COMMUNITY – BASED
FOREST HUSBANDRY: A CASE STUDY FROM MOZAMBIQUE

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ABSTRACT

Natural resource harvesting still plays an important role in the economy of southern Africa. In Mozambique, the continuous exploitation of the most valuable components of the indigenous woodlands in locations such as the Catuane Administrative Post in Matutuine District, have put pressure on the natural resources so that concern has motivated this research in order to guide such actions in support of sustainable use. This was a preliminary study, the intention being to establish:

- what are the necessary environmental conditions for the sustainability of silviculture?
- which species may be candidates for cultivation?
- whether local people would support cultivation of trees for charcoal and woodfuel; and
- what the attitude of government and non-government organizations was to tree cultivation.?

The research approach taken in this study was qualitative, relying on interviews, reviewing literature and documentary analysis. Respondents were drawn from different categories such as the local communities of the study area, experts in silviculture, government officials and NGO employees.

The study shows that environmental conditions are harsh and are not particularly favourable for the cultivation of trees. Nevertheless, a review of information on the requirements and properties of woody species indicates that there are candidate species that could be considered for cultivation, but productivity is likely to be low. Although there is some support for cultivation of trees, motivation is weak and strong extension support will be required to achieve success. The findings show, however that whilst there is policy support it is not accompanied by support on the ground. It is suggested that this reflects failure to appreciate the value of co-operative management and suggestions are made as to how these can be improved.

DECLARATION

The research described in this dissertation was carried out through the Centre for Environment and Development, University of Natal, Pietermaritzburg from August 2001 to January 2002.

The work contained in this thesis represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any other University. Where information from other sources is used in the text, it is duly acknowledged.

Signed: .... **Date:** 25 August 2003

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ACRONYMS AND ABBREVIATIONS

ARA-Sul	Administração Regional de Água Sul [South Region Water Administration]
CDA	Centro da Documentação Agrária [Agricultural Documentation Center]
CEAD	Centre for Environment and Development
CRMC	Community Resource Management Committee
CBNRM	Community Based Natural Resource Management
CBOs	Community Based Organizations
DINAGECA	Direcção Nacional de Geografia e Cadastro [National Directorate of Geography and Cadastre]
DNFFB	Direcção Nacional de Florestas e Fauna Bravia [National Directorate of Forestry and Wildlife]
DNAC	Direcção Nacional das Áreas de conservação [National Directorate of Conservation Areas]
DNA	Direcção Nacional de Água [National Directorate of Water]
DWAF	Department of Water Affairs and Forestry, South Africa
EWT	Endangered Wildlife Trust
EMS	Esselte Map Service Estocolm, Suecia
FAO	United Nations Food and Agriculture Organization
FRELIMO	Mozambique Liberation Front
FNP	Forum para a Natureza em Perigo [Forum for Preservation of Endangered Nature]
GOM	Governo de Moçambique [Government of Mozambique]
GERFFA	Gestão dos Recursos Florestais e Faunisticos [Management of Forestry Resources and Wildlife Resources]
HELVETAS	The Swiss Association for International Cooperation
INE	Instituto Nacional de Estatistica [National Institute of Statistics]

INAME	Instituto Nacional de Meteorologia [National Institute of Meteorology]
INIA	Instituto Nacional de Investigação Agronómica [National Agronomy Research Institute]
ICFR	Institute for Commercial Forestry Research
INR	Institute of Natural Resources
IIED	International Institute of Environment and Development
IDESP	Instituto do Desenvolvimento Economic e Social do Para [Para's Institute for Socio-Economic Development]
MINED	Ministério da Educação [Ministry of Education]
NGOs	Non-Governmental Organization
PFMC	Participatory Forest Management Committee
RDP	Rural Development Program
RENAMO	Mozambique National Resistance
RSA	Republic of South Africa
SPFFB	Serviços Provincial de Florestais e Fauna Bravia [Provincial Services for Forestry and Wildlife]
SDI	Spatial Development Initiative of Lebombos
SADC	Southern African Development Community Countries
TFCAs	Transfrontier Conservation Areas
WCFSD	World Commission on Forests and Sustainable Development

CHAPTER ONE
INTRODUCTION

1.1 Background and rationale

The ongoing destruction of indigenous vegetation through over harvesting, overgrazing and land clearing for unreliable subsistence cultivation practices in rural areas has reached massive proportions, to the extent that it will lead to increased human suffering and threaten the existence of indigenous woodlands (Schramm and Wartford, 1989). Lack of economic incentives, collapse of resource tenure arrangements, poor cultivation practices and excessive natural resource harvesting, particularly escalating levels of wood fuel consumption, have caused serious deterioration of vast areas of developing countries (Southgate and Disinger, 1987). Continuation of these practices will surely have long-term detrimental effects on biodiversity and the welfare of the communities in developing countries. Rosilo-Calle *et al.* (1996) have identified some of the ecological impacts of unsustainable harvesting of indigenous forests to be:

- the deterioration of habitat and food sources for native fauna;
- the decline in ground cover that increases soil erosion and removes organic layers, the combination of which reduces soil nutrients and quality;
- reduced productivity;
- increase food shortage and poverty; and
- the need to harvest further afield at greater cost and more effort, causing increased land and natural resources destruction.

Mozambique's indigenous forest resources are seriously threatened by rapid population growth which has resulted in increasing environmental degradation, deforestation and soil deterioration (Devereaux and Palmeiro, 1999). The civil war displaced most of the population, who relocated to urban areas, coastal regions and along major transport corridors, leaving much of the hinterland devoid of people. This movement was beneficial to the abandoned areas, providing an opportunity for the environment to regenerate, but the newly formed areas of high population concentrations created centralized demand and as nearby sources are depleted there is a need to harvest and transport wood fuels from greater and greater distances. This is endangering the abandoned areas once more.

Catuane is a settlement about 150km south of Maputo City (Figure 1.1). The inhabitants of this area are poor, mostly rural and subsist off the land (FNP, 2000). Commercial production of charcoal and fuel wood for urban consumption has begun to transform the subsistence economy. Over harvesting has resulted in the substantial loss of indigenous woodland. Local people who occupy the land appear to have unrestricted access to the natural resources and may be unaware of the options and potential benefits that might be achieved by a more proactive approach towards promoting the sustainable use of indigenous woodland (Griffin *et al.* 1999).

1.2 Problem statement

The need for cash to maintain and sustain livelihoods in the Catuane study area has encouraged people to over-harvest wood resources for charcoal production which is sold in the Maputo urban market as a source of income generation. In this context, the pressure on indigenous woodland resources is high and the continued unsustainable harvesting is likely to have long-term detrimental effects on biodiversity. The situation calls for urgent measures to redress the issue, taking into account the well being of both the people and the supporting ecosystem. This research considers what measures might be taken to reverse the trend of unsustainable use. The focus of the study is on the introduction of silviculture to replace the supply of wood from indigenous woodlands with a supply of suitable species for the provision of wood fuel. The key assumption made is that a silvicultural approach will reduce demand on indigenous species thereby creating sustainable practices for the harvesting of indigenous woodlands. The research question, aims and objectives are:

1.2.1 Research question

Are there species that might be cultivated to provide an alternative source of wood for charcoal production in the Catuane area?

1.2.2 Aim

The aim is to establish the feasibility of intervention through cultivation of suitable species as an alternative source of wood for charcoal production.

1.2.3 Objectives

The objectives are to determine:

- using a 'desktop study' whether there are suitable species which could be cultivated in the area to meet the demand for charcoal production and fuel wood;
- whether cultivation of trees would be acceptable to local people; and
- whether such an intervention would receive support from the government by means of policy, legislation and extension.

1.3 Structure of dissertation

This chapter has provided an introduction to the study, highlighting the study background and rationale, problem statement, research question, aim and objectives. The rest of the dissertation comprises five chapters. Chapter two *'Methodology'* details the general approach adopted in the research. Chapter three *'The study area'* outlines the background information of the Catuane area with particular reference to the location of the Catuane study area, administration and socio-economics, natural resources and conservation initiatives. Chapter four *'The problem of deforestation'* reviews the literature, presents a conceptual framework to describe deforestation as an environmental problem and indicates a possible alternative to deforestation. Chapter five *'Analysis of findings'* examines available practical evidence that applies to the study subject. The overriding emphasis is on the suitability of the environmental conditions, species suitability, social acceptability and government and institutions' support, non-governmental organisations and extension services, but not on achieving statistically significant results. In chapter six, the results are discussed, conclusions are drawn and recommendations are made.

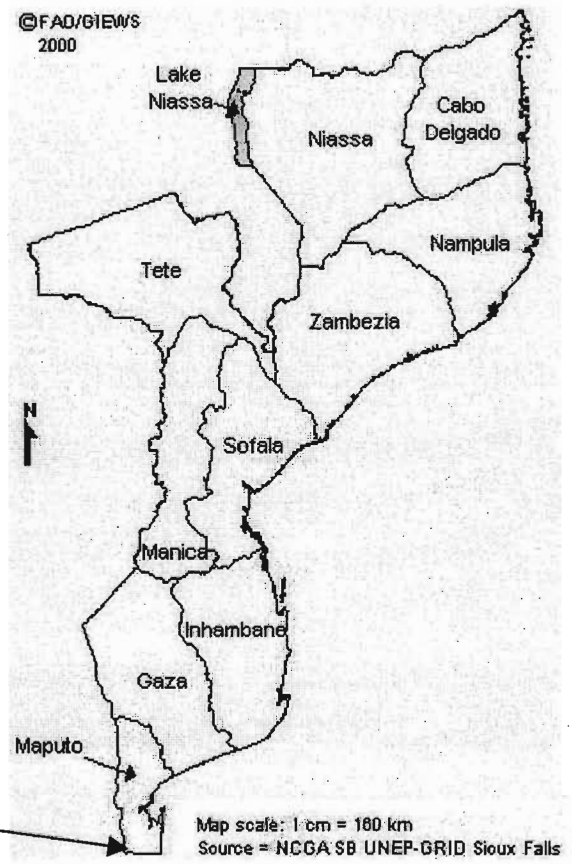

Figure 1.1 Map of Mozambique showing the ten provinces and the location of the Catuane study area

CHAPTER TWO
METHODOLOGY

2.1 Introduction

The term 'method' refers to the specific approaches, techniques or tools used to collect data (Bailey, 1982). Data are defined as raw, unevaluated facts, concepts or instructions arising out of a scientific enquiry (Hutchinson and Sawyer, 1994). This study is in the nature of a survey to inform the process of intervention to promote the sustainable use of wood. It was designed to provide a platform for more detailed research in the event that the findings suggest more detailed study is warranted. The study addresses those issues that would be critical for successful intervention, namely: which species might be cultivated; how supportive are local people of tree cultivation; and what extension support can be expected from government.

Given the nature of the study, it was important to use a combination of methods, particularly the synthesis of existing information, key informant interviews and a survey of perceptions of local people. The relationships between methods used and the objectives of the study are shown in Table 2.1.

Table 2.1 Summary of the methods applied in the research study.

Objectives	**1.Environmental conditions for suitable species**	**2.Social acceptability**	**3. Policies support and extension services**
Key issues	Climatic, soil and species suitability	Respondents' feelings and perceptions	Institutional support
Methods	Literature review on environmental conditions and suitable species	Open - ended questions	Literature review on policies
Target group	Experts in forestry and silviculture	Local community and local authority	Government institutions

2.2 Literature review

A review of relevant literature was conducted to reveal the theoretical underpinnings, debates and themes necessary to develop a conceptual framework to be used in the research (Chapter Four). It also enabled interpretation of the environmental conditions of the study area and of the Mozambican government's position regarding the theme of the study.

The review entailed consideration of books, project reports, aerial photographs (satellite images), periodicals, promotional leaflets, as well as statutory and general government records. These documents were housed in different libraries and resource centres[1] in both Mozambique and South Africa. Aspects covered in the review of literature are highlighted below and primary sources of information are indicated.

2.2.1 Environmental conditions

Information on climate (rainfall, humidity and temperature) was collected from records of six rainfall stations in the vicinity of the study area. The information was available from the Mozambique National Directorate of Water (DNA); Instituto Nacional de Meteorologia (INAME); South Region Water Administration (ARA-Sul) in Maputo; University of Natal Department of Agricultural and Engineering and the Computing Centre for Water Research. Agro-meteorological reports were obtanied from the South African Department of Agriculture, Kwazulu Natal at Cedara and the Institute for Commercial Forestry Research (ICFR).

Data on land (soil and vegetation) were gathered from available maps at the Direcção Nacional de Geografia e Cadastro-DINAGECA, [Mozambique National Directorate of Geography and Cadastre], Instituto Nacional de Investigação Agronómica-INIA [National Agronomy Research Institute], Departamento do Inventário Florestal

[1] The libraries and documentation centers used include the main and life sciences libraries at the University of Natal- Pietermaritzburg; the Institute of Natural Resources (INR) library in Pietermaritzburg; the Agricultural Documentation Centre in Maputo (CDA); the National Agronomic Research Institute (INIA); the National Directorate of Forest and wildlife (DNFFB); Institute for Commercial Forestry Research (ICFR) and Mondi Forestry in Pietermaritzburg.

[Forestry Inventory Department] and management reports and other related document sources from the United Nations Food and Agriculture Organizations (FAO).

Data on tree species, particularly wood density and calorific value and growth rate, were synthesized drawing on data and information from the timber company Mondi Forests, the Institute for Commercial Forestry Research (ICFR), both in Pietermaritzburg, and the Direcção Nacional de Florestas e Fauna Bravia (DNFFB) in Maputo.

The DNFFB policies and legislation governing use and protection of natural resources were reviewed. Also included were official government documents, white papers, management and action plans.

Fields researched were forestry, energy, land tenure and the environment. In as far the extension services were concerned, the task was to identify the organizations that are responsible for community forestry development and extension.

2.3 Survey

The survey approach facilitates the generation of "information to describe, compare, and predict attitudes, opinions and behaviour based on what people say or see and what is contained in records about them and their activities" (Fink, 1995, p.14). It also offers a range of options in terms of methods that can be applied in collecting data, including content analysis, interviews, questionnaires, focus group discussions, and other approaches.

To arrive at the appropriate methods of data collection, the researcher consulted and discussed the study with his colleagues and supervisor. This assisted in the formulation of a provisional conceptual framework that served as a guide to both the literature review and design of the study. In deciding upon the approach of the interviews, the researcher had to consider whether to use self-administered questionnaires or structured interviews.

The self-administered questionnaire was not adopted because the majority of respondents in the study area were illiterate. While acknowledging the value in terms of structured interviews in enhancing the degree of reliability of findings (Cohen and Manion, 1994; Neuman, 1994; Chambers, 1983), this approach was not chosen because of its tendency not to permit researchers to probe further on issues raised by respondents. The study required an interactive approach with all respondents so as to clarify issues on site, while permitting respondents to express their views, and also enabling the researcher to probe for more information where necessary. Open-ended interviews are recommended in situations where there is a strong need to obtain more information from an individual, particularly if the questions require considerable explanation, are difficult to answer or require spontaneous answers (Taylor and Bogdan, 1984). This approach was relevant for this study because in some cases, the information needed further elaboration and inputs by the respondents. Therefore, an interview schedule (Appendix I) containing open-ended questions was used.

As this study was a first step towards intervention, the question was simple: do local people support the idea of cultivating trees to provide wood for charcoal? This question was based on the understanding that the responses would help in the development of a strategy to promote active participation by local people in managing the production and use of wood resources. Focus was on social acceptability and perceptions about the cultivation of suitable species because it was considered necessary to establish a basis for their responses. An open-ended enquiring approach therefore allowed exploration of relevant issues related to cultivation of trees and charcoal production including problems and acceptability. Interviews with local people, some of whom were charcoal makers, were conducted in Shangane, the local language for the study area with translation into Portuguese where this was helpful.

People to be interviewed were identified using referral methods (Babbie, 1995). With the help of two interpreters and the local people, it was possible to identify those who make charcoal and those who do not. Three villages, namely Mahau, Manhangane-Um and Manhangane-Dois were selected because they were identified as the most affected by over-harvesting of wood resources (FNP, 2000; SPFFB, 1999). As planned initially, 10 people from each village were interviewed, half of whom were engaged in charcoal making while the other half were not. The sample comprised 21 men and 9 women.

The interview was structured in four sections. Section one sought perceptions about charcoal production, section two dealt with perceptions of problems about charcoal production for both charcoal producers and non-charcoal producers while sections three and four sought information on social acceptability of cultivating trees and extension services (policy and legislation) respectively. The interviews were preceded by the researcher presenting his credentials verbally and by way of a covering letter from the Centre for Environment and Development (CEAD), University of Natal Pietermaritzburg (UNP), South Africa. This was followed by an introduction to the purpose of the study, its importance, and the importance of those who agreed to participate in the study.

After developing the study framework and before setting out for fieldwork, it was also necessary to meet key informants (Appendix II) in order to gain needed information, ideas and insights on defined issues (Kumar, 1989). Through referral methods (Babbie, 1995) it was possible to identify key informants who were in a position to provide factual information. For example, to get information on suitable species which could be cultivated in the area, two key informants (experts in forestry) were identified from Mondi Forests and the Institute for Commercial Forestry Research, both in Pietermaritzburg. The two informants provided some insights with regards to species and the criteria used in selection and the risk involved and precautions that are necessary for such an intervention.

To determine government support towards promoting growth of suitable species at household scale, four government officials were identified from different departments: Serviços Provincial de Florestas e Fauna Bravia (SPFFB); Direcção Nacional de Florestas e Fauna Bravia (DNFFB) and two from the Local NGOs (HELVETAS and FNP), currently operating in the study area. The aim was to interpret legislation that guides the intervention for the cultivation of suitable species.

In addition, personal observations during the period of data collection contributed to informing the researcher on the extent and seriousness of the problem at hand in the study area. As Neuman (1994, p.221) has advised that 'good notes are bricks and mortar of field research,' notes were made during the process of data collection. The researcher resided in the study area during the period of data collection: September to October/2001 and December to January/2002. This enabled him to generate impressions of the study area and build a relationship with the local people. Transcribing the interviews shortly after they were conducted, made it possible in a few cases, to conduct follow-up interviews with the respondents to seek clarification. The stay in the study area, despite its brevity, helped to inform the interpretations of some activities in the area and people's attitudes and behaviour. Photographs were taken to record deforestation in the study area.

2.4 Data interpretation

Data analysis or 'the process of bringing order, structure and meaning to the mass of collected data' (Marshall and Rossman, 1989, p.112) was done qualitatively. Microsoft Excel 2000 was used in situations where there was a need. Emphasis was on developing an overall picture of the situation and associated prospects and not on achieving statistically analysable results. This is the basis for qualitative research. The analysis of qualitative data involved categorising the responses given to identify themes contained in the interview schedule. Comparisons were made according to similarities and differences in the responses made by the respondents.

2.4 Limitations

When interpreting the findings of the research, it is important to keep in mind the following three limitations encountered during the course of the study.

Language

The majority of people in the study area speak Shangane, the local language, and not everybody speaks Portuguese. This could have presented a difficulty for the researcher since he has only a working knowledge of Shangane. This problem was addressed by hiring two research assistants who were both fluent in Shangane and Portuguese. The research assistants were also introduced to the purposes of the study by the researcher before going out in the field. Debriefing sessions held at the end of each day between the researcher and the research assistants ensured timely responses to any problems that might have arisen on any particular day.

The language problem was complex because all interviews with the local people were conducted in Shangane and had to be translated into Portuguese and English. Possibilities of the original meaning being re-shaped in the process of translations cannot be completely be ruled out despite efforts made to ensure that the original meanings were not lost. An expert translator was consulted, thereby improving the chances of retaining the original meanings.

