State-community partnership as an option for sustainable management of an *Androstachys johnsonii* dominated woodland in Mabote District, Mozambique

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously, in its entirety or in part, submitted it at any other academic institution for a degree purpose.

Abstract

The state owned and managed forest and woodland resources during the colonial and post-independence periods in Mozambique. However, the centralised government forestry policies failed to stop the continual loss of natural forest and woodland resources under the state control. This study is concerned with the sustainability of a *cimbirre* (*Androstachys johnsonii*-dominated) woodland in a rural part of Mozambique. *A. johnsonii* trees are the major source of subsistence and income generation in southern Mozambique. Nevertheless, the exploitation of the species is running illegally because the diameters used for poles are below the harvestable diameter limit defined by the forestry legislation.

This study is part of the research activities of a community-based natural resources management project being implemented in the Mabote District. The study focuses on the four villages covered by this project funded by the Government of Finland. It intends to develop guidelines for sustainable management of the woodland which is of a great concern to the rural woodland-dependent communities. The study examines the socio-economic context of commercial harvesting of *A. johnsonii* trees for poles by local communities, as well as the sustainability of the woodland resources concerned, especially with respect to the setting of minimum harvestable diameter limits. It is assumed that the current deliberate burning of *cimbirre* woodlands to kill the desired species would cease once a sustainable diameter limit is established. Three methods are used to respond to the objectives of the study, namely: (1) Semi-structured interviews and group discussions with key informants; (2) Structured questionnaire surveys submitted to households randomly selected within the four villages being studied; and (3) Forest resource assessment.

The literature review documents the theoretical issues of sustainable management of natural resources and forest in particular, both past and present. It indicates that a state-community partnership should be considered for sustainable management of the area. It is also valid for communal areas in Mozambique in general, where the government legally controls forest resources.

The implementation of the structural adjustment programme that Mozambique currently pursues, allied to the retrenchments in the gold mining industry in South Africa and the abolishment of recruitment of Mozambican labourers in the South African mining industry, have transformed the traditional forms of rural livelihoods. These measures provide rather large incentives for private interests to exploit poles for commercial purposes. Findings of this study based on the forest resource assessment provide an ecological basis for allowing harvesting of juvenile trees of *A. johnsonii* for poles by local communities, because the current level of harvesting trees does not lead to woodland degradation. Besides, the centralised policies that governed the allocation of forest resources both in colonial and post-independent Mozambique have transformed traditional authorities. This has led to a confusion of roles and conflicting power in forest management.

Key words: Community involvement, deforestation, sustainable natural forest management.

Abstrak

Gedurende die koloniale en post-onafhanklike periode in Mosambiek is die woude en bosland hulpbronne deur die staat beheer en besit. Dié gesentraliseerde regeringsbeleide het egter nie die voortdurende verlies aan natuurlike hulpbronne onder staatsbeheer gestop nie. Hierdie studie handle oor die volhoubaarheid van 'n *cimbirre* (*Androstachys johnsonii*-dominated) inheemse bos in 'n landelike deel van Mosambiek. *A. johnsonii* bome is die hoofbron van bestaan en inkomstegenerering in die suidelike deel van Mosambiek. Nogtans word dié spesie onwettiglik uitgebuit omdat die deursnee vir pale onder die oesbare minimum deursnee is, soos bepaal deur bosbouwetgewing.

Dié studie vorm deel van die navorsingsaktiwiteite van 'n gemeenskapsbeheerde, natuurlike hulpbron bestuursprojek wat tans geïmplementeer word in die Mabote Distrik. Die fokus van dié studie is vier dorpies wat gedek word deur die projek. Die doelwit is om riglyne te ontwikkel vir die volhoubare bestuur van die bosgebied wat 'n groot bron van bekommernis is vir die landelike gemeenskappe wat van die bos afhanklik is. Die studie ondersoek die sosio-ekonomiese konteks vir die kommersiële oes van *A. johnsonii* bome vir pale deur die plaaslike gemeenskappe, sowel as die volhoubaarheid van die bosebied se hulpbronne hier betrokke, veral met die oog op die bepaling van 'n minimum deursnee beperking vir oesdoeleindes. Dit word aanvaar dat die huidige doelbewuste brand van *cimbirre* boslande, om die gewenste spesies dood te maak, beëindig sal word as 'n volhoubare deursnee limiet vasgestel word. Dit sal gedoen word met behulp van insette deur die afhanklike gemeenskappe. Drie metodes is gebruik om die doelwitte van die studie te behaal; (1) Semi-gestruktureerde onderhoude en groepbesprekings met kerninformante; (2) Getruktureerde vraelys opname wat aan lukraak geselekteerde huishoudings binne die vier dorpies (wat deel maak van studie) gegee is; en (3) Hulpbronwaardering in die bos.

Die literatuurstudie dokumenteer die teoretiese kwessies oor die volhoubare bestuur van natuurlike hulpbronne en dan spesifiek woude, beide in die verlede en in die huidige situasie. Die gevolgtrekking is dat 'n staatgemeenskapsvennootskap oorweeg moet word vir die volhoubare bestuur van die area. Dit geld ook in die algemeen vir die kommunale areas in Mosambiek, waar die regering wettiglik woudhulpbronne beheer.

Die implementering van strukturele aanpassings programme tans in Mosambiek, asook die afdankings in die goudmynindustrie in Suid-Afrika en die beëindiging aan die werwing van Mosambiekse arbeiders deur Suid-Afrika, het tradisionele vorms van landelike broodwinning getransformeer. Dit lei weer tot die misbruik van pale vir kommersiële doeleindes, deur die privaat sektor. Bevindings uit dié studie, gebaseer op die woudhulpbron waarderings, verskaf 'n ekologiese basis vir die oes van jong *A. johnsonii* bome vir pale deur die plaaslike gemeenskappe, want die huidige vlak van oes van dié bome lei nie tot boslandagteruitgang nie. Boonop het die gesentraliseerde beleide wat die toekenning van woudhulpbronne beheer, in beide 'n koloniale Mosambiek en 'n post-onafhanklike Mosambiek, tradisionele gesagsstrukture getransformeer. Dit het gelei tot 'n verwarring in rolle en 'n konflik in mag in inheemse bosbestuur.

Key words: Deforestasie, gemeenskapsbetrokkenheid, volhoubare natuurlike bosbestuur.

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Glossary of terminology and meanings

A number of terms and concepts relevant to the present research have been used. The terminology used is based on definitions of the research conducted by Thomson and Schoonmaker-Freudengerger (1997) and Ford-Robertson (1971).

Adult/mature stage - period during the life of a tree in which flowering occurs. In the context of this study, it includes trees at canopy and it refers to trees with diameter at breast height greater than 20 cm.

Canopy stems - the continuous cover formed by tree crowns in a forest. In the context of this study, it consists of adult trees i.e. it is defined as trees with diameter at breast height greater than 20 cm.

Carrying capacity under shifting cultivation – This refers to the number of people that can survive, without causing deterioration of woodlands through shifting cultivation practices.

***Cimbirre* woodlands** – name used in Mozambique for the *Androstachys johnsonii*-dominated woodlands. It develops within the savanna biome and is characterized by the dominance of *A. johnsonii* trees in gregarious and dense patches.

Committee - group of people elected or delegated to make decisions, usually in meetings.

Common property resources - renewable natural resources such as tree products, pastures and fisheries that have the characteristics of common pool resources, but to which access is controlled in some fashion. Some constraints on harvesting are also enforced by the group or unit that governs and manages the resource.

Communal or community forest - forest owned and generally managed by a community e.g. a village, town, tribal authority or local government, the members of which share in cash, kind or other benefits.

Community-based natural resources management - An approach to the use of renewable natural resources that relies on the empowerment of community groups to use those resources as they see fit using strategies arrived at through consensus. In an ideal situation, the use of the resources is sustainable in economic and ecological terms and the distribution of benefits occurs in a manner that is socially equitable.

Conservation - the continuing protection and management of natural resources in accordance with principles that assure their optimum economic and social enjoyment.

Diameter at breast height (dbh) - standard measurement of a tree diameter, usually taken at 1.3 m above the ground.

Diameter size-class - class in which the trees forming a stand are divided on the basis of diameter of the stem.

Ecologically sustainable – grants utilization without compromising the ability of future generations to meet their needs from the same source.

Exploitation felling/cutting - Removal of trees for immediate market returns, with little or no regard to silvicultural or other needs.

Extraction - process of removing forest products.

Felling cycle – refers to the time (years) needed for a stand of trees to restock in order to be exploited in a sustainable manner.

Forest management - Generally, the practical application of scientific, economic and social principles to the administration and working of a forest estate for specified objectives.

Forestation - the establishment of forest, naturally or artificially, on an area, whether previously carrying forest or not.

Grain - is a form of spatial analysis that compares the number of individuals of a species at the canopy level with the number of individuals in the sub-canopy or understory class.

Harvesting - removal of products from the forest for utilization, comprising cutting, sometimes further initial processing and extraction.

Harvestable diameter size-class – harvestable diameter size-class represents the fraction of the species that can be sustainably harvested. This fraction is defined by the limits set up for the lower harvesting limit of canopy stem density and sub-canopy stem density, respectively.

Increment - the increase in diameter at breast height of individual trees.

Increment rate - the increase of diameter of individual trees, during a given period of time.

Institution - the rules that govern a specific activity of a group or organization, as well as the behaviour of people in that activity. This includes traditional authority, local government administration, ruling party, community logger groups, wood transporters, timber enterprises and NGOs. Additionally, it includes the Administrative District, District Directorate of Agriculture and Rural Development and its particular services, namely, Forestry and Agricultural services.

Juvenile phase - the period during the life of a tree before flowering occurs. For *Androstachys johnsonii* it represents trees with diameter at breast height lower than 20 cm, also known as sub-canopy or understory trees.

Minimum harvesting diameter - standing trees, prescribed over bark diameter below which felling is not allowed. For *Androstachys johnsonii* it was defined at 30 cm.

Model - a formalized expression of a theory or of the casual situation regarded as having generated observed data. In this study, models are used to assess the sustainability of harvesting trees, based on information generated from other woodlands in Africa.

Non-governmental organisation (NGO) - voluntary and non-profit-distributing organisation, normally organised and funded from outside the local community in which it operates.

Partnership - agreement between two or more individuals or organisations to work together to achieve common aims.

Population structure – In the context of the present study, it is tree species distribution and representation of size-classes.

Recruits – trees that have entered a particular category during a given period, especially stems that have grown into a specific diameter or girth class. It refers to trees growing to the immediate upper size-class diameter.

Stakeholders - Individuals, groups or institutions that have an interest in forest management and its outcome. In the context of the present study, a distinction between local communities (householders) and the other stakeholders is made for the sake of easy discussion.

Sub-canopy or understory trees - trees and shrubs of the layer immediately beneath the canopy in a forest. It is also referred to as trees with diameter at breast height between 5 and 20 cm.

Sustainability – sustainable harvesting, in this study, implies that similar numbers of trees of a certain size-class continue to be harvested at periodic intervals indefinitely.

List of abbreviations

ANOVA – Analysis of variance

AAA – Acção agraria alemã (NGO)

AR – Annual recruitment

dbh - Diameter at breast height

CAMPFIRE - Communal Areas Management Programme for Indigenous Resources

CARE – Cooperative for assistance and relief everywhere (NGO)

CBNRM – Community-based natural resource management

CPD – Critical population density

DNFFB – Direcção Nacioanl de Florestas e Fauna Bravia (Portuguese) for National Forestry and Wildlife Directorate

FRELIMO – Frente de Libertação de Moçambique: The current ruling party in Mozambique

GIS – Geographic information system

MADER – Ministério da Agricultura e Desenvolvimento Rural (Portuguese) for Ministry of Agriculture and Rural Development

MAI - Mean annual increment

NGOs – Non-governmental organisations

PMSR – Projecto Maneio Sustentado dos Recursos (Portuguese)

RENAMO – Resistência Nacional Moçambicana: The main opposition party in Mozambique

SD – Standard deviation

SPFFB – Serviços Provinciais de Florestas e Fauna Bravia (Portuguese) for Provincial Forestry and Wildlife Services.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The savanna biome is the major plant community in southern, western and eastern Africa (FAO, 2001). The majority of Africa's population lives in savanna areas. Thus interest in social development in Africa leads to increased focus on people who live in savanna areas, where the miombo woodland is by far the most common vegetation type (Campbell et al., 1996). Woodlands supply many products and services essential for the well-being of rural communities, as well as service functions, including spiritual and cultural values (Clarke et al., 1996). While agricultural activities meet mostly the subsistence needs of rural African households, forest and woodland products provide at least 20% of disposable income used by African families to meet basic needs (World Bank-WWF, 2000). As a result, deforestation evokes concern in the effort to create a balance between conservation and socio-economic developmental concerns of rural communities (Rathogwa et al., 2000).

In Mozambique, about 70% of the population live in rural areas and depend on natural resources for survival (INE, 1997). Woodlands are the most common vegetation type in the country (Saket, 1994) and the most important broad-leaved woodlands are miombo, mopane and *cimbirre* (*Androstachys johnsonii*-dominated) woodland (Mangue and Oreste, 1999).

1.2 PROBLEM STATEMENT

The state owned and managed forest and woodlands resources during the colonial and post-independence periods in Mozambique. However, this centralised government policy failed to stop continued loss of natural resources, especially forest and woodland resources under the state control (Wily and Mbaya, 2001). Selective and indiscriminate felling of trees for timber, shifting cultivation, pasture and wildfires

have led to high levels of degradation (Castro, 1978). In addition, current political and socio-economic conditions in Mozambique seem to have increased pressure on natural forests for timber (Castel-Branco, 1994).

The structural adjustment programme that commenced in the mid-1980s and aims to create a liberalised economy also has far-reaching implications for sustainable forest management in Mozambique (Sousa et al., 2000). The programme creates a rather large incentive to the financial market, leading to increasing short-term forest decline (Conteros-Hermosilla, 2000). For example, most of the forests in the country have been disturbed by the removal of a few economically valuable species such as *Afzelia quanzensis*, *Androstachys johnsonii, Brachystegia spiciformis, Chlorophora excelsa, Dalbergia melanoxylon, Millettia stuhlmannii* and *Pterocarpus angolensis* (Saket et al., 1998). It is worth noting that all timber cutting is performed with scanty consideration for the productive capacity of the forest and for the need to keep a harmonious balance between biological and economic ends (CEF, 2000).

Furthermore, the forestry legislation in general still favours the private sector to the detriment of local community interests. For example, the forest management in general is guided by legislation that defines the minimum harvestable diameter limits for live trees based on its commercial value for timber (Chamber et al., 2002; Pereira et al., 2002). Nevertheless, a new strategy to develop the forest and wildlife sector was designed in 1997. The main objective of this new policy is to promote local community involvement in the management of natural resources through benefit sharing and sustainable use (Nhantumbo and Macqueen, 2003). It is important to note that although the process for formulating the framework policy and legislation upon which this regulation is premised was considered to include local communities, the process for enacting specific regulation rarely proceeds as intended (Wily, 2000). This is particularly valid in Mozambique where traditional leadership, local governance mechanisms and identification of communities are weak; the vision for developing community-based approaches is in the first place problematic (Nhamtumbo, 2000; Wily, 2000).

Of concern to this study are the *cimbirre* woodlands that have a restricted distribution in Mozambique. Little is known about the ecology of these woodlands (Sande, 1999). C*imbirre* woodlands occur in deciduous savanna, and they are characterized by gregarious and dense dry woodlands, frequently in more or less pure stands of *Androstachys johnsonii* trees (Codd, 1951). In Mozambique, this woodland type is confined to the Nampula, Sofala and Manica provinces and vast areas of the region South of Save River (Malleux, 1980). *Cimbirre* woodland is the major source for subsistence and income generation in southern Mozambique (Mantilla, 2002; Sande, 1999).

Two different commercial harvesting systems of *Androstachys johnsonii* trees are identified in Inhambane Province. These are the harvesting of juvenile trees (dbh < 15 cm) for poles by local communities and the harvesting of mature trees (dbh > 30 cm) for timber, by outsiders (private companies). The harvesting of mature trees is restricted to licensed timber bodies (Pereira et al., 2002). It is performed with scanty consideration of the reproductive capacity of the species, and the state has shown lack of capacity to control the activity (Chamba et al., 2002). On the other hand, the commercial harvesting of juvenile *A. johnsonii* trees for poles is an important source of income for local communities – mainly the poorest group of people with fewer possibilities to diversify their activities (Mantilla, 2002). Nevertheless, the activity is running illegally, since the tree diameter used for poles is below the harvestable diameter limit of 30 cm defined by the Forestry and Wildlife Law for live *A. johnsonii* trees (GoM, 2002). As a result, there are indications that local communities are burning *cimbirre* woodlands to kill *A. johnsonii* trees so that they qualify for utilisation (Mantilla, 2002). These practices, allied to shifting cultivation and pasture, have induced woodland depletion and encouraged soil degradation, leading to a vicious cycle of poverty-induced environmental degradation in the region (Telford and Hatton, 2001).

In this context, a community-based natural resource management project, Projecto Maneio Sustentado dos Recursos (PMSR), was established in 2001 in the Mabote District, Inhambane Province. The project intends to develop guidelines to reduce the current level of *cimbirre* woodland degradation and poverty. For its strategy, the

PMSR considers the resource availability assessment essential (especially looking at the potential for commercial pole exploitation). In parallel, the strategy considers the participation and involvement of local communities, as well as the incorporation of direct benefits to everyone concerned, as fundamental (Mantilla, 2002). Instead of persecuting "illegal" users, the central pillar of the project strategy has been to cooperate with them. For this reason, the project encouraged the establishment of an organised community group of loggers to represent this interest group on the local steering committee on woodland management (Mantilla, 2002).

The present study forms part of the PMSR research activities and complements the previous studies carried out in the focus area. It examines the socio-economic and legal context of the commercial harvesting of *A. johnsonii* for poles by local communities in addition to the sustainability of the woodland resource concerned, especially with respect to the setting of minimum harvestable diameter limits. It is assumed that the current deliberate burning of *cimbirre* woodlands to kill the desired species would cease once a sustainable diameter limit is established with dependent-community inputs. Within this scenario three major questions are identifiable: 1) What are the causes of fires in woodland? 2) How can the current commercial harvesting of trees for poles by local communities be put on a sustainable basis? 3) How can legal provision be made for the harvesting of *Androstachys johnsonii* poles? The hypotheses to the above questions are the following: 1) Local communities are involved in deliberate burning of trees in order to bypass the regulation that defines the minimum harvestable diameter limits for live trees; 2) The current commercial harvesting of poles is not sustainable as tree cutting is performed without concern for its reproductive capacity; and 3) A suitable harvesting system, including diameters suitable for poles can be put in place.

1.3 RESEARCH OBJECTIVES

1.3.1 Aim and objectives

The aim of this study is to contribute to the development of a strategic framework for sustainable management of natural resources by rural woodland-dependent communities in Mabote District and Mozambique in general.

1.3.2 Specific objectives

1) To assess the importance of the commercial harvesting of *Androstachys johnsonii* poles for the livelihood of rural households;
2) To assess the sustainability of the current harvesting systems and the potential of *Androstachys johnsonii* trees for poles;
3) To assess the role of different stakeholders in the management of *cimbirre* woodland and their perceptions; and
4) To recommend strategies and options that will aid in sustainable management of *cimbirre* woodland.

1.4 ORGANIZATION OF THE REPORT

This report is organized into six chapters. Chapter One is the introduction and it includes some background to the study, presents the problem statement, objectives, research questions and respective hypotheses. Chapter Two is the literature review, which examines theoretical issues of sustainable management of natural resources with emphasis on community involvement in the forestry sector in particular. Chapter Three defines the study area, provides details of the methodology used, explains techniques applied for data collection at the village level, and outlines the field measurement methods used. The survey results are presented in Chapter Four, and discussions in Chapter Five. Finally, the conclusions and recommendations are presented in Chapter Six.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter stresses some aspects of the development of the conservation concept. It focuses on the application of conservation concepts on natural resources in general and forest resource management policies in particular, as well as the conflicts that emerged from it. The chapter also examines theoretical issues of sustainable management of natural resources with some emphasis on community involvement in the forestry sector in particular. It starts with the history and development of conservation, followed by the review of community involvement in forest management and analysis on community-based natural resource management (CBNRM) initiatives in Mozambique, and it ends with a conclusion.

2.2 NATURAL RESOURCE MANAGEMENT

2.2.1 History and development of conservation concepts

During the pre-colonial periods in Africa, many traditional rural populations had sustainably managed environmentally sensitive regions, which acted as the main source of efficient and equitable benefits for their livelihoods (Abakerli, 2001). Although their direct dependency on the utilization of resources had varied, different cultures had shared similar characteristics such as low population density, consumption patterns and levels of pollution (Watts, 2003; Ghimire and Pimbert, 2000). Many populations had also developed a particular form of property management, which provided an assurance that the resources on which people depended would collectively be sustainable (Abakerli, 2001; Ghimire and Pimbert, 2000). In the course of the definition and continuous acceptance of a set of social norms and rules, individual behaviour towards the interdependent management of

resources had been regulated, ensuring livelihoods and maintaining the natural resource base (Abakerli, 2001).

Although much has been said in literature on human populations increasing, industrial and scientific revolutions gave an expanded ability to individuals to exploit natural resources and create material wealth (Watts, 2003; Attawood et al., 2000; Cox, 1997). In coastal environments, for example, natural refuges became rare as human access to the sea was improved, and new technology was used to locate organisms with greater precision (Attawood et al., 2000). This situation has led to the development of conservation activism and the increasing concern for the natural environment through much of society in western countries (Cox, 1997). The idea of protected areas emerged in that context in the late 19th century in the United States and has been based on a strictly preservationist ideology of a negative nature-society relationship (Pimbert and Pretty, 1997). Through colonialism and the establishment of world trade, this western system of conservation was spread so that it became the system even in areas where the basic philosophical view of humans and nature was different (Cox, 1997). In fact, the apparent merit of conservation has been the management of protected areas primarily for the conservation of extractive activities for subsistence or profit (Lunney et al., 1997).

2.2.2 Emergence of conflicts and a new perspective on sustainability

In developing countries, protected areas had been designed as one of the principal strategies for environmental conservation (Abakerli, 2001). Conservation was inspired by the aesthetic and ecological values without any consideration for the interests of local people (Cox, 1997). The process, therefore, has neglected the whole context of socio-cultural, environmental, political and economic dynamics, and resources management practices, which are all fundamental to nature conservation in these areas (Pimbert and Pretty, 1997). It also fails to see the effects of human action, to differentiate types of human activities and to recognise the economic value of sustainable use (Cox, 1997).

This conservationist approach has not only promoted tensions between resident peoples' livelihoods and protected areas, but also reinforces the legitimisation of social exclusion (Abakerli, 2001). A number of references has shown varying degrees of conflict between conservation and utilization of natural resources by local communities. As an example, Skonhoft (1998) refers to conflict in most national parks in African countries, where local communities are often prevented from killing problematic animals in order to protect their crops and livestock. Yet, the costs of conservation are high while the levels of compensation for crop damage are either minimal (Colchester, 1997) or non-existent (Maikhuri et al., 2001).

