
10 : A recent pit-sawing site.

Appendix 4: GPS Co-ordinates

COORDINATES OF THE SAMPLE PLOTS

Point n°	X	Y
SP1	505996	9127996
SP2	504560	9128000
SP3	503115	9128008
SP4	501675	9127984
SP5	500223	9127998
SP6	498754	9129446
SP7	501681	9129442
SP8	503115	9129454
SP9	504549	9129453
SP10	505997	9129446
SP11	507456	9129448
SP12	508893	9129452
SP13	510342	9130868
SP14	508890	9130879
SP15	507418	9130905
SP16	505998	9130900
SP17	504563	9130893
SP18	501662	9130891
SP19	500266	9130857
SP20	508809	9132524
SP21	510365	9132349
SP22	507312	9127984
SP23	508465	9126674
SP24	507440	9126557
SP25	504585	9126548
SP26	503103	9126557
SP27	501665	9126553
SP28	500233	9126545
SP29	498758	9126541
SP30	498781	9125113
SP31	500218	9125120
SP32	501671	9125104
SP33	503153	9125110
SP34	504569	9125093
SP35	506022	9125109
SP36	507405	9125101
SP37	504559	9123668
SP38	503128	9123667
SP39	501666	9123667
SP40	500231	9123648
SP41	498805	9123679
SP42	500230	9122235
SP43	501679	9122207
SP44	504553	9122218

COORDINATES OF THE MAIN TRAILS

Point n°	X	Y
MAINR1	498776	9130050
MAINR2	499105	9129852
MAINR3	499633	9129391
MAINR4	501778	9129347
MAINR5	503115	9129443
MAINR6	504585	9129416
MAINR7	495823	9131311
MAINR8	495935	9131237
MAINR9	496469	9130854
MAINR10	497005	9130932
MAINR11	497834	9130824
MAINR12	498586	9130435
MAINR13	498964	9129936
MAINR14	499270	9129731
MAINR15	499963	9129521
MAINR16	500617	9129401
MAINR17	501121	9129323
MAINR19	501461	9129260
MAINR25	501921	9129315
MAINR26	502080	9129306
MAINR27	503028	9129429
MAINR28	503519	9129433
MAINR29	504073	9129477
MAINR30	504508	9129488
MAINR31	504766	9129269
MAINR33	505145	9129023
MAINR34	505761	9129015
NOSOR1	505291	9123616
NOSOR2	505273	9124004
NOSOR3	505168	9124355
NOSOR4	505125	9124650
NOSOR5	505407	9125129
NOSOR8	505599	9125569
NOSOR9	505715	9126253
NOSOR10	505894	9126802
NOSOR11	505905	9127265
NOSOR12	505962	9127620
NOSOR13	505938	9128124
NOSOR14	506001	9128667
ETRA1	505874	9129468
ETRA2	506055	9129468
ETRA3	506242	9129351
ETRA4	506787	9129313
ETRA6	507376	9129153
ETRA7	508016	9128979
ETRA8	508460	9128538
SOUTR1	508216	9123876
SOUTR2	507832	9123918
SOUTR3	507222	9123747
SOUTR4	506851	9123609
SOUTR5	506468	9123554
SOUTR6	505691	9123499
SOUTR7	505316	9123454
SOUTR8	504889	9123406
SOUTR9	504365	9123310
SOUTR10	503396	9122959
SOUTR11	502822	9122795
SOUTR12	502402	9122312
SOUTR13	502245	9121896
SOUTR14	502236	9121580
SOUTR15	502172	9120960
SOUTR16	501910	9120460
SOUTR17	501503	9120532
SOUTR18	501123	9120698
SOUTR19	500682	9120804
SOUTR20	499995	9120753
SOUTR21	499217	9120997
SOUTR22	498521	9120732
NORR1	505968	9129003
NORR2	505907	9129325
NORR4	505848	9129597
NORR6	505861	9130502
NORR7	505571	9131782
NORR8	505654	9132366
EAR1	506047	9128935
EAR2	506366	9128740
EAR3	506637	9128497
EAR4	507011	9128269
EAR6	508013	9127768