Status of the researcher

As the researcher was not a resident of the study area there was a risk of reduced co-operation on the part of the respondents, especially as they may have felt that their livelihoods were threatened. The introduction of the researcher as a researcher from UNP and providing a full explanation of the project minimised suspicions and is considered to have secured co-operation from the community and the local authority.

Time factor and fieldwork realities

This study was planned to provide an overview that would direct further, more detailed research and activities. As such, it was scheduled for completion in six months. This was also a requirement for the minor thesis in the Master of Environment and Development programme at UNP.

CHAPTER THREE
THE STUDY AREA

3.1 Introduction

Mozambique is located in southeast Africa, covering an area of 799 830 km², of which about half (40 000 million hectares) is covered by indigenous forests (Matakala and Mushove, 2001). In 1997 the human population was estimated to be around 18 million with a projected growth to nearly 20 million by 2000 (Instituto Nacional de Estatistica [INE], 1999). The agriculture and fishery sectors contribute 45% of the Gross National Product (GNP), employing about 80% of the active labour force and generating 80% of income from all exports (Devereaux and Palmeiro, 1999; GOM, 1998a). All natural resources in Mozambique are state property, mainly for public use (Government of Mozambique [GOM], 1998; 1997; 1996). Government institutions and traditional authorities have little effective control over a major part of the natural resources and this can result in open access to resources (Hulme and Murphree, 2001; Abakari, 2000; Devereaux and Palmeiro, 1999; Mansur and Karlberg, 1986). Mozambique's indigenous woodlands include different vegetation types from small patches of high forest, extensive low forest and thicket to wooded grasslands and, in many instances, patterns of use exhibit open access (Nhantumbo, 1997; Direcção Nacional de Geografia e Cadastro [DNFFB], 1997a).

Rural areas in Mozambique are generally affected by the unsustainable harvesting of indigenous woodlands for charcoal production (Pereira, 2001; Mansur, 1986). Charcoal is a major source of domestic energy for low-income suburban dwellers (Mansur and Karlberg, 1986). The strong demand for charcoal provides incentives for charcoal making and selling. This is evident in Catuane, a rural Administrative Post where indigenous forest is being destroyed by charcoal making. This chapter provides background information about the Catuane Administrative Post.

3.2 Catuane: location, administration and socio-economics

Catuane, approximately 150 km south west of Maputo is the Administrative Post of the Matutuine District, and covers nearly 1500 km^2 (Forum para a Natureza em

Perigo [FNP], 2000). To the south, Catuane shares a border with South Africa's KwaZulu-Natal Province along the Maputo River (Figure 1.1). The Kingdom of Swaziland bounds Catuane in the west, while to the northwest and southeast, it shares borders with the Changalane and Zitundo Administrative Posts respectively. The Administrator *"Chefe do Posto administrativo de Catuane"* is responsible for the whole area assisted by the Deputy Secretary who is responsible for community mobilization and conflict resolution (Manuel, pers. comm. 2001). The Administrator, with the help of local chiefs (village secretaries) who are appointed by the government, is responsible for overseeing all activities within the area. This is done with support from the district administration, and other organizations and NGOs.

Economic activities include agriculture and natural resources exploitation (hunting, charcoal making and fishing) and small-scale livestock rearing. The farming system is characterized by shifting cultivation of food crops mainly, for subsistence consumption (Morais, 1988). Farm production is generally poor and relies heavily on family labour with simple tools and low capital input. The people in the three villages north of Catuane "*sede*" where this study was conducted, namely Mahau, Manhangane-Um and Manhangane-Dois seem to engage charcoal production and harvesting wood fuel for sale in Maputo as their main source of income. The majority of charcoal producers are reported to be non-residents, mainly demobilised soldiers and unemployed immigrants to the area (FNP, 2000; SPFFB, 1999).

Following the signing of the peace agreement by FRELIMO and RENAMO in 1992, some demobilised soldiers engaged in charcoal production as a way of earning a living (GOM, 1997a). Easy access into the area and the availability of a market led to an and influx of people. The rate of deforestation increased as more and more people resorted to charcoal burning as a form of self-employment.

3.3 Natural resources in Catuane

Catuane is located within the Maputaland Centre of Endemism, which supports a wide variety of species of wildlife, birds, insects and reptiles (Pollet *et al.* 1996; Davis *et al.* 1994). The proximity of Catuane to conservation areas in neighbouring

South Africa, the Futi corridor and the proposed Transfrontier Conservation Areas (TFCAs) all influenced its selection for this study.

The majority of Catuane's estimated 9 000 people (FNP, 2000) are dependent the exploitation of natural resources. The surrounding indigenous woodlands provide wood and non-wood forest products for both direct subsistence purposes and sale. They provide building timber, honey, medicine, fibre, and a variety of traditional vegetables including mushrooms. It is also a habitat to a variety of bird and animal life. As such, the condition of Catuane's indigenous woodlands, as much as that of other areas within Maputaland, is considered critical to the overall biodiversity of the region.

The continuous and unregulated exploitation of the indigenous woodlands for income generation such as wood fuels and charcoal production has caused drastic changes in the original vegetation and habitats of the area (Monjane, 2001; Saket *et al.* 1995). The numbers of large game have also been seriously reduced due to poaching and habitat destruction (Zandamela, pers. comm. 2001).

3.4 Conservation initiatives in Catuane

Two projects have been undertaken in response to concerns about the impacts of deforestation: the Community Guard project and the HELVETAS[2] project. The former was an initiative that was developed by FNP as a derivative of the Maputo Elephant Park initiatives. According to Reina (2001), the project was meant to:

- preserve and conserve natural resources in the area with the involvement of the local community;
- create awareness among local people about the value of natural resources, especially indigenous woodlands;

[2] HELVETAS Mozambique is a local NGO, one of the pioneers on the land delimitation and zoning especially in Maputo province. It is actively involved in the dissemination of new a legislation framework on land tenure, under the direction of the land campaign (Jaimito, pers. comm. 2001).

- work closely with the Ndumu Reserve and Tembe Elephant Park along the border between Mozambique and South Africa, as part of a Transfrontier Conservation Area (TFCA) initiative;
- provide employment to people from local communities based on natural resources conservation;
- reduce pressure on natural resources exploitation especially indigenous woodlands and wildlife; and
- help the government implement control measures for the use of natural resources, and operations in the field.

The project started in early 1997 by training six community game guards with financial support and assistance from FNP and the German Embassy (FNP, 2000). The pressure on natural resources particularly indigenous woodlands and wildlife is a principal factor for the presence of FNP in Catuane. HELVETAS' intention is to promote the cultivation of suitable tree species on a household scale by the local community of Catuane, to meet the requirements of varied uses of wood and to promote long-term economic gains (Dinis and Nhancale, 1999). The project began in 1999 with the aim of propagating tree species to improve socio-economic conditions and guarantee the long-term supply of wood for charcoal production, to supply markets in Maputo.

Even though HELVETAS has intervened in promoting growth of tree species, it is apparent that they are adopting a trial and error approach. In contrast, this research entails an assessment of the suitability of environmental conditions (see Chapter Five), species suitability, local people's perceptions, government support and extension for implementing an integrated management system and options for establishing suitable species in the area. The intention is to provide a better foundation for decision making around the introduction of silvicultural practices to supply wood for charcoal production.

CHAPTER FOUR
THE PROBLEM OF DEFORESTATION

4.1 Introduction

Indigenous woodlands have particular importance for human beings and the environment because of their aesthetic, ecological, recreational, socio-economic, historical, cultural and religious value to people (Luoga *et al.* 2000b). Today, however, human beings driven by need and greed have neglected these values provided by indigenous woodlands, instead they threaten them (Monjane, 2001).

Most indigenous woodlands have been affected and are at great risk because of over harvesting ultimately resulting in deforestation. The World Commission on Forests and Sustainable Development (WCFSD, 1998) defines deforestation as an enduring change of land use marked by wood loss in a particular area and consider it one of the most serious problems facing the world today. Large areas of indigenous woodlands that cover more than one third of the world are being deforested and with serious effects on the environment, food production and people's livelihoods (Grainger, 1990). The FAO (1997) estimates about 3 500 million hectares of woodlands worldwide representing about 27% of land that is being used, have been affected.

Some authors (Laarman and Sedjo, 1992; Bryant *et al.* 1997) have estimated that the world has lost about 40% of indigenous woodland areas, about 6000 million hectares over the last 800 years as a direct consequence of human activities. However, a recent report by the World Resources Institute (1996) has indicated that more than 80% of the world's indigenous woodlands have already been destroyed through human action.

This chapter presents evidence of deforestation and considers the factors that induce deforestation and its consequences. It also considers the alternatives to counteract this practice, especially in developing countries, in the region and at local scale. Degradation of the environment due to deforestation has been acknowledged as a global problem (Annersburg, 1993). Even though deforestation may be localized, collectively it is resulting in overexploitation and destruction of indigenous woodlands with consequent loss of habitat and biological diversity occurring everywhere in the world (Hofstad, 1997). Markandya and Richardson (1992) suggest that despite measures taken now, indigenous woodlands will continue to be deforested in the foreseeable future.

The consumption of wood fuel, particularly in the developing countries where this energy source is predominant, is often associated with poverty and growing demand for energy. Dudley *et al.* (1995) have demonstrated that one third of the world population depends on wood fuel as a source of energy. However, detailed analysis by Chidumayo (1997) and Bradley and Dewes (1993) of where and in what form wood fuel is harvested, as well as where it is used, reveals other competing uses of indigenous woodlands and wood biomass that may also be important causes of deforestation.

Deforestation and poor land use have many adverse knock on effects. For example, upland farmers in the Himalayas experience hundreds of millions of dollars worth of damages in the form of agricultural losses (FAO, 1981), while in India it is estimated that 50% of the land area is subjected to serious erosion and every year more than 600 million tons of topsoil are washed away (Anon., 1982, p.23). Also, about 100 million inhabitants of countries in the developing world are affected by cold because they have insufficient energy to heat their homes; many are hungry because they lack energy to cook their food; and about one billion people face hardship and a growing threat of starvation, in part because of the growing wood fuel crisis (FAO, 1981, p.8). This problem is evidenced in all regions of the developing world (Bemeki and Venkata, 1997).

Deforestation caused by harvesting for charcoal production and unsustainable practices in indigenous woodlands are predicted to continue, mainly in the areas of high population concentration, where competing demands for land and wood biomass are high (Markandya and Richardson, 1992). This reflects the increasing population dependent on indigenous woodlands for part of their daily livelihood (SADC, 1993; FAO, 1981). In Africa the trend of deforestation is high. About 90% of the entire continent's population use wood fuel (charcoal and firewood) for cooking[3].

The primary value of indigenous woodlands in the southern Africa region is realised through domestic and subsistence uses of products and services by many African households (Luoga *et al.* 2000a; Shackleton *et al.* 1999; Campbell *et al.* 1997; Shackleton, 1983). Uses of indigenous woodlands include charcoal production, firewood collection, timber, medicine, food/fruits, building poles, carving, spiritual and others traditional uses (Luoga *et al.* 2000b). This is illustrated by the use of miombo woodlands of eastern Tanzania where charcoal production can have the highest use value, accounting for 18.4% of total use value, followed by firewood 16.6%; 65% of the value is attributed to a variety of other uses (Luoga *et al.* 2000b). In Kinshasa (Democratic Republic of Congo) 70% of the households rely on charcoal energy derived from indigenous woodlands (Tshibangu, 1996). In Mozambique about 85% of the total energy consumption that includes biomass, petroleum, electricity and coal is wood fuel (Brower and Falcao, 2001; Monjane, 2001; DNFFB, 1997). This compares with only 14% in South Africa (SADC, 1993) where urbanisation is pronounced and provision and use of the energy services is more developed. Yet even in South Africa deforestation continues (Republic of South Africa [RSA], 1998).

The wood fuel crisis specifically in the Southern African Development Community Countries (SADC), was highlighted in the 1980's (international institute for Environment and Development [IIED], 1980), but it continues to worsen (Kaale, 1995; Monela *et al.* 1993). This is clearly demonstrated in a 1992 report claiming that nearly 70% of the fuel energy consumption in the SADC was derived from

[3] (http:/web.mit.ed/Africantech/www/articles/deforestationbox.htm, 2002; Shackleton *et al.* 1999).

wood biomass and that in the household sector wood fuel accounted for 97% of all the energy used (Chidumayo, 1997; Bradley and Dewes, 1993). The process of urbanization that has accelerated rapidly in many SADC countries (SADC, 1993) does not always relieve the domestic energy problem. Urban inhabitants commonly still continue to depend on fuel wood based energy sources such as charcoal, because the costs of substituting this with urban energy, for example electricity, are not affordable by the poor (Chaposa, 1999; FAO, 1981).

Mozambique has about 40 000 km² of indigenous woodlands.[4] Population growth, poverty, logging and agricultural expansion are significantly decreasing these woodlands, contributing to a variety of impacts on local livelihood (Pereira, 2001). The economic stagnation of the country in the early 1980's pushed the poverty – stricken and the unemployed out of the cities and into the remote indigenous woodlands (Fraser and Karkari, 1987). During this period the DNFFB (1997) documented the disappearance of about 20% of woodlands in Maputo province as a result of wood fuel and timber harvesting, farming and bush fires. Since the 1980's, urban demand for harvested wood fuel has increased pressure on production areas (Chaposa, 1999; Mansur and Karlberg, 1986).

4.2 What drives deforestation?

Deforestation is an environmental problem resulting from over harvesting and clearing of trees combined with natural processes such as floods and droughts (Mentis and Seija, 1993). These actions are promoted by the interaction of the economy, population dynamics, especially growth and concentration and poverty. They are the primary social forces (Table 4.1) in any given area and vary from country to country (Ehrlich and Ehrlich, 1977). In many cases, deforestation involves competition among different users for increasingly scarce woodland resources and this may be aggravated by counter- productive policies and weaknesses of responsible institutions (Griffin *et al.* 1999). These interconnected factors

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[4] (http://www.efi/cis/english/creports/Mozambique.html, 2002; Nhantumbo, 1997).

contributing to deforestation are considered with the aim of developing the necessary understanding to guide intervention.

Table 4.1 Driving forces of deforestation.

Driving forces	Resulting pressure
▪ The economy	▪ Change from subsistence to market economy ▪ Change from barter to cash ▪ Change from self sufficient to employed ▪ Change in skills needs ▪ Change in attitudes from meeting subsistence needs to meeting cash and subsistence needs ▪ Harvesting for sale and increased demand for indigenous woodlands resources ▪ Conversion of indigenous woodland areas to farmland and industrial zones
▪ Population growth and concentration	▪ Centres of population growth ▪ Population segregation, inequality and widespread poverty (unemployment and underemployment) ▪ Increased demands for the resources ▪ Resettlement of people in marginal areas
▪ Poverty	▪ Reliance on natural resources ▪ Increased dependence for resources to meet cash needs for the living expenses (schools, health, transport, food, clothes, etc)
▪ Regulation and support	▪ Empower control ▪ Lack of support ▪ Unsustainable harvesting of wood

In traditional societies, people depended mainly on the natural environment for their subsistence needs (Mahar, 1989). Traditional systems were organised in social structures such as extended families, clans and tribes, which included institutional rules and rights of use that empowered people to protect, conserve and regulate the use of natural resources (Grove, 1987). Simple tools and technologies were adopted and used which contributed to regulating uses. Traditional societies were characterised by subsistence use of resources and direct exchange of goods and products among individuals. These systems worked for a considerable period until the introduction of colonialism (De Beer and Swanepoel, 2000). Local livelihood patterns changed in response to introduction of a monetary economy and new technologies.

Colonial authorities introduced "economic" development policies and new governance systems (Rostow, 1960). These, among others, resulted in the expropriation of land and the introduction of rules that gradually gave the colonialists control over the local people.

Traditional systems were weakened and suppressed with the advance of colonialism. Colonial policies largely neglected the adverse impacts on the environment, in the drive for accelerated economic growth (Field, 1997). The management of natural resources, previously regulated under traditional systems, was changed under colonialism systems, and these were inconsistent with traditional rules (Hettne, 1992).

Local people resented this departure from customary practices for the management of natural resources. In fact, this approach led to a breakdown of the traditional natural resource management systems used within areas that were nominally still under the control of tribal authorities (Evans, 1979). Moreover, colonialism introduced its own demands for different types of natural resources. For example, indigenous woodlands were sources of wood fuel for the "smelters and foundries of new industries" (Rosillo-Calle *et al.* 1996, p.25). Other consequences included the clearing of forests to accommodate the emerging land uses such as large-scale agriculture, road networks, housing projects, industrial sites and to meet the timber demands for various industrial operations like railways and the mines (Brouwer and Falcao, 2001). In short, forests started for the first time to feel the common pressures of economic growth as demanded by colonial governments. This was in addition to meeting local people's needs such as wood for fuel, cooking, and construction purposes.

At the heart of colonialism was the introduction of a cash economy, a practice that was traditionally unheard of in the developing countries. This resulted in a change from a subsistence way of living to one characterised by harvesting for profit and change in lifestyle from barter to a cash economy (Morais, 1988). Basic social needs increased as people now required new knowledge, skills and resources as they responded to colonial influence, and to a market driven economy that shifted emphasis from basic needs to mass consumption (Rostow, 1960).

The lifestyle of people changed to suit the new demands and perceptions of a better life. The result was a shift from self-sufficiency to employment by way of marketing labour and skills. This led to social differentiation and societies became structurally more complex; their traditional values, attitudes, practices and social structures broke down (Grove, 1987).

Previously, traditional societies now engaged more "modern" industries of society, which required the application of new technologies and skills and which operated under quite different relationships with the resource base (Rostow, 1960). It heralded a period of massive exploitation to promote the welfare of the colonialists and the emerging market economy.

During the industrial era, demand for timber led to unsustainable harvesting so that eventually supply was no longer able to meet demand. Suppliers looked to sources abroad and the forests of developing countries were opened to markets in developed countries (Monela *et al.* 1993). Exploitation of these resources required infrastructure and this resulted in the development of urban centres.

With the changing economy which followed the arrival of colonialism, most of the markets for labour existed in fledgling urban centres. People migrated from rural areas to urban environments looking for job opportunities and later sometimes, because of the civil unrest, they migrated to cities to find a refuge and so the population in towns grew. People gained new skills and were encouraged to trade their skills to meet requirements of the cash economy. As a result, local communities became stratified within the market economy (Evans, 1979).

By the middle of the 20th century the rate of population growth in developing countries had risen to unprecedented levels as mortality declined and life expectancy increased (World Bank, 1998). This contributed to unemployment and under employment, and subsequently to poverty. Population growth was not accompanied by access by the poor to services and most continued to rely on, for example, wood and or charcoal for fuel. Since some people were employed and had disposable income, they could purchase their requirements. Thus developed the informal market in wood and charcoal, which provides opportunity for those who do not find employment in the formal sector. Self-employment as suppliers of wood and charcoal enables these people to secure cash for buying food, clothes, paying school fees, transport and health.

Growing urban populations of poor people established a large demand for natural resources located in rural areas. Local market forces started to drive the use of indigenous woodlands by local people (World Bank, 1992). In rural areas the traditional common property regimes were breaking down as ownership was increasingly vested in the state, but a state that was largely unable to effect control. Common property systems gave way to open access. The absence of an effective authority regime allows harvesters to adopt unsustainable practices.

Since the colonial period and including the Post independence period, the central governments in developing countries managed natural resources through the use of policies and through law enforcement as major tools for conservation (Griffin *et al.* 1999). From the beginning, communities exploited the resources for their livelihood, but with increased demands and lack of employment, the resources were overexploited and government control over the resources was ineffective (Kgathi, 1997, p.1-9).

Weak support from governments, inadequate budgets to manage indigenous woodlands, lack of trained staff, and poorly paid staff, has resulted in a failure to prevent over harvesting of indigenous woodland resources by local communities. Poor co-ordination among various government institutions has continued to frustrate sustainable development efforts and conservation support for indigenous woodlands (Kgathi, 1997). Over the last decade, throughout southern African countries, a different approach has been developed aimed at improving the management and sustainable use of indigenous woodlands (Griffin *et al.* 1999; Murphree, 1995).