Later on, the protected area system gave rise to a politically viable source of income through recreation and tourism development (Abakerli, 2001). According to Skonhoft (1998), in developing countries, tourism and hunting in protected areas generate money for the central governments. The revenues from these areas are controlled and used by governments and outside stakeholders rather than for programs to sustain the resources (Abakerli, 2001; Skonhoft, 1998). In addition to local communities not obtaining any significant part of the revenues from commercial activities, the acquisition of land for establishing protected areas has often displaced rural communities and curtailed their access to natural resources that were traditionally theirs, limiting or restricting local rights of tenure and use (Colchester, 1997).

The rapid growth in human population has proven to be the underlying basis of conflict between conservation and rural development in many developing countries (Watts, 2003; Skonhoft, 1998). As a consequence, the political system of land tenure and rightful allocation breaks down (Colchester, 1997). Apart from the direct conflicts between conservationist agencies or governments and local communities, the system of conservation in protected areas has led to disruption of local community beliefs, their practices, and knowledge used in the management of natural resources (Colchester, 1997).

Wildlife is an example of the conservation resource that has been in conflict with local people in most African countries (Ghimire and Pimbert, 2000). Many times, people living in rural Africa incur the costs of leaving their areas and/or living with

wildlife without receiving any benefits from the relationship (O'Connell-Rodwell et al., 2000). In Zimbabwe, for example, communities surrounding the Hwange National Park are not only excluded from the park's benefits, but they are also prejudiced by its existence as they view the park as a place from where animals emerge (Mclvor, 1997). In the Caprivi region of Namibia, negative attitudes towards wildlife had the potential to undermine conservation efforts, except when crop and stock depression costs were reduced and a system of returning benefits from wildlife implemented (O'Connell-Rodwell et al., 2000). Skonhoft (1998) referred to this situation as being in accordance with the current situation for most national parks and game areas in Africa. According to Colchester (1997), the negative attitudes towards conservation by local communities are influenced by four primary factors: (1) conservationists have put the preservation of nature above the interests of human beings; (2) with authority for regulation in the hands of the state, perceptions of local communities have been tinged with the same prejudices as to protected area models of conservation; (3) radical approaches based on bottom-up processes of decision-making; and (4) not respecting indigenous tenures or traditions. Additionally, the potential economic value, either monetary or in terms of utilization of forest by-products is often unknown or unappreciated by managers (Wickens, 1994).

From mid-1980s to mid-1990s, it became more common to downplay the importance of protected areas and focus on approaches outside these areas (Brandon et al., 1998). Although most of the references focus on the conflict between conservation and utilisation of natural resources within protected areas, some conflicts also occur outside these areas. However, even outside protected areas, local communities have been hostile to conservation efforts, particularly when conservation activities result in reduced access to resources, employment and income (Messmer, 2000). Fortunately, conservation organizations have acknowledged these problems and are trying to become more socially responsive. Conservation outside protected areas aims at rehabilitating or improving the environmental resources in or adjacent to settlement areas to ameliorate living conditions of such social groups as farmers, the landless and women (Ghimire and Pimbert, 2000).

2.3 FOREST MANAGEMENT DYNAMICS

2.3.1 Inadequacies of states in managing forests

During the post-independence periods, most of the countries in Africa adhered to forestry policies implemented by centralised government decisions, in a top-down manner, in which no attention was given to the existing social context and economic-environmental dynamics (Abakerli, 2001). In addition, the increasing demand for wood and its products, for forest services, and the decline of forest available for their production, resulted in increased pressure for wood supply (Schlaepfer and Elliott, 2000). However, these centralised governments failed to stop the continuing loss of forest resources directly under their control (Wily and Mbaya, 2001). The lack of acknowledgement of the livelihood strategies of local communities in the environmental movement, the apparent lack of integrated policies for development and conservation, and the absence of direct alternatives to certain forest products, have all led to the systematic failure of the state control of natural resources (Abakerli, 2001). The lack of control was determined by the limitation of the administrative capacity to effectively protect all forests (Watts, 2003; Conteros-Hermosilla, 2000), and was also due to technical and financial constraints (Matakala, 2001). This is mainly because local communities have been kept outside the mainstream political sphere in relation to control over resources.

In Mozambique, the government's capacity to protect forest and woodlands progressively declined during the post-independence periods (Schafer and Bell, 2002). This is because the state experienced difficulties due to a reduction in the government's budget, retrenchment of workers (Mlay et al., 2003), corruption and unnecessary bureaucratic controls (Matakala, 2001). It was aggravated when the peace came after the 16-year civil war in the country when people started returning from towns, where they had gone to escape the war affected rural areas (Brouwer, 1999). As a result, forests and woodlands became even more vulnerable to degradation than before. For example, after Mozambique's independence in 1975, some protected areas were no longer patrolled, nor were the rules enforced (Schafer and Bell, 2002). Derre Forest Reserve, despite being a protected area, had private

sector activities, such as forest harvesting for exportation of logs and local log processing (Nhantumbo et al., 2003a). The inability of the state in managing the forests in the country alone was also determined by the rigidity, hierarchical structure and centralised procedures regarding management of forests (Zacarias et al., 2001). In the Narini Forest, Monapo District, the Provincial Services of Forests and Wildlife (SPFFB) has been criticised for not collaborating with the district Directorate of Agriculture and Rural Development regarding forest issues. Senior officials within the provincial services have little understanding of the field situations and there was no mechanism to learn from the experience of official workers at the local level (Zacarias et al., 2001). Corrupt attitudes of government officials have been identified in nature reserves, where licenses are issued, even though tree harvesting is illegal (Nhantumbo et al., 2003a). Furthermore, due to financial limitations, some activities at local level are dependent on external funds provided by international organizations (Soto et al., 2001). In the Niassa Province, for example, activities of SPFFB were supported by the Ford Foundation funds, through a community-based natural resources management project (Ndayambwana, 1998).

Afterwards, it became clear that the ecological and social basis of forest management needed to be improved. Multi-functional and holistic approaches should increasingly become the basis for managing forest resources worldwide (Cox, 1997). Conservationists have started to recognise that the success of conservation efforts on communal land hinges upon the relationship between people and forest resources (Wild and Mutebi, 1996). They realized, for instance, that Serengeti's grassland ecosystem, in Tanzania, was in part maintained by the presence of the Massai and their cattle. With the Massai's expulsion from their lands, the Serengeti would be encroached by bushes, meaning less grazing for antelopes (Colchester, 1997).

2.3.2. Community involvement in natural forest management

The inclusion of local communities in conservation has gained increasing importance. This has been associated with the inability of governments to enforce and implement relevant policies and laws (Nhantumbo et al., 2003a). For the majority of countries in southern and eastern Africa, customary land tenure is the issue of land reform that

most affects local communities (Wily and Mbaya, 2001). Many efforts have been made to improve forestry management in southern Africa. These include revising policies and legislation, and involving and empowering local communities for forest management (Kowero et al., 2003). Devolving control over resources to users is also addressed in this context (Nhantumbo et al., 2003a). More attention had shifted to facilitate local community involvement in forest management, through community-based natural resources management programs (CBNRM) (Wily and Mbaya, 2001). However, the capacity of local communities alone to enforce such conservation requisites has declined throughout rural Africa (Kowero et al., 2003; Watts, 2003). This is mainly because, unlike the pre-colonial periods where the common resources were managed sustainably, the political and socio-economic context of the present time such as rapid increases in human populations, trade liberalisation and new technologies, have casted doubt on the effectiveness of local communities to manage common resources sustainably (Watts, 2003). For instance, instruments employed for tree harvesting constituted management prescriptions on conserving trees and forests (Kowero, 2003). In Namibia, for example, many chiefs have adopted illicit practices in adapting to changing realities (Watts, 2003).

It is worth noting that in the past forest resource management was guided by subsistence needs, but with the subsequent establishment of world trade, the production system has changed in most of the developing countries in Africa (Kowero et al., 2003). In Mozambique, forest products became an important source of income for many households (Nhantumbo et al., 2003a). There is increased commercialisation of building materials, firewood, handcrafts, honey, game meat and charcoal (Serra, 2001; Zacarias et al., 2001; Lorbach, 1996). Reasons for this increased commercialisation of forest products include the lack of an adequate marketing system for agricultural products (Kowero, 2003), and increased demand for some of these products in nearby towns (Serra, 2001; Lorbasch, 1996). In addition, the number of stakeholders and the demand on the forests has increased in comparison with the past (Kowero et al., 2003). According to Mushove (1999), when community forests are under pressure, there is a transition in the resource use model and forests become open access resource areas. It is difficult to control resource use and it becomes unsustainable when it is open access.

In some cases, community systems of forest management in areas of previously scarce resources were well implemented (Obidzinski and Barr, 2003). However, in other areas the land is already too degraded so that investment to bring it into production is too great for local people to undertake (Hobley and Shah, 1996). In southern African countries, for example, there is a lack of capital (human, monetary and physical), which limits the economic exploitation of forest resources by local communities (Nhantumbo et al., 2003b). As a result, it can be argued that only CBNRM and local initiatives involving high valued natural resources are more likely to be sustainable. Therefore, CBNRM initiatives involving forest products are more likely to break down, as markets for forest products are underdeveloped and undervalued, resulting in the misallocation and over-exploitation of resources, i.e., the financial cost for conservation cannot be covered (Child et al., 2003). This is because viable markets for the various products arising from CBNRM are important for long-term sustainability of projects (Matakala, 2001).

The integration of non-timber forest products (NTFP) with timber production can provide both local benefits and make forest management more environmentally sustainable and economically feasible. Unfortunately, NTFP marketing occurs mostly in areas where markets for these products are generally underdeveloped, e.g. in most of the developing countries in Africa (Child et al., 2003; Mwamba, 1996). Forest products are diverse in nature, quantities collected are often uneconomical in size, and the price depends solely upon few buyers (Mwamba, 1996). Moreover, previous analysis suggests that the management of NTFP is a complex issue that needs the serious attention of policy-makers and forest managers to promote forest conservation and economic development, and this is not yet well developed (Child et al., 2003). However, marketing of NTFP is only one part of the problem; there is still insufficient information on how to manage forests to yield a diversity of products (Matakala, 2001). Therefore, the profit-oriented private sector is unlikely to invest in these areas in the near future (Kowero et al., 2003, Nhantumbo et al., 2003a). The major areas for private sector participation will continue to be in forest plantations, industrial wood processing and trade in forest products (Kowero, et al., 2003). For example, Nhantumbo et al. (2003a) found that the private sector in the Derre Forest Reserve in

Mozambique has no interest in establishing partnerships with local communities in the area. This finding concurs with the statement made by Kowero et al. (2003) that central governments and local communities in this region will continue to be the main stakeholders in forestry, in the near future. Thus, there is a great need for central governments and local people to join hands in managing the resources upon which they depend for various reasons.

2.3.3. State-community partnerships

The sustainability of CBNRM is currently plagued by contradictions and problems that cannot be dealt with by merely devolving authority for managing natural resources to local communities. The increased number of outside stakeholders is starting to recognise that forests must be managed in a much more interdependent and complex manner (Cox, 1997). It is also believed that incentives created by markets for forest resources should contribute to achieving both conservation and development and balance subsistence and market demands for forest and woodland products in the long run (Matakala, 2001). The most critical change recognised is the need for the establishment of partnerships. The strategy for implementing this is a higher consideration for interactive community participation (Wily and Mbaya, 2001; Nhantumbo et al., 2003b). Based on the issues discussed above, state-community partnership should be considered for sustainable forest management in the southern Africa region, in which each partner's responsibilities and duties are clearly specified.

Experiences from various areas suggest that a decentralised system of forest management often leads to more sustainable use of resources, with local communities involved in decision-making (Obidzinski and Barr, 2003). Local communities should be involved in forest management initiatives to solve day-to-day problems, and share benefits and profits from conservation (Colchester, 1997; Colfer, 1995). The challenge is to find new ways of involving local people in management. This is because local communities are physically located close to where their policies will be implemented (Matakala, 2001). This proximity often gives local communities a unique knowledge of forests, based on their long-term local experience (Obidzinski and Barr, 2003). According to the same authors, such knowledge may pertain to the

biophysical, social and institutional conditions of the species. This influences forest management at field level, resulting in a better capacity to monitor the activities of forest user groups, and a greater access to local knowledge about the management and utilisation of forest resources. In addition, recognition of the utilisation of their knowledge is a powerful tool for enhancing communication and cooperation between local people and forest managers, and for empowering local people (Colfer, 1995).

Nonetheless, the state should retain its monitoring and regulatory functions (Kowero et al., 2003; Matakala, 2001). The state has a number of important roles such as: to regulate and mediate conflicts (Campbell et al., 2003); to support reliable markets outside the villages and internationally; to ensure adequate budget and qualified personnel for CBNRM implementation through their support of capacity building programmes at all levels (Matakala, 2001); to encourage partnership between different stakeholders in natural forest management and investment in research and training at community level (Kowero, et al., 2003; Nhantumbo et al., 2003b). In Mozambique, for example, Nhantumbo et al. (2003a) identified that the role of the state in the construction of roads, and government incentives such as tax reduction for tree planting, importing inputs and equipment for developing and processing NTFP in the rural areas might boost the establishment of the private sector.

Colchester (1997) suggests some ways of reducing the cost of conservation on local communities and these include tourism-revenue sharing, tourism-related enterprises, agroforestry, improved agricultural practices, rural development, conservation education and the use of state-owned resources. Though local participation in conservation is now part of most conservation plans, the actual methods for achieving this are not well developed (Wild and Mutebi, 1996).

Brandon et al. (1998) refer to the clarity of resource ownership as influencing how resources are used. Due to local uncertainty, people may begin extracting or claiming resources as fast as possible. Of central concern is the tenurial future of the community-forest relationship (Wily and Mbaya, 2001). Therefore, state-community partnership is an especially important concept regarding forest resources, since most forests are legally controlled by the state (Watts, 2003; Barrow et al., 2002).

Moreover, co-management with residents and the provision of tangible benefits to local communities have been shown to be among the mechanisms advocated to reduce conflicts (Barrow et al., 2002). Significantly, partnership implies a change of roles, local communities doing some or all of the managing and forest services acting in a service role (Hoskins, 1994). For this to happen, all partners must see rewards from participatory management (Watts, 2003). It is, therefore, important to clarify the role of each partner and identify priority opportunities to increase local participation (Watts, 2003; Hoskins, 1994).

2.4 CBNRM INITIATIVES IN MOZAMBIQUE

Recently, many efforts have gone into addressing the issues of sustainable forest management in Mozambique. These include revising policies and legislation, and involving or empowering local communities in forest management (Schafer and Bell, 2002; Kowero, 2001; Nhantumbo, 2000). More attention is now being given to the mobilization of resources for the implementation of plans as well as for facilitating local community involvement in forest management (Kowero, 2001), through community-based natural resource management projects (CBNRM).

CBNRM projects in Mozambique began in 1994 (Wily and Mbaya, 2001). From more than 40 CBNRM projects running in 2000, around 45% were forest-based, and, for the most part, CBNRM initiatives operated outside forest reserves (Wily and Mbaya, 2001). Early initiatives in Mozambique were established upon Zimbabwe's Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) and they were implemented as a conflict resolution mechanism and for benefit sharing by different stakeholders, or as a way to promote sustainable use of resources (Nhantumbo, 2000).

The landmark CBNRM project in Mozambique is Tchuma Tchato, which was implemented as a conflict resolution mechanism (Nhantumbo, 2000). However, criticisms arose from some writers about the lack of legal title to natural resources for local people. There is also no official power to implement a wildlife management policy for community game scouts (Schafer and Bell, 2002), and the issue of benefit

sharing is restricted to a specific project site (Zacarias et al., 2001). However, for others the community of the area manages the resource and benefits from the contribution of the safari operator (Nhantumbo, 2000). The Tchuma Tchatu project tries to combine the security of property rights of the operator with the traditional rights to resources of local communities in a manner that creates incentives to manage and conserve, which are the issues of conservation on privately owned land (Barrow et al., 2002). Although the new policy recognises the customary tenure and stimulates local communities' involvement in the management of natural resources, it does not give total devolution of land to local communities, as the state still owns and controls the land. This is evident in the case of Tchuma Tchatu, and in several CBNRM studies carried out in the country (Serra, 2001; Wily and Mbaya, 2001; Nhantumo, 2000). As a result, CBNRM is governed by a dualistic tenure system. In some cases, customary land tenure is effectively applied locally. Nevertheless, in the majority of cases there are conflicting authority systems, and each with erratic adherence to power (Wily and Mbaya, 2001).

According to studies conducted in the country, most of the CBNRM project failures in Mozambique are related to: (1) The unsuccessful empowerment of local community institutions and total devolution of land to local communities (Schafer and Bell, 2002; Wily and Mbaya, 2001); (2) CBNRM projects are rarely financially sustainable (Matakala, 2001); and (3) New institutions in the form of committees or councils are being created, under the influence of government and conservation agencies (Serra, 2001). The following sections review each of the points raised.

2.4.1 Unsuccessful empowerment of local community institutions

Mozambique has recently adhered to new policies that guide the management of natural resources. The challenging aspect of these policies lies in their empowering of local communities to proactively participate in the management of natural resources through CBNRM programmes (Wily and Mbaya, 2001; Nhamtumbo, 2000). Even though CBNRM initiatives began in Mozambique before any associated legislation had been approved to formalise the shift in control over natural resources (Schafer and Bell, 2002), the new tenure law is more incomplete than desirable, and local

governance and identification of communities are weak (Nhantumbo, 2000). The vision as how to develop community-based approaches is also lacking (Wily and Mbaya, 2001; Nhantumbo, 2000). This is because the details of regulations and laws are still not precise enough to allow consistent implementation (Schaffer and Bell, 2001; Wily and Mbaya, 2001; Nhantumbo, 2000). Consequently, the efficacy of the implementation of CBNRM in the country is under threat, since tenure rights remain weak. This is because issues concerning tenure over resources have largely determined the motivation of local individuals and groups in managing the forest (Matakala, 2001).

It can be argued that total devolution of land to local communities is unlikely in Mozambique in the near future, at least in areas with a high value of natural resources. This argument can be explained using the example of the Tchuma Tchato, where the state controls the profits from safari operation; the proportion of profits that goes to local communities also depends on a state decree (Schaffer and Bell, 2001). As a result, the local communities that live within protected areas do not have rights of ownership of these lands (Wily and Mbaya, 2001). Additionally, the state has already alienated more productive land from communities and allocated these lands to safari hunting, timber extraction and agricultural enterprises (Wily and Mbaya, 2001). Communities are restricted mainly to marginal lands, where the resources are relatively poor (Nhantumbo, 2000). In some of those areas, local communities have gained title deeds and they have the means for negotiation and the signing of land-use contracts with investors (Nhantumbo, 2000).

Other difficulties in the empowerment of local communities relate to the absence of clear community identity and the recognition of local institutions for the management of natural resources (Wily and Mbaya, 2001). For example, in the Gaza Province, community delimitation raised conflict between communities, where one claimed exclusive rights over natural resources, including the communal resources (Nhantumbo, 2000). As a result, the procedure and mechanisms for benefit-sharing from the CBNRM initiatives have been rather slow and jeopardize the success of CBNRM implementation (Kowero et al., 2003). Readinesses to adjudicate and to

manage the resources will determine the successful implementation of CBNRM in Mozambique (Nhantumbo, 2000).

Apart from social and economic motives, though neglected in the literature, political division in the country is an important aspect of the management of natural resources. For example, in a CBNRM project in the Moribane Forest Reserve, the state (also identified as ruling party) was reluctant to give power to local people identified with the main opposition party (Schafer and Bell, 2002).

In conclusion, without secure rights to land and resources for rural communities, CBNRM initiatives can only be successful in state-community and/or private partnerships, with the state acting through the use of state institutions for law enforcement, while the community and/or private interest undertakes day-to-day management and law enforcement activities (Watts, 2003).

2.4.2 Financial sustainability of CBNRM projects

Most CBNRM projects in Mozambique are initiated by government donors and NGOs (Nhantumbo et al., 2003a; Child et al., 2003). However, it can be argued that the outside funded projects are more likely to fail, once the funding stops, if the revenues from the conservation are low. In other words, only CBNRM and initiatives involving high valued natural resources such as wildlife and eco-tourism are more likely to be sustainable. Tchuma Tchato is an example of a CBNRM financial success in Mozambique. Further, where the resource base is relatively poor, CBNRM initiatives involving forest products are more likely to break down in rural areas as markets for forest products in the country are undervalued, as previously indicated. It becomes worse if we consider that only non-productive forest and marginal lands are left for rural communities (Nhantumbo, 2000).

2.4.3 Influence of government and conservation agencies in new institutions

Committees or bodies created under the influence of donors (government and conservation agencies) in CBNRM have been reported as a cause for the failure of some projects in Mozambique (Schafer and Bell, 2002; Serra, 2001). This happened because those projects worked mainly with funds from external institutions, with donors in many instances posing as "key policy-makers" (Child et al., 2003: 259). In some cases, local committees are created for forest management using models and constitutions put forward by donors, which define number and gender (Serra, 2001), and even the educational level and language spoken by the constituent members (Schaffer and Bell, 2002). This approach is more likely to lead to project failure, as it continues with the top-down approach that opposes the philosophy of CBNRM (Barrow et al., 2002). Most of the time the top-down approach considers local communities as homogeneous in terms of their priorities and interests in natural resources (Serra, 2001). In other cases, the definition of project objectives, although participative, and the categorisation of objective priorities, depend on a donor's motivation (Schaffer and Bell, 2002). As a result, those committees do not represent the different groups within local communities, and, therefore, do not allow such groups to play an important part in decision-making. In some cases, the lack of community representation in decision-making has resulted in disinterest, and cultural issues among community members concerning some projects have also led to negative results (Serra, 2001). Therefore, ultimately such a top-down process is unlikely to work, mainly because it has no legitimacy (Serra, 2001) and local people do not recognize it (Schafer and Bell, 2002).

It is worth noting that Zimbabwe's CAMPFIRE programme upon which Tchuma Tchato was modelled has failed to identify all the different groups within the community due to the lack of full (or active) community representation in the decision-making (Madzudzo, 2001). The CAMPFIRE considers communities as entirely homogeneous. Consequently, inappropriately, some communities would like inherent community differences to be reflected in the distribution of benefits from CAMPFIRE. Also the differences emerge at local level where the dominant ethnic

groups seek appropriate benefits from CAMPFIRE at the expense of minority groups (Madzudzo, 2001).

In summary, the models of constituent committees used in some of these donor-funded projects are replicated from previous successful experiences. However, it is important to note that these successes occurred in different environments, with different perceptions, resources and local community expectations and were introduced into new areas. Tchuma Tchato is an example of a constituent committee model (Serra, 2001).

2.5 CONCLUSION

In developing countries and in Africa in particular, conflicts between conservation and utilisation of natural resources emerged through the implementation of conservation systems that have been designed for the western countries. It is possible to notice from this analysis that conflicts between conservation and utilization of natural resources by local communities happen when the costs of conservation are greater than the benefits obtained by local communities. The costs of conservation borne by local communities are loss of land and land tenure due to lack of respect for indigenous tenures and traditions. The interests of local communities are of less concern to conservationist interests, and the perceptions of local communities about natural resources have been tinged with prejudices by radical approaches based on a top-down process. For wildlife conservation, local communities have to pay the cost of living with wildlife in terms of loss of property and life. Furthermore, state land ownership and unequal income distribution from some activities in conservation areas have led to conflicts in most developing countries.