COORDINATES OF THE VILLAGES

Point n°	X	Y
MANGWI	506952	9137244
MKUPUKA	494946	9133958
UMWE CENTRE	498394	9121193
NYAMTIMBA	518813	9141677
UMWE SOUTH	498923	9120500
UMWE NORTH	498308	9122235
MUYUYU	508216	9123876

COORDINATES OF THE SUB-VILLAGES

Point n°	X	Y
NJIANNE	505359	9123456
MBAWA	513744	9130198
NGUMBURUNI	506052	9128814
MISIMBO	503896	9136575
MISUGURI	505888	9130339

COORDINATES OF AGRICULTURAL ENCROACHMENTS

Point n°	X	Y
AGEN1	498935	9125167
AGEN2	505599	9125846
AGEN3	505772	9126412
AGEN4	505774	9129501
AGEN5	505820	9130032
AGEN6	505883	9130383
AGEN7	503832	9123051
AGEN8	503399	9122965
AGEN9	502949	9122824
AGEN10	502237	9121529
AGEN11	498756	9125278
AGEN12	498919	9125166

COORDINATES OF COASTAL FOREST AREAS

Point n°	X	Y
COFO1	507197	9127606
COFO2	504227	9128712
COFO3	508990	9131045
COFO4	504585	9129104
COFO5	499247	9129728
COFO6	507572	9129386
COFO7	509626	9130796
COFO8	501610	9130840
COFO9	504229	9131112
COFO10	504116	9131091
COFO11	505778	9130867
COFO12	507150	9130924
COFO13	501123	9124358
COFO14	501461	9122748
COFO15	502099	9122592
COFO16	500337	9122295
COFO17	500503	9122984
COFO18	503343	9125114
COFO19	503674	9125085
COFO20	504283	9125036
COFO21	499945	9126970
COFO22	499875	9127188
COFO23	499675	9129422
COFO24	501658	9130012
COFO25	505360	9122697
COFO26	505695	9131097
COFO27	507593	9129417

COORDINATES OF RIVERINE FOREST AREAS

Point n°	X	Y
RIV1	501847	9129522
RIV2	502618	9129536
RIV3	507441	9128728

COORDINATES OF MIOMBO AREAS

Point n°	X	Y
MIOM1	500621	9129193
MIOM2	500808	9129321
MIOM3	500601	9126101
MIOM4	499607	9125334
MIOM5	508001	9128514
MIOM6	502517	9121662
MIOM7	506613	9124383
MIOM8	498985	9125799
MIOM9	498988	9126004
MIOM10	499426	9127774
MIOM11	499283	9128005
MIOM12	500706	9124944
MIOM13	507089	9129249