The implementation of a variety of organizations, roles and their projects has helped to promote an alternative approach to conservation commonly known as Community Based Natural Resources Management (CBNRM) (Kumagwelo, 2000; Filimao *et al.* 1999; GOM, 1999; Murphree, 1991). This approach emerged in response to the perceived need to revitalise the participation of local communities in the local natural resources management and achieve compatibility with adjacent protected areas (Hulme and Murphree, 2001). Also, it enabled governments to allocate and devolve power for some functions to the community level thereby strengthening local control over resource use (Murphree, 1993).

4.3 Consequences of deforestation

The term 'deforestation', in the context of this research, is a result of over harvesting of indigenous woodlands to supply domestic energy. This practice has short-term benefits for local people and long-term national social, economic and environmental consequences (RSA, 1998; Southgate and Disinger, 1987). Since sustainable development is founded on these (De Beer and Swanepoel, 2000), the long-term consequences are more significant for the region than are the short-term benefits, even though they are matters of survival at individual level.

Society functions through a dynamic interplay between economic, social and environmental factors. Consequently, sustainable development requires a balance between these. If social conditions create, for example, a demand for wood energy and a requirement for cash, the interplay between these leads to the exploitation of indigenous sources of wood fuel. Eventually, if the sources of wood fuel are used beyond their capacity to regenerate, the declining availability of wood fuel in turn creates higher prices, declining affordability and greater poverty (Amelung, 1992). This provides structure for the analysis that follows.

Deforestation can exert pressure on economies and societies outside the immediate areas of harvesting and destruction (Faminow, 1998). The local communities directly affected by deforestation are usually among the poorest and least educated, with limited influence and power and are less effectively represented in government (Murphree, 1995). They have little cash to purchase individual, household or community basic needs. With a market economy it becomes difficult for them to compete and survive, because mostly they are not skilled and are not educated. Therefore, those local people who are not able to survive as resources become more scarce may be forced to move in search of refuge and relief (Luoga *et al.* 2000a). The influx of these 'environmental refugees' can put enormous pressure on social services and the resource harvesting immediately surrounding the area of settlement, exacerbating conflicts and leading in some cases, to civil strife (Meyers, 1980).

Some local communities that are affected by deforestation find themselves trapped by immediate economic pressures to extract the most they can from the indigenous woodlands, even when they recognize that they are contributing to the deforestation of their indigenous woodlands and their future impoverishment (Rostow, 1960). In these situations of survival, traditional practices that protect indigenous woodlands come under stress and are commonly not robust enough to persist (Grove, 1987). Hansen (1997) observed that in global economic terms, the woodlands destroyed every year for various reasons represent a loss in wood capital valued at US $45 billion. By destroying indigenous woodlands all future revenues and future employment that could be derived from their sustainable management for timber and non-timber products disappear. The rest of society has ultimately to bear the direct and indirect costs of the loss of capital.

Woodland areas have also suffered negative impacts from large development projects such as logging for timber, cattle farming, road and industry constructions, and increases in agricultural production which was aggravated by the adoption of new practices, often monoculture (Cardy, 1993). For example the *chitemene* system of northern Zambia was largely abandoned for new technology, which replaced multi-cropping with mono-cropping (Cardy, 1993). Traditional cropping strategies were disrupted by the incorporation of agriculture into expanding world markets accompanied by a growing cash economy (Mahar, 1989; Meyers, 1980). These developments have affected the productivity of local communities in these areas because they did not have cash to buy fertilizers, pesticides, and were not able to establish irrigation systems and use a new technology to improve agricultural crops. Consequently they were restricted to using woodland resources for generating cash incomes.

The social consequences of deforestation may differ from country to country (Hargreaves, 1985). Before the advent of 'civilization' local people lived with indigenous woodlands which supported their livelihoods with timber and non-timber products (RDP, 1995; Grove, 1987). The arrival of 'civilization' resulted in the destruction of traditional lifestyles and the breakdown of their social institutions (Grove, 1987). The rights of local people to wood resources have been ignored, and they have been excluded and marginalized from these resources. This has contributed to creating open access to these resources (Abacar, 2000). Particularly with the emergence of a growing cash economy, an increased demand for the resources has been created, hence there has been increased pressure on the exploitation resources to the disadvantage of local residents, and this has caused conflicts between them and outsiders. Conflicts also arise because the declining wood resources are not able to satisfy the basic needs of local people (Martins, 1982).

Women are commonly the most disadvantaged because they are the most dependent users of woodland resources for food and fruits, wood fuel, agricultural practices, while men commonly migrate in search of income generating activities in urban areas (Hargreaves, 1985). Generally, because decrease in ground cover increases soil erosion, local people who settle in woodland regions are often forced to move to new suitable areas where they can resettle and cultivate. When those areas are depleted and no longer suitable for agriculture, they move again and again in search of suitable regions. Vast areas thus become devastated (Luoga *et al.* 2000a).

Unsustainable harvesting of indigenous woodlands also leads to ecological impacts, including further losses of vegetation cover, which aggravate broad scale environmental problems such as habitat destruction. Habitat destruction together with environmental change, threatens biodiversity[5] at all levels from genes to species and ecosystems (Viana, 1989). According to Noss (1990), biodiversity has three components, which include composition[6], structure[7] and function[8]. Destruction in any one of these areas affects all three because all are interdependent. For example, the felling of trees to satisfy human needs affects species composition, the structure and the function of the habitat. Structural change from extensive harvesting of timber can cause habitats to become widely separated and isolated so that the demography and genetic dynamics of species become independent of one another (Fearnside, 1989b).

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[5] 'Biodiversity' means the variability among living organisms from all sources including, *inter alia,* terrestrial marine and other aquatic ecosystems and the ecological complexes, of which they are a part, this include diversity within species, between species and of ecosystem.
[6] 'Composition' means the identity and variety of elements and includes species list and measures of species diversity and genetic diversity. Function involves ecological and evolutionary process, including gene flow, disturbances and nutrient cycling
[7] 'Structure' means the physical organization or pattern of a system, from habitat and genetic, habitat complexity as measured with communities to the pattern of patches and other elements at a landscape scale.
[8]'Function' involves the ecological and evolutionary process, including gene flow, disturbances and nutrient cycling.

The explanation of Noss (1990) illustrates how the environment can be affected on different scales (local, regional and global). This study, is located at Catuane, a 'local scale' where wood resources are being over harvested. The composition of woodland is changed to grassland, shrubland, and open woodland (Saket, 1994) and this affects structure and function. For example, loss of ground cover increases the potential for soil erosion and the removal of organic layers, the combination of which reduces soil nutrients and quality. This in turn affects many living species that are found in the area and may lead to local extinction and loss of genetic variation. Selective clearing to meet human requirements may also cause extinction of valuable plant species as they are harvested for a variety of uses including medicinal uses and charcoal production (Cardy, 1994).

Over exploitation does not only affect the environment and living species, it also affects human livelihoods. Traditional shifting agriculture which has been practised for centuries in the region, is considered to have had little effect on the environmental 'balance' as the cultivated areas were small, the fallow periods were very long (between 10-15 years) and usually only patches with relatively good soils were cultivated (IDESP, 1988). However, this situation changed when large tracts of forests were cleared and where commercialization of agriculture and pastoralism spread across the land. With these changes the fallow period was shortened to a stage where vegetation and soil quality are degraded, jeopardizing its sustainability (Uhl, 1989). In addition, population growth led increasingly to cultivation and grazing practices that led to environmental degradation. As resources become scarce, the pressure on limited resources increases and local people compete more intensely for their survival. Sometimes they are forced to migrate to other areas where resources are more abundant or to urban areas looking for job opportunities, thus becoming 'environmental refugees'.

4.4 A conceptual framework

This review has exposed the complexity of the causes and effects of deforestation. In order to be able to define and plan the study, it was necessary to develop a 'mental model' of the problem. The model or conceptual framework presented in Figure 4.1

shows the relationships between causes and effects from an analysis of the literature which has been enriched with local information. The above framework is a depiction of hypothetical relationships informed by current understanding. The model is interpreted as follows.

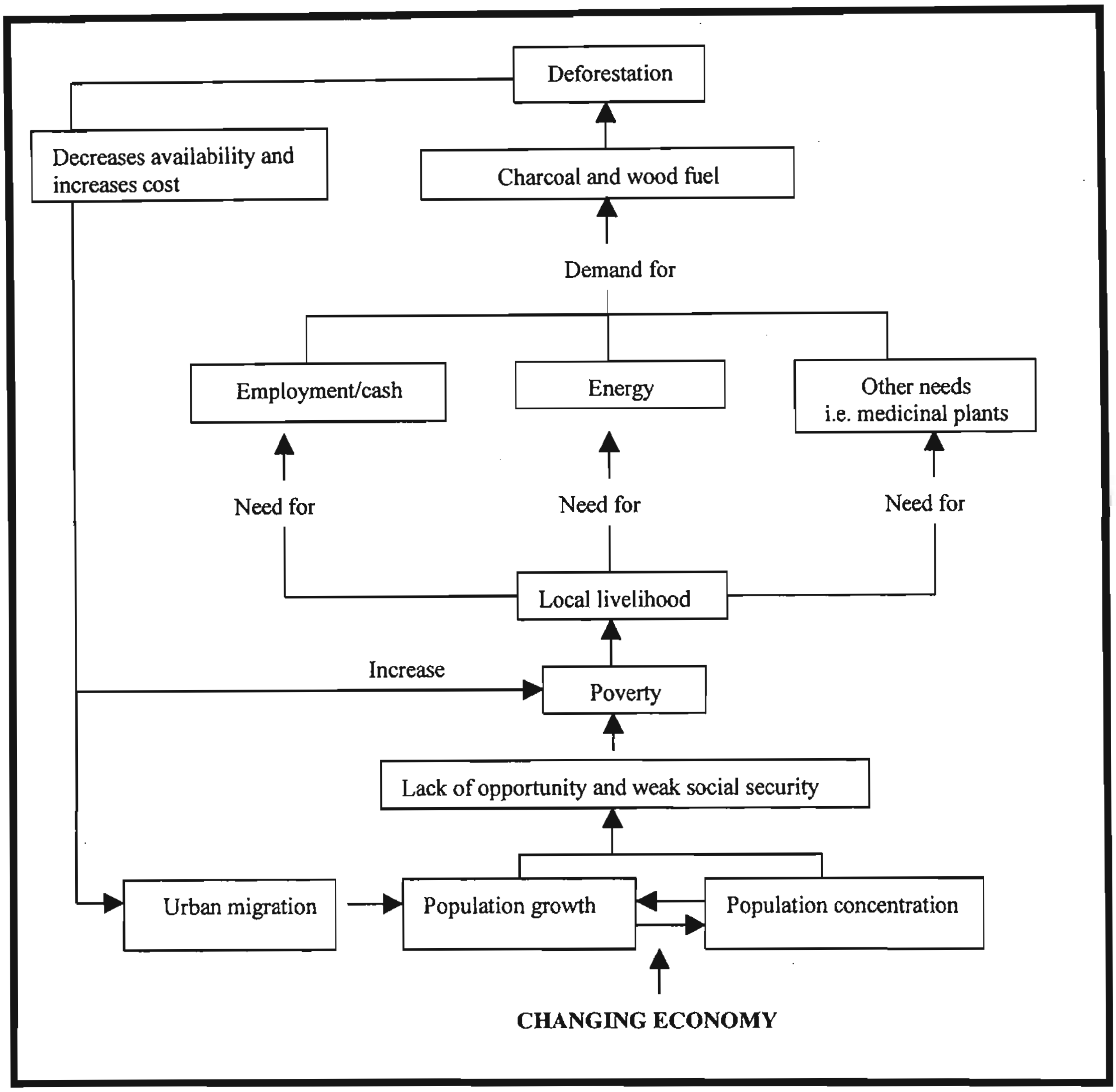


Figure 4.1 Conceptual framework illustrating how a changing economy and poverty lead to localized demands for energy.

The changing economy is perceived as a driving force that has led to population growth and population concentration. Rapid population growth, expansion of human activities in the absence of economic opportunity and inadequate social security leads to poverty. This, in turn, forces people to seek ways of securing their livelihoods and they turn to the common property resources as sources of goods, some of which have market value. The need for cash and a market for energy (charcoal) create opportunity. Realization of the opportunity creates the pressure on indigenous woodlands that leads to unsustainable use.

Deforestation decreases the availability of wood resources as it becomes more and more scarce. This has negative effects on people's livelihoods as they have to gain access to the resources further away, and in smaller quantities, thus increasing the cost of travel, often at the expense of other social activities. These stresses increase the poverty of local people and induce or encourage people to migrate to urban areas in search of new life conditions, thus giving rise to population growth in urban areas.

4.5 Solutions for deforestation

All environmental problems require intervention in order to manage the causal factors. These interventions must be socially, economically, politically and environmentally sound. However, it is important to understand that no single intervention is likely to be the best under all circumstances and a combination is usually required. For this study, intervention options to combat deforestation are grouped into two categories: regulatory measures (Figure 4.2) and replenishment/substitution.

Regulatory measures

The model (Figure 4.2) draws attention to the fact that in many developing countries, the state of forests reflects human pressures. These pressures are at least partially, a result of the changing economy which influences harvesting of wood resources to meet people's needs. The resultant change to the forests alters people's perceptions and their attitudes towards resources harvesting. Based on these changed perceptions, attention is directing use towards sustainable harvesting. Policy and legislation are the instruments made and used by societies to regulate their behavior in relation to harvesting of resources. These are shaped by the perceptions society has of the resource and the way it is being used. However, where there is a survival need for a resource and policy and legislation are perceived to be preventing use, people will behave (harvest) in ways that conflict with policy and legislation. Clearly, a behavioural change to promote sustainable use cannot be easily achieved when survival is threatened. If, however, policy and legislation are perceived to be supportive, behaviours are more likely to accord with policy and legislation. Should government perceive the state of a forest to be deteriorating and establish policy and legislation to regulate harvesting without establishing appropriate perceptions in society, then those policies and legislation will be difficult and costly to implement and in all probability they will fail to bring about the desired changes in behaviour.

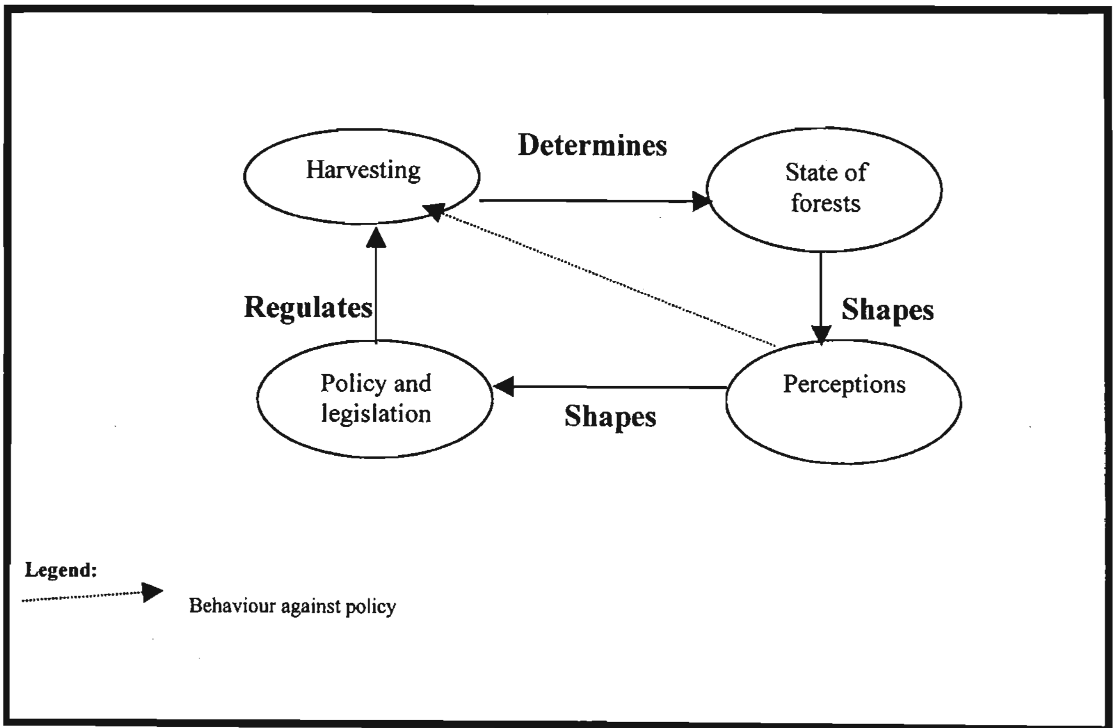


Figure 4.2 A model of the relationships between harvesting pressure, state of forests, perceptions, policy and legislation. Adapted from Breen (1999).

In the case of Catuane, evidence indicates that people's livelihoods are dependent on charcoal production. It is a survival strategy that brings pressure to bear on the forests. The implication is that attempts to reduce the pressure and change the state of the forest without sustaining the survival strategy are likely to fail. Better enforcement on its own does not suggest itself as a solution. There is, therefore, compelling cause to consider substitution of indigenous timber with cultivated trees. Such an approach would reduce harvesting pressure whilst sustaining livelihoods, but adoption of such practice is contingent upon it being favourably perceived by local people and government.

The introduction of silviculture would also call for new management approaches through Community Based Natural Resource Management (CBNRM). Most of these challenges can only be met by securing the participation of local people in the process of establishing local resources management and giving them a greater responsibility in decision making for the use of resources. Therefore, there is need to develop new management strategies which would integrate local people and other stakeholders in the use of wood resources (Roberts and Nagale, 1997; Krasner, 1983).

Replenishment

'Replenishment' in this study is defined as restoration of degraded woodlands in a given area to a former condition by cultivation of suitable species (Hanking, 1987; FAO, 1981). Whilst it is acknowledged that replenishment is necessary at Catuane, the focus of this research is on substitution of indigenous woodland resources with cultivated wood resources.

Substitution by growing suitable species is not a practice that has started recently. It has a long tradition and people have been planting trees for many years for varied use such as food and shelter, and for ceremonial, religious, and other general purposes (Morais, 1988). The present development of species can be traced back to the sixteenth and seventeenth centuries when exploration and expansion of the European influence took place (Grove, 1987). The period between 1900 to 1945 saw the first extensive growth of industrial tree crops, which took place in countries with little useable natural forest (Evans, 1990; FAO, 1981). In the period between 1945 and 1965 growth of species was influenced by a number of additional factors, including internationalism (Rostow, 1960) and an awareness of silvicultural potential (Schonam, 1988; Anon., 1982). The mid 1960s to 1980s saw the acceleration of the trends initiated in the previous period. New projects emerged and were multiplied, since then the growth of suitable species became an important part of many national forest policies (Kgathi, 1997; FAO, 1996).

Several new silviculture trends began to take shape in 1980s and suitable species cultivated for industrial and other purposes including wood fuel, charcoal and, recently non-timber products. The cultivation of suitable species accelerated (Bialay, 1986) and opportunities for replenishment have thereby also improved (Hanking, 1987, FAO, 1981).

4.6 Refining the conceptual framework for the study

In section 4.4 and Figure 4.1, it was shown how the changing economy has set in motion a sequence of events that have led to the destruction of woodlands and how this in turn, (feeds back) worsens the situation. Figure 4.1 did not consider intervention. Section 4.4 considered solutions and justified the need for intervention by way of substituting cultivated timber for that harvested from natural woodlands. The purpose of this section is to refine the conceptual framework presented in Figure 4.1 to include the proposed intervention.