The CBNRM approach was introduced to resolve some of these people-conservation problems. The new approach is seen to be a better approach, especially where local people are given property rights and benefits in the form of a fixed share of profits. This strategy aims to gain the support of local communities. A central element in community-based forest management is revenue sharing, which has been recognized as possibly the most critical incentive for the improved sustainability of forest

resource utilization. Land resource ownership and the guarantee of benefits to local communities will encourage communities to take on a long-term management of forest resources. This new opportunity will allow local people to contribute to a sustainable forest in a pragmatic manner. In practise, the development of alternative ways of income generation out of natural resources seems to be the best way for conflict resolution. It further reduces the pressure on natural resources.

It is important that governments and donors encourage and support state-community partnership, particularly as there is ample evidence that neither the state nor the community has the capacity to manage natural resources on their own. This is evident by the relentless loss of forest and woodland resources on state and de facto communal lands. This is particularly valid for Mozambique where the forest services, or the government, legally controls forest resources.

Donors have a wide range of expectations from community forestry projects, so that most CBNRM projects are donor-funded. However, most donor-funded projects are designed so that local people are only involved in the implementation. Tenure decisions are often made at a high policy level, and often not even within a local or project context. It would seem that the first step in obtaining participation in the management of forest resources is to assure access to resources and their benefits, for now and for the future. Therefore, the challenge for donors and policy-makers is to understand traditional local rules, effects of new laws and any attempts that local people make to address problems of access to land resources.

CHAPTER 3

STUDY AREA AND RESEARCH METHODS

3.1 STUDY AREA

3.1.1 Location

The geographical focus of this study is the Mabote District of Inhambane Province, southern Mozambique (Figure 3.1). It is specifically centred on four villages, namely, Macheco, Mahungane, Manhique and Tsumbo (Figure 3.2).

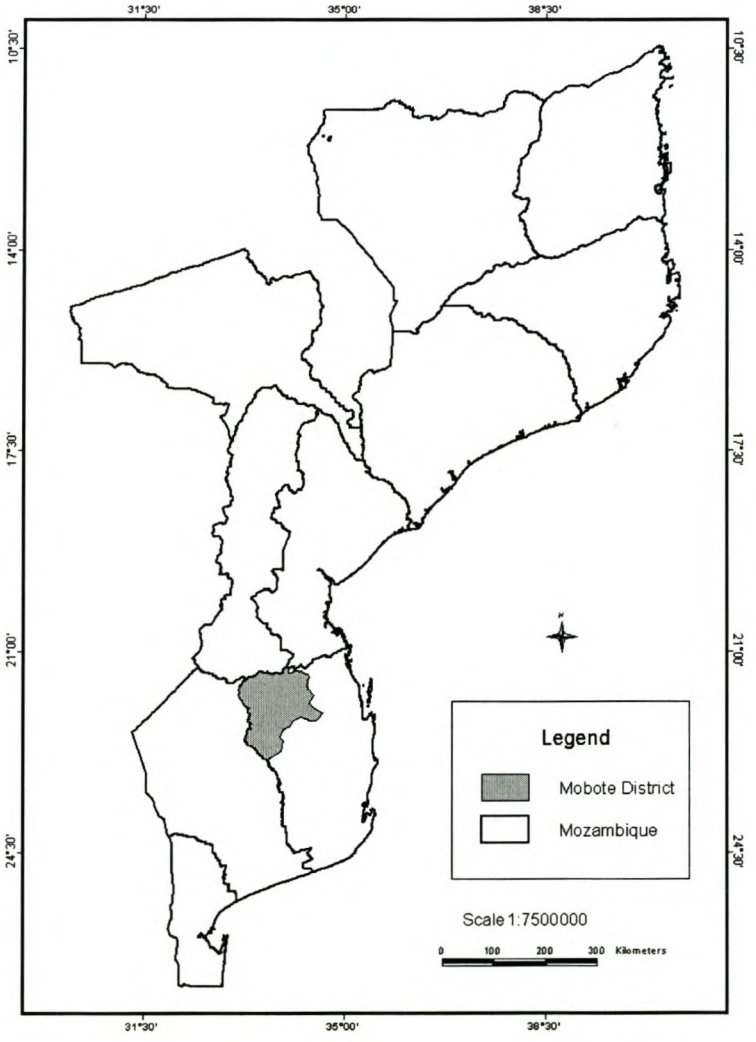


Figure 3.1 Geographical location of the study area

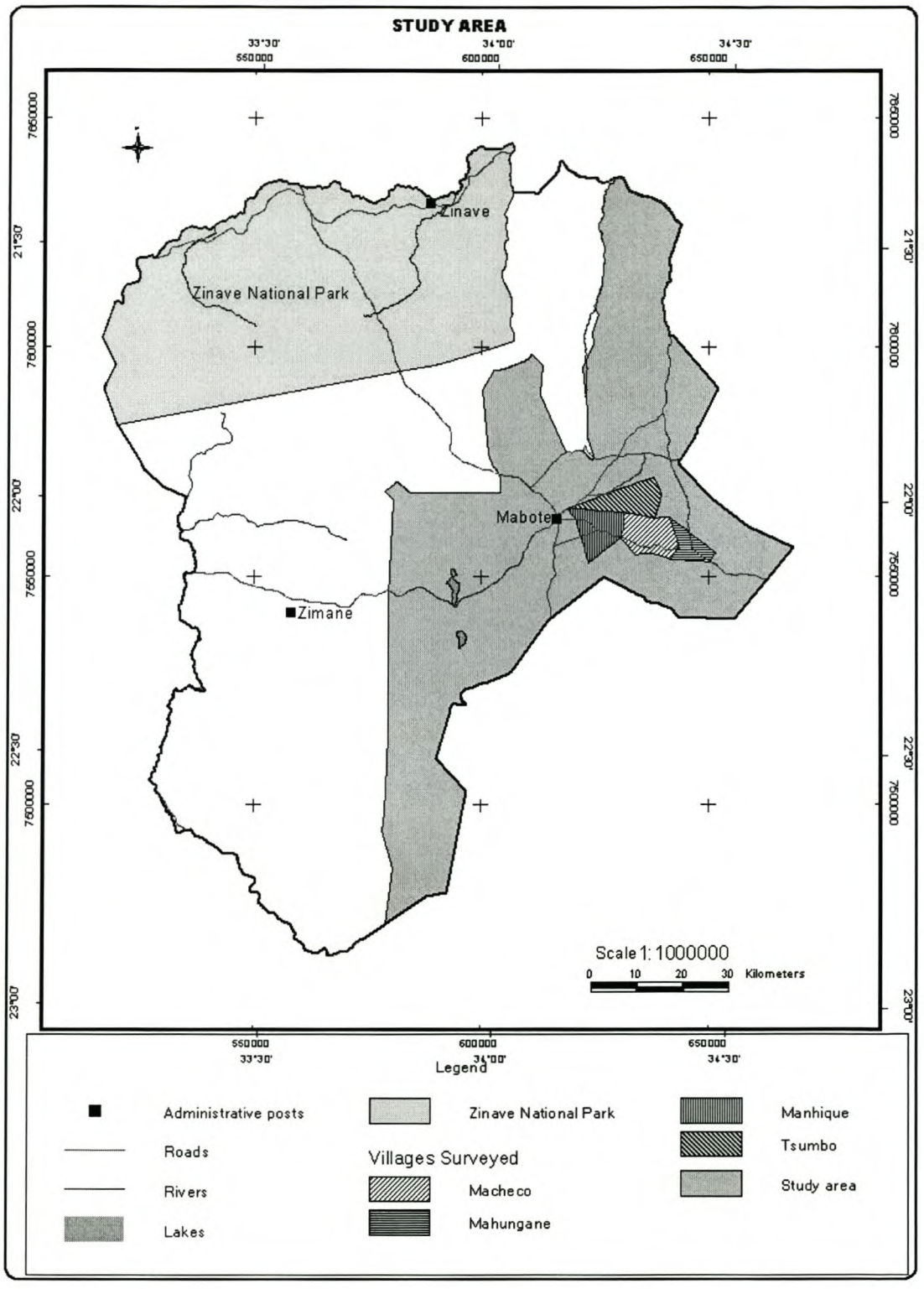


Figure 3.2 Location of the four villages covered by the study

3.1.2 Environmental conditions of the study area

Climate

The climate of the area is tropical dry, with an average annual rainfall around 620 mm (data provided by the local meteorology station in the District Directorate of Agriculture (DDA) between 1988 and 2002). The rainfall is seasonally distributed, providing a warm rainy season from October to March and a cooler dry season from April to October. The extreme annual minimum and maximum records are 225.1 mm and 1297.5 mm, respectively. The annual mean temperature is 22.5°C while the annual minimum and maximum temperatures are 17.7°C and 25.4°C, respectively. The highest mean monthly temperature is in January and February and the lowest mean monthly temperature is in June and July (ACNUR-PNUD, 1997).

Soil

The soils, derived from the underlying basement gneissic granite are predominantly shallow, moderately leached, coarse-grained sands with low fertility and water-holding capacity. About 70% of the district consists of sandy soils that contain topsoil of variable thickness and sand-clay subsoil. The subsoil is in general firm and compact often with high sodium content. About 12% of the area has soils of good drainage, which are neither saline nor sodic. The remaining area consists of shallow soil of a thick structure; deep soils are found under calcareous rock and red soils are derived from calcareous rock itself (DPADR, 2001).

Vegetation and land use

The vegetation of the area has been described by Saket (1994) as thicket (open, semi-open, medium and closed woodlands). The predominant vegetation type is *cimbirre* woodland, followed by undifferentiated forest types of *Afzelia quanzensis, Brachystegia sp* and mixed vegetation *(tsenguene)*, which are subjected to seasonal inundations (Chamba et al., 2002). Major land uses include communal grazing, multiple uses of indigenous forests, hunting lands and subsistence farming. The climate supports a regular rain-fed cropping regime, with the main crops being millet, sorghum, maize, beans, cassava and peanuts and fruit trees such as cashew, mango, marula and Natal mahogany. Commercial crops are cashew, beans, peanuts and millet. Mabote District alone represents 13% of the grazing area of the whole

Inhambane Province (DPADR, 2001). Domestic animals such as chickens, ducks and pigs are used for subsistence, while cattle, goats and sheep are important for commercial purposes. Wild herbivores, diverse birds and reptiles are also present (Chamba et al., 2002). However, elephants and lions that once were in the area are now extinct (ACNUR-PNUD, 1997).

Human population

Table 3.1 presents population densities of all provinces in Mozambique, and for districts within Inhambane Province. With a population density below the average total population density (21 inhabitants/km^2), Inhambane Province has one of the lowest population densities in the country (16 inhabitants/km^2). Except for Funhalouro District, Mabote District has one of the lowest population densities in the province (3 inhabitants/km^2) (INE, 1997).

Table 3.1 Total population, area and population density by sex and province

Province	District	Population (1000 habitants) Total	Men	Women	(Km^2)	Population density
Niassa		848.9	416.1	432.8	129,056	7
Cabo Delgado		1,436.5	695.7	740.8	82,625	17
Nampula		3,196.5	1,589.6	1,606.9	81,606	39
Zambézia		3,240.6	1,570.5	1,670.1	105,008	31
Tete		1,287.5	619.2	668.4	100,724	13
Manica		1,103.9	529.0	574.9	61,661	18
Sofala		1,424.4	693.7	730.7	68,018	21
Inhambane		1,123.1	539.1	683.2	68,497	16
	Funhalouro	30.3	13.0	17.3	13,617	2
	Govuro	29.0	12.7	16.3	3,965	7
	Homoine	92.8	40.2	52.6	1,917	48
	Inhambane cidade	52.4	24.8	27.6	195	
	Inharrime	76.5	33.6	42.9	2,747	28
	Inhassoro	43.4	19.0	24.4	4,746	9
	Jangamo	81.2	35.6	45.6	1,293	63
	Mabote	39.7	16.0	23.7	15,326	3
	Massinga	186.6	79.8	106.8	7,410	25
	Maxixe	94.0	42.1	51.9		
	Morrumbene	110.9	49.0	61.9	2,580	43
	Panda	46.5	20.0	26.5	6,841	7
	Vilanculo	113.0	49.8	63.2	5,849	19
	Zavala	126.8	55.5	71.3	2,011	63
Gaza		1,173.3	509.4	663.9	75,709	15
Maputo		899.3	427.8	471.5	26,058	35
Maputo Cidade		1,007.6	493.0	514.6	300	3,359
Total		17,864.7	8,574.2	9,389.6	867,759	21

Source: INE (1997): 1997 census - final results

In general, the study area has a low population density. Therefore, there are no land-use problems so far (ACNUR-PNUD, 1997). Subsistence farming is the main activity in the area, practised by 90% of the households (DPADR, 2001). On average, households that practise agriculture have two or more farming areas at certain distances apart, according to the soil type. The total area occupied by households is dependent on the household size, although each household farms on average 5.5 ha (Chamba et al., 2002; Mantilla, 2002).

3.1.3. Background of the Projecto Maneio Sustentado dos Recursos (PMSR)

Projecto Maneio Sustentado dos Recursos (PMSR) is a government project funded by the government of Finland and it is being implemented by the Provincial Forestry and Wildlife Services (SPFFB) with technical assistance of STORAENSO (a Finish forestry company). It is a five-year project that aims at the implementation of the forestry and wildlife sector's strategy of community-based natural resources management (CBNRM). Its focus area is the Mabote District in Inhambane Province. The project covers three components, namely: pilot areas, institutional capacity building and education and fire control.

Under the pilot area component, four villages were selected based on the fact that the communities represent the economically poorest and institutionally weakest of the province. In addition, uncontrolled fires contribute to the depletion of extensive areas affecting vegetation, animals and contributing to complications in the predominant farming system (Mantilla, 2002). The selected villages are Macheco, Mahungane, Manhique and Tsumbo. The approach in this component has been to encourage the impoverished local communities to rekindle their responsibility for the preservation of the environment, particularly to motivate local people to manage woodland resources around their villages. Lessons learnt from this pilot area should be replicated in other areas.

The main purpose of the project has been to create and strengthen a local institution to provide leadership and assure the full participation of all the concerned stakeholders in the use and management of natural resources. Hence, the project encouraged the creation of a local committee for woodland management. Local organisations that were identified as having some legitimacy, that is, traditional authorities, state, the private sector and a local community group of loggers, are represented on this committee. The committee has benefitted from the project in terms of institutional and organisational management training. Another group that is being trained through the project is the recently formed community logger group. The training includes institutional management, and improved harvesting techniques to ensure good product quality and marketing.

The present study is developed within the scope of the PMSR and will contribute to the development of a strategy to reduce the continuing woodland degradation in the area.

3.2 RESEARCH METHODS

3.2.1 Data collection

To obtain as much information as possible and to address the research objectives, the study uses three methods, namely: 1) Semi-structured interviews and group discussions, 2) Structured questionnaire survey, and 3) Forest resource assessment.

Semi-structured interviews and group discussions

In the first stage, semi-structured interviews and group discussions were conducted to identify stakeholders and their role in the management of *Androstachys johnsonii*-dominated woodland. Key informants were traditional authority (n = 4), community members (n = 9), private sector (n = 1), and state (n = 4) representatives. The interview was based on:

i) Identification of stakeholders in woodland management
ii) Knowledge of traditional rules and government legislation for forest management
iii) Involvement in natural resource management

Structured questionnaire survey

The second stage was based on a structured questionnaire administered (face-to-face) to households in order to gather information on the practices used for subsistence and income generation. In this phase, questionnaires were administered to 83 households in four villages identified by the PMSR: Mahungane (n = 10), Macheco (n = 12), Manhique (n = 36) and Tsumbo (n = 25) (Table 3.2). Households to be interviewed were randomly selected and were proportional to the population size of each village following Kalton (1988). This sample size represented a sampling intensity of 10% as suggested by FAO (1990). The respondents were the heads of the households or their substitutes and the questionnaire covered broad social and economic perspectives of

the household. Stakeholders identified in the first stage were also interviewed in order to identify their roles and views on the management of *Androstachys johnsonii* woodland. Generally the questionnaire covered:

i) Household characteristics
ii) Resource utilization
iii) Commercial and subsistence activities
iv) Knowledge of traditional rules and government legislation for forest management

Table 3.2 Total population, household number, sample size and village

Village	Total population	Household number	Sample size
Manhique	2,988	360	36
Mahungane	830	100	10
Macheco	996	120	12
Tsumbo	2,075	250	25
Total	6,889	830	83

Questionnaires used for both semi-structured and structured interviews are presented in Appendix 1 and Appendix 2, respectively.

Additionally, the local consumption of poles for building and commercial purposes was examined. The length and average circumference of each pole for a living-hut structure, comprising those used for wall construction, frames and roofing poles were measured in all households surveyed. The per capita number of poles extracted annually for commercial purpose was also examined.

Forest resource assessment

Finally, a forest inventory was conducted to investigate the sustainability of the current harvesting systems of *Androstachys johnsonii* trees. Forty eight sample plots of 25 m x 20 m were randomly located in different woodland patches to gather data on tree species distribution, density and diameter size structure as well as potential natural regeneration. Decision on the optimum dimensions of the sample plots for this study was based on the following advantages: data collection is more rapid, the

possibility of sampling errors is smaller and demographic estimation is more valid (Pereira, 2001). The sample size was calculated by the expression (Guisandez, 1973):

$$n = \frac{t^2 x Cv^2}{E^2 + \frac{t^2 x Cv^2}{N}} \quad (1)$$

where, n is the number of plots required for the sampling, E^2 is the sampling error of 15%, Cv is the coefficient of variation (35%) acquired from a previous inventory in the area, t is student's t value at 0.95 probability, and N is the number of sample units in which the total forest area is divided.

Manhique Village was excluded from the forest resource survey as it does not have a significant area of *cimbirre* woodland, and people from Manhique cut trees from neighbouring villages. Sample plots were randomly located in each of the remaining villages, namely, Mahungane (16), Macheco (16) and Tsumbo (16) (Table 3.3).

Table 3.3 Total woodland area, number of sample units in total population (N), sample size and village

Village	Area (ha)	N	Sample size (n)
Mahungane	882	22,049	16
Macheco	577	14,422	16
Tsumbo	958	23,954	16

Using ArcView software, sample plots were located within the woodland patches. GPS receptors were then used to locate the plots on the ground. In each plot, all trees with diameter at breast height greater than five centimetres (dbh ≥ 5 cm) were measured and the height recorded. All stumps, representing harvested trees were identified and their basal diameters were measured. Because these trees do not buttress, the basal diameter is only slightly larger than dbh measurements (Schwartz et al., 2002). For each plot, one subplot of 5 m x 5 m was established at the southwest corner, where the natural regeneration diameter (dbh < 5 cm) was measured. The following information was collected: tree species composition, diameter at breast height (dbh), height of the tree, and the number and diameter of stumps.

3.2.2 Data analysis

Semi-structured interviews, group discussions and questionnaire survey

Data from the semi-structured and group interviews were analysed using simple descriptive statistics. The data were grouped and summarized by response category. For the structured questionnaire survey, cross-tabulations, reported as likelihood Chi-square values (X^2), were used to determine the significance ($p < 0.05$) of all binominal variables. Data collected were also subjected to one-way analysis of variance (ANOVA) where appropriate. All data analysis was performed using the Statistica Software (release 6.0, Statsoft Corporation 2003).

The mean ranking of individual households was used to analyse the perceived importance of the main household activities. Values given by individual households were grouped in the form of a frequency table for each activity, as several respondents had given identical values (Zar, 1999). The same procedure was used to analyse the household rankings of the causes of fires in woodlands. The mean rank was calculated as:

$$x = \frac{\sum_{i=1}^{k} fiXi}{n} \qquad (2)$$

Where x is the mean ranking value, Xi is the ranking value of an individual household (i), fi is frequency with which Xi occurs in the sample, n is the number of households that are involved in the activity, and k is the total ranking values ($k = 5$). The rank value ranged from 1 (highest) to 5 (least) importance levels. Then the final ranking value was based on the following table:

Table 3.4 Mean ranking range and corresponding final ranking values

Mean ranking range	Final ranking value
1 - 1.5	1
1.6 - 2.5	2
2.6 - 3.5	3
3.6 - 4.5	4
4.5 - 5.0	5

In addition, the sustainability of the shifting cultivation practice by rural households was analysed using the model of carrying capacity under shifting cultivation produced by Allan (Chidumayo, 1987), i.e.,

$$CPD = (100/Cp)Ca \times L, \quad (3)$$

where CPD is the critical population density, Cp is the percentage of the territory which can be cultivated, Ca is the area required to support one person per year and L is the number of plots required to allow a proper ratio of the years of fallow to the number of successive years of use. L is calculated as follows:

$$L = (R/U) + 1 \quad (4)$$

where R is the number of years of fallow and U is the number of successive years of use of a cultivated plot.

Forest resources assessment

For the forest resources analysis, a total of eight diameter size-classes of trees consisting of 5 cm intervals from 0 to above 35 cm (i.e. <5, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, ≥35 cm) were used, encompassing all size classes currently observed in the woodlands. Different models were run in order to define the population structure, species potential for poles and sustainable harvesting rates of *A. johnsonii*. The models are presented below.

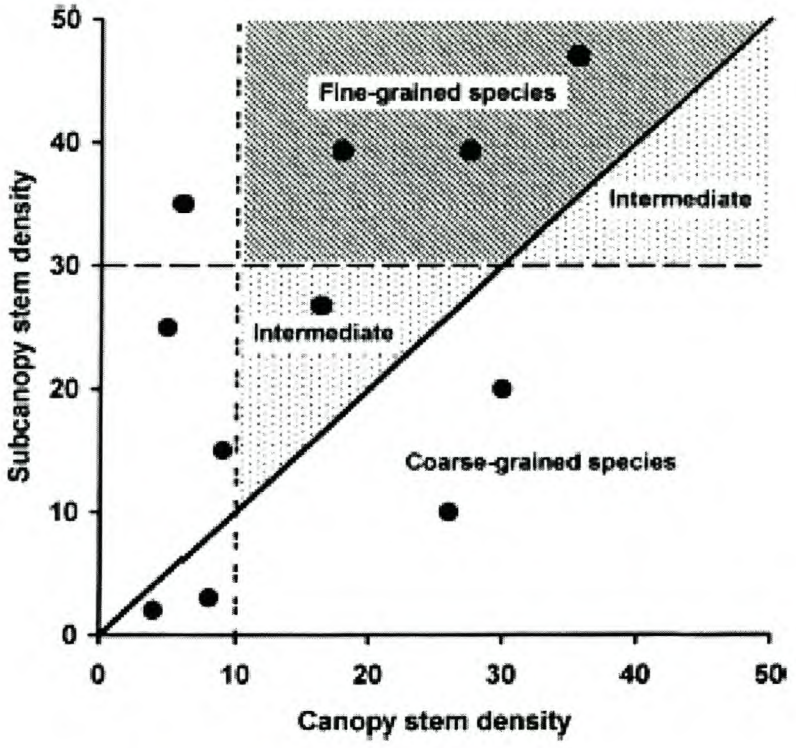
Population structure

The size-class frequency distribution was used to define population structure. Least-square linear regression was calculated with diameter size-class midpoint as the independent variable and the average number of individuals (per hectare) in the class (N_i). In order to derive straight-line plots of the size-class distribution, the average number of individuals in each diameter size-class (N_i) was transformed by ln (N_i +1). The slope interpretation for this study was based on the three types described by Obiri et al. (2002) and Condit et al. (1998). Slopes are usually negative and indicate recruitment. Flat distribution with a slope of zero indicates equal numbers of regenerating trees and mature individuals. Positive slopes are characterised by relatively many canopy individuals, but no regeneration. Moreover, approximately constant quotients (N_i/N_{i+1}) across sample diameter size-classes indicate a stable population and fluctuating quotients indicate an unstable population (Shackleton, 1993).