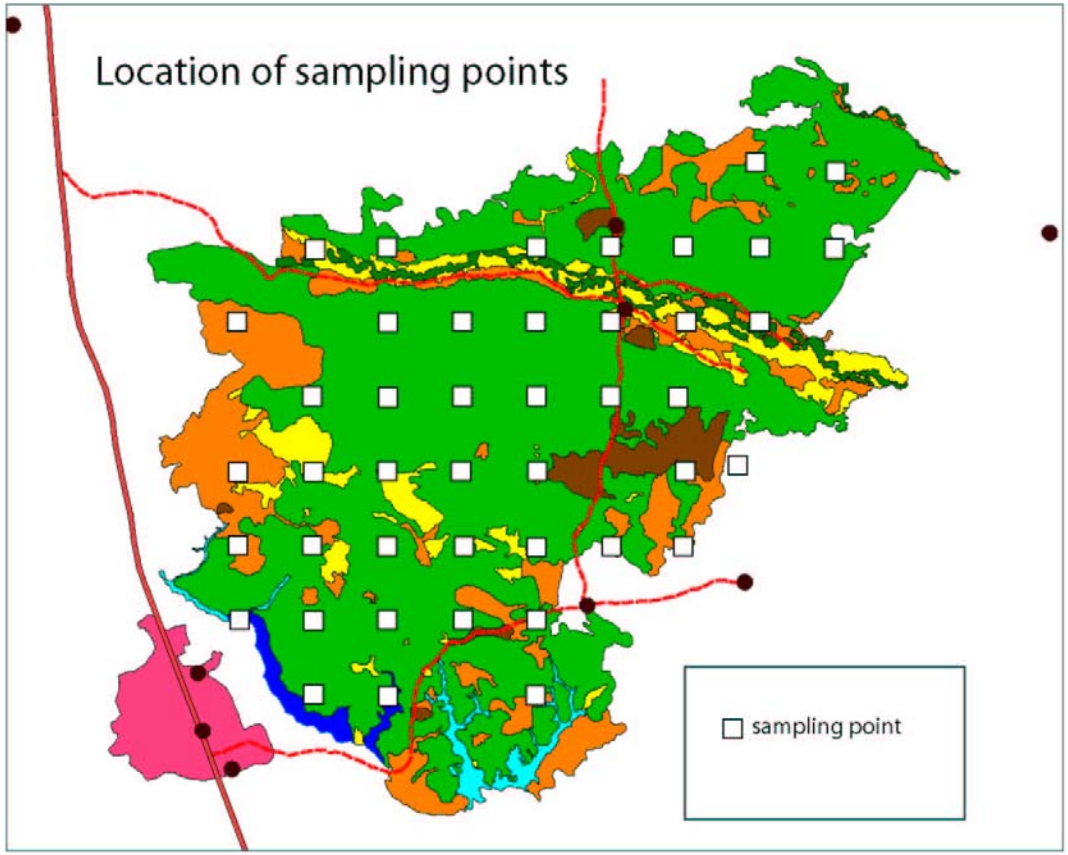
COORDINATES OF WOODLANDS

Point n°	X	Y
WOLA1	505761	9129060
WOLA2	501740	9129413
WOLA3	504551	9129484
WOLA4	500268	9125175
WOLA5	502543	9125999
WOLA6	501801	9129592
WOLA7	505571	9125492
WOLA8	508887	9127999
WOLA9	500836	9124384
WOLA10	500671	9124356
WOLA11	507938	9129068

COORDINATES OF THE IKWIRIRI EXTENSION PROJECT

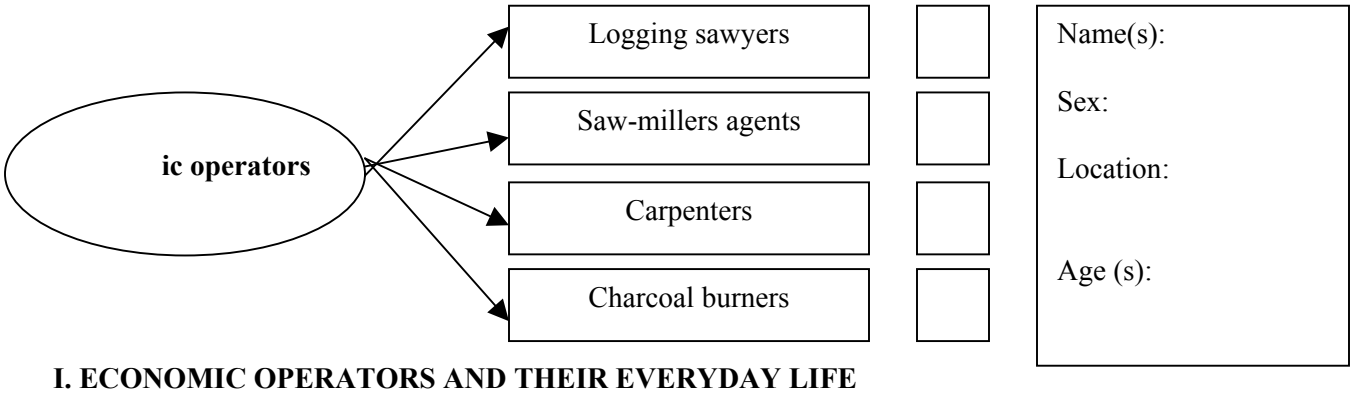
Point n°	X	Y
IKEX1	497075	9125039
IKEX2	498598	9125378
IKEX3	502033	9122349
IKEX4	502281	9120380
IKEX5	500560	9121047
IKEX6	498501	9121679
IKEX7	494321	9121428
IKEX8	494321	9123198
IKEX9	495383	9125462

Appendix 5: Map of Sample Plot Location



Appendix 6:Stakeholder Questionaires

INTERVIEW FORM n° :



I. ECONOMIC OPERATORS AND THEIR EVERYDAY LIFE

- At present, where do you work ?
- Is this activity the only one you have ?
- Do you work for your own business or do you do it on somebody else's behalf ?