The key assumption embodied in the framework (Figure 4.3) was that the cultivation of suitable species in the area offers long-term replacement of income and benefits to a majority of local people that were previously derived from the use of indigenous woodland for charcoal production. By contributing to a reduction in poverty through income generation and promoting sustainable livelihoods, it is envisaged that the perceptions local people have of the state of the woodlands and the appropriateness of policy and legislation will lead to behavioural changes. This in turn will support efforts to achieve sustainable use. The opportunity being explored in this study is the cultivation of trees for charcoal production. Issues addressed are: the suitability of the environment; the selection of species; the attitudes of local people; and the support system (Figure 4.3).

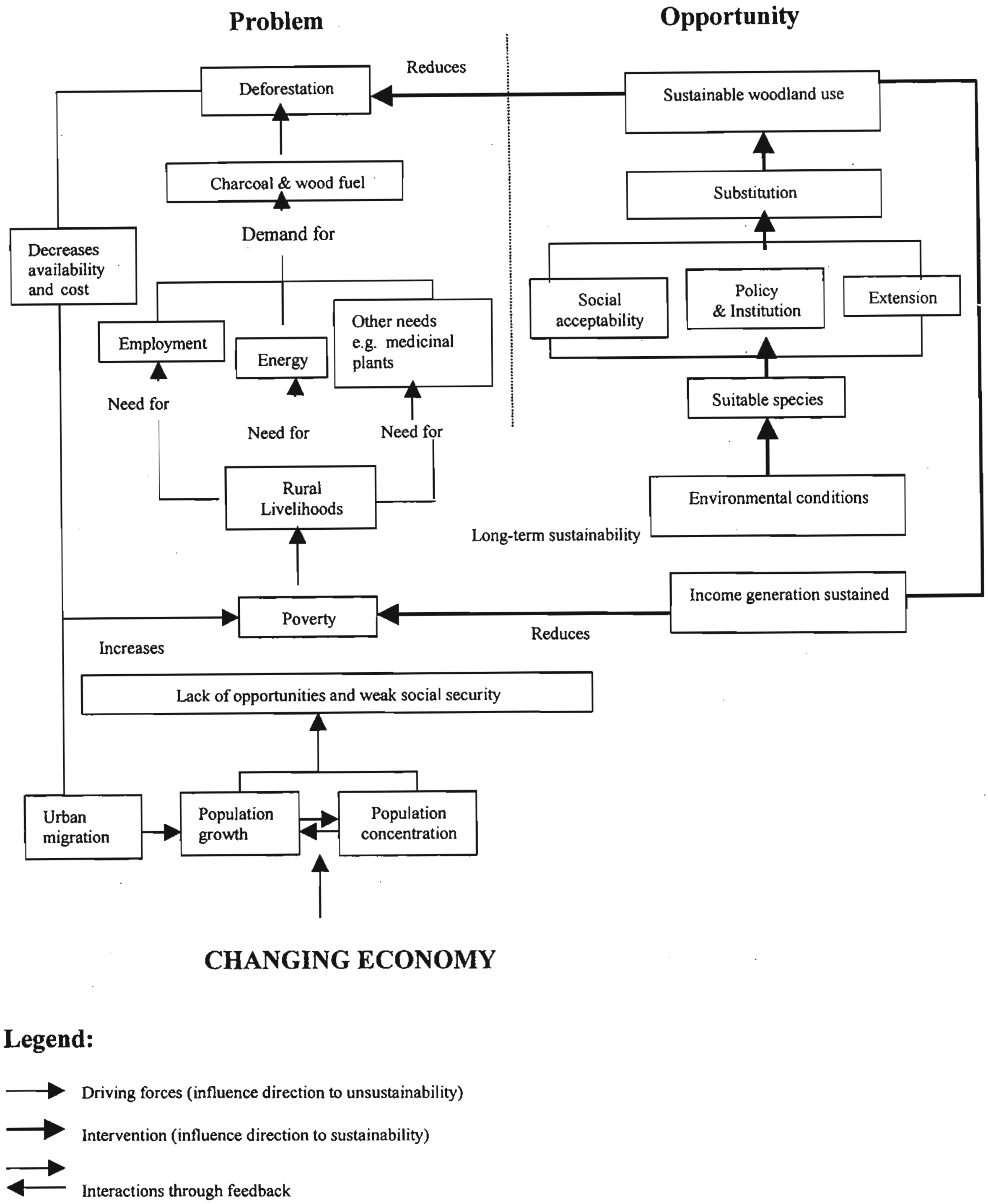


Figure 4.3: A conceptual framework depicting how the opportunity for substitution can be realized and lead to sustainable use of woodlands. (Refer to section 4.4 and Figure 4.1 for further explanation).

CHAPTER FIVE
ANALYSIS OF FINDINGS

5.1 Introduction

The central theme of this study is to identify an intervention to promote the cultivation of suitable species as alternative sources of wood for charcoal production in the Catuane study area. This is the first step in determining whether such intervention has any prospects for success. It reports on the suitability of the environmental conditions (section 5.2) and on species that might be candidates in an intervention strategy (section 5.3).

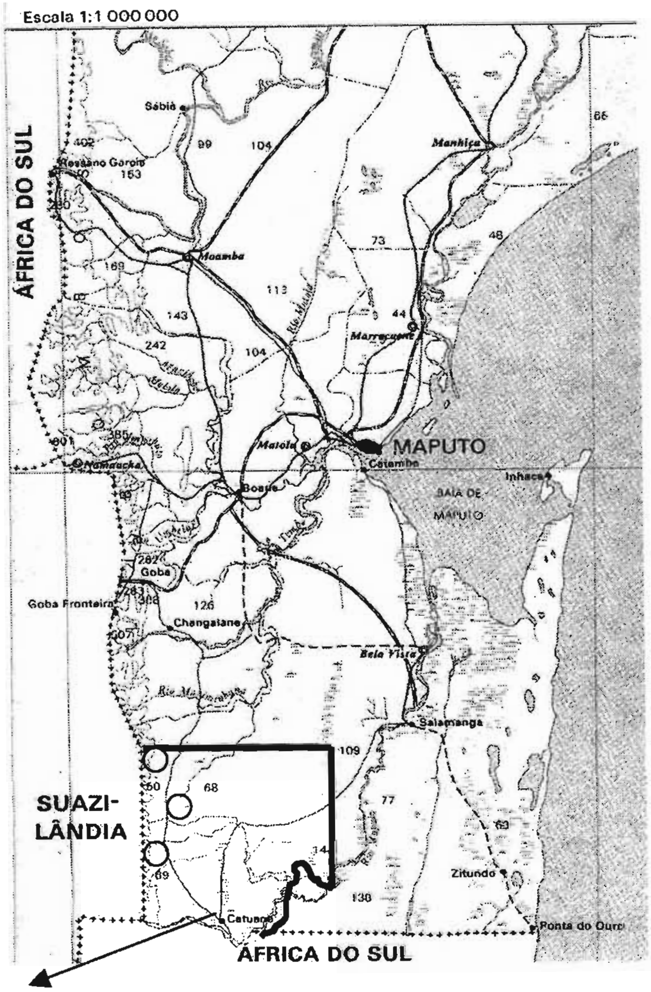
5.2 Suitability of environmental conditions

Principal determinants of plant growth are topography, climate including rainfall, evaporation and temperature, and soil, particularly water holding capacity and fertility. This section is a scoping analysis to determine environmental suitability.

5.2.1 Topography

Surface topography is an important determinant of environmental conditions across the range of scales from large to small. It exerts influence through its effects on incident radiation, wind, rainfall and runoff, and through many factors consequent upon these, such as evapo-transpiration and soil structure. It follows that the spatial pattern of environmental conditions reflects topography; the more pronounced the topographical variation the more pronounced the variation in the environmental conditions.

The study area is located on the Mozambique coastal plain (Figure 5.1), which was exposed during a series of the general lowering of sea levels during the Pleistocene. This caused the coastal shoreline to shift progressively eastwards exposing a nearly flat surface of sandy material (Port Durnford beds) overlying Miocene rocks. " At each position where the shoreline was located for any length of time through the sea level being static, a system of long shore dunes developed" (Heeg and Breen, 1994).



Catuane (Main Administrative Post)

Source: MINED and Esselte Map Service AB, 1986.Vol. 1 Scale 1:1 000 000

Legend:

Road network

Water bodies (rivers, lakes, swamps)

Study sites

Catuane study area boundary

Railway line

Figure 5.1 Map of southern Mozambique showing the location of the study area.

The macro topography comprises a relatively flat coastal plain rising in the west where it adjoins the Lebombo Mountains. The implications for this study are that the influences of topography on climate are such that conditions change gradually across the plain, with more distinct gradients apparent with elevation at the Lebombo mountain range. This is clearly evident in the orientation of isohyets and gradients in evaporation shown in Figures 5.2, 5.3, 5.4, 5.5 and 5.6. Given this situation, one can reasonably interpolate likely conditions for a site on the plain from data recorded elsewhere on the plain. During the past 33 years (from 1969 to 2001) the Catuane Administrative Post has not been serviced by any meteorological stations (Manuel, pers. comm. 2001). This study therefore relied on interpolation in an attempt to determine the suitability of environmental conditions for growth of species for charcoal production.

Table 5.1 Mean monthly and mean annual rainfall (mm) of six stations.*

Month	Otobotini	Makhatini	Ndumu	Catuane	Tinonganine	Belavista
Jan	108	97	142	94	134	128
Feb	104	100	103	89	123	105
Mar	109	70	73	71	67	76
Apr	48	43	62	42	43	49
May	24	29	25	29	19	18
Jun	16	11	9	16	26	22
July	11	14	22	14	26	23
Aug	12	14	16	14	20	16
Sept	33	48	45	28	29	32
Oct	451	53	51	55	63	56
Nov	101	78	96	73	68	74
Dec	113	76	92	83	80	96
Year	730	633	735	608	698	695
Record period	24-50	66-84	73-84	31-69	31-69	31-69

Sources: (INAME[9]; DNA[10]; INIA[11]; DAgr[12]; Koch, 1987)

* The stations have been ordered east to west in the study area and its vicinity. Otobotini is situated on the lower east slopes of the Lebombo mountains.

[9] Instituto Nacional de Meteorologia
[10] Direccao Nacional de Agua
[11] Instituto Nacional de Investigacao Agronomica
[12] Department of Agriculture (Agro-meteorological Reports)

The meteorological stations used for this study are situated to the west and east of the study area on the coastal plain with altitudes varying between 73 m at the Makhatini Agricultural Research Station and 122 m at Ndumu Game Reserve south of the study area.

5.2.2 Climate

The study site is located at 27° 30'S and 32°30'E. The south flowing Mozambique ocean current contributes to the extension of warm to hot and humid subtropical conditions on the coastal plain (Schulze, 1965). The most comprehensive data available are from the Makhatini Agricultural Research Station (Table 5.2) and even these are incomplete. This shows mean monthly maximum temperatures range between about 28°C (July) in winter and 38°C (December) in summer. Monthly minimum temperature ranges between 17°C (July) and 26°C (December). This indicates frost-free conditions prevail throughout the year.

Table 5.2 Climatic data measured at the Makhatini Agricultural Research Station during the period 1978 to 1988.

	Temperature °C (Mean monthly)					
Month	Mean max	Mean min	Mean	Mean monthly rainfall (mm)	Mean monthly class A pan evaporation (mm)	Mean monthly wind run (Km/day-1)
July	28.1	17.0	22.5	10.8	110.0	80.8
August	29.2	16.3	22.7	17.7	66.0	104.9
September	31.0	16.7	23.8	28.8	79.2	129.8
October	36.4	17.8	27.1	35.4	103.1	147.0
November	35.7	25.9	30.8	66.3	113.0	125.8
December	38.2	26.3	32.2	53.7	113.1	125.8
January	35.0	24.9	29.9	120.9	110	120.6
February	37.1	25.4	31.2	90.2	111.0	96.6
March	35.7	27.5	31.3	71.6	92.0	111.8
April	33.6	26.7	30.1	24.2	68.0	93.7
May	32.9	21.5	27.7	30.8	72.0	89.6
June	31.1	19.8	25.4	25.0	53.0	78.5
Year	33.6	20.7	27.8	575.4	980.4	108.7
Record period	1978 1988	1978 1988	1978 1988	1978 1988	1978 1988	1978 1988

Sources: Department of Agriculture-Makhatini Reseach Station Reports from 1978-1988; Koch, 1987.

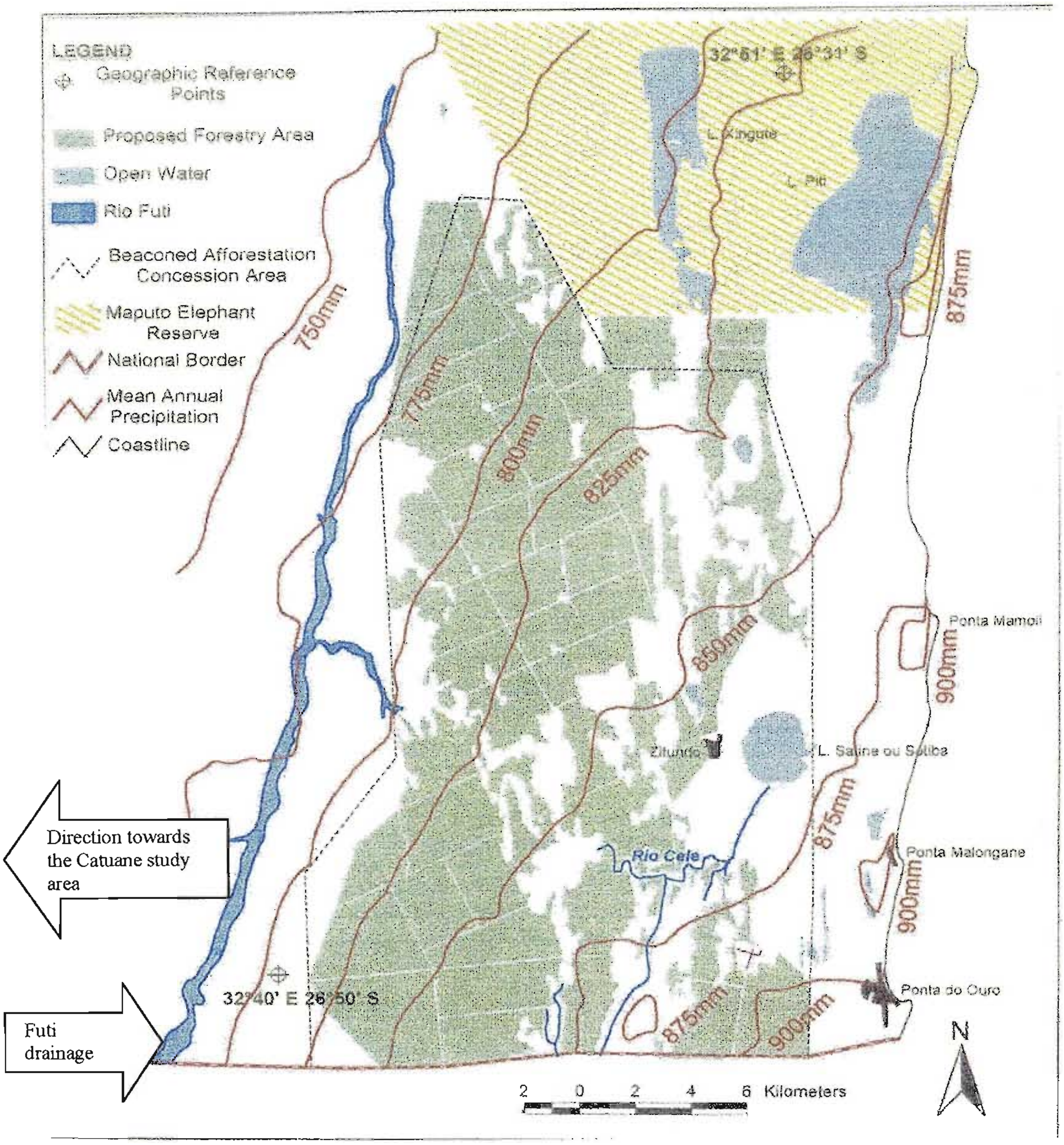
Rainfall is markedly seasonal with most rain falling in summer. December (90mm) and January (120mm) are the wettest months, and June (25mm) and July (10mm) are the driest months (Table 5.2, Figure 5.4). The mean annual precipitation at the Makhatini Agricultural Research Station is 575mm, which is considerably less than that recorded at stations further east (Table 5.3), which range from 713 mm to 1077 mm. This shows the extent to which precipitation decreases inland (Figure 5.2).

The hot conditions and high run of wind contribute to high evaporation throughout the year (Table 5.2). As a result, evaporation is consistently higher than rainfall (Figure 5.3 and Figure 5.4). The difference varies between about 50% more in winter to 40% more in summer during the rain season. Evapotranspiration is aggravated by wind. Heeg and Breen (1979) observed that the "frequency and force of winds are of sufficient magnitude to cause mechanical damage and scorching to field and horticultural crops" at Makhatini which is located across the border in South Africa.

Table 5.3 Mean Annual Precipitation (MAP) of stations east of the study area .

Station	Record period	Record length (complete years)	MAP (mm)
Salamanga	Jan 1952-Dec 1989	31	713
Manhoca	Jan 1962-Nov 1982	13	799
Zitundo	Dec 1952-Oct 1968	15	996
Ponta de Ouro	Nov 1952-July 1988	32	1077

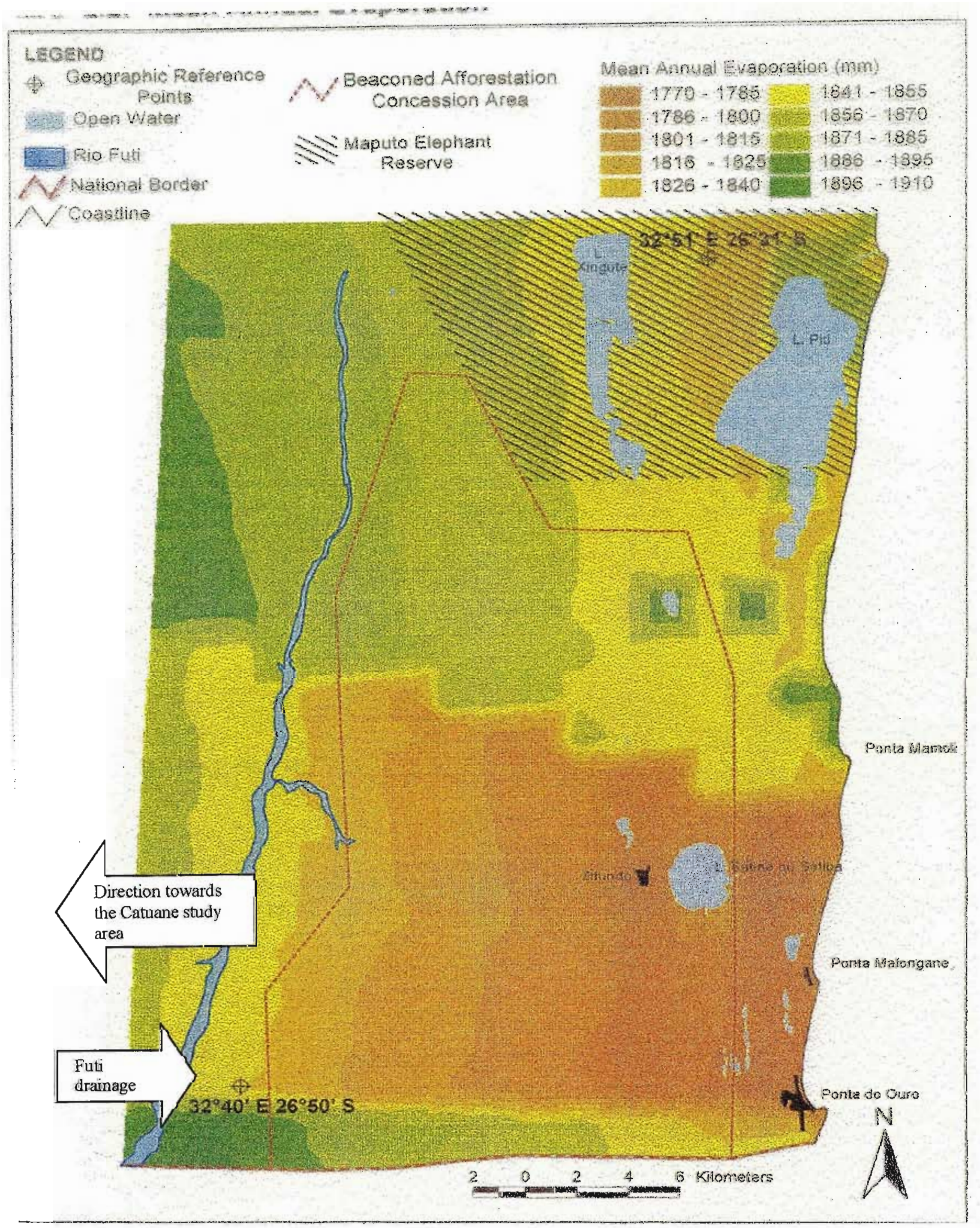
Source: Pollet *et al.* 1996.