Potential for harvesting *A. johnsonii* for poles

A linear-programming approach to model the selection of harvestable diameter size-classes graphically was used to assess the potential of harvesting *A. johnsonii* for poles. The model was described by Lawes and Obiri (2003), Obiri et al. (2002), and Condit et al. (1998), and it identifies fine-grained species with potential for harvesting by defining the lower harvesting limits for canopy and sub-canopy stem densities. Species are at canopy when they reach the maturity or reproductive stage, which is dbh = 15 cm for *A. johnsonii.* Species below this stage are at canopy or vegetative stage. The model is based on the concept of spatial grain of regeneration, which defines fine-grained species as those that tolerate moderate harvesting levels and sustainable use. Species grain was determined by comparison between the mean frequencies of the largely vegetative and most harvested stems (5cm < dbh < 15 cm) in a sample plot, with the number of canopy or reproductive stems (dbh ≥15 cm) in a scatter-plot. Species are of intermediate grain if their average sub-canopy and canopy stem densities across the sample plots are similar. In general, species that lie above this threshold are fine-grained, and those positioned below the threshold are coarse-grained (Figure 3.3).

This study analyses only the distribution of the target species because the model assumes that the population dynamics of tree species are independent of one another. The lower limits for canopy stem density and sub-canopy stem density for the *cimbirre* woodlands of the study were defined as 10 and 20 individuals per hectare, respectively, as used in other subtropical forests (Lawes and Obiri, 2003).



Source: Obiri et al. 2002

Figure 3.3 Theoretical representation of the linear-programming approach to model the selection of harvestable diameter size-classes graphically

Tree growth rate

The sustainability of the current harvesting system was determined by a comparison between the current harvesting rate and the estimate of annual recruitment (AR) of trees to the next diameter size-class. The estimated rate of annual recruitment is given by the population projection to the next felling cycle (i.e. number of trees of a certain size-class recruiting to the next size-class). Sustainable harvesting, in this case, implies that similar numbers of trees of a certain diameter size-class continue to be harvested at periodic intervals indefinitely, that is, the felling cycle. The felling cycle

refers to the time (years) needed for a stand of trees to restock in order to be exploited in a sustainable manner - the time that should elapse from one harvesting season to the next to ensure a sustainable production of the forests.

Trees are harvested in diameter size-class 10-14 cm for poles. Therefore, the felling cycle of trees for poles was estimated from trees of diameter size-class 5-9 cm recruiting to the next size-class, i.e. 10-14 cm. Similarly, trees are harvested in diameter size-class greater than 30 cm for timber. Therefore, the felling cycle of trees for timber was estimated from trees of diameter size-class 25-29 cm recruiting to the next size-class. Because of the absence of direct estimates of *A. johnsonii* population size over time, the growth rate used is based on a literature study carried out by Monjane (1998), who reviewed available information on the subject both at national and regional levels. The study indicates the mean annual increment (MAI) of the diameter of a single tree, in similar vegetation types and climatic conditions in Mozambique to be in the range 1.5 mm to 3 mm per year. Given the relatively dry conditions of the villages being studied, the increment was conservatively set at 1.5 mm per year. Therefore, the time needed for the growing trees to recruit from one size-class to the next (or the felling cycle) was given by the expression:

Felling cycle = Diameter size-class interval/MAI (5)
= 50 mm/ 1.5 mm/year
= 33 years

Where, 50 mm is the diameter size-class interval used in this study, MAI is the mean annual increment of a single tree, estimated from previous studies to be 1.5 mm/year.

The annual recruitment (AR) in diameter size-class was estimated as follows:

AR = Number of recruited trees/felling cycle (6)

The AR was than compared with the current harvesting rate of *A. johnsonii* trees for poles to evaluate the sustainability of this harvesting system.

The main assumption of the AR model is that forest is stable (in equilibrium). By assuming that prior to the observed harvesting in the area there was no anthropogenic

loss of trees, the current size-class frequency distribution of live plus harvested trees gives a stable population. Therefore, mortality, growth and recruitment in each diameter size-class do not vary (Saket et al., 1999; Monjane, 1998). Thus the population structure (the proportion of trees in each size-class is constant. Therefore, population projections to the next felling cycle can be based on a single diameter size-class frequency distribution.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

This chapter presents the results of each objective of the study in the following sections: importance of the commercial harvesting of *Androstachys johnsonii* poles for rural household livelihoods; sustainability of the current harvesting systems and the potential for harvesting *A. johnsonii* trees for poles; and the role of the different stakeholders in the management of *cimbirre* woodland and their perceptions. Although the distinction between local communities and other stakeholder groups is not necessary, it is made in this study for the sake of easy discussion. Unless the difference between villages is indicated, the results are presented for the study area as a whole.

4.2. IMPORTANCE OF COMMERCIAL HARVESTING OF *A. JOHNSONII* POLES FOR RURAL HOUSEHOLD LIVELIHOODS

The results in this section are based on group discussions with key informants and structured questionnaire surveys administrated to the households. Information on household characteristics, resource utilization as well as household strategies for subsistence and income generation was collected and the results are presented below. Results from structured questionnaire surveys are presented in tables and figures, whereas results from group discussions and semi-structured interviews with key informants are in a descriptive format.

4.2.1 Interviewee's profile data

The household respondent's age averaged 44.46 ± 14.85 (X ± SD) years. The average age is not significantly different (One-way ANOVA: $F_{3,82} = 0.070$, $p = 0.976$) between the four villages of the study. The majority (54.2%) of the household respondents have some elementary education, and 12.1% have acquired secondary education. The

education level of the respondents varies significantly between the four villages under consideration (X^2 = 15.95, d.f. = 6, p = 0.01). Manhique and Tsumbo have more respondents with elementary education, while Macheco and Mahungane have more respondents with no education level (Table 4.1).

Table 4.1 Mean and standard deviation (SD) of age, and education level of the interviewees per village

Village	n	Age		Education*		
				No	E	S
Macheco	12	Mean	43.86	8	4	
		SD	12.33			
Mahungane	10	Mean	44.10	6	3	1
		SD	15.23			
Manhique	36	Mean	45.43	5	26	5
		SD	15.75			
Tsumbo	25	Mean	43.50	9	12	4
		SD	15.22			
Total	83	Mean	44.46	28	45	10
		SD	14.85	33.7%	54.2%	12.1%

* Educational level: No – no education; E – elementary; and S – secondary

4.2.2 Household characteristics

Households are mainly headed by men (87.8%) as compared to women (12.2%) (Table 4.2). Women who head households are either widowed or single. In general, the household size is 7.74 ± 5.20 (± SD) members per household. The mean number of members per household are 7, 8, 7, and 6 for, Macheco, Mahungane, Manhique and Tsumbo, respectively. Most of the people left their villages during the civil war in the country (1982-1992) and returned after 1992. Table 4.2 presents the household characteristics in the study area.

Table 4.2 Household size, gender of the head and household establishment in the village

Village	n	Household size		Gender of the head		Period in the village*		
				F	M	a	b	c
Macheco	12	Mean	7.08	4	8	0	2	10
		S.D.	3.94					
Mahungane	10	Mean	8.6	0	10	1	0	9
		S.D.	2.80					
Manhique	36	Mean	7.08	2	34	5	17	14
		S.D.	6.56					
Tsumbo	25	Mean	6.04	4	21	2	8	14
		S.D.	3.63					
Total	83	Mean	7.74	10	73	8	27	47
		S.D.	5.20	12.2%	87.8%	9.8%	32.9%	57.3%

* Household establishment in the village is divided into three periods, namely: a – before 1982; b- between 1982 - 1992; and c- after 1992

Further results show that polygamy is a customary cultural practice in the area, where about 20% of the heads of households had on average two wives. Gender serves to determine the household members' activities in the study area. Collection of firewood, wild fruits, thatching grass and raising small livestock are activities restricted to women and children. Pole harvesting, building houses, raising large livestock and hunting are the prerogative of men. Both men and women practise agriculture.

4.2.3. Perceived importance of the household activities

The mean of the individual household ranking of main activities is used to assess the perceived importance of their activities. The analysis was done in the way described in section 3.2.2, and also based on the corrections mentioned in the same section. Only the activities practised by more than 5% (n = 4) of respondents are included in the study. The results are presented in Table 4.3.

Results from the question pertaining to household activities ranking show that agriculture is the most important activity in the area. Of the total household interviewees (n = 83), the majority (98.8%, n = 82) practise agriculture and classify it as number one (96.3%, n = 79). For the remaining respondents, agriculture falls in the second (2.5%, n = 2) or third (1.2%, n = 1) position. Firewood extraction and employment in the Republic of South Africa (RSA) follow at the second level. Of the households that mentioned these activities, the majority (62.5% firewood extraction, n = 15; 64.2% work in RSA, n = 38) classify it in the second position, other respondents rank it first (8.3% firewood extraction, n = 2), third (20.9% firewood extraction, n = 5; 27.1% work in RSA, n = 16) and fourth (8.3% firewood extraction, n = 2; 8.5% work in RSA 9.4%, n = 5).

Pole harvesting for commercial purposes and livestock rearing are classified in the third level. Of the respondents who practised these activities, some (31.2% livestock rearing, n = 15; 32.1% pole harvesting, n = 9) classify them in the second, third (39.6% livestock rearing, n = 19; 46.4% pole harvesting, n = 13), fourth (29.2% livestock rearing, n = 14; 10.7% pole harvesting, n = 3) and fifth (7.2% pole harvesting, n = 2) positions. Harvesting of edible wild fruits is positioned in the fourth level. Of the 31 households involved in the activity, respondents classify it in the second (6.8%, n = 4), third (20.3%, n = 12) and fourth (32.2% n = 19) positions. The remaining households classify the activity in the first (1.7%, n = 1) and fifth (39.0%, n = 7) positions. Finally, hunting is ranked at the fifth level. Of the 64 households that practise the activity, the majority (68.8%, n = 44) classify it in the fifth position. The remaining households classify it in the third (3.1%, n = 2) and fourth (28.1%, n = 18) positions.

Other activities practised by households comprise teaching, nursing, provision of security services and running small businesses. These are the main sources of employment in the area. Some household members find employment in other districts. However, due to the reduced number of households involved in these activities, they were not included in this study.

Table 4.3 Ranking of the household main activities, frequency (n) of respondents per activity, and percentage of total per village

Activities	Rank*	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total (∑n = 83)
Agriculture	1	(12)	(10)	(36)	(21)	(79) 96.3%
(n = 82)	2				(2)	(2) 2.5%
	3				(1)	(1) 1.2%
Mean	**1**					
Firewood	1				(2)	(2) 8.3%
extraction	2	(1)	(7)	(3)	(4)	(15) 62.5%
(n = 24)	3	(1)	(3)		(1)	(5) 20.9%
	4			(2)		(2) 8.3%
Mean	2					
Work in	2	(3)	(7)	(17)	(11)	(38) 64.4%
RSA	3	(2)	(2)	(8)	(4)	(16) 27.1%
(n =5 9)	4	(1)	(1)	(1)	(2)	(5) 8.5%
Mean	2					
Pole	1				(1)	(1) 3.6%
extraction	2	(5)	(2)		(2)	(9) 32.1%
(n = 28)	3	(3)	(4)	(2)	(4)	(13) 46.4%
	4		(2)		(1)	(3) 10.7%
	5			(1)	(1)	(2) 7.2%
Mean	3					
Livestock	2	(2)		(11)	(2)	(15) 31.2%
rearing	3	(3)	(4)	(9)	(3)	(19) 39.6%
(n = 48)	4	(2)	(6)	(3)	(3)	(14) 29.2%
Mean	3					
Wild fruits	1			(1)		(1) 1.7%
extraction	2	(1)	(1)	(1)	(1)	(4) 6.8%
(n = 59)	3	(2)	(1)	(6)	(3)	(12) 20.3%
	4	(4)	(1)	(8)	(6)	(19) 32.2%
	5	(4)	(7)	(4)	(8)	(23) 39.0%
Mean	4					
Hunting	3	(1)			(1)	(2) 3.1%
(n = 68)	4	(1)	(2)	(9)	(6)	(18) 28.1%
	5	(10)	(8)	(12)	(14)	(44) 68.8%
Mean	5					

* Ranking value of importance from 1 (highest) to 5 (least)

4.2.4 Factors influencing the perceived importance of the household activities

Analysis of the household strategy for subsistence and income generation is used to identify socio-economic and resource use factors that could have influenced the perceived importance of the household activities. Results in this section are based on group discussions and the series of questions pertaining to household resource utilisation.

Agriculture

Shifting cultivation is the main farming technique for food crop production in the area. Food crops cultivated in the area are sorghum, maize, been, millet, cassava, peanut and cashew nut crops. All other crops are cultivated in shifting cultivation plots with mixed cropping, except cashew trees, which are cultivated in permanent mono-cropping and permanent mixed cropping systems. Fertilizers, chemical pesticides and machinery are not used. The major environmental factors that affect agricultural production in the area are droughts and floods. Cashew nuts are the major source of income in the area. Income generation from other crops is only possible when there is a surplus of production. During the group discussions it was pointed out that agricultural activity had been affected by a sequence of droughts in 1983, 2001 and by successive floods in 1990, 1999 and 2000. During the survey conducted for this study, which occurred from January to March 2003, there was another flood. Since 1999 the situation has been critical in terms of food security. The World Food Programme embarked on a programme called "Work for Food", where local communities have to work some hours on any activity in the village, such as opening roads and building schools, in exchange for food. Thus, no income has been generated from agricultural activity since then. For example, during the actual campaign the World Food Programme prohibited the trade of cashew nuts as a measure for securing food, so that local people could use it as a source of protein.

Fuelwood collection

Firewood is the most significant source of energy in the area. All respondents affirmed the use of firewood for domestic fuel, although only 31.2% perceived it as one of the main activities (Table 4.3). Of the 12 species most frequently used for firewood, *Brachystegia spiciformis* is the most preferred by respondents, followed by *Androstachys johnsonii, Strychnos madagascariensis*, *Terminalia sericea* and *Arthrocnemum indicum* (Table 4.4). Other tree species used for firewood by households in the area include: *Baphia massaiensis*, *Afzelia quanzensis, Salacia kraussii*, and *Melanodiscus oblongus*.

Table 4.4 Tree species used for firewood and frequency of respondents (n = 83) using the species

Species	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total (Σn = 83)	
					n	%
Brachystegia spiciformis	11	10	36	25	82	98.8
Androstachys johnsonii	7	2	19	11	39	47.0
Strychnos madagascariensis	4		11	16	31	37.3
Terminalia sericea	4	5	16	6	31	37.3
Arthrocnemum indicum	6	10	3	3	22	26.5
Senecio madagascariensis	3	3	7	5	18	21.7
Anacardium occidentale			10	7	17	20.5
Pteleopsis myrtifolia	2	2	2	4	10	12.0
Hymenocardia ulmoides	3	1	2		6	7.2
Acacia nigrescens	1		3	1	5	6.0
Sclerocarya birrea		1	1	1	4	4.8
Artabotrys brachypetalus		1	1	1	3	3.6
Others			7	3	10	12.0

There is total dependence on firewood for domestic cooking and night lighting, as electricity and liquid fuel energy are inaccessible in the study area. For cooking, respondents prefer firewood from tree species that give longer lasting coal and produce less smoke, while for illumination purposes firewood that gives longer and brighter flame is preferred. Although *Androstachys johnsonii* trees produce smoke, it is included in the most important firewood tree species, because some respondents also used the tree for night lighting. *A. johnsonii* is reported to burn with the brightest flame in comparison to other species used in night lighting. According to the household responses, firewood comprises dead wood, and wet wood that is collected when fields are cleared for agriculture.

Apart from subsistence use of firewood, some respondents have collected firewood as a commercial commodity for the informal market in the village. All respondents who trade firewood are from the Mahungane Village. Firewood tree species used for sale by traders are *Brachystegia spiciformis, Dalbergia melanoxylon, Hymenocardia ulmoides* and *Terminalia sericea*. None of the respondents affirmed having used or produced charcoal.

Work in the RSA

Having a job in the RSA is an important activity for people from the area. About 71% of respondents have household members working in the RSA (Table 4.3). The number of households with family members working in the RSA ($X^2 = 6.8$, d.f. = 3, p = 0.08) is not significantly associated with the village of origin. According to key informants, almost all households previously had at least one member of their family working in South Africa in the past years. The majority of respondents (41.2%) lost their work after 1995. Figure 4.1 shows the cumulative percentage of household respondents (n = 24) that have lost their jobs in the RSA over time.

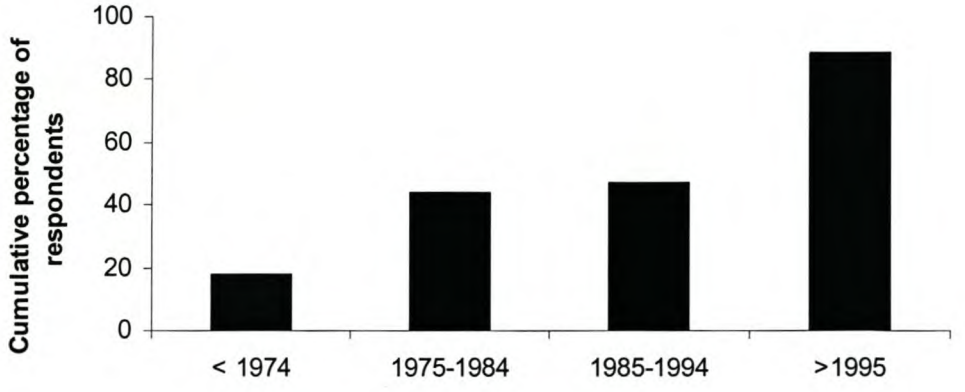


Figure 4.1 Cumulative percentage of respondents who lost their jobs in the RSA over time (n = 24)

Livestock rearing

Livestock rearing is a common activity in the area, practised by 57.4% of the respondents (Table 4.3). All pastoral-farming respondents use the undifferentiated forest and not the *cimbirre* woodland for animal grazing. Poultry farms are established at home, while grazers and browsers such as goats, sheep, and cows are useful for

bride price payments and, in critical situations, they might be bartered for food or other products. For example, at the time of this survey the area was facing a food crisis, and some households exchanged their animals for rice, flour or sugar purcchased from retailers. A mature duck was exchanged for 50 kg of rice. Oxen are also used in land tilling.

Edible wild fruit extraction

The harvesting of edible wild fruits is a seasonal activity, and occurs mainly during the rainy season (November to March). Seventy one percent of the respondents practise it (Table 4.3). The five predominant fruit trees pointed out by respondents are *Strychnos madagascariensis, Sclerocarya birrea, Anacardium occidentale*, *Landolphia kirkii* and *Artabotrys brachypetalus*. No fruits are collected from the *cimbirre* woodlands. The extraction of wild fruits is both for subsistence as well as income generation.

As a source of income, some respondents affirmed that they have made fresh or alcoholic drinks from the extracted fruits that they sell. The drinks are sold at homes. Flour made from *Strychnos madagascariensis* seeds is another source of income in the area. During periods of recession when food is scarce this flour is used for food.

Building pole extraction

About 34% of household respondents are involved in the harvesting of building poles (Table 4.3). *Androstachys johnsonii* is the unique tree species identified in the survey for building purposes. Local community members have selectively harvested *cimbirre* woodlands for poles. Pole extraction is used at subsistence as well as commercial level for constructing houses. Most of the houses in the study area used poles of *A. johnsonii* trees. Traditional houses (living-huts) have a typical round structure and are built from *A. johnsonii* poles of different diameters, which support wall erection, frames and roofing poles (Table 4.5). Storage huts have the same structure, but are smaller than the living-huts. Schools, teachers' houses and local government administrative buildings have larger constructions and are square structures.

The living-huts surveyed use on average 110 ± 23.34 (SD) poles (Table 4.5). Additional materials used to build living-huts, such as grass and cords, are collected

from undifferentiated forest types, outside the *cimbirre* woodlands. Residents prefer *A. johnsonii* poles for construction due to their longevity and natural high tolerance to termites and other bio-degraders. The age of the average respondent's house is 7.24 ± 5.53 (± SD) years; yet the majority of respondents (70%) affirmed that its life span could be more than 20 years and perhaps even more than that of an average human lifetime. The average number of houses per household is 3.74 ± 0.27 (SD). There is a positive correlation ($r = 0.75204$, $p < 0.01$) between the average number of houses and household members.

Table 4.5 Diameter, number and volume (mean ± SD) of *Androstachys johnsonii* poles used to build a living-hut

Pole category	Number per house	Length (m)	Diameter (cm)	Volume per house (m3)
Wall erecting (n=73)	53 ± 23.74	2.45 ± 0.05	8.42 ± 0.66	0.7067± 0.13 (11)
Frames (n=73)	14 ± 15.8	1.72 ± 0.04	11.84 ± 1.47	0.2794 ± 0.07 (6)
Roofing (n=68)	43 ± 3.60	2.45 ± 0.06	5.6 ± 0.23	0.2510 ± 0.12 (14)
Total	110 ± 23.34			1.2397 ± 0.22 (31)

Building poles were first used at a subsistence level. Pole extraction for commercial purposes began around 1983, and gradually this has become an important activity in the area. From the total households involved in the activity, 3.6 % began in the period 1975-1984 and 82.1% began after 1995 (Figure 4.2); their markets are their own villages.

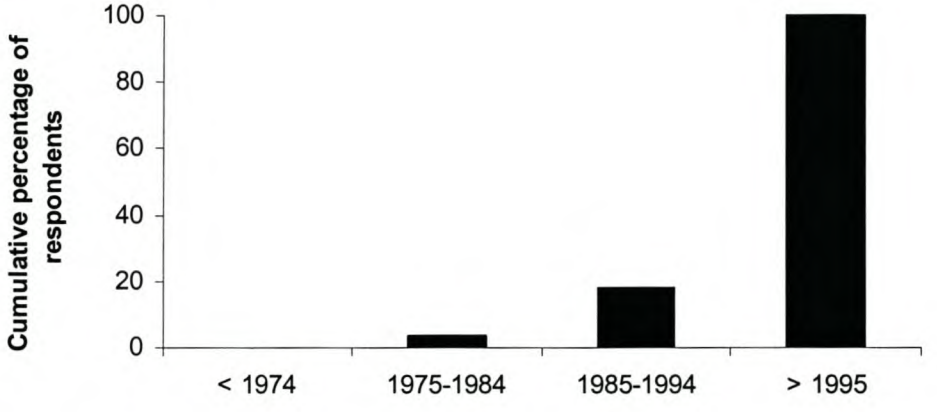


Figure 4.2 Cumulative percentage of households involved in pole extraction over time

For commercial pole extraction, pole diameters are limited to 10-14 cm diameter class. It is practised during periods when there is less agricultural activity (May to December). However, some respondents mentioned harvesting poles throughout the whole year. The number of poles extracted per day, times a week and period (number of months) are given in Table 4.6. The number of poles extracted annually per household is 145 ± 114 (SD).