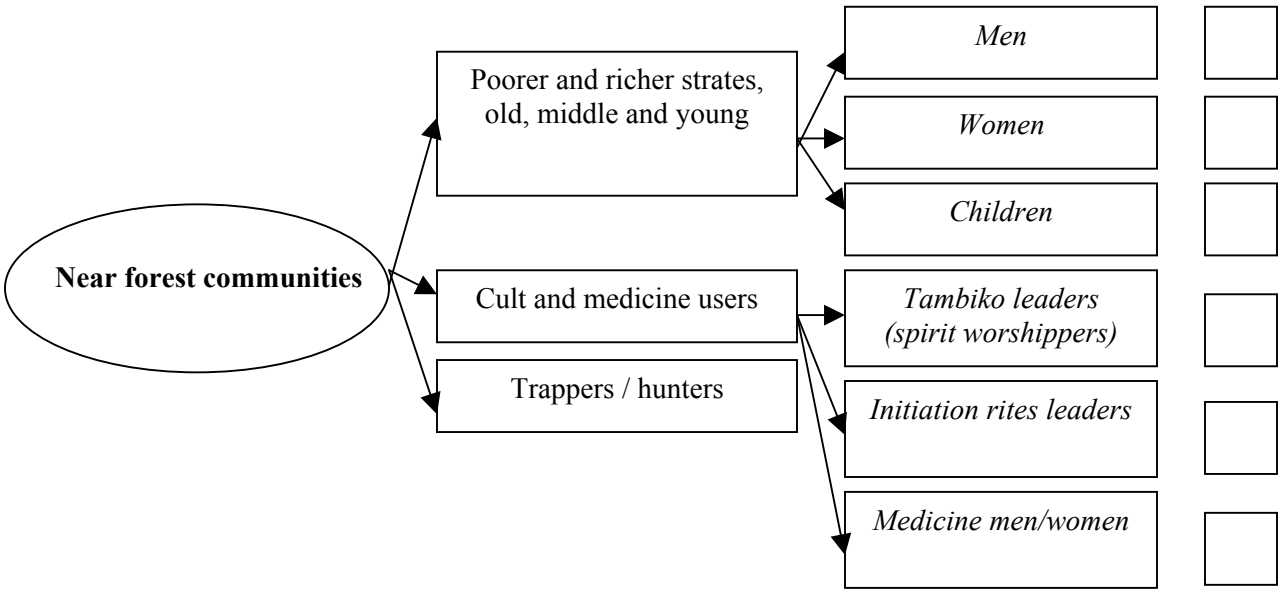
II. ECONOMIC OPERATORS AND THEIR PERCEPTION OF ENVIRONNEMENT AND OF THE FOREST IN PARTICULAR

- What do you know about the history of the Ngumburuni forest ?
- Do you know the current boundary of the forest (in the main lines) ?
- Do you think the forest has changed over the years ? If yes, how and what are the causes?
- What does the words "environment" (mali asili ? mazingira ?) and "protection of the nature" (uhifadhi wa pori) mean to you ?
- What do you think about the condition, problems and future of the forest ?

III. ECONOMIC OPERATORS AND FOREST MANAGEMENT

- Who manages the forest now ?
- What kind of organisation should be the manager of the forest and how should it operate?
- At the present time, what tree species do you use ?
- Is it possible to forbid harvesting of the scarcest tree species ?
- The saw-mills (industrial and traditional) and the charcoal burners are satisfying a wood market demand. While protecting the forest, how should this reality be taken in consideration ?
- **If the forest was put under your management, how would you do it ?**

INTERVIEW FORM n° : ☐



Name(s):
Sex:
Location:
Age (s):

I. VILLAGERS AND THEIR EVERYDAY LIFE

- At present, At what distance from the forest are you living ?
- At the present time, what do you harvest from the forest ?
- Do women and men use the forest in different ways ? If yes, how (cultural, spiritual activities,…) ?
- Is anyone living in the forest ? If yes, where do they come from and who gave their permission to settle in the forest ?