Source: Pollet *et al.* (1996)

Figure 5.2 Map of the south eastern of Mozambique showing isohyets and illustrating the gradient in rainfall from east to west.

NB: The study area is located west of the Futi drainage system.

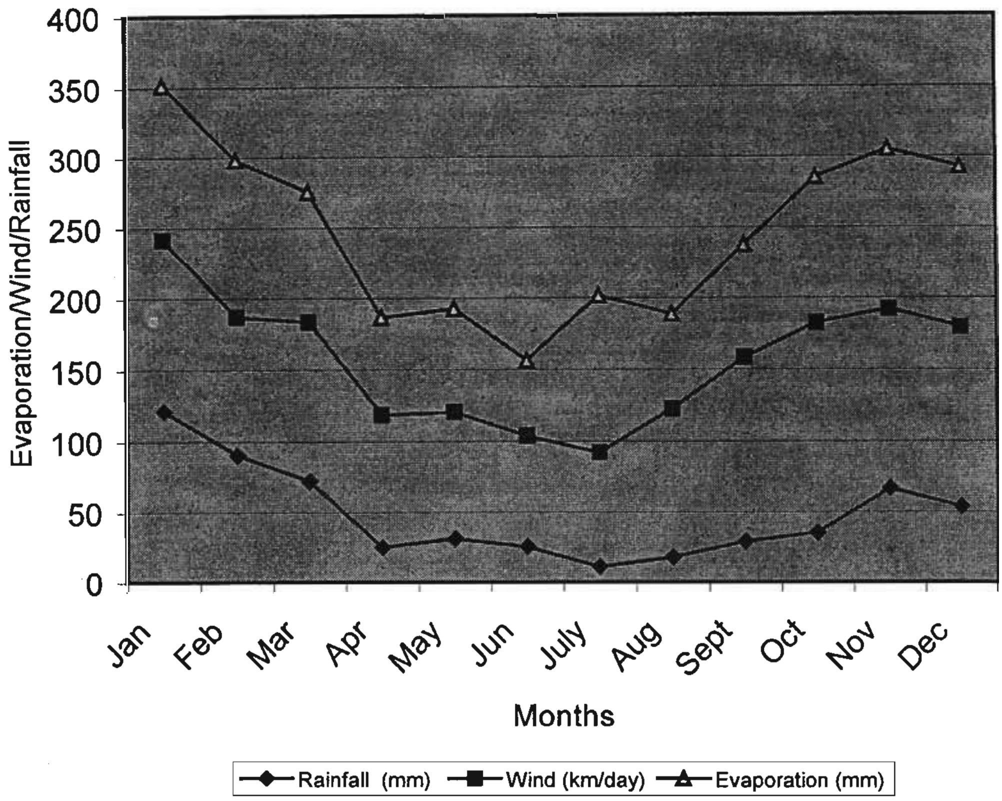


Source: Pollet *et al.* (1996)

Figure 5.3 Map of the south eastern of Mozambique showing mean annual evaporation.

NB: Evaporation increases westwards towards the study area located east of the Futi drainage.

The report by Pollet *et al.* (1996), shows that evaporation increases westwards (Figure 5.3), with an increasing hostility of environmental conditions for plant growth. In this case it would be reasonable to infer that as conditions become harsher inland, the prospects for tree growth and wood production decrease. Clearly, it would be appropriate to identify species which are tolerant of dry conditions before promoting silviculture.



Source: Department of Agriculture (Makhatini Research Station Reports from 1978-1988)

Figure 5.4 Mean monthly fluctuations in evaporation, wind run and temperature at Makhatini station.

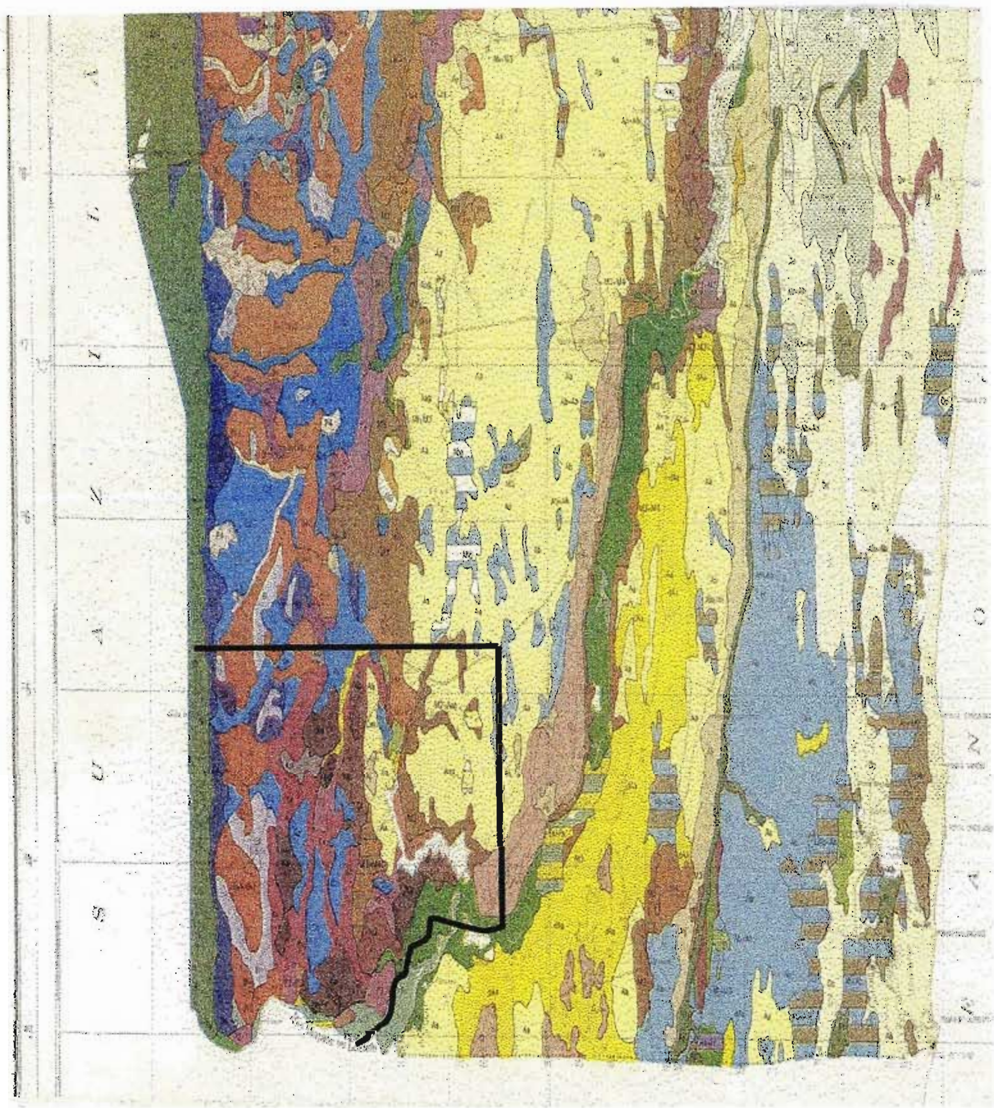
Conditions improve eastwards to the extent that 60km east and 90km north of the Makhatini Agricultural Research Station there was an intention to cultivate Eucalyptus species in commercial plantations in the Zitundo area (Figure 5.2;

DNFFB, 1996). A feasibility study and impact assessment showed this to be both economically feasible and environmentally acceptable (Pollet *et al.* 1996).

5.2.3 Soils

The study area is located where precipitation and evaporation conditions are sub-optimal. Much of the coastal plain is overlain by aeolian sands, particularly in the east (Myre and Ripado, 1953; Figure 5.5). In the west however, the weathering of the Lebombo Mountain rhyolitic and basaltic rocks have yielded soils on the plain that are favorable for cultivation (Figure 5.6), although high rates of evaporation and upward movement of mineralized water from underlying cretaceous sediments can cause salinisation in irrigated soil (Pollet *et al.* 1996; Heeg and Breen, 1994).

The sandy soils in the east have low water retention properties (Kelbe and Rawlins, 1992), whilst those in the west have higher water retention properties (Pollet *et al.* 1996). Thus, conditions for growth in the east are more favorable because of the higher precipitation on the soil with lower water retention than in the west where this rainfall is lower but water retention is better. These conditions reflected in the vegetation of the Catuane area (Figure 5.7, section 5.1.4) because it is located on the transition between the sandy soils in the east and the heavier textured soils in the west adjacent to the Lebombo Mountain (Figure 5.8).



Source: INIA-Maputo (1999); scale 1:250 000

Legend: (major soil characteristics)

Rhyolitic littocrest soils (Lubombo range)
Basalt and cretaceous flats
Denser clay soil (bottomlands)
Red sands convexity (sands)
Alluvium (Maputo river and floodplain)
Pallid sand sub arid (deep sand)
Sketch map of Catuane

Figure 5.5 Soil map of southern Mozambique and study area.

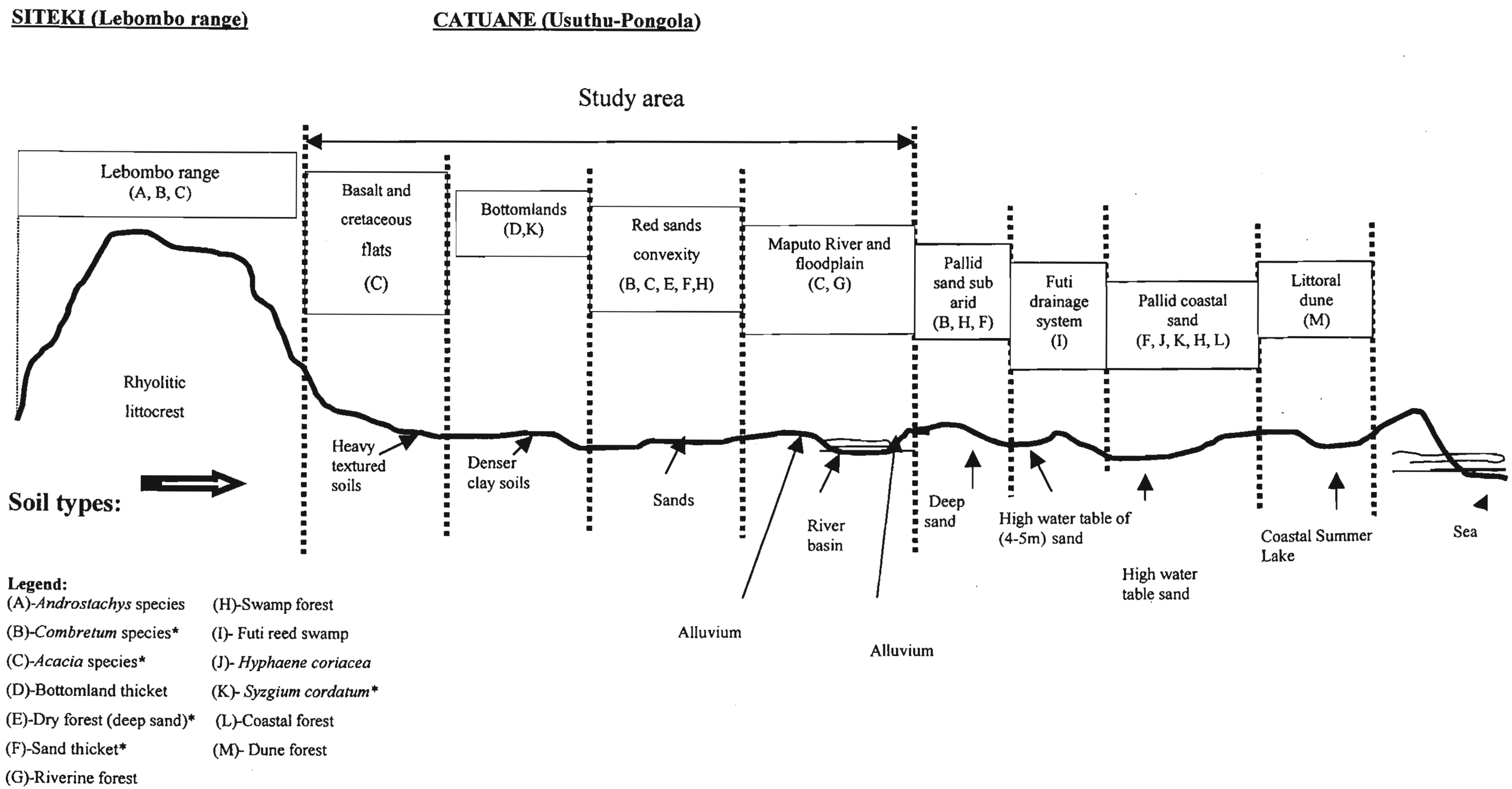


Figure 5.6 Vegetation formations containing species used for charcoal and a profile diagram from Siteki to Catuane (Adapted from East African Technical Services, 1990. In: Pollet *et al.* 1996). * Species suitable for charcoal making.

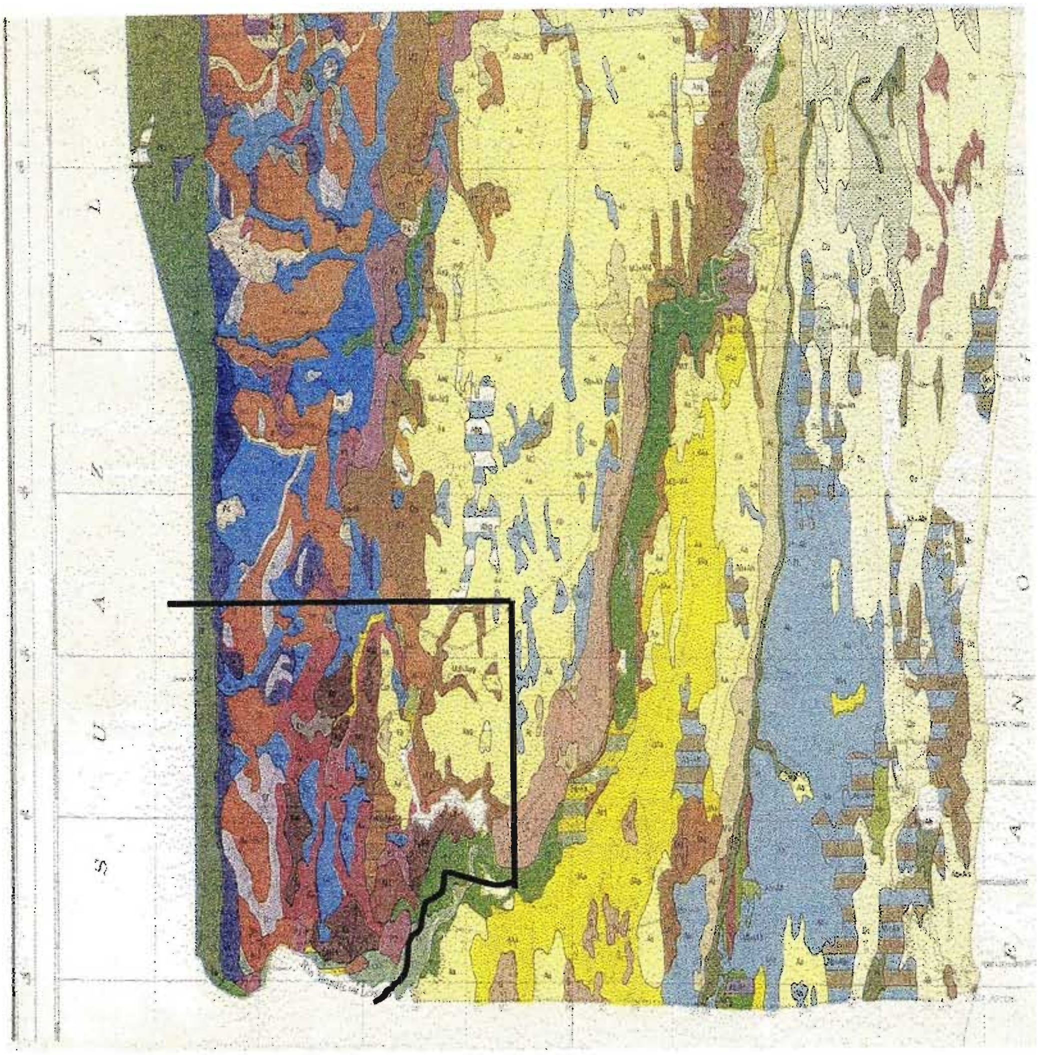
5.2.4 Vegetation

No primary data on the structure, composition and status of vegetation were collected for the area. In the absence of data on vegetation cover it was necessary to use available general descriptions and a map (scale 1: 250.000) to develop a general description of the extent of woody vegetation. It was not possible to derive information on growth rates and wood production rates.

In southern Maputo, particularly in the Catuane region, it is possible to recognize two regional mosaics: the Zanzibar-Inhambane and Tongoland-Pondoland regional mosaics separated by the Limpopo River (Pollet *et al.* 1996). From the Limpopo River to the south, as far as Port Elizabeth, the composition of the Tongoland and Pondoland regional mosaics seem to be more heterogeneous than in the northern area, with undifferentiated relatively dry vegetation types with a poorly developed under storey (FAO, 1974).

The vegetation is quite varied from east to west (Figures 5.6 and 5.7) including bushlands, open woodlands, thicket as well as woody grassland, swamp grassland, swamp forests and sand forest (Monjane, 2001; DINAGECA, 1999; Saket *et al.* 1995). In the study area there is a wide belt of sand forest characteristic of the coastal forest, which mainly comprises *Newtonia hildebrandtii, Hymenocardia* spp, *Erythrophleum* species, *Balanites maughamii, Afzelia quanzensis and Dialium* species. This vegetation type may "denote the original location of successive lines of coastal dunes marking the retreat of the sea" (Heeg and Breen, 1979, p.34). The sand forest within the study area occurs in a mosaic of either sand forest and thicket or open woodland with sand thicket (Saket, 1994).

In open woodland of the study area the dominant spp are *Syzgium cordatum* in wetter areas and *Terminalia sericea, Acacia* species and *Combretum* spp in drier areas. The two latter species are good for charcoal production (Eberhard and Poynton, 1986; Mullin, 1982).



Source: Dinageca (1999), scale 1:250 000

Legend

Open Woodland
Bushland
Wooded Grassland
Scrub Wooded Grassland on shallow soils
Medium thicket
Grassland
Wetland areas
Shrubland
Sand Forest and Thicket

Sketch map of Catuane study

Figure 5.7 Vegetation map of southern Mozambique and study area.

Woodland in the area varies from open canopy to closed canopy woodland. The woodland species found in the area include *Syzgium cordatum, Trichelia emetica, Albizia adianthifolia, Sclerocarya caffra, Bridelia micrantha and Acacia* spp.