Table 4.6 Number (mean ± SD) of *Androstachys johnsonii* poles extracted per household

Pole extraction	Mean (x ± SD)	Frequency of respondents
No. per day	6.03 ± 2.06	15
Times a week	3.18 ± 1.60	10
No. of months	7.06 ± 2.88	15
Total year	145 ± 114	

There is a significant difference in the number of household respondents involved in the activity (X^2 = 24.69, d.f. = 3, p<0.001) between the four villages of the study. Significantly fewer respondents from the Manhique Village are involved in pole extraction compared with Mahungane ($p < 0.001$) and Macheco ($p = 0.01$). In addition, significantly more respondents from Macheco Village are involved in the activity compared to respondents from Tsumbo (Figure 4.3).

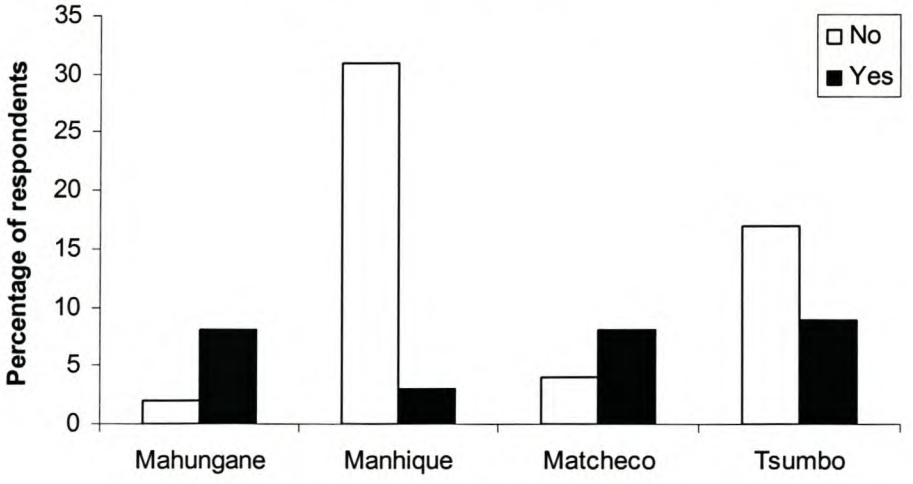


Figure 4.3 Proportion of household respondents who are involved (Yes) and who are not involved (No) in the harvesting of poles per village

4.3 SUSTAINABILITY OF THE CURRENT HARVESTING SYSTEMS OF *ANDROSTACHYS JOHNSONII* TREES FOR POLES

In this section, data from the forest resource assessment are analysed to determine the population structure, the potential for harvesting *A. johnsonii* for poles as well as tree growth rate in order to assess the sustainability of the current harvesting systems of *A. johnsonii* trees. Two different harvesting systems are identified in the area, namely, the harvesting of juvenile trees (dbh < 15 cm) by local communities, and the harvesting of mature trees (dbh > 30 cm) by outsiders (private companies), for timber. From the four villages covered by the study, Manhique Village was excluded from this survey as it does not have a significant area of *cimbirre* woodland, and people from Manhique cut trees from neighbouring villages.

A total of 22 species were found in the *cimbirre* woodland around the three villages covered by the study. This list is presented in Appendix 3. The woodlands being studied are dominated by *Androstachys johnsonii* in the canopy (dbh > 15 cm) and sub-canopy (dbh < 15 cm). The total densities of trees are about 1670 ha^{-1}, 1,240 ha^{-1} and 1,200 ha^{-1} in Macheco, Mahungane and Tsumbo, respectively. *A. Johnsonii* alone comprises more than 90% of all species in each village (Table 4.7).

Table 4.7 Stem density (dbh > 5 cm) and relative abundance (p [%]) of dominant species (p >1%) in the *cimbirre* woodlands of the three villages

Species	Macheco		Mahungane		Tsumbo	
	Density (Stems/ha)	p (%)	Density (Stems/ha)	p (%)	Density (Stems/ha)	P (%)
Unidentified$_1$	18.8	1.1	59.4	4.8		
Androstachys johnsonii	1,543.8	92.0	1,153.1	92.7	1,136.1	94.2
Pteleopsis myrtifolia	46.9	2.8	3.1	0.3		
Alchornea laxiflora					41.7	3.5
Brachystegia spiciformis	50.0	3.0	12.5	1.0		
Others	18.6	1.1	15.7	1.2	27.8	2.3
Total	1,678.1	100.0	1,243.8	100.0	1,205.6	100.0

4.4.1 Population structure

The density distribution of diameter size-classes (5 cm intervals) shows a similar pattern with respect to *A. johnsonii* in all three villages. It shows a continuous reverse-J shape, with many smaller trees and few larger ones (Figure 4.4). There is also a steep reduction in the number of trees from the first diameter size-class (dbh < 5 cm) to the subsequent size-class (dbh = 5–9 cm), with more than 60% of all individuals in the first size-class. The number of *A. johnsonii* stems above 20 cm is greatly reduced in the three villages. *A. johnsonii* populations of the three villages show negative slopes. The SD slopes of the ln (stems/ha + 1) versus diameter size-class are -1.03, -0.84 and -0.79 for Macheco, Mahungane and Tsumbo, respectively. The species is included in type 1 (negative SD slope) (Figure 4.5).

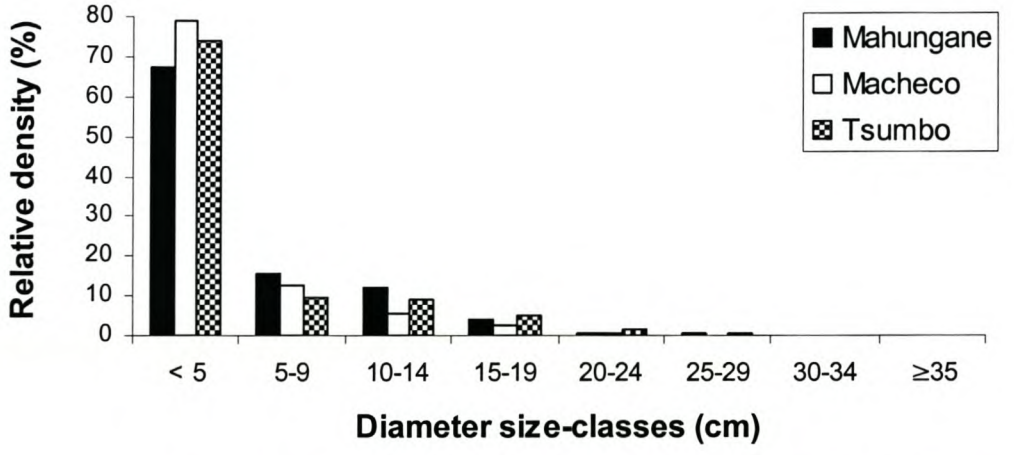


Figure 4.4 Relative density of diameter size-class distribution of *A. johnsonii* in the three villages

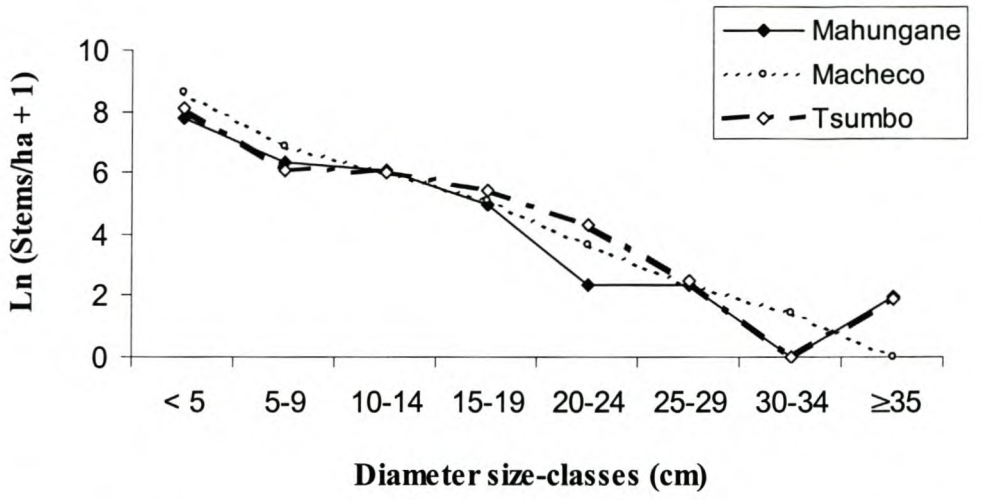


Figure 4.5 Straight-line plots of the diameter size-class distribution of *A. johnsonii* in the three villages

The analysis of quotient plots indicates that *A. johnsonii* populations have even quotient transitions from one diameter size-class to the next (Figure 4.6). It indicates that populations in each of the three villages are stable.

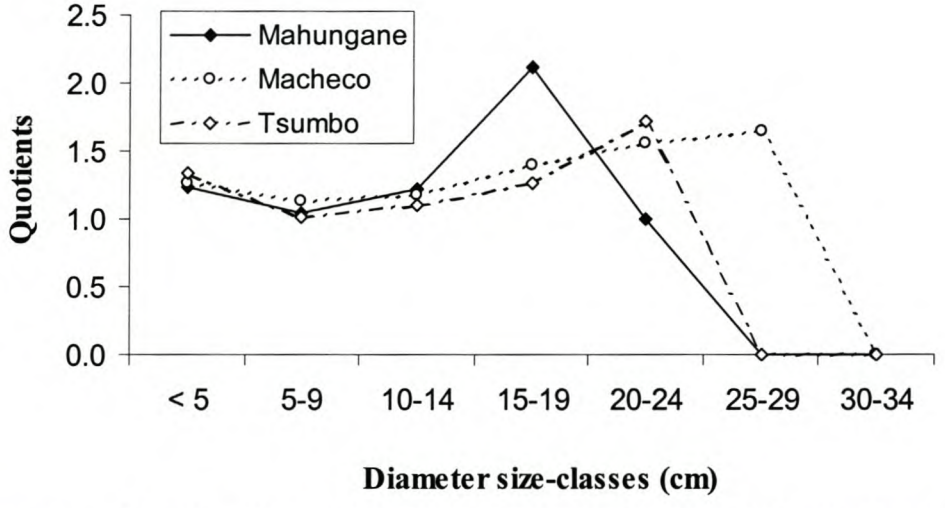


Figure 4.6 Quotient distributions for *A. johnsonii* determined for the three villages

The distribution of diameter size-classes of harvested and live *A. johnsonii* trees demonstrates that loggers are cutting almost all size-classes. Individuals are mostly harvested from the diameter size-class of 5-9, 10-14, 15-19, 25-29 and 30-34 cm. Considerable harvesting pressure on larger trees has led to their decline and *A. johnsonii* trees now occur mainly in small size-classes (Table 4.8).

Table 4.8 Stem density of diameter size-class distributions of *A. johnsonii* trees in the three villages, distinguishing live and harvested trees

Villages		Diameter size-classes (cm)						
		5-9	10-14	15-19	20-24	25-29	30-34	≥35
Macheco	Harvested	81.3	168.8	6.3		6.3	3.1	
	Live	925.0	403.1	165.6	37.5	9.4	3.1	
Mahungane	Harvested	62.5	59.4	6.3	3.1	3.1	3.1	3.1
	Live	562.5	425.0	140.6	9.4	9.4		6.3
Tsumbo	Harvested	86.1	105.6	22.2		13.9	13.9	2.8
	Live	422.2	402.8	222.2	72.2	11.1		5.6

4.4.2 Potential for harvesting *A. johnsonii* for poles

The current stem densities at canopy (dbh ≥15 cm) and sub-canopy (dbh < 15 cm) of the three *A. johnsonii* populations (Macheco, Mahungane and Tsumbo) are above the lower harvesting limits for canopy (10 individuals/ha) and sub-canopy (20 individuals/ha) stem densities defined by the linear-programming approach to graphically model the selection of harvestable diameter size-classes (Figure 4.7). This result shows that the species has potential, in the model, to be harvested from the most vegetative diameter size-classes (5-19 cm) for poles.

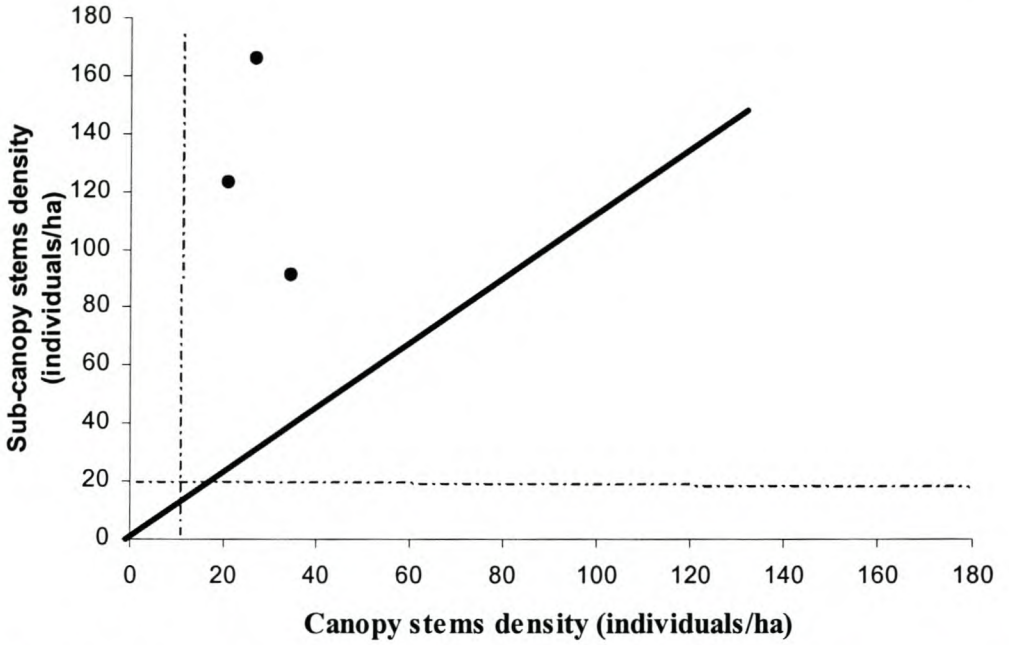


Figure 4.7 Scatter-plot of the density of harvestable sub-canopy stems against canopy stem density of *A. johnsonii* for each village

4.4.3 Tree growth rate

Estimates of annual recruitment (AR) from one 5 cm diameter size-class to the next are used to evaluate the sustainability of the current harvesting systems. AR is estimated in the way described in section 3.2.2 and is based on the assumptions mentioned in the same section. The number of trees per hectare recruiting to the next highest diameter size-class was obtained from the current diameter size-class frequency distribution of live plus harvested trees given in Table 4.9.

Table 4.9 Density distribution (stems/ha) of diameter size-classes of both living and harvested *A. johnsonii* trees in the three villages of the study

Villages	Diameter size-classes (cm)						
	5-9	10-14	15-19	20-24	25-29	30-34	≥35
Macheco	1006.3	571.9	171.9	37.5	15.6	6.3	0.0
Mahungane	625.0	484.4	146.9	12.5	12.5	3.1	9.4
Tsumbo	508.3	508.3	244.4	72.2	25.0	13.9	8.3

In terms of the future of the populations, from an average 15.6, 12.5 and 25.0 trees/ha in diameter size-class 25-29 cm, 6.3, 3.1 and 13.9 trees/ha are expected to progress to the upper size-class 30-34 cm (for timber) in Macheco, Mahungane and Tsumbo, respectively, within a felling cycle of 33 years. Correspondingly, from the average 1006.3, 625.0 and 508.3 trees/ha in diameter size-class 5-9 cm, 571.9, 484.4 and 508.3 trees/ha, respectively, are expected to progress to the upper size-class 10-14 cm (for poles) in Macheco, Mahungane and Tsumbo, respectively.

Using the equation (6), the estimated annual recruitment (AR) of trees to diameter size-class 30-34 cm (for timber) is 0.2, 0.1 and 0.4 trees/ha/year for Macheco, Mahungane and Tsumbo, respectively. On the other hand, a total of 17.3, 14.7 and 15.4 trees/ha/year for Macheco, Mahungane and Tsumbo, respectively, progress from the diameter size-class 5-9 cm to size-class 10-14 cm, which is used locally for poles.

4.4 ROLE OF DIFFERENT STAKEHOLDERS IN THE MANAGEMENT OF *CIMBIRRE* WOODLAND AND THEIR PERCEPTIONS

This section presents the role that the different institutions play in the management of natural resources in the study area, and the perceptions of these role players. Householders' perceptions on woodland degradation, as well as their knowledge of the Forestry and Wildlife Law are analysed. The results in this section are based on group discussions and semi-structured interviews with key informants and structured questionnaires completed during the survey. The results are based on replies to questions pertaining to the respondents' perception of woodland management.

4.4.1 Role of different institutions in woodland management

The majority of the respondents are not aware of any local institution that could be involved in the management of *cimbirre* woodland. However, the identification of local institutions was possible during group discussions with key informants. Local institutions identified in the survey are the traditional authorities (chiefs), the private sector, loggers (from the local communities), the political party in power (FRELIMO), non-governmental organizations (NGOs) and state institutions such as

local government administration as well as agricultural and forestry services. The hierarchical diagram of the stakeholder groups identified is presented in Figure 4.8 and the role that each stakeholder group plays in woodland management is presented below.

Local communities

Chiefs and local community logger groups constituted the community institutions identified during the discussions as playing some role in woodland management. Chiefs represent the traditional authority in the area; they control land distribution for agriculture and the allocation of areas to build houses in the village. Chiefs play an important role in the enforcement of traditional rules of management. Traditional rules of conservation go from strict control to total prohibition on harvesting practices. For example, the use of firewood is restricted to dead trees and dried branches and wet wood collected when agricultural fields and residential areas are cleared. Rules of management are regulated by taboos and beliefs whilst the conservation is embodied in rites and ceremonies. According to respondents wood from *Commiphora zanzibarica* and *Ozoroa obovata* cannot be used for firewood, buildings or in any instrument. In cases of transgression, offenders are warned that bad omens would fall upon their family or that particular group. It was mentioned during the discussion that *Sclerocarya birrea* fruits are preserved because they are used to make drinks that feed the ancestors. In addition, any harvesting practice involving other species needs permission from the ancestors, through payment of a tribute in the form of money or alcoholic drinks to the chief responsible for the area. Chiefs represent the interests of ancestors. The geographical jurisdiction of a chief coincides with the village boundaries.

The local community logger group is a new organization that was established for the extension of the Projecto Maneio Sustentado dos Recursos (sub-section 3.1.3). All household members that harvest poles for commercial purposes are registered by this organization. In each village, there is one or more sub-groups. The number of sub-groups depends on the size of woodland patches available for harvesting, and it does not represent the geographic limits of the village. No outsiders can become members of the community logger group, whose role is to ensure sustainable pole extraction through more efficient control of these outsiders. People considered as outsiders are

those coming from villages outside the area covered by the PMSR. All group members were patrollers. Each sub-group had a leader and vice-leader, and it was led by a communal steering committee (Figure 4.8) composed of all chiefs, local government administration heads, as well as the sub-group leaders and vice-leaders of the four villages.

Private sector

Pole transporters and licensed timber bodies represent the private sector identified in the study. Licensed timber bodies comprise big timber enterprises with sawmills and small pole traders that have simple harvesting licenses. The big timber enterprises and small pole traders work together with the forestry services as well as with the local communities. They hire labourers and follow the traditional rituals defined by the chiefs. So far, pole transporters have less contact with the local communities. Their contact with local residents is confined to merely the buying and transporting of poles to markets outside the villages. Additionally, they buy pole transit sheets from the community logger groups in order to satisfy forestry guards. The pole transportation truck can carry an average of 21 poles per load. The pole transporter respondents affirmed that they transport poles from the villages to other areas two times a week almost for the whole year.

State

Local government administration and the District Directorate of Agriculture and Rural Development (DDARD) are the local government institutions that could be involved in the management of natural resources since they have authority and responsibility in the area. Although traditional authorities play a key role in land distribution, the forestry services is responsible for timber licensing as well as the identification and definition of potential forest areas for timber harvesting. In line with the scope of the Projecto Maneio Sustentado dos Recursos, forestry services provides technical support to the communal steering committee. On the other hand, agricultural services offers agrarian technical support to the local communities; it is also involved in the distribution of fruit trees, subsistence crops, seeds and other income generating crops.

The local government administration represents the government at village level. Local government administration is also involved in consultations with the local

communities concerning the development of projects in the village area. At this level, there is no clear division of power and role between local government administration and the ruling party.

Political party

Two political parties are represented in the area, namely, the ruling party (FRELIMO) and the main opposition party (RENAMO). There is a RENAMO chapter in one village (Manhique) in the study area. This chapter was recently formed, and as a result, it is not very active and plays no noticeable role in the overall functioning of the village institutions. There are, however, FRELIMO chapters within each of the four villagers. The ruling political party appears to play an important role in the affairs of local institutions. It is difficult to differentiate the power and role between the local government administration and FRELIMO in this study area. FRELIMO was in control of the study area during the civil war and the population has remained sympathetic to their ruling.

Non-governmental organizations (NGOs)

NGOs identified in the study area were working in the area at the time of the survey. These are the Cooperative for Assistance and Relief Everywhere (CARE) and Accão Agraria Alemã (AAA). They work closely with the District Directorate of Agriculture and Rural Development and agricultural services in particular. Both NGOs are involved in the provision of food security in the area. CARE implements the "Work for Food" programme, and it also is involved with AAA in seed and tool distribution campaigns and technical support for the agricultural service technicians and local community members.