II. VILLAGERS AND THEIR PERCEPTION OF ENVIRONNEMENT AND OF THE FOREST IN PARTICULAR

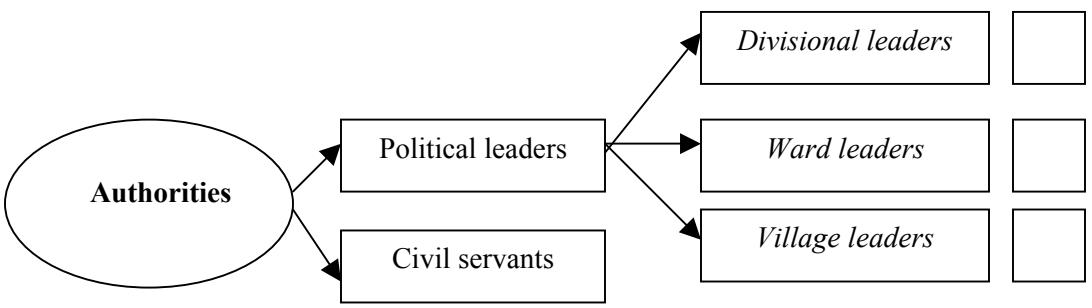
- What do you know about the history of the Ngumburuni forest ?
- Do you know the current boundary of the forest (in the main lines) ?
- Do you think the forest has changed over the years ? If yes, how and what are the causes?
- What does the words "environment" (mali asili ? mazingira ?) and "protection of the nature" (uhifadhi wa pori) mean to you ?
- In your village, who knows most about the forest and why ?
- According to you, who uses the forest most ? Are outsiders using it too ?
- Which uses are most and least damaging ?
- What do you think about the condition, problems and future of the forest ?

III. VILLAGERS AND FOREST MANAGEMENT

- Who manages the forest now ?
- Where should the boundaries of the community-based managed forest lie ? Who will need to be party to agreeing these ?

- What kind of organisation should be the manager of the forest and how should it operate?
- How should the forest be protected and guarded ? Who will apprehend offenders, levy fines, fix the rates of these fines and what will happen if offenders fail to pay fines ?
- How should the forest be used ? Are you interested in non-timber activities (beekeeping, pharmacology, butterfly farming, …) ?
- Is it conceivable to have a tourist activity in the forest ?
- Is it possible to forbid harvesting of the scarcest tree species ?
- What other actions will be needed to secure the forest and make it useful at a long-term?
- How should the progress of the community in managing the forest be monitored ?
- Is it conceivable to create plantations ?
- **What are the villagers ready to do for implementing plantations ? Can they find money for that ? From who ?**
- The saw-mills (industrial and traditional) are satisfying a wood market demand. While protecting the forest, how should this reality be taken in consideration ?
- **If the forest was put under your management, how would you do it ?**

INTERVIEW FORM n° :



Name(s):

Sex:

Location:

Age (s):

I. PRESENTATION

- At the present time, where are you in office ?
- What are your functions ?

II. AUTHORITIES AND THEIR PERCEPTION OF ENVIRONNEMENT AND OF THE FOREST IN PARTICULAR

- What do you know about the history of the Ngumburuni forest ?
- Do you know the current boundary of the forest (in the main lines) ?
- Do you think the forest has changed over the years ? If yes, how and what are the causes?
- What does the words "environment" (mali asili ? mazingira ?) and "protection of the nature" (uhifadhi wa pori) mean to you ?
- According to you, who uses the forest most ? Are outsiders using it too ?
- Which uses are most and least damaging ?
- What do you think about the condition, problems and future of the forest ?

III. AUTHORITIES AND FOREST MANAGEMENT

- Who manages the forest now ?
- **Where should the boundaries of the community-based managed forest lie ? Who will need to be party to agreeing these ?**
- What kind of organisation should be the manager of the forest and how should it operate?
- How should the forest be protected and guarded ? Who will apprehend offenders, levy fines, fix the rates of these fines and what will happen if offenders fail to pay fines ?
- How should the forest be used ? Are you interested in non-timber activities (beekeeping, pharmacology, butterfly farming, …) ?
- Is it conceivable to have a tourist activity in the forest ?
- Is it possible to forbid harvesting of the scarcest tree species ?
- What other actions will be needed to secure the forest and make it useful at a long-term?
- The saw-mills (industrial and traditional) are satisfying a wood market demand. While protecting the forest, how should this reality be taken in consideration ?
- **If the forest was put under your management, how would you do it ?**