Swamp forest is found mainly around lake Pandjene, east of the study site. In some places along rivers, swamp forest develops with closed canopy cover and comprises *Ficus* species, *Syzgium cordatum, Rauvolfia caffra.* In the drier swamp forest areas, species like *Schefflera umbelifera* and *Bridelia micrantha* are present (Malleaux, 1980).

Woody grassland in the study area is dominated by *Themeda triandra, Aristida stipitata* and *Diheteropogon* species. However, prominent tree species are also found including the palms *Hyphaene coriaceae* and *Phoenix reclinata* and trees such as *Strychnos spinosa, Trichelia emetica, Acacia* species and *Terminalia sericea* (*ibid.*). The last two are most used for charcoal production in the area. Species commonly used for charcoal production are shown in Table 5.4. Most consumers report that these species have good wood quality of high density and calorific value (Brouwer and Magane, 1999; Manso, 1993; Mansur and Karlberg, 1986).

Table 5.4 Tree species commonly used for charcoal production in the Catuane region.

Local name (Shangane)	**Scientific name**
Micaia	*Acacia* spp
Chimondzwana	*Combretum* spp
Ndzenga	*Syzgium cordatum*
Lhevenjovo	*Bridelia micrantha*
Nhanchichane	*Terminalia sericea*

Source: Field interviews during the research

The low rainfall, high evaporation and run of wind imply that most of the vegetation in the study area is adapted to dry conditions. This indicates that species requiring high water intake might not survive unless they have deep root systems that draw water and nutrients from locations in the soil profile where it is continuously available. Shallow rooted species have to depend entirely on seasonal water from the rain and on moisture gained from dew and mist. The presence of woody vegetation that is suitable for charcoal production demonstrates that it can be grown in the study area, but whether or not it can be grown productively is not known.

The vegetation of the southern mosaic has been most affected by the commercial activities of the dense population living in and around Maputo. These woodlands supply the industrial sector including bakeries, hospitals and hoteliers (Neves, pers. comm. 2001) and the domestic energy sector (charcoal and firewood) for both rural and urban areas.

This harvesting has resulted in a disturbance of wood resources (Monjane, 2001; Mabonga, 1981) and current levels of exploitation are not sustainable. Generally, all districts in Maputo province are characterized by a reduction of certain types of vegetation cover, particularly sand forest and thicket (LF1, LF2, LF3; Figure 5.9). This leads to a substantial increase of bushlands (T) and grasslands (G). For example, based on interpretation of satellite images of two years: 1990 and 1997 by Monjane (2001), it was possible to estimate the magnitude of the changes that have occurred in vegetation cover in Matutuine district of which Catuane is a part.

Sand forest and thicket (LF1) exhibited a reduction of 42 587 ha over a period of seven years (1990-1997). From Table 5.5, it can be seen that sand forest and thicket (LF1), which represented 11% of the total area determined from satellite images in 1990, represented only 3% in 1997. Further, more than 60% of the area covered by sand forest and thicket (LF1, LF2, LF3) in 1990 was converted to open woodlands and grasslands shrub land, as a result of high levels of clearing and harvesting of indigenous woodland.

Table 5.5 Changes in vegetation cover in Matutuine district from 1990-1997.

Categories	Vegetation type code	1990 total area (ha)	1990 total area (%)	1997 total area (ha)	1997 total area (%)	Changes area (ha)	(%)
Permanent agricultural area (short and long fallow period)	A2	32 411	6	45 219	8	12 808	2
	A3	15 002	3	11 984	2	-3 018	-1
Grassland	G	88 285	17	82 776	16	-5 509	-1
Sand forest and thicket	LF1	58 803	11	16 216	3	-42 587	-8
	LF2	81 672	15	96 180	18	-14 508	3
	LF3	76 553	14	58 679	11	-17 874	-3
Mountain forest	M	5 535	1	1 172	0	-4 363	-1
Shrub land	S	37 966	7	30 383	6	-7 582	-1
Bush land	T	45 313	9	103 910	20	58 595	11
Woodland	W	16 800	3	16 800	3	0	0
Woody grassland	Wg	71 278	14	66 302	13	-4 976	-1
	Total area (ha)	529 618	100	529 618	100	0	0

Source: Monjane, 2001.

The observed changes in vegetation type occurred mainly north of the road Bela Vista-Porto Henriques in the Catuane study area (Mahau, Manhangane-Um and Manhangane-Dois) and west of Ponta do Ouro and Zitundo. The forestry inventory results from the charcoal transporters, indicate that the Mahau, Manhangane-Um and Manhangane-Dois areas around Catuane are areas of intense harvesting and high levels of clearing of indigenous woodland in the Matutuine district (Mansur and Karlberg, 1986, Monjane, 2001). Harvesting from these woodlands supplies the demands for energy in the Maputo urban areas (Brouwer and Falcao, 2001). It is predicted that if present harvest and clearing trends continue, wood fuel shortages will soon be critical throughout southern region of Mozambique (Pereira, 2001; Mansur, 1986). Some intervention is urgently required if the energy and livelihood needs of the population are to be continuously met.

Generally, the suitability of environmental conditions in the study area are sub-optimal. The climate is dry with hot temperatures. Evaporation exceeds precipitation throughout the year with a considerable margin, varying from about 40% more in summer to 50% more in winter. The soil characteristics east of the study site are sand soils with low water retention properties whereas in the west, heavy textured and denser clay soils are present with higher water retention capacities. To some extent this offsets the lower rainfall which reduces prospects for tree cultivation in the study area.

5.3 Species suitability

Not all tree species are suitable for charcoal production and wood fuel. In addition, species have different climatic and soil condition requirements so that selection of species to be grown in a given area must be based on matching site conditions with the specific requirements for productive growth.

5.3.1 Criteria for selection

Different authors have suggested different criteria for the selection of species suited to production of charcoal and wood fuel (Smith, pers. comm. 2001; Dyer, 1994; Hines and Eckman, 1993; Eberhard, 1990; Riley and Brokesha, 1988). These are illustrated in Figure 5.8

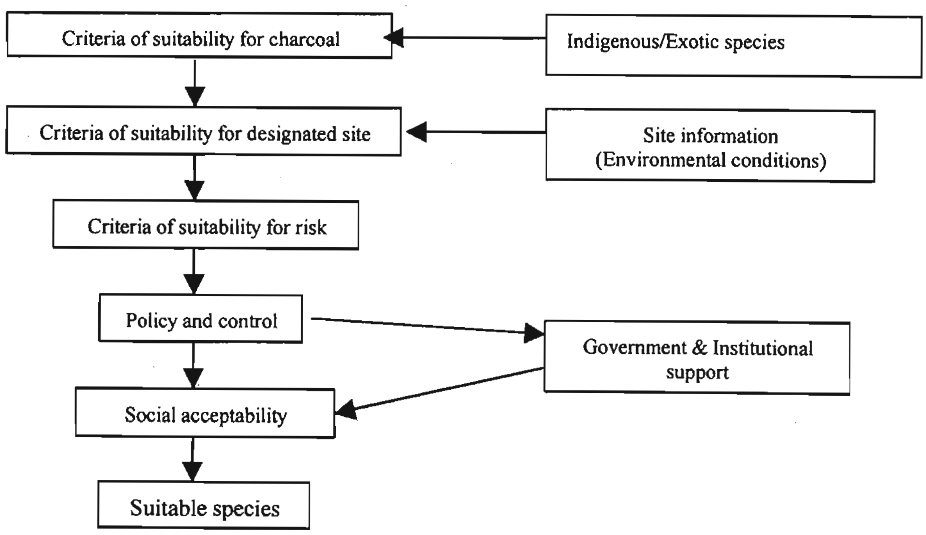


Figure 5.8 A model to integrate various criteria for species selection. The model shows the sequence of application of criteria for selection of species suited to charcoal and wood fuel production.

Properties that determine suitability for production of wood fuel and charcoal are:

- dense wood with low moisture content, as this produces good quality charcoal with high calorific value. The result is lower rates of consumption and less input costs and slow burning with high calorific value, producing very little smoke without objectionable or toxic fumes. The more favourable the product the more readily peasants are able to market the products.
- the ability to coppice or sprout when cut is an important property because this reduces labour costs (time and resources) and increases productivity (Gardner, pers. comm. 2001).
- rapid growth with high volume production and quality of wood fuel is particularly important in situations of high demand and relatively hostile environmental conditions (Dyer, 1994; Hines and Eckman, 1993).
- the wood should be relatively easy to cut, easy to handle with few or no thorns, splitting easily and readily transportable. This reduces input costs particularly labour which is a dominant feature of peasant charcoal production.

These criteria were used in combination in order to select candidate species. The approach used was to scan available literature to identify species that have been recorded as useful for wood fuel and charcoal production. For each of these species literature was scrutinized for information on:

- suitability for wood fuel;
- gross calorific value;
- density;
- habitats in which the species occurs naturally;
- soil characteristics associated with the species;
- resistance to frost;
- resistance to drought; and
- growth rate.

In most circumstances the information available was qualitative and as it was derived from different sources, the mode of assessment varied. The information available and the sources are shown in Table 5.6. It must be stressed that whilst every attempt has been made to be thorough, there are limitations in the data set. One of the limitations is the anomalous relationship that is exposed between density and calorific value. The data presented in Table 5.7 illustrates this very clearly. Two difficulties arise, of which the most compelling is whether it is appropriate to consider both of these characteristics as criteria.

The second difficulty is that one cannot use a regression to determine calorific values from density values and vice-versa. This study should therefore be regarded as exhibiting an approach for consolidating information useful for species selection and as a first step in adoption of such an approach. It also serves to direct research endeavours towards gathering the required information.

Limitations in the data assembled led to a decision to allocate two classes for each selected criterion. For example, a species may be moderately good or very good for wood fuel or it may be slow or fast growing. In each instance a value of 1 (least favourable) and 2 (most favourable) were allocated.

In the case of characteristic of drought resistance the scores were 2 for tolerance of drought and 0 if the species was not tolerant. Whilst acknowledging that all criteria might not carry equal importance in selection, the scores were summed for all criteria to provide an overall suitability score (Table 5.8 and Table 5.9).

Comparisons of these scores enabled identification of suitable species (Table 5.8). Since the ability of trees to grow fast is important in order to reduce present pressures on indigenous vegetation, the species selected were further identified on the basis of growth rate to identify the 'super candidates' (Table 5.9).

Table 5.6 Species suitability for charcoal production based on properties characteristics and site conditions. (Refer to text for procedures).

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m^3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Drought resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Acacia caffra	xx	19.81	980	Found in woodland and wooded grassland	Along rivers and stream banks, mainly in alluvium soils	The species is cold resistant	Is resistant to drought	xxx
Acacia erioloba	xxx		1144	Dry woodland	Arid/sandy areas, sand loams and deep Kalahari sand	It is not resistant to cold	It is drought resistant	xx
Acacia karoo	xxx	18.77	890	It is distributed in wide range of altitudes from coastal scrub to woodland	Grow well in alluvium soils, along rivers and stream banks, but adapted to any soil conditions even on the margins marsh areas	Adapted to extreme temperatures (frost resistant)	Drought resistant	xxx

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Drought resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
*Acacia mearnsii**	xxx	19.2			It can grow in heavy textured and alluvium soils	Only resists light frost	It is drought resistant	xxx
*Acacia melanoxylon**	xx	19.15	670	Native to Australia	Moist rich soils, along rivers	Not frost resistant	Fairly drought resistant	xxx
Acacia sieberiana	xx	19.37	720	It is rare in distribution	Suitable to moist soils	It is cold resistant		xxx
Acacia nilotica	xxx		1100	Found in low lying brackish areas, in a variety of type of woodland, wooded grassland and river valley scrub	Can grow well in alluvium soils	The species is fairly cold resistant		xx

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m^3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Drought resistant (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Acacia senegal	xx		930	It is found in low altitudes, bushveld woodland and wooded grassland, also found south of Pafuri in Mozambique	Adapt well in sandy soils, near rivers and lakes	It is sensitive to frost	It is resistant to drought	xxx
Acacia seyal	xx				Adapted to heavy textured soils	Frost resistant	Drought resistant	xxx
Acacia nigrescens	xxx		1100	It is distributed and abundant on basaltic soils, bushveld and wooded grassland	It can grow on a variety of soil types, clayey soils, except sand soils	It is sensitive to frost	It is drought resistant	xx

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	Species Suitability for wood fuel (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	Gross calorific value (MJ/kg) (Eberhard, 1990)	Density (kg/m^3) (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	Plant distribution (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Soil characteristics (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Frost resistant (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Drought resistant (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Growth rate (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Acacia tortilis	xxx	18. 95	890	It is extensively distributed in bushveld, thicket and wooded grassland and is native to Sudan and north Africa deserts	The species does not survive in saline soils	It is cold resistant	It is drought resistant	xx
Bridelia micrantha	xxx	18.95	670	Found along rivers and stream banks. Also along the Sabie river	Can grow well in granite soils, forest edges and streams	It is cold resistant		xxx

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	Species Suitability for wood fuel (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	Gross calorific value (MJ/kg) (Eberhard, 1990)	Density (kg/m^3) (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	Plant distribution (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Soil characteristics (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Frost resistant (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Drought resistant (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	Growth rate (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m^3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Drought resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Colophospermum mopane	xxx	18.99	1200	Found in south tropical Africa, mainly in hot low-lying areas. Also found on the Lebombo mountains dry lowland woodland	Grows well in alluvium soils, alkaline and poorly drained soils	It is cold resistant		xx
Combretum apiculatum	xxx	20.39	1 230	The most abundant species in low altitude and in dry open woodland. From Kenya in the north to Kwazulu Natal in the south	Grows well in granitic and rhyolitic soils and rock basalt adjacent to the Lebombo (sandy to rock soil)	It is not resistant to frost	It is drought resistant	xx
Combretum erythropyllum	xxx		670	Found mainly along river banks	It can grow in alluvium soils, but it is not restricted to any specific type of soil	It is frost resistant	It is resistant to drought	xxx
Combretum imberbe	xxx		1200	Distributed in low lying areas, mixed woodland and along rivers or dry water courses	Requires basaltic soil of the Lebombo flats and alluvial soils (riverine)	It is fairly frost resistant	It is drought resistant	xxx
*Casuarina equisetifolia**	xxx		850	Origin: Burma, India and Malaya northern Australia and	Grows on every soil but preferably on light sandy soils near		Adapted to a dry climate with winter rains	xxx

Table 5.6 continued

				Queensland	sea shore			
		20.88			Grows well along tidal creeks	Adapted to adverse weather conditions	It can withstand drought conditions	xxx
Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m^3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Drought resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Dialium schlechteri	xxx			It is distributed in coastal bush and dry forest	Suited to dry sandy soils	It is frost resistant	It is drought resistant	xxx
*Eucalyptus globulus**	xx	19.35	900	Origin: Australia	Suitable in Basaltic soils	It is frost resistant	Drought resistant	xxx
*Eucalyptus camaldulensis**	xxx	19.64	930	It is widely distributed in Australia	Adapted to dry land and low hills, silty soils		Suitable to high summer temperature	xxx
*Eucalyptus grandis**	xx	19.69	615	Origin : New south Wales and Queens land	Suitable in alluvium plains and moist soils		It is resistant to drought	xxx
*Eucalyptus tereticornis**	xx	19.76	960	Origin: Western Australia and Queensland	Suitable in poor soils and shallow soils of different composition		It is drought resistant	xxx
Faurea saligna	xxx	19.48	1040	Found in open woodland and on stony hillsides	Adapted to sandy and granitic soils and often grows along river banks	It is cold resistant		xxx

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m^3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Drought resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Haloxylon persicum	xx	20.44		Found mainly in arid sand fields	Suitable to sandy soils	Withstands low temperatures	It is resistant to drought	xx
Olea europaea	xxx	20.76	1 140	Found in dense bush and ravine and stream banks	Suitable on stony soils	It is cold resistant	It is drought resistant	xx
Pterocarpus angolensis	xx	20.76	656	Has limited distribution in woodland and wooded grassland on mountain tops	Can grow well on sandy soils and well drained soils	It is not cold resistant		xx
Rhus lancea	xx	20.17	1040	Found in a variety of altitudes and habitats or along drainage lines	Grows in practically any soil type, along rivers and stream bank soils, termite mounds and rocky soils. Thrive in poorly drained soils (for example, black soils),	It is frost resistant	Fairly drought resistant	xxx

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m^3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; Van Wyk, 1984; ***Moll, 1981;*** Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Drought resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Strychnos madacascariensis	xx		85	It is abundant in bushveld open woodland, rocky koppies and coastal forest	Lebombo rhyolitic sandy soil and alluvium soils	It is resistant to cold	Not resistant to drought	xxx
Syzgium cordatum	xxx	19.55	750	Found near permanent water swamp forests and wooded grassland	Grows well on alluvium soils (riverine habitat)	It is resistant to cold	Not resistant to drought	xxx
Sclerocarya caffra	xx		560	Found in open woodland, medium to low altitude and open woodland and bush. Also abundant on the Lebombo plains	Can grow in various types of soils, sandy to sandy loam and basatic soils	Not cold resistant (susceptible to frost)		xxx

Table 5.6 continued

Species Indigenous/Exotic* (Scientific name) (Pooley, 1993; Moll, 1992; Moll, 1981; Van Wyk, 1984; Coates, 1977)	**Species Suitability for wood fuel** (Dyer, 1994; Poynton, 1984) Key: xxx very good xx moderately	**Gross calorific value (MJ/kg)** (Eberhard, 1990)	**Density (kg/m^3)** (Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984)	**Plant distribution** (Funie and Venter, 1996; Pooley; 1993; Moll, 1992; Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Soil characteristics** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; Van Wyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Frost resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992;Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Drought resistant** (Funie and Venter, 1996; Pooley, 1993; Moll, 1992; Eberhard, 1990; VanWyk, 1984; Moll, 1981; Coates, 1977; FAO, 1955)	**Growth rate** (Eberhard and Poynton, 1986; Van Wyk, 1984) Key: xxx Fast growing xx slow growing
Terminalia sericea	xxx		870	It is widely abundant found in bushveld	Suitable to sandy soils, along stream and riverine areas	It is cold resistant	Fairly drought resistant	xx
Trichilia emetica	xxx		560	Found along rivers in coastal forests	Grows well on alluvium and sandy soils, and stream banks	Sensitive to cold		xxx

During field interviews, it emerged that *Combretum apiculatum, Acacia* spp, *Terminalia sericea, Syzgium cordatum, Bridelia micrantha* are considered to be the best species for charcoal and wood fuel by charcoal makers from the study area. *Acacia* spp (locally known as "micaia") and *Combretum apicul-atum* (known as "chimondzwana") are most often used and preferred by the consumers (Xigogwane, pers. comm. 2001). These were included in the suitability assessment. Most of the species in Table 9 (76%) are indigenous with about one quarter (24%) being exotic.

Table 5.7 Comparisons between Gross Calorific Value and Density.

Species **Exotic species***	**Gross calorific value (MJ/Kg)**	**Density (Kg/m3)**
*Casuarina glauca**	20.88	900
Pterocarpus angolensis	20,76	560
Olea europaea	20,76	1040
Haloxylon persicum	20,44	656
Combretum apiculatum	20,39	1200
Rhus lancea	20,17	870
Acacia caffra	19,81	890
*Eucalyptus grandis**	19,69	960
*Eucalyptus camaldulensis**	19,64	930
Faurea saligna	19,48	1 140
Acacia sieberiana	19,37	930
*Eucalyptus globulus**	19,35	615
*Acacia mearnsii**	19,2	720
*Acacia melanoxylon**	19,15	1100
Colophospermum mopane	18,99	670
Bridelia micrantha	18,95	1 230
Acacia tortilis	18, 95	650
Acacia karoo	18,77	670

Sources: Funie and Venter, 1996; Eberhard, 1990; Van Wyk, 1984

These comparisons (Table 5.7) illustrate that the relationship between calorific value and density is highly variable. This makes it impossible to use a regression from which one can estimate calorific value from densities and vice versa.