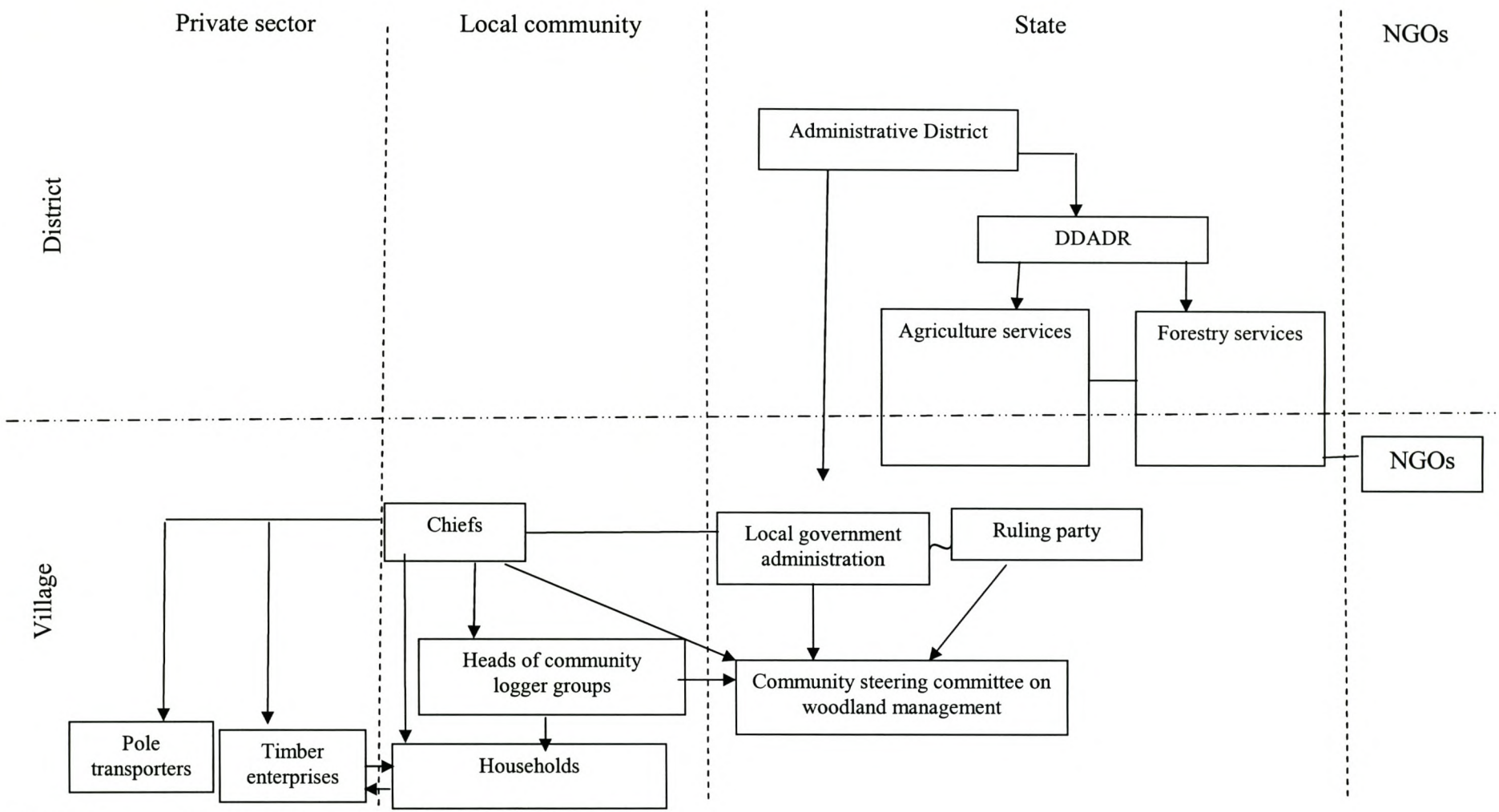


Figure 4.8 Identity and hierarchy of local institutions

4.4.2 Respondent perceptions of *cimbirre* woodland degradation

Having identified the local institution with a role in woodland management in the last section, this part of the study examines local institution representatives and householders view on the current harvesting systems of *A. johnsonii* trees and woodland fires in degraded woodland areas of the study. Results are provided for each of these themes.

Current harvesting systems of *A. johnsonii* trees

Responses from stakeholders and householders interviewed concerning the existing practice of harvesting juvenile trees for commercial purposes and mature trees for sawn timber in the four villages under consideration differed. The majority of local institution representatives interviewed, including all chiefs and 75% of local government representatives, believe that *cimbirre* woodlands can survive for longer than 50 years (long-term) with the harvesting of juvenile trees (Figure 4.9). For them, the harvesting of juvenile trees has lower impact on woodland degradation than the harvesting of mature trees, because mature trees need the construction of harvesting roads and therefore have more destructive effects on non-target trees. Removal of mature trees also reduces the number of mother trees that are useful sources of seed for future crops. Of the remaining local institution representatives interviewed, 71% of the community logger group representatives, all private sector representatives and 25% of the local government representatives believe that the survival of *cimbirre* woodland would be less than 50 years (short-term), if the harvesting of juvenile trees continues at the present rate (Figure 4.9). For them, the level of degradation due to harvesting of juvenile trees is high. They indicated that the selective cutting of juvenile trees for pole and other building materials on a commercial scale requires more trees than for sawn timber. As a result, extensive forest areas will become degraded.

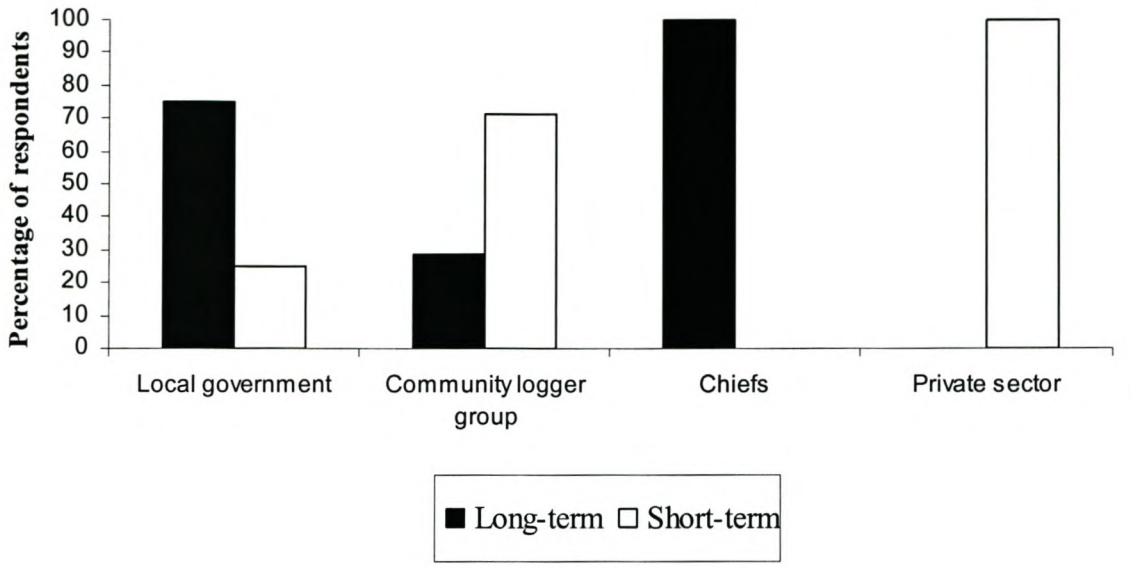


Figure 4.9 Perception of local institution respondents on survival time of *cimbirre* woodland under the harvesting of juvenile trees for commercial purposes

Analysis on household perceptions on the survival time of *cimbirre* woodland under the harvesting of juvenile trees for commercial purposes shows a significant difference ($X^2 = 19.9$, d.f. = 3, $p < 0.001$) between villages (Figure 4.10).

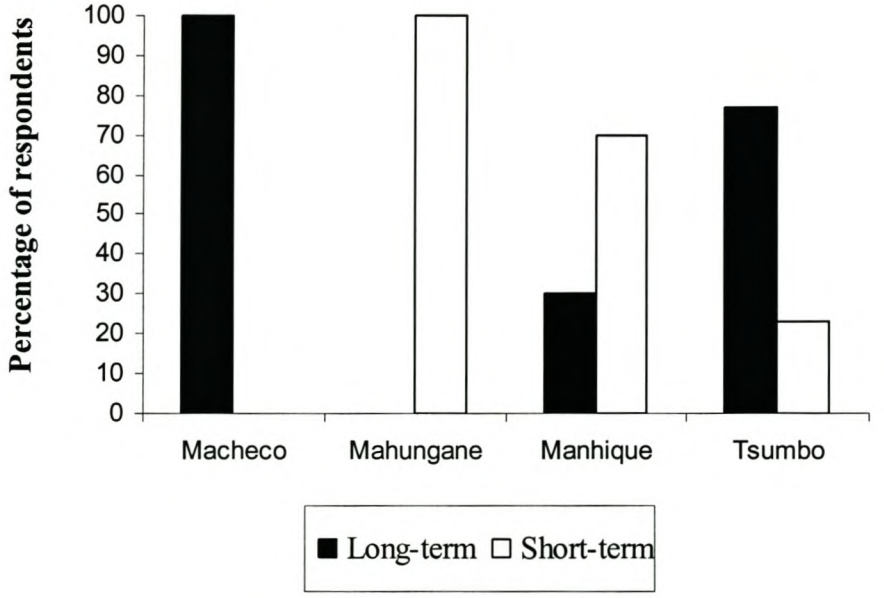


Figure 4.10 Household perceptions on survival time of *cimbirre* woodland under the harvesting of juvenile trees for commercial purposes

All householder respondents from Macheco and 77% of respondents from Tsumbo believe that *cimbirre* woodlands might survive longer (50 years and more) under the harvesting of juvenile trees for commercial purposes. All householder respondents from Mahungane, 70% of respondents from Manhique and 23% of the respondents from Tsumbo believe that *cimbirre* woodlands might survive less than 50 years (Figure 4.10), if the harvesting of juvenile trees continues at the present rate.

In general, household respondents involved in commercial pole extraction believed that under the actual harvesting system the woodland will survive in the long-term. Yet, the perceived survival time of *cimbirre* woodlands under the harvesting of juvenile trees does not differ significantly (X^2 = 1.41, d.f. = 1, p = 0.23) between respondents who are involved in commercial pole extraction and those who are not (Figure 4.11).

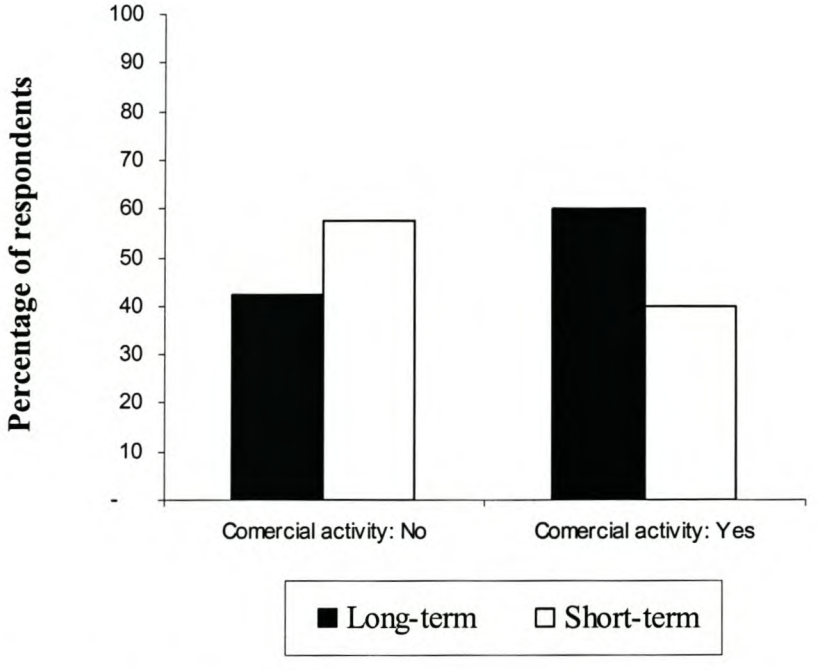


Figure 4.11 Household perceptions on *cimbirre* woodland survival time under harvesting of juvenile trees between respondents involved in commercial pole extraction and those who are not

Woodland fires

Woodland fires in the area start in agricultural plots where fire is used in land clearing and pasture maintenance, especially slash-and-burn or shifting cultivation. In fact, the majority of respondents rely on fire to prepare crop fields and maintain pasture, in addition to the use of fire in hunting. Ranking of four main causes of woodland fires in the area show that the farming system, characterized by clearing and burning of agricultural land was the main cause of fire in *cimbirre* woodlands. This is followed by hunting, transportation of burning charcoal, and alcohol distillation within the woodland, as outlined in Table 4.10 below.

Table 4.10 Ranking of the causes of fires in *cimbirre* woodlands, number (n) and percentage of total respondents per activity and village

Activities	Rank*	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total ($\sum n = 83$)
Farming system	1	(8)	(8)	(19)	(22)	(57) 68.7%
	2	(3)	(2)	(17)	(3)	(25) 30.1%
	3	(1)				(1) (1.2%)
	4					
Mean	1					
Transportation	1	(1)		(14)	(3)	(18) 21.7%
of burning	2	(9)	(2)	(5)	(8)	(24) 28.9%
charcoal	3	(2)	(5)	(13)	(12)	(32) 38.6%
	4		(3)	(4)	(2)	(9) 10.8%
Mean	2					
Hunting	1	(3)	(1)	(3)		(7) 8.4%
	2		(4)	(4)	(11)	(19) 22.9%
	3	(8)	(2)	(13)	(6)	(29) 34.9%
	4	(1)	(3)	(16)	(8)	(28) 33.7%
Mean	3					
Alcohol	1		(1)			(1) 1.2%
distillation	2		(2)	(10)	(3)	(15) 18.1%
	3	(1)	(3)	(10)	(7)	(21) 25.3%
	4	(11)	(4)	(16)	(15)	(46) 55.4%
Mean	4					

*Rank values of importance from 1 (highest) to 4 (least)

It is a common practice in the area to transport burning wood from one area to another to save matches. However, in this process, burning charcoal accidentally drops down and causes fire. Alcohol distillation is conducted within the woodlands where fruits are selected and placed in pots to boil. Sparks from burning logs and burning charcoal left unattended after distillation are sources of fire that burn woodlands. Hunting with fire was not a common practice in the area; hunters use traditional hunting dogs. However, because of the dwindling number of other wild animals in the area, hunters have recently started to use fire to flush out wildlife, especially the greater cane-rat (*Thryonomys swinderianus*).

Statistically, there is no significant difference between the number of respondents from the four villages in terms of perceived importance of different sources of fire in woodlands, for example, farming system ($X^2 = 9.82$, d.f. = 9, p = 0.36), hunting ($X^2 = 13.25$, d.f. = 9, p = 0.15), alcohol distillation ($X^2 = 8.81$, d.f. = 9, p = 0.45) and transport of burning wood inside the woodlands ($X^2 = 11.96$, d.f. = 9, p = 0.22).

Owing to the awareness of the degradation level of their activities and the fact that they believe that the *cimbirre* woodland can survive only for a short period, some of the local community logger respondents affirmed that agriculture would be their alternative source of income in the village in the event of a total destruction of *cimbirre* woodland.

Smoking cigarettes and honey hunting are other causes of woodland fires in the area. However, these practices were not included in this study as few respondents practise them.

4.4.3 Respondent knowledge of the Forestry and Wildlife Law

Results in this section pertain to the question of listing the government and traditional rules regarding forest management. Based on the list, respondents' knowledge of the Forestry and Wildlife Law was divided into three levels (low, medium and high). The knowledge of law was then compared with the respondents' attendance of meetings

that are convened by government officials and non-governmental organizations (NGOs) at which the law is promulgated.

In general, local institution representatives have a low level of law knowledge. Even though respondents attended law meetings, it did not seem to have any effect on their knowledge of the law (Table 4.11).

Table 4.11 Level of knowledge of the Forestry and Wildlife Law demonstrated by local institution representatives and its relationship with meeting attendance: number (n) and percentage

Institutions		Knowledge of the Forestry and Wildlife Law		
	n	Low	Medium	High
Local government	4	(3) 75%	(1) 25%	
Community logger group	7	(5) 72%	(1) 14%	(1) 14%
Chiefs	4	(3) 75%		(1) 25%
Private sector	1			(1) 100%
Meeting attendance: Yes		(6) 60%	(2) 20%	(2) 20%
Meeting attendance: No		(5) 83%		(1) 17%

Analysis of knowledge among households of the Forestry and Wildlife Law shows a significant difference ($X^2 = 36.43$, d.f. = 6, $p < 0.001$) on the level of legal knowledge between the four villages. There are more respondents from Tsumbo Village with low knowledge of the law and more respondents with high knowledge of the law in Manhique Village. In addition, there is a significant difference ($X^2 = 29.15$, d.f. = 6, $p < 0.001$) on knowledge of the law between respondents who attended meetings and those who did not attend meetings on the promulgation of the Forestry and Wildlife Law (Table 4.12).

Table 4.12 Level of knowledge of the Forestry and Wildlife Law demonstrated by household respondents and its relationship with meeting attendance: number (n) and percentage

Villages		Knowledge of the Forestry and Wildlife Law		
	n	Low	Medium	High
Macheco	12	(4) 33%	(6) 50%	(2) 17%
Mahungane	10	(3) 30%	(7) 70%	
Manhique	36	(18) 50%	(6) 17%	(12) 33%
Tsumbo	25	(22) 96%	(1) 4%	
Meeting attendance: Yes		(10) 35%	(9) 30%	(10) 35%
Meeting attendance: No		(38) 70%	(10) 19%	(6) 11%

Generally, there is a lack of knowledge of the Forestry and Wildlife Law among the participants that attended meetings, whereas traditional rules of woodland management are well known in the villages. All respondents indicated the main traditional rules of woodland management in the area covered by the study as seeking permission from the chief for any activity, pay tribute to the chief for any activity and use only dead trees for firewood.

4.4.4 Respondent opinions on land resource ownership

Respondents differ in opinions regarding the ownership of land resources for sustainable management of *cimbirre* woodlands (Table 4.13). The majority (75%) of respondents support community land ownership, while the rest believe in state (12.5%) and community-state partnership (12.5%). All chiefs, 89% of local community logger group representatives and 50% of local government representatives believe in community land ownership. The private sector and 25% of local government representatives believe in state land ownership. The remaining 25% of local government and 11% of community logger group representatives believe in state-community partnership. Weak local capacity to enforce laws and local decisions are the factors pointed by the respondents that did not support community land ownership for sustainable woodland management.

Table 4.13 Local institution opinions on land resource ownership for sustainable woodland management

Institutions	n	Land resource ownership		
		Community	State	State-community partnership
Local government	4	(2) 50%	(1) 25%	(1) 25%
Community logger group	7	(6) 86%		(1) 14%
Chiefs	4	(4) 100%		
Private sector	1		(1) 100%	
Total	16	(12) 75.0%	(2) 12.5%	(2) 12.5%

CHAPTER 5

DISCUSSIONS

5.1 INTRODUCTION

The failure of sustainable management of natural resources is generally related to centralised decision-making, in a top-down manner, in which no attention is given to the existing social context and economic-environment dynamics (Abakerli, 2001). It has become clear that the ecological and social basis of forest management needs to be improved.

This study reveals five fundamental issues: 1) The structural adjustment programme allied to the retrenchments in the gold mining industry in South Africa and abolishment of recruitment of Mozambican labourers to the South African mining industry, increased demand for *A. johnsonii* poles. 2) Contrary to one hypothesis of this study, *A. johnsonii* woodland fires cannot be attributed to deliberate burning by local communities in order to bypass the regulation that specifies permissible diameter for exploitation, but rather to fires arising from agricultural activities. 3) Also contrary to another hypothesis, the study suggests that the current harvesting of *A. johnsonii* for poles is sustainable. 4) Colonial and post-independence centralised governmental policies have changed the authority of the traditional leaders, leading to an apparent lack of clarity in the responsibility of the different stakeholders in the management of natural resources in the study area. 5) In management of the *cimbirre* woodlands in the study area, focus should be on sub-canopy tree sizes. Therefore, there is a need to legalise the harvesting of *A. johnsonii* for poles by local communities.

5.2 IMPORTANCE OF COMMERCIAL HARVESTING OF *A. JOHNSONII* POLES FOR RURAL HOUSEHOLD LIVELIHOODS

Ranking of household activities for rural livelihoods expressed by people of the four villages in the Mabote District is based on a perceived importance largely influenced by the economic value gained from the activities. This result explains why subsistence activities, such as hunting, wild fruit extraction and livestock rearing, are ranked below the main income generation activities, which are working in the RSA and commercial pole extraction (Table 4.3). Agriculture has been the main activity. The seasonality of the activity makes it compatible with other activities, with interruptions during the sowing periods (November and December) (First, 1998). In the case of firewood extraction, although ranked on a high level, there is considerably a reduced number of respondents (31.2%) that referred to the activity as important. Nevertheless, all respondents rely on firewood as a source of energy. Additionally, a large number of respondents who referred to firewood extraction are from Mahungane Village where firewood is exploited for commercial purposes.

Commercial pole extraction is a relatively new activity in the area. It started in 1983, and has gradually become one of the most important activities (Table 4.3). The growing trend in pole extraction by the local people might be due to the reduction of migratory labour in South African gold mines (Figure 4.1). Since 1886 when the gold mining industry commenced in South Africa, most of the employees were migrants from Mozambique (Butchart, 1996), and particularly from Inhambane Province in southern Mozambique (First, 1998). During 1987-92, however, the gold price declined steadily and the Rand gold price started falling (Nattrass, 1995). This resulted in a major squeeze on the South African gold mining industry and vast numbers of jobs were lost. For example, Chamber of Mines employment fell by 6.3% per annum during that period (Nattrass, 1995). The majority of household respondents in the study area lost their jobs in the period 1995-1999 (Figure 4.1).

Despite the decline in the number of Mozambican employees in the South African mining industry, most of the Mozambicans continued working as illegal immigrants in South Africa. The majority of them work on farms in Kwazulu-Natal and

Mpumalanga (First, 1998). This explains why 71% of respondents in this study have at least one household member who works in the RSA (section 4.2.4). Working in South Africa has been a traditional source of income for households in the area. However, pole extraction for commercial purposes seems to be the only viable alternative for local communities whose members have lost jobs in South Africa. The activity has become an important source of income, mainly for the poorest group of people with fewer possibilities to diversify their activities. Pole extraction is time consuming, tedious and arduous, and generates low returns and only community members without congenial alternatives practise it (Mantilla, 2002). Additionally, the low educational level of the local community members, where only 11% of respondents have secondary education (Table 4.1) does not expose community members to favourable job opportunities. Besides, job opportunities within the study area are restricted to teachers, nurses, and guards or running small businesses (ACNUR-PNUD, 1997). This explains the results that show that there are more respondents from Manhique and Tsumbo villages who are not involved in pole extraction compared with respondents from the other villages (Figure 4.3) because these two villages have more respondents with elementary education (Table 4.1).

In addition to the declining labour recruitment, the severity of the structural adjustment programme on people with low incomes, aggravated by social inequality and poverty, result in increasing dependence on forest resources in the study area. This is particularly because the agricultural production in the area does not ensure food security as described in section 4.2.4. The increasing number of pole extractors is also due to the expansion of urban demand for building poles, because pole extraction became an extractive activity strongly dependent on the market requirement (Mantilla, 2002).

Unlike the situation found in the study area, remittance of income by migrant employees might increase or maintain social stability and the economic well-being of migrants, so that they do not need to rely on natural resources later (Adger et al., 2002; Naylor et al., 2002). For example, in the island of Kosrae in the Federated States of Micronesia, where a similar migratory pattern of household members seeking enhanced employment opportunities elsewhere in the Pacific was practised, it

was shown that after the return of the migrants the average consumption of mangrove resources has not increased despite increases in population and decline in aid and government jobs (Naylor et al., 2002).

Pole extraction for commercial purposes will continue to be an important source of income for the local communities in the study area, especially for the poorest group of people, until better alternatives are introduced.