Table 5.8 Candidates for introduction into the Catuane study area.
The maximum possible score for any species was 8. Species that scored 5 or more points were regarded as particularly suitable. Refer to text for explanation of scoring.

Scientific name	Gross calorific value (MJ/kg)		Density (kg/m3)		Growth rate		Drought	Total Score	Species
	Low 18.7 - 19.7 (score 1)	High 19.8 –20.7 (score 2)	Low 560-890 (score 1)	High 891-1230 (score 2)	Fast growing (score 2)	Slow growing (score 1)	resistant Score 2		candidate C
Acacia caffra		2		2	2		2	8	C
Acacia erioloba						1	2	3	
Acacia karoo	1		1		2		2	6	C
*Acacia mearnsii**	1				2		2	5	C
*Acacia melanoxylon**	1		1		2		0	4	
Acacia sieberiana	1		1		2			4	
Acacia nilotica				2		1		3	
Acacia senegal				2		1	2	5	C
Acacia seyal					2		2	4	
Acacia nigrescens				2		1	2	5	C
Acacia tortilis	1		1			1	2	5	C
Bridelia micrantha	1		1		2			4	
Colophospermum mopane	1			2		1		4	
Combretum apiculatum		2		2		1	2	7	C
Combretum erythropyllum			1		2		2	5	C
Combretum imberbe				2		1	2	5	C
*Casuarina equisetifolia**			1		2		2	5	C
*Casuarina glauca**		2			2		2	6	C
Dialium schlecteri					2		2	4	
*Eucalyptus globulus**	1			2	2		2	7	C
*Eucalyptus camaldulensis**	1			2	2		2	7	C
*Eucalyptus grandis**	1		1		2		2	6	C
*Eucalyptus tereticornis**	1			2	2		2	7	C
Faurea saligna	1			2		1		4	
Haloxylon persicum		2				1	2	5	C
Olea europaea		2		2		1	2	7	C
Pterocarpus angolensis		2		2	2		2	8	C
Rhus lancea		2		2	2		0	6	C
Strychnos madacascariensis			1		2		0	3	
Syzgium cordatum	1		1		2		0	4	
Sclerocarya caffra			1			1		2	
Terminalia sericea			1		2		0	3	
Trichilia emetica			1		2			3	

*Exotic species

Thirty-three species (indigenous and exotic) were assessed against the criteria on suitability for charcoal and wood fuel, and site conditions (Table 5.8). Of these, only 57% qualified as candidates as a source of wood for charcoal production in the study area, while 43% were disqualified. In subsequent assessment based on growth rate, eleven species were assessed to be "super candidates" (Table 5.9). Of these seven were exotics and only two species of Acacia accord with local preferences. It is appreciated that within a single species, there may exist, particularly in commercial operations, many varieties that vary considerably. However, further analysis was beyond the scope of this study.

Table 5.9 Growth rate comparisons for selection of candidate species.

Species (exotic*)	Growth rate XXX Fast Growing	 XX Slow Growing	S Super candidate
Acacia caffra	XXX		S
*Acacia mearnsii**	XXX		S
Acacia senegal		XX	
Acacia tortilis		XX	
Acacia karoo	XXX		S
Combretum apiculatum		XX	
Combretum erythropyllum	XXX		S
Combretum imberbe		XX	
*Casuarina equisetifolia**	XXX		S
*Casuarina glauca**	XXX		S
*Eucalyptus camaldulensis**	XXX		S
*Eucalyptus globulus**	XXX		S
*Eucalyptus tereticornis**	XXX		S
*Eucalyptus grandis**	XXX		S
Haloxylon persicum		XX	
Olea europaea		XX	
Pterocarpus angolensis		XX	
Rhus lancea	*XXX*		*S*

* *Exotic species*

NB: 11 indigenous species and 7 exotic species qualified to be 'super candidates' for the study area.

There are eleven species, indigenous and exotic, from which a selection may be made for this study. Eberhard and Poynton (1986) and FAO (1955) have pointed out that, even if all the theoretical requirements have been fulfilled, and certain species may be found 'super candidates' to be grown in the area, no definite conclusions should be reached as to its practical suitability until the trees have been actually planted and tested in the designated area and have survived for a considerable time.

5.3.2 Risk considerations and policy for control

The tendency for exotic species to become invasive is an important issue and a drawback in promoting cultivation of some species for charcoal production. Risk considerations and assessments are needed for the screening of exotic species such as *Acacia mearnsii, Casuarina equisetifolia, Casuarina glauca, Eucalyptus camaldulensis, Eucalyptus grandis, Eucalyptus tereticornis* and *Eucalyptus globulus* which were identified as super candidates in the study area. This screening could also include the need for chemical treatment such as fertilizers, pesticides used for plant growth and treatment, before any introduction takes place. This is in order to minimise the risk of propagating of invasive species, which may become harmful to the environment and indigenous species in the area.

Under current Mozambican Forest legislation, the government controls and can prohibit introduction of invader species that are considered to be agricultural weeds. Generally provision is made for and consideration must be given to, environmental impacts (Avaliacao do Impacto Ambiental-AIA). Only those species that are known to cause problems are controlled (GOM, 1998). The introduction or propagation of exotic species (especially invaders) is also controlled by restrictions set out in other legislation including:

- Environmental law (Lei do ambiente 1997)
- Land law (Lei de Terras no. 19/97)
- Forest Law (Lei da floresta no. 10/99)

Risk considerations and policy for control of alien invasive species have implications in promoting the growth of species, especially for the household scale community initiatives. It is burdensome for the communities wanting to promote growth of species because the costs incurred in the assessment process by the experts can disadvantage poor local people.

5.4 Social acceptability

5.4.1 Introduction

The subject of social acceptability was directed to explore perceptions of the need to cultivate trees, particularly:

- perceptions on the availability of wood;
- perceptions on the shortage of wood;
- perceptions on the need to cultivate trees for wood; and
- perceptions on support/control.

5.4.2 Sample information

Field research was carried out in the Catuane Administrative Post where three study sites were selected namely Mahau, Manhangane-Um and Manhangane-Dois villages. The selection was based on high intensification of charcoal productivity in these three villages. Respondents comprised those who make charcoal and those who do not. These were categorized into gender (men and women) and resident status (permanent residents and non residents; see Table 5.10).

5.4.3 Findings

Successful introduction of wood species for charcoal production depends on how local people perceive the practice (see section 5.3.3). As the focus of this study was identification of species that might be suitable for cultivation in the area, it was not intended to conduct a detailed survey of perceptions and the factors that determine these. Nevertheless, it was considered desirable to establish, in general terms, whether local people were or were not supportive of the initiative of tree growing.

(Pictures: Paulo Singini)

Figure 5.9 Eucalyptus tree grown in the study area.

HELVETAS, an NGO working in the study area promotes the cultivation of *Eucalyptus sp.* The top picture shows young plants being cultivated and the bottom picture shows mature plants, approximately 3 years old.

5.5 Charcoal production

The composition of the sample of 30 respondents is shown in Table 5.10. there were more people who make charcoal (16) than who did not. Most (11) of those who made charcoal were not residents and these, 9 were men and only 2 were women.

During interviews in the three villages of Mahau, Manhangane-Um and Manhangane-Dois, it was learnt that charcoal production is a relatively new practice. Until recently, the people of Catuane apparently did not know how to make kilns for charcoal production. Without this skill, the local woodlands remained relatively intact, particularly where the population in the area was low. Charcoal production is largely attributed to the arrival of outsiders, most of them dislocated from their homelands during civil strife. The migrant communities had lost their means of survival in the process of fleeing for their safety, and charcoal making was identified as a practical and quick way of making money to meet their immediate basic needs. Importantly, a market existed for charcoal in the urban areas of Maputo. This created the impetus for charcoal production, which has expanded over time and space, raising concerns for the integrity of the woodlands in Catuane as deforestation spreads.

Table 5.10 Gender and participation in charcoal production.

Categories	Make charcoal				Do not make charcoal			
	Permanent resident		Non resident		Permanent resident		Non resident	
Gender participation	M	W	M	W	M	W	M	W
Mahau	1	1	4	1	2	1	-	-
Manhangane-Um	1	1	3	1	1	1	1	1
Manhangane –Dois	1	-	2	-	5	1	-	1
Subtotal	3	2	9	2	8	3	1	2
Total	16				**14**			

Source: Field Survey
(M=Men and W=Women)

Of those interviewed, 53% sustained their livelihoods by making charcoal all year round. The remainder responded that that they were not engaged in charcoal making as their major source of livelihood. This suggests that they are multiple resource users engaged in varied subsistence activities.

Four of the nine women included in this study were full time charcoal makers. Some of the reasons advanced by respondents for engaging in this activity included the death of a husband, absence of the husband over an extended period of time, as well as it being a way of contributing towards meeting household needs.

The majority of the respondents (95%), who make charcoal and who do not make charcoal, expressed the opinion that Catuane is endowed with tree species (Table 5.4) suitable for charcoal making. This makes charcoal from Catuane compete favorably in the market, as customers desire charcoal that will give value for money. However, both categories of respondents expressed concern about the growing levels of deforestation, which they attributed to high levels of poverty among the people of Catuane.

5.6 Perceptions of the need for the cultivation of trees for charcoal production

People's perceptions are a central issue in the success or failure of the proposed intervention. Fifteen respondents (50%) supported the idea of cultivating trees. The majority of these (10) are those who stated that they do not make charcoal, and are original inhabitants of Catuane (see Table 5.11). However, the majority (10 of 16) of those who make charcoal did not support the idea and elaborated that because trees take a long time to grow before they can be harvested, they do not provide immediate benefits. Some (13%) of the respondents expressed uncertainty, elaborating that they did not know about the feasibility of such an initiative.

Table 5.11 People's perceptions of cultivation of trees.

Categories	**Support**				**No support**				**Uncertain**			
	Permanent resident		**Non resident**		**Permanent resident**		**Non resident**		**Permanent resident**		**Non resident**	
Gender participation	M	W	M	W	M	W	M	W	M	W	M	W
Make charcoal	1	0	3	1	0	1	9	0	0	0	0	1
Do not make charcoal	6	4	0	0	0	0	1	0	1	0	1	1
Total	15				11				4			

Source: Field Survey
(M-Men and W-Women)

Eleven of the 13 permanent residents supported the idea of cultivating trees, whereas only 4 of the 17 non-residents favoured it. This suggests that while the permanent residents are concerned about the future of their local environment, it is arguable that non-residents are in Catuane for "business" and they care less about what happens to the local environment because they may migrate to alternative areas.

5.7 Government and non-governmental extension and support

5.7.1 Policy and legislation

Presently Mozambique is emerging from the destructive impact of 25 years of civil strife. The country is going through a period of significant transition, from a single political party to multi-party politics, from a centralised to free market economy, from refugees and war to new investment and economic development (GOM, 1998; Anstey, 2000). Part of this transition process includes the development of new policies and legislation covering a wide range of issues.

The forestry and wildlife legislation approved in July 1999, introduces and emphasizes the concept of participatory management (Table 5.12). The new legislation provides for delegation of authority and responsibility and the empowering of local communities for the management and control of their surrounding natural resources. It includes legal mechanisms that facilitate benefit sharing based on CBNRM principles (North, 1990; Murphree, 1993; Chabal and Daloz, 1999; Kumagwelo, 2000). Rules are established by community, authority and / or custom to control and remedy over harvesting of indigenous woodland resources (Da Cunha, 1998).

The National Directorate of Forestry and Wildlife-DNFFB acknowledges the importance of natural resources in sustainable development and has expressed its purpose as the protection, conservation, utilization, development and sustainable use of forest and wildlife resources for the economic, social and ecological benefit of present and future generations of Mozambicans (GOM, 1998). It is intended that in the long term, this strategy will reduce current pressures on the resources, and promote sustainable use as an alternative to deforestation.

Table 5.12 Evolution of policies and Legislation that regulate management and utilisation of indigenous woodland resources in Mozambique.

LAWS, POLICIES, REGULATIONS	MAIN THEMES AND PROVISIONS
▪ Nationalization policy of 1975	▪ Revoked some property rights thereby discouraging privatisation as well as the evolution of some institutions in the private sector
▪ The structural adjustment programme adopted in 1987	▪ Reverses the nationalization policy, with the aim of promoting the participation of the private sector in production ▪ and liberalization of the terms of trade
▪ Environmental policy of 1995	▪ A base for sustainable development aimed at eradicating the poverty and reducing the environmental impact to improve the quality of environment and people's livelihoods
▪ Land law and tenure of 1997 (Lei nº. 19/97)	▪ Encourages both the public and private sector to participate in the development of the sector
▪ Environmental law of 1997	▪ Executes the environmental policy, co-ordinates, supervises and controls and provides incentives for correct planning and utilization of natural resources
▪ Forestry and wildlife development policy of 1997 (BRI: 14, 1997)	▪ Governing the access and ownership of resources, emphasize management of natural resources with community involvement
▪ Land Law regulation of 1998 (GOM 66/98)	▪ Guardian of the resources, holding power for allocation, awareness raising of community rights and obligation stated in the law
▪ Forest Law and wildlife of 1999 (GOM: 10/99)	▪ Resource tenure and utilization policy ▪ Delegation of power, benefits sharing based on CBNRM

Sources: (GOM, 1999; GOM, 1998; Da Cunha, 1998; GOM, 1997; GOM, 1996).

5.7.2 Tenure

During the previous political regime the state assumed tenure over all natural resources. By contrast the present government envisages reinstatement of common property tenure regimes, and encourages the public and private sectors to participate in the development (CEF, 1992; DNFFB, 1991). Currently the land is still owned by the state and the state defines the rights and conditions for use. Rights of use (usufruct) can be granted to individuals and groups. The land rights are still not well defined and this has provided a major shortcoming in the promotion of tree cultivation by the communities, because they do not easily accept the need to plant trees that may take 8 to 10 years to harvest, without having rights to use the land where trees are grown. If the community does not secure rights to land use, the risk of losing trees that are already planted is perceived to be unacceptably high, making the effort worthless. Where communities have secured their rights to land use, for example, the Kwa-Jobe Community in north-eastern Kwa-Zulu

Natal in Ubombo District, South Africa, there is evidence of a willingness to engage in the process of cultivating trees (RSA, 1998).

In terms of current land and forestry legislation of Mozambique, communities can be granted rights to own the land if it is proven that they have lived on that parcel of land for more than ten years (>10years). Land use rights can also be given renewable concessions to individuals or collectives for 50 years. In such cases communities occupying that portion of land must be consulted before the right to land use is given to other individuals or investors.

What becomes evident is that the impediment in establishing cultivation of trees is not in the legislation itself but rather in the ability of government to administer the allocation of tenure and regulations of land use. This suggests a failure of extension services. It is noticeable that whilst government is to promoting CBNRM, which requires allocation of rights and redefinition of tenure, there remains considerable centralization of control over forestland issues and over the disposal of wood products. This includes permits/licenses for cutting and transportation of wood aggregates (GOM, 1998). The distinctions between large scale commercial and local community based commercial operations are not sufficiently clear, and this may contribute to the inertia in allocating rights to use land.

5.7.3 Extension services

Evident from the aforegoing is that local people require extension support both to gain rights of land use and to cultivate trees (Hanking, 1987). Extension is an important service to influence the perceptions of local people encouraging them to adopt interventions and innovations, such as cultivating of species as a source of wood for charcoal production. They clearly need access to extension officers with experience in the policy, legislation, administration and forestry extension.

Presently two extension officers from DDADER are active in the study area. They are assisted by HELVETAS who are providing extension services for the small-scale cultivation of trees (Figure 5.9). They coordinate activities at community level, by involving and mobilizing local communities in the area, providing some training and technical support in seedlings productions and planting.

The responses to the survey suggest that this initiative may not be sufficiently comprehensive and integrated. Applying the framework on page 35, it is suggested that amongst the community, if indeed one exists, there are quite different perceptions of the 'state' of the woodlands and of the 'pressures' bringing about that state. In practice, whilst policies seem to accord with perceptions of a need for allocation of rights they are failing to do this and so they fail to regulate the pressures. It is suggested that acknowledgement of the pressure, state, perception, and policy framework (Figure 4.2, p. 31) by government, would encourage a comprehensive and integrated approach.

The findings have shown that environmental conditions in the study area are harsh. In spite of these conditions, certain woody species can grow and some of these were found to be suitable for charcoal production. Among these are indigenous and at least over time scales that permit the quick response necessary to halt and remove current trend in deforestation. Neither environmental conditions in the study area nor species suitability are amenable to change, at least over time scales that permit quick response necessary to halt the current trends in deforestation.

The findings showed diverse perceptions with some people, mostly residents of the area, accepting silviculture whilst others showed less support, and a minority were uncertain. The support and extension services provided by the government and NGOs operating locally appear neither well founded nor integrated. Of principal concern is the absence of an integrated management system that leads to a systematic, structured approach to the introduction of substitute species and sustainable use of indigenous wood resources. This forms the foundation of the analysis of the next chapter.

CHAPTER SIX

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The problem considered in this study (Figure 4.3) is the unsustainable use of naturally occurring wood resources, driven by poverty and local livelihood needs. These constitute the driving forces behind supplying the growing market for charcoal and wood fuel needs in the Maputo urban area. The pressure on woodland resources is high and growing and continued unsustainable use is likely to have long-term detrimental effects on biodiversity and the people who are directly or indirectly dependent upon the resources.

This situation calls for urgent measures and a proactive approach towards promoting the sustainable use of indigenous woodland is indicated. Whilst the natural environment is sub-optimal for the production of wood fuel, an even greater limiting factor at present is the absence of an integrated approach to wood fuel production and use. Two strategies applied simultaneously through integrated co-management are proposed (Figure 6.1).

The environmental conditions prevailing in the study area (Chapter Five) are unfavourable and likely to result in slow growth of cultivated species. Also, interviews indicate that only 50% of the people in the study area support cultivation of suitable species as a source of wood for charcoal production. So, participation in cultivation will require active facilitation and might be quite slow to take hold and become self-organised and self-sustaining. Cultivation of suitable species is therefore likely to be a slow process, which may take years until the benefits start to be generated. In this case, action needs to be taken now to ensure that use of the existing wood resources is well planned and managed. Thus, a dual strategy for solving the problem presented by this study is proposed, namely the management of indigenous woodlands for sustainable use, and substitution (Figure 6.1). This discussion considers these two strategies and the management process required for their implementation.