5.3 SUSTAINABILITY OF THE CURRENT HARVESTING SYSTEMS OF *ANDROSTACHYS JOHNSONII* TREES

5.3.1 Population structure

The floristic composition of *cimbirre* woodlands is similar in the different villages of the study. The complete dominance of *Androstachys johnsonii* stems reflected in the results (Table 4.6) is characteristic of these woodlands (Codd, 1951; Coates-Palgrave, 2002). Chamba et al. (2002) and Sande (1999) found the same pattern of floristic composition in their studies on *cimbirre* woodlands in other parts of Mozambique. *A. johnsonii* usually grows communally in patches, often to the exclusion of other trees (Codd, 1951). Distribution of size-classes of harvested and lives *A. johnsonii* trees demonstrate that loggers are cutting almost all diameter size-classes. Trees are mostly harvested from the diameter size-classes 5-9, 10-14, 15-19, 25-29 and 30-34 cm. Harvesting of larger trees has led to their decrease in the stands (Table 4.8). It is important to note that in the past, *A. johnsonii* was intensively harvested for timber (dbh > 30 cm) (Saket, 1994). The indiscriminate selection of the species and size-class for poles and timber may be a consequence of over-using the desired size-class trees. During the discussions with key informants, it was pointed out that in the absence of desired diameter size-class for poles, bigger poles could be harvested and then debarked to arrive at the required size-class. Similarly, in the absence of desired diameter size-class for timber, smaller logs could be harvested. This seems to be a more plausible explanation for the indiscriminate selection of all diameter size-classes during harvesting.

The results of this study indicate that *cimbirre* woodlands match in floristic composition and also show similarity in the grain of the woodland patches in the different villages. The diameter size-class distribution of *A. johnsonii* confirms that the species is fine-grained (Figure 4.4) as defined by Coates-Palgrave (2002). Fine-grained species produce a large supply of sub-canopy pole-sized trees whose exploitation, if sustainable, would have less effect on forest structure and composition than would exploitation of other species (Obiri et al., 2002; Everard et al., 1995).

The approaches of diameter size-class frequency distribution and of species grain (spatial forest dynamics) used in this study have proved to be workable and provide a clear indication of species and size-classes that can be sustainably harvested over the short to mid-term periods (Lawes and Obiri, 2003; Obiri et al., 2002; Everard et al., 1995; Shackleton, 1993). The combined information on community composition, grain and diameter size-class distribution gives the best initial understanding of the status and dynamics of forest stands. For example, Geldenhuys (1996) suggests that although there are other factors that determine the regeneration status of a species, the typical inverse J-shaped stem diameter distribution with many stems in the lower diameter classes might indicate that the concerned species is fire tolerant and responds well to uncontrolled fires.

5.3.2 Potential for harvesting *A. johnsonii* for poles

The linear-programming approach to model the harvestable diameter size-classes shows that *A. johnsonii* has potential to be harvested for poles (Figure 4.7). For the management of *cimbirre* woodlands covered by the study, focus should be on sub-canopy tree species diameter size-classes in allowing harvesting of poles of *A. johnsonii.* Fortunately, the most important products required by local communities from the *cimbirre* woodlands in the area are poles, and they are harvested from the non-reproductive (dbh < 15 cm) diameter size-classes (Table 4.5). A forest management system based on this initial understanding should provide conditions for the regeneration of species (Geldenhuys, 1996). This would maximize forest production in contrast to the traditional ban on harvesting the lower diameter species based on its commercial interests for timber. However, the diameter size-classes

selection model used in the study does not make specific recommendations regarding harvesting levels or rates. This is not necessary if the lower limit of the density constraint is not exceeded (Lawes and Obiri, 2003). However, to comment objectively on the sustainability of a harvesting system, estimates on harvesting capacities of a given area are needed.

Despite the lower diameter limits for harvesting trees defined by the Mozambican forest regulation, forests and woodlands have been degraded by selective and indiscriminate harvesting of a few economically valuable species (Saket et al., 1998). Most of the species have exceeded the viable limit of harvesting and became rare (Pereira et al., 2002). That is mainly because this regulation is based on market forces without consideration to species ecology and rarity. In addition, the state has no capacity to enforce the law in the field (Nhantumbo et al., 2003b).

Based on the preceding discussions, provision for a legal basis for the harvesting of poles by local communities should be considered. This would ensure successful *cimbirre* woodland management through resources control and the benefits to local communities. Local communities play an important role by complementing the government's capacity for law enforcement in natural resource management (Nhamtumbo et al., 2003b).

5.3.3 Tree growth rate

Section 4.4.3 gives estimates for recruitment of *A. johnsonii* trees to diameter size-classes used locally for poles (dbh 10-14 cm) and for timber (dbh > 30 cm) during a felling cycle for each village under consideration. The number of poles annually per household extracted is 145 trees/year (Table 4.6). Thirty four percent of the households are engaged in pole extraction (Table 4.3). This estimate represents 282 households. The total pole extraction in the whole study area is estimated to be 40,890 poles year^{-1}. Dividing by the total *cimbirre* woodland in the area of 2,417 ha (Table 3.3) the estimated harvesting rate per hectare in the area is 16.9 trees/ha/year.

The estimated annual recruitment of trees to diameter size-classes used locally for poles in all the villages (47.4 trees/ha/year) is greater than the current harvesting rate for poles. This result indicates that the current harvesting rate of *A. johnsonii* trees for poles is potentially sustainable. If, on the other hand, more than 47 trees/ha were removed annually, then the number of harvestable stems would be exhausted within a felling cycle of 33 years.

There are no data on the current harvesting rate of this species for timber in the area. However, the diameter size-class frequency distributions show that there is harvesting pressure on larger trees. This result is explained by the reduced number of large trees in the stands (Figure 4.4). Thus, the harvesting of the species for timber (dbh > 30 cm) should be considered carefully, and the best approach would be to ensure the development of the regeneration of trees into a useable diameter size-class. No management was required initially, other than to harvest. However, to optimise benefits from such harvesting activities, a structured harvesting program may have to be developed and implemented by management.

The estimated tree growth rate approach applied in this study uses static information on the diameter size-class distribution to predict population performance. Although, generally, there is a good correlation between diameter size-class and age, variability can be large (Poorter et al., 1996). For example, static information about the diameter size-class distribution in a forest population in Panama was not sufficient for predicting long-term dynamics (Condit et al., 1998). As a result, the study of population dynamics is important. Recruitment, growth and mortality processes may largely influence the population composition (Poorter et al., 1996; Condit et al., 1998). The predictions generated by equations (5) and (6) (section 3.2.2) are based on a life-table model. The key assumption underlying the estimated tree growth rate is that growth and mortality of a stem depend only on its current diameter size-class, not its prior history, and there is no density dependence in the model. These assumptions are violated when demographic parameters vary, since density dependence on growth, mortality and recruitment, have been documented (Condit et al., 1998). Nevertheless, Platt et al. (1988) found that simulation of these simple life-tables produced good

matches between observed diameter size-class distribution and those predicted from a life-table.

Information on growth is essential for forest yield predictions and harvesting capacities. However, only long-term monitoring of population dynamics provides the clue to the growth of trees (Geldenhuys, 1996; Grundy, 1996). Sustainable forest management systems require other information, in addition to the information obtained from a forest inventory, for successful implementation (Geldenhuys, 1996). However, Mozambique does not have consistent data and information on forests and tree species (Saket et al., 1999; Monjane, 1998), particularly on *A. johnsonii* growth rates. Therefore, despite all limitations discussed above, the MAI concept has been used in forestry exploitation in the country and is still the guiding principle (Saket et al., 1999). The principles of the annual recruitment in the diameter size-class model of harvesting used in this study apply the same concept as the maximum sustainable yield models that have dominated resource management for many years in fisheries, forestry and wildlife (Cox, 1997). The approach, therefore, is a technical instrument generally agreed upon among professionals (Saket et al., 1999; Condit et al., 1998). Hence, in the absence of direct estimates of population size over time, this approach seems to be reasonable. It is useful as a means of establishing a good basis for investigating the possible consequences of different types of harvesting strategies. It can be used as a tool for decision-making. The concept becomes more useful as more information is added to the models (Rayfuse and Wilder, 2001; Cox, 1997).

5.3.4 Effects of selective harvesting of *A. johnsonii* trees on *cimbirre* woodland management

There is a strong species selection for building purposes in the four villages under consideration. *A. johnsonii* poles are used in the majority of living houses in the area. The high longevity, the natural resistance to termites and other bio-degraders are the factors for this preference by respondents. On the other hand, Grundy et al. (1993) and Liengme (1983) found that *Colophospermum mopane* poles are mostly used for living huts in Zimbabwe and South Africa, due to this species durability and insect-resistant properties. The high selectivity for one tree species might lead to an increased rate of

extraction, mainly because of the market oriented characteristic of the activity in the area. Unlike firewood, newly cleared lands are insignificant sources of construction wood. In addition, unlike many of the tropical tree species that have sprouting capability (Negreros-Castillo and Hall, 2000), *A. johnsonii* stumps have high sensitivity to harvesting intensity and harvesting diameter size (Rathogwa et al., 2000). There is evidence of the sprouting ability of *A. johnsonii*, as mentioned during the group discussions. However, respondents stressed that the tree survives and coppices if the size of the harvested tree is smaller than five centimetres in diameter. Rathogwa et al. (2000) found same result in his experiment.

Pole and timber harvesting for commercial purposes in the study area are selectively concentrated on only one species (*Androstachys johnsonii*), with diameter size-classes of 10-14 cm and 30-34 cm for poles and timber, respectively. The approach to sustainable tree harvesting applied in this study implies maintaining the stand structure in its present state and harvesting all excess production. This approach assumes that the present population structure is in a desirable state and that removal of excess products will not alter the inherent dynamics. However, to maintain sustainable harvesting of the timber resources it is important that more than woody resources available from the woodland are used (Geldenhuys, 1996). Consequently, the policy strategy here could either be a partial or total substitution of pole and timber harvesting by alternative sources of income, or increased supply by tree planting. Research on alternative sources of wood from other species and their gradual introduction into the market should also be addressed. This could be more appropriate because the management of the resource also needs to take into account the declining prospects for some of the presently more important products (Arnold and Townson, 1998).

5.3.5 Alternative options to the harvesting of *A. johnsonii* trees

Tree planting in the study area is restricted to exotic fruit trees, and there is no incentive to plant for construction wood at present. Awareness of the need to plant trees on a national level also appears to be limited. Thus, an extensive tree-planting programme through agricultural extension should encourage tree planting through the

already existing interest in fruit trees in the area. In Malawi, for example, a number of indigenous and exotic agroforestry species are being promoted successfully through extension and government incentives to farmers to plant these species (Dewees, 1995). The Tree Improvement Research Centre (TIRC) in Zambia also initiated studies on forest fruit trees, medicinal plants and non-edible industrial oil crops with the object of commercialising the products in order to enhance national development (Mwamba, 1996). Hence, there is a need to plant trees to increase supplies of much needed woody products in the study area. However, government incentives to drive this vision should be well thought out.

Besides, in the study area where pole extraction has became an important source of income for local communities, there is a need to diversify their resources by exposing people to other income generating activities. A strategy in this matter should be the evaluation of other non-timber forest products (NTFPs). Beekeeping and fruit processing, such as cashew nuts, are feasible activities, which could be introduced into the area to diversify the economy and hence reduce pressure on woodlands.

The local market for non-timber products should be reliable once a good transport infrastructure is developed. However, the problem is that there is little knowledge about the structure of trade for these products, as in most southern African countries (Mwabumba, 2001). A possible strategy should consider the improved storage and utilization of resources and expansion into markets outside the villages. These markets should be founded on processed products with added value, e.g. marula (*Sclerocarya birea*) fruit rolls rather than the raw timber (Shackleton, 1996). The extraction of cooking oil from the seeds of marula (*Sclerocarya birea*) and *Trichilia emetica* fruits is already traditionally practised in a community-based indigenous woodland project in Mozambique (Skottke and Mauambeta, 2000). Examples from other African countries, such as South Africa, Namibia, and Botswana (Shackleton, 2001), have shown that NTFPs can also be marketed at international level, either raw or with increasing value additions.

Additionally, nature-based tourism (or eco-tourism) is usually portrayed as the most benign use of natural habitats because no products are removed (Harstshorn, 1995).

However, the study area has little potential for tourism because it has no wild game or attractive physical features.

5.4 ROLE OF DIFFERENT STAKEHOLDERS IN *CIMBIRRE* WOODLAND MANAGEMENT AND THEIR PERCEPTIONS

5.4.1 Role of different institutions in woodland management

The lack of clarity in power relations between the chiefs and state institutions found in this study could be attributed to the integration of traditional institutions into the formal local government structures during the colonial and post-independence periods. During the colonial period, the traditional authority in the study area was transformed into the hierarchy of local government administration whose principal tasks were: to collect taxes, labour recruitment for colonial plantations, enforce colonial rules, regulations concerning public dress codes, prevention and control of epidemics among people and livestock, and brewing and selling of alcoholic beverages (West and Kloeck-Jenson, 1999). Later on, the post-independence government replaced the local authority with the ruling party secretariat, causing some of the chiefs to side with FRELIMO (West and Kloeck-Jenson, 1999). Furthermore, the post-independence communal village policies in rural Mozambique have transformed the traditional authority territories to what are now the administrative village units (Coelho, 1998). Therefore, the power of the state or centralisation of authority during the colonial and post-independence period best explains the lack of clarity between the traditional authority and local government administration in the Mabote District.

It is worth noting that the state created rules and regulations for forests based only on their timber resource needs because the colonial and post-independence policy for forestry was concerned solely with timber production (Wicknes, 1994). This allows local communities to continue with their indigenous forest management systems (Wiersum, 1997), creating a lack of clarity between traditional authorities and forestry services regarding the allocation and control of forest and woodland resources. The development of coconut and cashew crops and the recruitment of labour to work in South African mines also contributed to the monetary economy in southern

Mozambique (First, 1998). This, in turn, contributed to local communities changing their attitudes to common property resources in the study area.

The political divisions and the system in the country where the ruling party is reluctant to give power over natural resources to local people who support the main opposition party (RENAMO) (Schafer and Bell, 2002), also provides a plausible explanation for the co-option of traditional authorities by the ruling party. Therefore, people very often identify FRELIMO with the state. This is evident in the study area where the ruling party was in control during the civil war and the local people have remained largely sympathetic to the party. According to West and Kloeck-Jenson (1999), almost everywhere in Mozambique the judicial area ruled by a local authority constitutes a dimension of political hierarchy that is of a relatively recent era.

Besides the centralised government policies, there are other factors that could have played a role in the disruption of traditional authority in the management of natural resources in the study area. These factors encompass the anti-colonial and destabilization wars allied to rural-urban migration, displacement of people into neighbouring countries, and the return of refugees. These appeared to have an influence on new social networks that helped in the management of natural resources in other areas of the country (Schafer and Bell, 2002; Chilundo and Cau, 2000; Nhantumbo, 2000; Mangue, 1999).

In some areas of southern Mozambique, the recent civil unrest destroyed the traditional systems of management of natural resources and forced the adoption of new practices and attitudes (Soto et al., 2001; Chilundo and Cau, 2000; Mangue, 1999). For example, in the Maputo Province, the charcoal-trading network was taken over by soldiers during the war, and has been maintained by demobilised soldiers after the war (Schafer and Bell, 2002). This is in competition with local inhabitants who had formerly controlled the charcoal trade. It is worth noting that most of the householders in the study area left their villages during the civil war and went back at the end of the war in 1992. This might have resulted in new social networks, practices and attitudes that changed the traditional management of natural resources. However, in central (Schafer and Bell, 2002) as well as northern (Lorbasch, 1996) Mozambique,

some lineages have laid claims to land after decades of absence, and their rights have been restored; they are still recognised as the holders of the land.

Without any clear sense of responsibility, local community attitudes towards common property resources have changed, leading to woodland degradation in the area. Therefore, there is a need to resolve these conflicting power relations between the state and resource-dependent communities, and this would improve the livelihoods of these communities in a sustainable manner.

The lack of clarity in the power of stakeholders has been referred to in most of the literature because it influences the success of community involvement in natural resource management. This is because the strength of stakeholder interest in natural resources is determined by their power to negotiate and by the obligations that such groups have to others (Nhantumbo et al., 2003b; Barrow et al., 2002; Reeb, 2000). This involves clear distribution of duties and responsibilities.

5.4.2 Respondents' perception on *cimbirre* woodland degradation

Current harvesting systems of *A. johnsonii* trees

The different perceptions concerning woodland degradation due to the current harvesting operations might be attributed to the fact that respondents have different interests concerning the resources. Local communities, chiefs and local government representatives perceived that the harvesting of juvenile trees for poles has less effect on woodland degradation (Figure 4.9) than the harvesting of trees for timber. The private sector representatives' perception of forest or woodland degradation might be related to log harvesting for timber, because private interests are focused principally on timber production and its sustainable yield, without consideration for other forest and woodland resources (Montalembert and Schmithüsen, 1994). Understanding the interests and perceptions of stakeholders can facilitate understanding the use of natural resource systems.

Besides having shown awareness of the current level of degradation, all chiefs believed that under the current harvest of juvenile trees, the *cimbirre* woodland could survive longer (50 years or more). This perception might be attributed to the chiefs'

awareness of the renewal ability of woodlands as well as other natural resources, which have to be passed onto the following generation. The result suggests also what has been found in the literature that the identity of stakeholders and the nature of their interests vary, and that different stakeholders within a community may have different interests in the same resource (Barrow et al., 2002).

Household representatives have different opinions about the most destructive of the two current harvesting systems of the *cimbirre* woodland, namely, the harvesting of mature trees for timber or the harvesting of juvenile trees for pole by local community members. The majority of respondents from Macheco and Tsumbo villages indicated that *cimbirre* woodlands could survive longer periods if only juvenile trees are harvested. Once more, the result suggests that local community members have divergent interests and perceptions with respect to natural resources. Respondents who believe that *cimbirre* woodlands would survive longer periods were mostly those involved in commercial pole extraction (Figure 4.11). In addition, a respondent's perceptions on woodland degradation seem to reflect the availability of the woody resource. The majority of respondents who believe that *cimbirre* woodland would survive for only a short period if juvenile trees were harvested are from villages where the availability and quality of the required pole size have been reduced (Figure 4.10). In this case, local people involved in pole extraction have to walk long distances to find good poles and sometimes they start felling larger size trees (Mantilla, 2002). According to Conroy et al. (2002), local community members become aware of forest degradation when villagers experience scarcity of certain forest products. Their perception is influenced by, among other things, the rate of degradation, nature of degradation and availability of substitutes for forest products (Conroy et al., 2002).

However, to have a proper understanding of the full scope of forest management, one should proceed from an empirical analysis of how different groups of local people define and evaluate the various components of the forest and how they interact with the forests (Wiersum, 1997). This is more so because of the wide variation in needs and use of forest resources between richer and poorer members within a community, and within a household between men and women, and even between age groups (Byron and Arnold, 1999). This is particularly valid for the study area because gender

serves to determine the activities between household members. Further, mainly the poorest group of people within the local communities are involved in the commercial harvesting of poles.

Woodland fires

Local communities in the study area burn the forest and woodlands for a variety of reasons related to their livelihoods. The most important cause of fire in the area is perceived to be due to farming systems that include agriculture and livestock rearing. This is followed by the practice of hunting, alcohol distillation and the transportation of burning charcoal (Table 4.10).

Shifting cultivation is the characteristic farming system in the area. The results of the study confirm the findings of the Provincial Directorate of Agriculture and Rural Development (DPADR, 2001) and other authors, that subsistence farming is the main activity in the study area. The average size of farming area is 5.5 ha per household, cultivated for 3 successive years, and a fallow period of 4 years (Chamba et al., 2002; Mantilla, 2002). According to the DPADR (2001), approximately 65% of the arable land in the Mabote District is used for shifting cultivation. Using equations (3) and (4), it is found that the shifting cultivation in the Mabote District is not a major factor in woodland degradation, as the actual population density of 3 inhabitant/km^2 (INE, 1997) is less than the critical population density (CPD) of 6.5 person/km^2, acquired with the model. However, the shortening of the fallow period in the study area leads to a progressive decline of soil fertility and to a reduction in crop yields. It confirms Mantilla (2002) who postulates that the actual agricultural system leads to a vicious cycle of poverty and soil degradation in the area. The shifting cultivation practised in the study area does not allow full restoration of the woodlands. A fallow period of 25 years is necessary for full restoration of the woodlands (Chidumayo, 1987).

Although the relationship between overpopulation and deforestation using equations (3) and (4) is evident in other areas of southern Africa (Luoga et al., 2000; Chidumayo, 1987), in the present study, the reduced fallow period determines the unsustainability of the shifting cultivation. The reduced fallow period may not be attributed to overpopulation or lack of land availability as postulated by Mantilla

(2002), but rather to the fact that clearing of woodlands is a hard task suited to men. However, because most adult and young men have migrated to South Africa in search of employment, women and children are left to undertake the task of agricultural production. Women find it easier to return to areas that have been cultivated before, where trees are still absent. Similarly, a study in shifting cultivation practices among traditional farmers in Peru (Coomes et al., 2000) found that households with access to more male labour were more able to open more land for swidden-fallow cultivation. Analysis of fallow periods and household members was not covered in this study. However, such findings suggest that there should be better understanding of differential fallowing practices among traditional people, with particular attention to the issue of how households come to gain access to more labour.

Cimbirre woodland fires in the area are also associated with slash-and-burn practices (shifting cultivation system). The burning that occurs in the practice of shifting cultivation is mainly to facilitate the clearing of an area for cultivation. Woodlands are burnt to kill trees and also to reduce the grass cover. Although slash-and-burn practices increase soil nitrogen, phosphorous, potassium, calcium, magnesium and sodium contents in the topsoil immediately after burning (Chidumayo, 1987), the increment of soil fertility does not seem to be the main factor for burning in the Mabote District. This is because soil fertility limitations are found on only 0.02% of the total land in the district (DPADR, 2001).

Woodland fires are an important anthropogenic cause of deforestation in the study area. According to respondents, most woodland fires are due to accidents and not deliberately done to kill trees as suggested by Chamba et al. (2002) and Mantilla (2002) in previous studies in the area. Similarly, numerous fires escape out of control or become ignited accidentally each year (Kull, 2002). The high incidence of fire in agriculture might also be explained by the fact that when fire is used for slash-and-burn, herbaceous weeds soon become dominant and form a severe fire hazard (Muller-Dombois and Goldammer, 1990).

A strategy for reducing uncontrolled woodland fires should be the introduction of beekeeping. Improved beehive has been successfully introduced in the Derre Forest

Reserve as a mechanism to reduce fire (Nhantumbo et al., 2003a). When people invest in beehive, they keep control over fire. Moreover, if beekeeping is practised as a source of income, beekeepers will be aware of the destructive effects of uncontrolled fires in their activities, mainly because smoke and fire destroy and reduce the nectar flow (Nhantumbo et al., 2003a).

5.4.3 Respondents' knowledge of the Forestry and Wildlife Law

The majority of households are unaware of government rules for the management of natural resources. The root cause of the prevailing unawareness is the low attendance of law meetings (Tables 4.11 and 4.12). Furthermore, the prevailing low education level seems to have influenced the degree of the law knowledge of the respondents. In Manhique Village, which has more respondents with some elementary education, there are correspondingly more respondents with a high level of law knowledge (Figure 4.12). It is thus clear that the method of law dissemination to local communities has not been effective. Similarly, in their reflection of the opportunities and constraints on the National Forest and Wildlife Directorate's strategy implementation in Mozambique, Nhantumbo and Macqueen (2003) identified the lack of knowledge of the Forestry and Wildlife Law among local community members. They found that this was mainly due to a high rate of illiteracy; the law was not translated into local languages; involved NGOs did not have deep understanding of some concepts; and the lack of capacity of the government agents.

In a study conducted in the Maputo Elephant Reserve, in Mozambique, Soto et al. (2001) recommended the establishment of community education and public relations units (CEPRU) at the provincial and village levels. This is because the community services unit, under the National Directorate of Forestry and Wildlife was established at the headquarters and its role was limited to policy-making. Furthermore, in the field, the National Directorate of Forestry and Wildlife (DNFFB) relies on NGOs, whose availability is linked to donor funds. Once the donor-funded projects expire, there would not be any NGO carrying out awareness work for DNFFB (Soto et al., 2001).

Of particular importance in this study is the capacity that local communities have to transmit and transfer traditional rules and practices from one generation to the next. Traditional rules of management are well-known among respondents in the study area. This emphasizes the value of taboos and beliefs as explained in section 4.4.1. This result indicates that the traditional authority in the study area did not disappear completely during the colonial and post-independence periods, and also during the 16-year civil war when only state ownership prevailed in the country.

The main point is that local communities have not been involved in decision-making and forest management in the country. If they were treated as partners by the authorities, they would participate in setting up systems of rules, including national legislation into this. National legislations are built at a top level to be implemented at a local level. This top-down approach on forest management has been proved to be inefficient.

5.4.4 Respondents' opinion on land resource ownership

The majority of stakeholder representatives believe in the ability of community ownership to create sustainable woodland management. The remaining respondents do not believe in the effectiveness of local community ownership because to them local community has neither the power nor the capacity to enforce the law and local decisions. Respondents who support community ownership, namely, the chiefs, the majority of community logger group representatives and even the state are confident in the prevailing traditional authority rules which still guide the harvesting of forest products in the area. However, community ownership depends on legal recognition of the community with clear responsibilities and duties.

Issues of land tenure and the management of natural resources have been broadly referenced in the literature. The land in Mozambique is the property of the state that grants the title of occupancy. The state recognizes three land ownership categories: private, common, and state or public. The study area belongs to the third category of ownership. In the analysis made by Barrow et al. (2002) on stakeholder power and responsibilities in the eastern and southern Africa, the best results in community

involvement in forest management were acquired when stakeholder power was given through total devolution of power. However, having in mind the evidence from literature that neither the local communities nor the state has the ability to manage forest resources sustainably on their own, state-community partnership appears to be the best alternative for sustainable woodland management in the study area and in Mozambique in general.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Cimbirre woodland management in the study area is embedded in an evolving process of multiple interactions. These include the influence on local resource management systems by conflicting interests of those wielding power, unclear legal frameworks and administrative agendas that are supportive of resource interests as well as rural livelihood dynamics. The implementation of the structural adjustment programme that Mozambique currently pursues, allied to the retrenchments in the gold mining industry in South Africa and abolishment of recruitment of Mozambican labourers, have transformed the traditional forms of rural livelihoods and management of natural resources. The structural adjustment programme interventions provide rather large incentives for private interests to exploit common pool resources. Agricultural production does not offer food security in the study area. As a result, local communities have to expend considerable effort to meet their subsistence requirements in the form of food and income. In this context, commercial harvesting of poles by local communities has become one of the main income generating activities, especially for the poorest group of people who do not have alternatives.

The market preference is for poles of a particular species (*Androstachys johnsonii*) and stem size (dbh 10-14 cm). However, out-dated regulations designed to regulate forest resources compound the hardships of harvesters because the lower limit for harvesting *Androstachys johnsonii* trees (dbh ≥30 cm) is based on the private sector interests for timber. Despite such prohibitions, harvesting of the species for poles is a reality in the area. It is also time that such deterrents are removed and replaced with research results on the ecology and harvesting potential of the species. Based on the ecological findings of this study, the current harvesting system of *Androstachys johnsonii* poles by local communities is sustainable. This provides an ecological basis for allowing harvesting of juvenile trees for poles by local communities. The practice would ensure the social, economic and ecological aspects needed for the sustainability of the *cimbirre* woodlands in the area. Complementary to this is the need for

promoting incentives to reduce consumption, along with appropriate provision of alternative income sources. The rural economy needs to be diversified by exposing people to other income generating activities, otherwise people will persist with selective commercial exploitation of woodland resources, which will be at the expense of their social well-being. This is mainly because pole and timber extraction in the area is selectively concentrated on only one species, and two diameter size-classes: 10-14 cm and 30-34 cm.

The centralised natural resource management policies that governed the allocation of natural resources (including forestry) both in the colonial and post-independent Mozambique and whose vestiges could be found in the results of this study, have transformed and integrated traditional authorities into formal local government structures. This has led to unclear roles and conflicting power relations in forest management. Without any sense of responsibility, local community attitudes towards common property resources have changed. Nevertheless, the study indicates that the traditional authority in the study area did not disappear during the colonial and post-independence periods or during the 16-year war when only the state ownership prevailed in the country.

This study has shown that shifting cultivation is not a major factor in woodland degradation in the study area. The high level of *A. johnsonii* woodland degradation is not caused by agricultural expansion per se, but rather by fires resulting from agricultural land preparation accidentally spreading into wild woodlands. In fact, the majority of the fires in *A. johnsonii* woodlands are not due to deliberate burning by local communities to kill trees in order to bypass the regulation defining minimum diameter for utilization, as originally hypothesized. Uncontrolled woodland fires, which have been shown to be one of the important factors of woodland degradation in the area, occur mainly due to traditional practices that characterize the livelihoods of the local communities in their daily activities, such as agriculture, hunting, alcohol distillation and transportation of burning charcoal. The development of NTFP and beekeeping should reduce uncontrolled woodland fires.

The findings of this study provide lessons for other woodlands in Mozambique and in other developing countries, where mistaken policies have led to changes in rural community livelihoods. The findings are also valid for most of savanna areas, which are governed by dualistic systems of land tenure, namely, traditional and state ownership.

6.2 RECOMMENDATIONS

The directions for future research and recommendations for sustainable management of woodlands indicated in this study are summarized as follows:

1) The key policy intervention for overturning the inherent institutional deficiencies that led to lack of clarity of responsibilities and duties between traditional authorities (who are responsible for articulating community needs) and local government is to implement interactive community participation. State-community partnership should be considered for sustainable management of woodlands in the area, in which each partner's responsibilities and duties are clearly specified. Local institutions identified in this study should be involved in this process. The membership of each community in such a partnership should be well defined and they should demonstrate a collective willingness and capacity to implement sustainable management. The government should gradually trade its responsibilities in the state-community partnership for sustainable natural resource management by local communities. Nonetheless, the state should retain its monitoring and regulatory functions, and should be ready to intervene when sustainable forest management is compromised under any community-based management regime. The communities may assume full responsibility or enter into contractual agreements with outsiders (e.g., community-private partnership) on the acquisition of adequate negotiation skills and the capacity for sustainable forest management. Instead of pursuing joint ventures with outsiders, committee members may opt to lease resource utilisation rights to community members.

2) Natural resource-dependent communities in Mozambique need to be empowered through the above process before they assume full responsibility for the resources supposedly under their stewardship and before they suffer degradation without any positive input to the socio-economic well being of these primary stakeholders. Currently, both the state and rural communities need capacity building to pursue sustainable management of natural resources. It is worth noting that the state should support and facilitate the improvement of farming practices in the area to make smallholders more responsive to natural resource degradation or conservation.

3) Provision of a legal basis for harvesting of juvenile *A. johnsonii* trees for poles by local communities in the area is recommended. In addition, a revision of the legal basis for the harvesting of other trees based on ecological studies is also recommended.

4) Involvement of a multi-disciplinary team in reshaping the policy processes required to manage forest resources in the study area should be considered. Existing institutions and organizations identified in the study and their current programmes should be considered. Policy processes should include monitoring the impact of strategies and involvement of stakeholders in all monitoring stages.

5) There is a need for research on alternative sources of income for the local communities in the area, especially for the poorest group of people. Research should also be extended to non-timber forest products and their possible markets.

6) The use of geographic information system (GIS) technology to assess the extent to which fires are degrading woodlands in the area (mapping) is recommended to create awareness about fire in local communities. Introduction of beekeeping as a strategy for reducing uncontrolled woodland fires should also be considered.

7) Long-term studies into the dynamics of *A. johnsonii* and *cimbirre* woodland in particular to fill the existing gaps for the models used in the present study should be pursued. There is also a need for systematic monitoring of the effects of changes in habitats through a management plan.

8) Permanent monitoring of individual woodland stands, by estimating the abundance of trees in the demanded diameter size-classes, is required to define more accurately the sustainable harvesting rates.

9) Finally, pro-community development NGOs, advocacy groups and the government should conduct a thorough inventory of community capacity for sustainable management of natural resources. This should facilitate more accurate understanding of community needs in terms of skills development. Such skills audit should also result in the selection of appropriate interventions aimed at sustainable rural development. This should also supply the government with the relevant information for establishing joint ventures with communities.

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APPENDICES

APPENDIX 1

SEMI-STRUCTURED QUESTIONNAIRE

(Questionnaire used in this study for individual and group interviews of key informants: chiefs, pole exploiters, pole transporters and village headmen)

A. GENERAL INFORMATION

1. Date: ...../.../.....
2. District ..... Village .....
3. Institution name: .....
4. Institution type

Government	☐
Private sector	☐
Local community	☐

5. Name .....Gender .....
6. Age .....
7. Education .....
8. What are the criteria for membership of your institution? .....
.....

B. INVOLVEMENT IN NATURAL RESOURCE MANAGEMENT

1. How is your institution involved in the use/management of c*imbirre* woodland?
.....
.....

2. When was your institution involved in activities in 1?
.....
.....

3. Should c*imbirre* woodland be sustained? Why?
.....
.....

4.What type of land resource ownership do you think will result in sustainable management of *cimbirre* woodlands? Why? .....

Community ownership	☐
State/public ownership	☐
State-community partnership	☐

C. MANAGEMENT

1. For how long do you think this woodland can survive? Why? .....
.....
.....

2. Which criteria are used to select *cimbirre* trees for exploitation? .....
.....

3. Which system leads to the most severe degradation, if comparing small tree and mature tree harvesting systems? Why?
.....
.....

4. What do you think the village community would do if all the *cimbirre* trees were gone?.....
.....

5. List all rules (government and/or traditional) that you know regarding the protection of *Cimbirre* woodland

Government rules	Traditional rules
5.1 5.2 n	1 2 n

Government rules: Traditional rules:
High ☐ Medium ☐ Low ☐ High ☐ Medium ☐ Low ☐

6. Besides government foresters, which other institutions in the village have been active in protecting woodlands? .....
.....
.....

7. What do you think are the factors leading to forest degradation? How can it be avoided?
.....
.....

8. What are the causes of fires in woodlands? .....
.....

9. Give general comments on what could be done to improve the management of the natural forest in this area .....
.....

APPENDIX 2

STRUCTURED HOUSEHOLD QUESTIONNAIRE

(Questionnaire administered to households)

A. INTERVIEWEE'S PROFILE DATA

1. Date ...../.../.....
2. District ..... Village .....
3. Household identification number .....
4. Enumerator .....
5. Interviewee's profile
   - 5.1 Name .....
   - 5.2 Gender .....
   - 5.3 Age .....
   - 5.4 Education .....
   - 5.4 Period in the village*

   *1- before 1982; 2 –1982 – 1992; 3- after 1992

1	2	3

6. Household characteristic

6.1 Composition of household members

Gender		Education*			Activity	Year
F	M	No	E	S		

* Education level: No- no education, E - elementary; S - secondary

B. LIVELIHOOD STRATEGIES

1.1 Importance of household activities

In which activities is your household involved? Enumerate it according to the level of importance. Give also the period (years) your household is practising each activity

.....	1
.....	2
.....	3
.....	4
.....	5
.....	6
.....	n

C. WOODY RESOURCE UTILIZATION

1. Firewood

Which tree species do you prefer or use for firewood? Give reasons for preference.

Tree species	Reason for preference		
		1	2
1			
2			
3			
4			
5			

2. Commercial and domestic building materials

2.1 Domestic building materials. Which diameter sizes do you use in house construction?

Type of material	Size of tree
Walling poles	
Roofing poles	
Frames	

How often do you re-build your houses?
How many houses do you have in your home garden?
For how long have you lived in the village?
Is your household involved in the commercial production of wood?

2.2. If yes, answer the following questions:

	Firewood/charcoal	Building materials	Both
Commercial production	1	2	3
No. of trees exploited/ week			
Period of year			
Height (m)			
Tree species			
Availability in the vicinity			

D. PERCEPTION OF WOODLAND DEGRADATION

1 For how long do you think *cimbirre* woodlands can survive under the current practice of harvesting of juvenile trees?

Long-term (< 50 years) ☐ Short-term (> 50 years) ☐

Why? .....

1.1 Do you think there is any alternative if all *cimbirre* trees are gone?

[1] Yes [2] No

1.2 If yes, what can be the alternative?.....

2 What are the main causes of fires in woodlands? Give in order of importance

Agriculture
Hunting
Alcohol distillation
Smoke/Fire transport

3. Have you attended any meeting on Forestry and Wildlife Law ?

[1] Yes [2] No

4. List some rules (government and/or traditional) that you know regarding the protection of *Cimbirre* woodland

Government rules	Traditional rules
1 2 N	1 2 n

Government rules:
High [ ] Medium [ ] Low [ ]

Traditional rules:
High [ ] Medium [ ] Low [ ]

APPENDIX 3

Plant species identified in the *cimbirre* woodlands of the study area

Scientific name	**Family**	**Local name**
Acacia *sp*	Leguminosae	Mungo
Alchornea laxiflora (Benth.) Pax & K. Hoffm.	Euphorbiaceae	Siquire
Androstachys johnsonii Prain	Euphorbiaceae	Cimbire
Brachystegia spiciformis Benth.	Leguminosae	Tsondzo
Carissa praetermissa Kupicha	Apocinaceae	Chivelevelane
Clerodendrum kentrocaule Bak.	Verbenaceae	Powapowane
Combretum celastroides Welw. Ex Laws.	Combretaceae	Fambabolile
Combretum padoides Engl. & Diels	Combretaceae	Mulucachache
Diospyrus inhacaensis F. White	Ebenaceae	Chitomane
Garcinia levingstonei T. Anders.	Clusiaceae	Imbero
Hymenocardia ulmoides Oliv.	Hymenocardiacea	Tsotsotane
Markhamia zanzibarica (Boj. Ex DC.) K. Schum.	Bignonaceae	Tsanhi
Pavetta *sp*	Rubiaceae	Chisinzi
Pteleopsis myrtifolia (Laws.) Engl. & Diels	Combretaceae	Muanja
Securidaca longipedunculata Fresen.	Polygaliaceae	Tsatso
Strychnos *sp*	Loganaceae	Mugapwetane
Syzigium *sp*	Myrtaceae	Curi
Voacanga thouarsii Roem. & Schult.	Apocinaceae	Caua-caua
Xylia mendocae Torre	Leguminosae	Chipsopsolane
Unidentified$_1$		Chire
Unidentified$_2$		Livenguane
Unidentified$_3$		Lombalombane

APPENDIX 4

RAW DATA FROM THE STRUCTURED QUESTIONNAIRE SURVEY

A. INTERVIEWEE'S PROFILE (n = 83)

Item		Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total n	Total %
Gender	F	4		2	4	10	12.2
	M	8	10	34	21	73	87.8
Age	≤34 years	2	3	9	9	23	27.7
	35 - 44	4	5	8	6	23	27.7
	45 - 54	3	0	8	5	16	19.3
	≥55 years	3	2	11	5	21	25.3
	Mean	43.86	44.10	45.43	43.50	44.5	-
	S.D.	12.33	15.23	15.72	15.22	14.9	-
Education	No	8	6	5	9	28	33.7
	Elementary	4	3	26	12	45	54.2
	Secondary		1	5	4	10	12.1
Household size	≤5 people	6	1	10	12	29	34.9
	6 - 10	3	6	17	8	34	41.0
	11 - 14	3	3	5	5	16	19.3
	≥15 people			4		4	4.8
	Mean	7.1	8.6	7.08	6.0	7.74	-
	S.D.	3.99	2.80	6.56	3.63	5.2	-

B. LIVELIHOOD STRATEGIES

1. Ranking of household main activities

Activities	Rank*	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total n	Total %
Agriculture	1	12	10	36	21	79	96.2
(n = 82)	2				2	2	2.5
	3				1	1	1.2
Mean	**1**						
Firewood	1				2	2	8.3
extraction	2	1	7	3	4	15	62.5
(n = 24)	3	1	3		1	5	20.9
	4			2		2	8.3
Mean	**2**						
Work in	2	3	7	17	11	38	64.4
RSA	3	2	2	8	4	16	27.1
(n = 59)	4	1	1	1	2	5	8.5
Mean	**2**						
Pole	1				1	1	3.6
extraction	2	5	2		2	9	32.1
(n = 28)	3	3	4	2	4	13	46.4
	4		2		1	3	10.7
	5			1	1	2	7.2
Mean	**3**						
Livestock	2	2		11	2	15	31.2
rearing	3	3	4	9	3	19	39.6
(n = 48)	4	2	6	3	3	14	29.2
Mean	**3**						
Wild fruits	1			1		1	1.7
extraction	2	1	1	1	1	4	6.8
(n = 59)	3	2	1	6	3	12	20.3
	4	4	1	8	6	19	32.2
	5	4	7	4	8	23	39.0
Mean	**4**						
Hunting	3	1			1	2	3.1
(n = 68)	4	1	2	9	6	18	28.1
	5	10	8	12	14	44	68.8
Mean	**5**						

Others: teaching, nursing, provision of security services, running small business, etc.

2. Period (years) practising the activities

Activities	Starting year	Total	
		Frequency	Percentage
Agriculture (n = 82)	< 1974	82	100
	1975 – 1984		
	1985 - 1994		
	> 1995		
Firewood extraction (n = 24)	< 1974	24	100
	1975 – 1984		
	1985 - 1994		
	> 1975		
Work in RSA (n = 59)	< 1974	21	35.6
	1975 – 1984	17	28.9
	1985 - 1994	10	16.9
	> 1995	11	18.6
Pole extraction (n = 28)	< 1974		
	1975 – 1984	1	3.6
	1985 - 1994	4	14.3
	> 1995	23	82.1
Livestock rearing (n = 48)	< 1974	48	100
	1975 – 1984		
	1985 - 1994		
	> 1995		
Wild fruits extraction (n = 59)	< 1974	59	100
	1975 – 1984		
	1985 - 1994		
	> 1995		
Hunting (n = 68)	< 1974	68	100
	1975 – 1984		
	1985 - 1994		
	> 1995		

C. WOODY RESOURCE UTLIZATION

1. Firewood.

Which species do you use for firewood? Give reasons for preferences (n = 83)

Species	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total n	Total %
Brachystegia spiciformis	11	10	36	25	82	98.8
Androstachys johnsonii	7	2	19	11	39	47.0
Strychnos madagascariensis	4		11	16	31	37.3
Terminalia sericea	4	5	16	6	31	37.3
Anthrocnemum indicum	6	10	3	3	22	26.5
Senecio madagascariensis	3	3	7	5	18	21.7
Anacardium occidentale			10	7	17	20.5
Pteleopsis myrtifolia	2	2	2	4	10	12.0
Hymenocardia ulmoides	3	1	2		6	7.2
Acacia nigrescens	1		3	1	5	6.0
Sclerocarya birrea		1	1	1	4	4.8
Artabotrys brachypetalus		1	1	1	3	3.6
Others			7	3	10	12.0

(Others: *Baphia massaiensis*, *Afzelia quanzensis*, *Salacia kraussii*, *Melanodiscus oblongus*).

2. Commercial and domestic building materials

2.1 Domestic building materials and period in the village (n = 83).

		Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total (n = 83) n	%
How often rebuilt house?	5 or less	4	3	20	13	40	48.2
	6-10	4	2	7	6	19	22.9
	11-14	2	4	3	4	13	15.7
	15 or more	2	1	6	2	11	13.2
	Mean (Year)	**8.5**	**9.1**	**6.9**	**6.3**	**7.2**	
How many houses at home?	5 or less	10	8	27	23	68	81.9
	6-11	2	2	7	2	13	15.7
	11 and more			2		2	2.4
	Mean	**3.2**	**3.3**	**4.3**	**3.2**	**3.7**	
Period in the village	Before 1982		1	5	2	8	9.6
	1982 – 1992	2		17	8	27	32.6
	After 1992	10	9	14	15	48	57.8

2.2 Is you household involved in commercial pole exploitation? (n = 83)

Response	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total (n = 83) n	%
Yes	8	8	3	9	28	33.7
No	4	2	31	18	55	66.3

Household involved in the commercial pole exploitation (n = 28)

		Macheco (n = 8)	Mahungane (n = 8)	Manhique (n = 3)	Tsumbo (n = 9)	Total (n = 28) n	%
No of trees exploited/week	≤5				1	1	3.6
	5 - 10	8	6	3	8	25	89.3
	≥11		2			2	7.1
Times a weak	≤3	4	8		6	18	64.3
	≥4	4		3	3	10	35.7
No of months	≤3	1	1			2	7.1
	4 - 7	5	4	3	2	14	50.0
	≥8	2	3		7	12	42.9

D. PERCEPTION OF WOODLAND DEGRADATION

1. For how long can *cimbirre* woodland survive under the current harvesting of juvenile trees? (n = 83)

Survival time	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total (n = 83) Frequency	Percentage
Long	12		11	19	42	50.6
Short		10	12	6	41	49.4

2. What are the main causes of fires in woodlands? (n = 83)

Activities	Rank*	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total (n = 83) n	%
Farming system	1	8	8	19	22	57	68.7
	2	3	2	17	3	25	30.1
	3	1				1	1.2
Mean	**1**						
Transportation	1	1		14	3	18	21.7
of burning	2	9	2	5	8	24	28.9
charcoal	3	2	5	13	12	32	38.6
	4		3	4	2	9	10.8
Mean	**2**						
Hunting	1	3	1	3		7	8.4
	2		4	4	11	19	22.9
	3	8	2	13	6	29	34.9
	4	1	3	16	8	28	33.7
Mean	**3**						
Alcohol	1		1			1	1.2
distillation	2		2	10	3	15	18.1
	3	1	3	10	7	21	25.3
	4	11	4	16	15	46	55.4
Mean	**4**						

* Ranking from 1 (highest) to 4(least).

3. Have you attended any meeting on Forestry and Wildlife Law? (n = 83)

Attendance	Macheco (n = 12)	Mahungane (n = 10)	Manhique (n = 36)	Tsumbo (n = 25)	Total (n = 83) Frequency	Percentage
Yes	6	3	17	4	30	36.1
No	6	7	19	21	53	63.9

4. Respondents knowledge of the Forestry and Wildlife Law (n = 83)

Villages		Knowledge of the Forestry and Wildlife Law		
	n	Low	Medium	High
Macheco	12	33%	50%	17%
Mahungane	10	30%	70%	0%
Manhique	36	50%	17%	33%
Tsumbo	25	96%	4%	0%

APPENDIX 5

FOREST RESOURCES ASSESSMENT DATA SHEET

Village ……………　　　　　　　　Sheet no. ……..
Date ……………　　　　　　　　Plot no. ……..

ID	Species name	Dbh	Height	Observation*