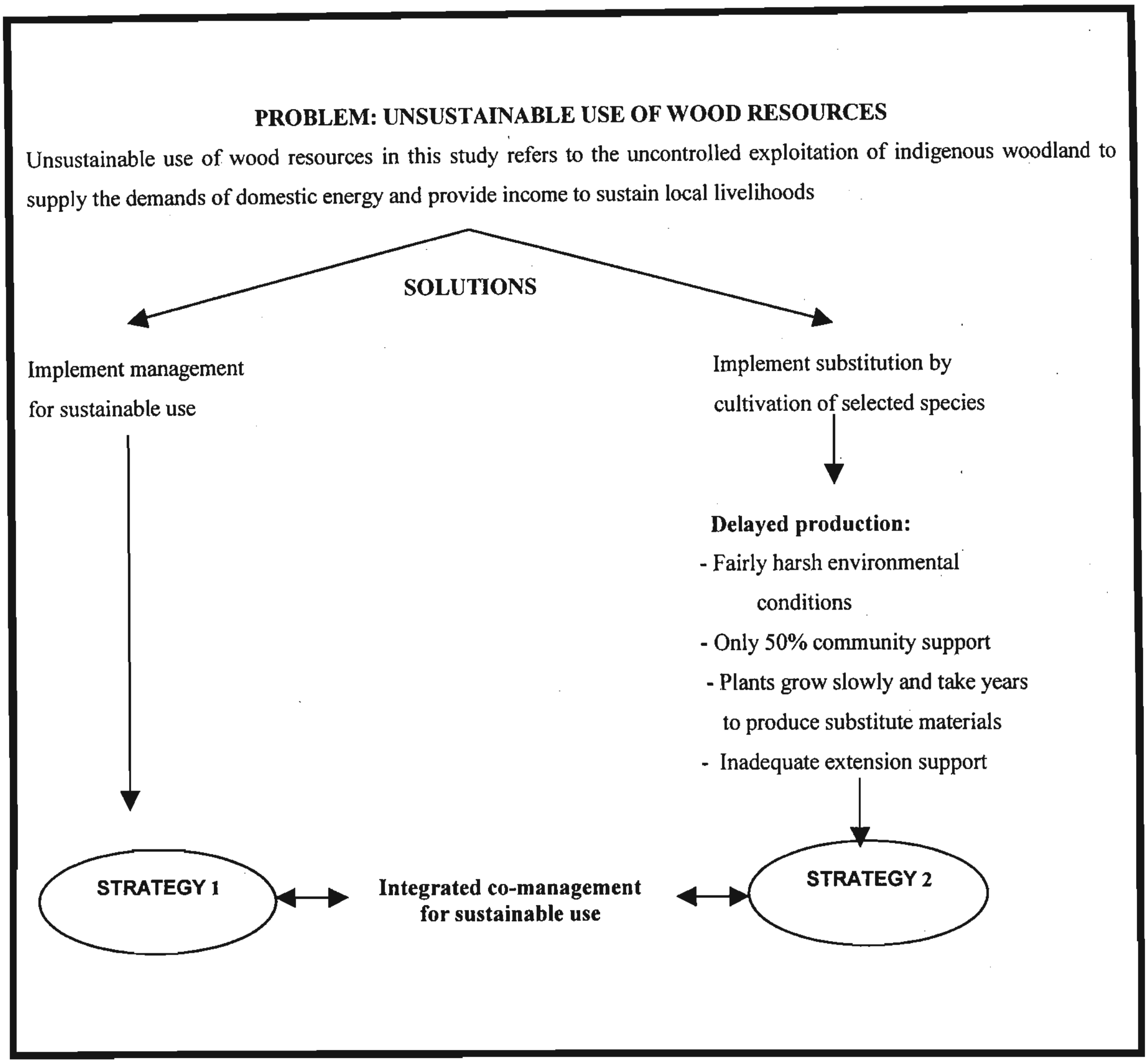


Figure 6.1 A framework illustrating the dual strategy proposed for promoting sustainable use of indigenous woodland and the integrated co- management system.

6.2 Managing for the sustainable use of indigenous woodland

The Mozambique government intends to promote the sustainable use of indigenous woodlands by implementing the policy of Community Based Natural Resource Management (CBNRM). In recent years there has been a consensus that community based forest management is the best option to tackle the problem of deforestation. This consensus stems from the fact that the national resource is too widespread, large and unproductive for government institutions or any other body, to police or manage.

In Mozambique, poverty dictates that economic incentives are a key to achieving the community based forest and natural resources management. It is improbable that people who are financially desperate will be able to put time and effort into formal, structured forest management (Devereaux and Palmeiro, 1999). The possibility of generating income could provide a sufficient stimulus for communities to become involved in actively managing the forest resources.

Hulme and Murphree (2001) emphasise that CBNRM has sustainable management of natural resources, through the devolution of control over the resources to the community, as its chief objective. CBNRM implies the regulation of use of natural resources by local stakeholders who could include a village, group of villages, and individual or group of individuals with shared interest in the resources. The fact is that stewardship over natural resources resides at local rather than the state level. This concept entails the principles of empowerment, capacity, authority and responsibility for planning, management, use and control of natural resources. Local communities are promoted and actively participate in decision-making processes to determine and manage the course of actions that affect their daily livelihoods. CBNRM is expected to generate benefits that motivate local community interest and aims to ensure long-term involvement in management. In doing so, it promotes sustainable use of resources to allow a continuation of benefits generation, without prejudice to the environment (Hulme and Murphree, 2001).

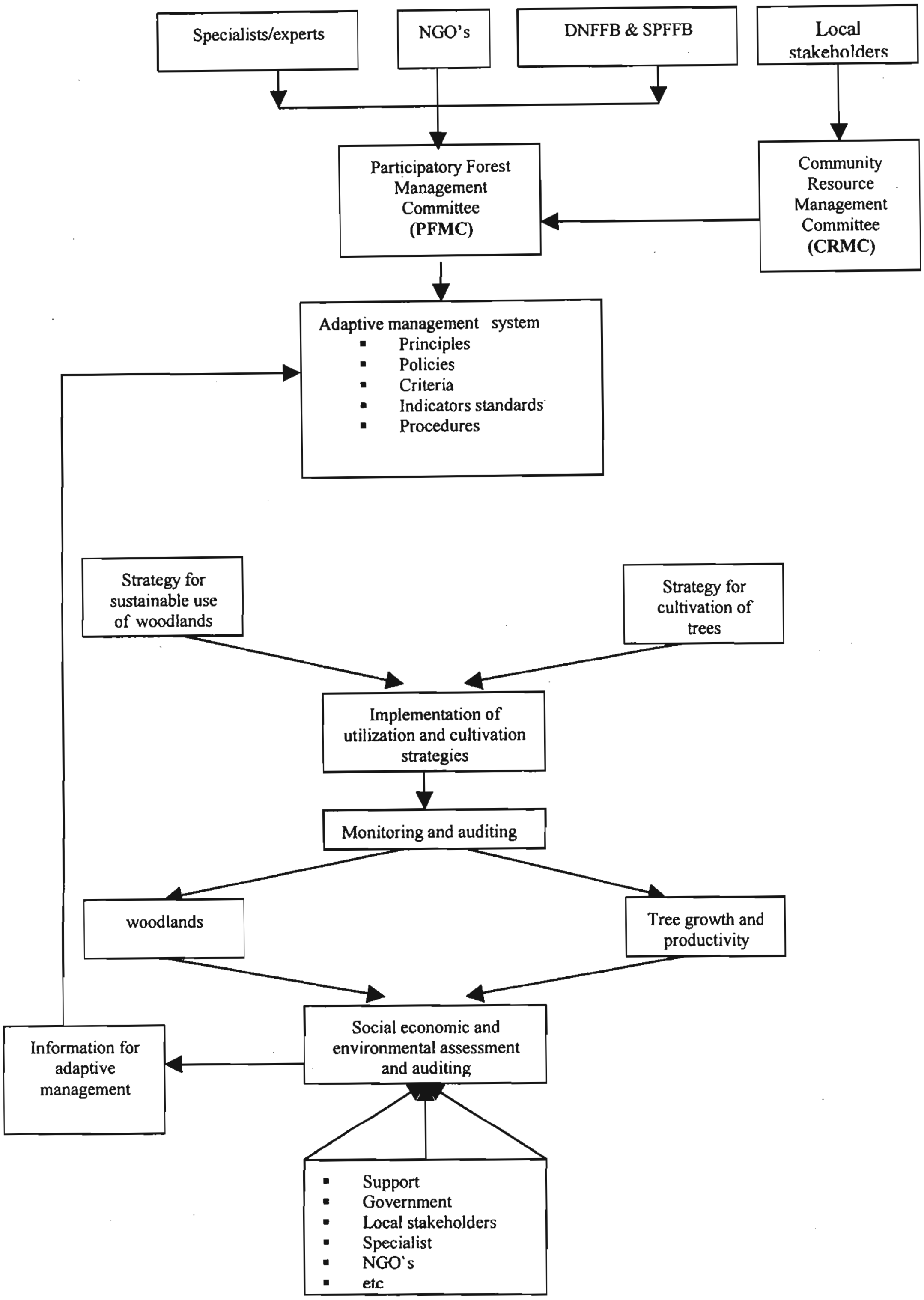
The efficiency and success of CBNRM initiatives depends on the degree to the authority and responsibility of local communities are linked. According to Barrow (1996), tenure is a key variable in determining the shape and performance of CBNRM. The term tenure refers to the rights of secure, long-term access to land and other resources, their benefits, and the responsibility related to these rights, this includes ownership, property rights, proprietorship and entitlement. The rights to resources can be conferred by the state, or they can arise from customary law derived from the norms or practices of traditional institutions. In CBNRM, local communities have the status of ownership and tenure (Bruce, 1989). They own the land and its resources including the rights, privileges and limitations to use of a resource. These include *de jure* and *de facto* rights to use and sale of a resource. These rights come with responsibilities, particularly that use should conform with relevant policies and legislation.

To achieve the objectives of CBNRM, it is necessary to establish a structure and management process that adequately responds to needs and that will promote collaboration between stakeholders in resource use. Such a structure and process does not currently exist in the study area. Approaches proposed by various authors (Benello and Roussopoulos, 1971) suggest that it would require establishment of an effective and legitimate Participatory Forest Management Committee (PFMC) which must be democratically elected, with representatives that have the support and backing of the stakeholders.

The PFMC would be responsible for all matters relating to the management of the use of wood resources (natural and cultivated) in the area. Since cultivation will introduce new complexities, including private ownership of trees within an existing common property regime, a dedicated committee (CRMC) is suggested (Figure 6.2 and Table 6.1).

It is suggested that management system should:

- define conditions that are necessary to manage the resources;
- establish the legal framework and operating principles to enable stakeholders to participate in the management system;
- create administrative structures, procedures and mechanisms that would facilitate the establishment and implementation of policies;
- gather and increase information dissemination; expand opportunities for local people to access government and non governmental extension and support;
- and establish financial support and contracting mechanisms to support management activities (Brinkerhoff and Crosby, 2002; and Figure 6.2).



Source: Adapted from Lewis *et al.* (2002)

Figure 6.2 Organizational structures for the promotion of sustainable use of indigenous woodlands. Government and stakeholders collaborate on the Participatory Forest Management Committee.

Table 6.1 Two levels of committees to implement Participatory Forest Management Committee (PFMC) as part of the proposed institutional arrangements and management strategy.

	Level 1: Community Resource Management Committee
Composition	Local representative from each resource utilization group, this could be: ▪ Charcoal makers ▪ Others including vulnerable groups (youth, women and elderly) who might benefit from or be adversely effected by intended activities
Responsibility	▪ Represent interests of the resource users ▪ Represent interests of those who may be affected by implementation of strategies ▪ Feedback information to community and decision regarding rules and regulations ▪ Posses legal status in the community and powers to enforce and implement rules in relation to wood resource harvesting locally
Incentives	▪ Incentives should be attributed to representatives to motivate responsibility and dedication when carrying out their duties ▪ Disincentives should be attributed to representatives who fail to carry out their duties and responsibilities
Adaptive management [1]	▪ Monitoring system must be developed and implemented locally by the stakeholders. ▪ Monitoring should be based on utilization of local people and their knowledge and not rely on skills of specialists, as this would make implementation of monitoring system expensive and difficult to implement. ▪ Assessment would include economic and social benefits and costs capacities of resource managers to fulfil their responsibility ▪ Environmental activities such as woodland conditions and spread of exotic species
Allocation and regulation	Coordination process between PFMC and CRMC should be strengthened in order to Democratically determine: ▪ rights of use of woodland and land for cultivation ▪ and allocate harvest and planting quotas, and ▪ regulatory procedures
Enforcement and regulation	A regulatory system should be implemented to ensure that conditions and rules for wood harvesting and cultivation of trees are met and measures to control illegal users and uses are taken
Education and training	Capacity building and training on aspects such as policies, legislation, sustainable use, harvesting, cultivation and monitoring must be initiated: ▪ for democratically elected stakeholder ▪ administrators ▪ community extension personnel

[1] Including monitoring, assessment and auditing of impacts associated with wood resource utilization and cultivation of trees.

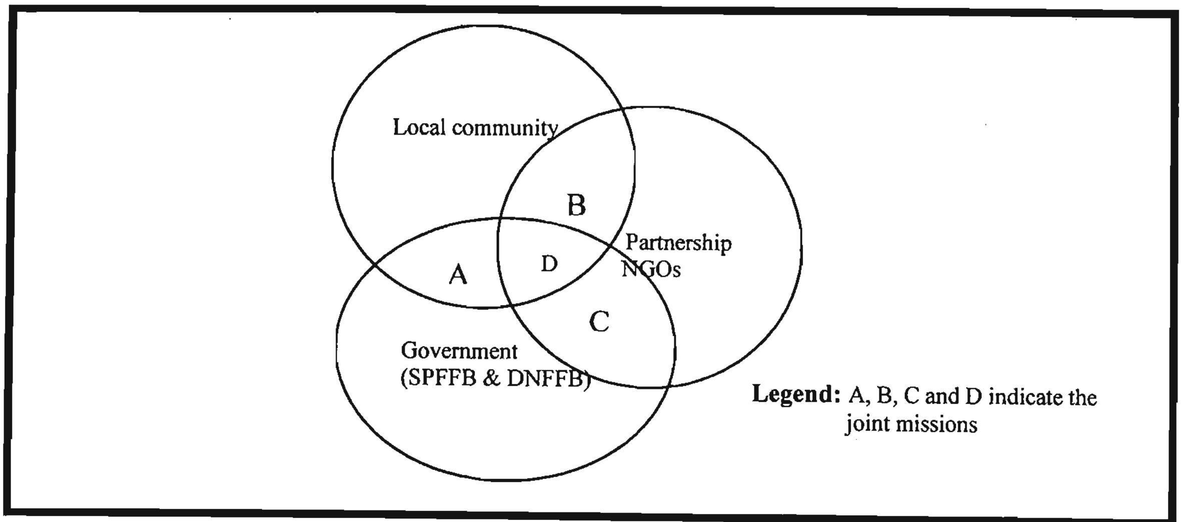
Table 6.1 continued

Level 2: Community Resource Management Committee	
Composition	All interested constituencies and groups: • Representatives from Community based Resource Management Committees (CRMC) • NGO's operating locally (i.e. FNP and HELVETAS) • Local authority representative of chief administrative post and district authority • Provincial government (SPFFB) • Specialists/experts (foresters and resource managers) • National government (DNFFB)
Responsibility	Planning and implementing an integrated management strategy for the study area that would cover a range of issues including: • Conservation of indigenous woodland resources • Optimising contribution to development of local economy and country as a whole Local management plan would include: • Securing financial and technical resources • Conflict resolution • Promotion of legislation regulating of harvesting and silviculture • A strategy for sustainable harvesting from woodlands • A strategy for tree cultivation • Equity in distribution of costs and benefits • Design and implementation of adaptive management system • Development of human resources
Incentives	Use of generated information to adapt management, e.g. • To regulate quantities for harvesting as well as the rules for harvesting • To regulate introduction of exotic species and areas for planting
Adaptive management	PFMC would be responsible for determining • Quantities of wood resources to be harvested • That allocation of wood resources to be harvested be based on consideration of sustainability and equitable distribution of costs and benefits • Selection of sites and participants for development of silviculture • Harvesting regimes
Allocation and regulation	• Establish and enforce legal requirements • Provide for enforcement • Report on enforcement and regulation
Enforcement and regulation	• Establish and enforce legal requirements • Provide for enforcement • Report on enforcement and regulation
Education and training	SPFFB and DNFFB staff would benefit from training and develop local capacity to implementing a system for assessing trends in the conditions of resource base. These skills would provide information to PFMC on the impacts of legal harvesting of wood and utilization by stakeholders. The communities must ensure that its members are informal and have the necessary skills and expertise to provide guidance and support. Important fields are: • Adaptive management • Communication and conflict resolution • Sustainable harvesting • Silviculture • Charcoal production

Adapted from Lewis *et al.* (2002).

Effective Community Based Management requires that agreed authority for decision-making and the planning for the management of use of the wood resources is decentralised to local levels and if silviculture is implemented, it is done so through a participatory approach. A common misconception in developing and implementing a participatory approach is to regard only the local people as participants. In fact, all parties are participant in a common process. The intention should be to strengthen democratic procedures at all levels so that strategies and implementations reflect the desires of all stakeholders and have their support (Salafsky and Margoluis, 1999; Fenn, 1991). It should be appreciated that partners drawn from local stakeholders, non-government organizations and government may have quite different missions. It is, therefore, very important that the parties agree on their joint missions (Figure 6.3). Failure to do so maintains conditions of conflict. Co-management is established to promote effective resolution of issues such as differing missions, jurisdictional disputes and conflicts in multiple resource use (Ingles *et al.* 1999; Benedickson, 1992).

Co-management has been defined as "the integration of local and state levels in environment and natural resources management systems in partnership arrangements where power and responsibility are shared between the government and local resources users" (Brinkerhoff and Crosby, 2002, p.98).



Source: Adapted from Salafsky and Margoluis (1999, p.98)

Figure 6.3 A model illustrating collaborative management.

The model depicted in Figure 6.3 illustrates that whilst various stakeholders may have different missions, they can at the same time develop their shared missions.

Partnerships are evident in the study area although they are not adequately developed. The "Forum para a Natureza em Perigo-FNP" has been established to support a community guard project to take care of existing indigenous woodland resources, and HELVETAS assists local communities in promoting cultivation of species suitable for fruits/food, building materials, wood fuel and others uses.

Establishing co-management and partnerships for promoting sustainable use of resources is not in itself sufficient for achieving the intended outcomes. Supporting services (financing and training), are also required (Lewis *et al.* 2002). For partnerships to function effectively, the state needs to exhibit the willingness and capacity to respond effectively and appropriately to secure commitment from local people (Coston, 1998a; Migdal, 1988; Tendler, 1997). Making partnerships in natural resources management work involves actions by all partners (Heap, 1998). It also requires change in the way participants operate severally and jointly. Senge *et al.* (1999) have exposed how complex organizational change is and how individuals respond to the need for change. It is evident that this issue has been grossly underrated as a factor in establishing effective co-management for the sustainable use of natural resources. Because all participants have to change in order to establish shared missions and to implement new behaviours and so all need to be empowered. For too long empowerment in CBNRM has been designed for local people in isolation. A pre-requisite for successful management is that all participants should be envisaged as being empowered for a common purpose (Brousell, 1992). Empowerment has been used in several contexts including quality management, self-work teams, continuous improvement and participative management (Gerald *et al.* 1997).

According to Kirkpatrick (1992) empowerment is not simply granting power. It entails a more equitable sharing of power and a higher level of political awareness and strength for disadvantaged groups (Brinkerhoff and Crosby, 2002). Such definitions are however, inadequate because they do not sufficiently emphasize empowerment for joint decision-making. It is suggested that a more appropriate definition of empowerment in CBNRM would emphasize:

- co-management that enhances capacity building with stakeholder organizations;
- strengthening the legal and financial status of these organizations; and
- supporting initiatives conceived independently by stakeholders to establish and enforce rules governing their resources base, within a broad environmental policy framework (Western and Wright, 1994; Brinkerhoff, 1999b)

Ingles (*et al.* 1999) defined collaborative management arrangements that are negotiated among various stakeholders involved in multiple resource use. He based this on a package of rights, privileges, and ownership and tenure status recognized by the government and widely accepted by the resource users. The definition reflects the process of power sharing among stakeholders for decision-making and control over the resources use. Therefore, local institutions will only function if they are well organised. Hulme and Murphree (2001, p.26-27) suggested that any organisational vehicle for such collaboration is likely to require four characteristics: cohesion, demarcation, legitimacy, and resilience.

Cohesion

This refers to a sense of common identity and interest, which serves to bring people together for collaborative action, and leads them to collectively differentiate themselves from others. At its core this characteristic arises from subjective perceptions although it is fed by instrumental considerations. Its sources commonly arise from a shared history and culture, although it may be a product of political and economic factors that force people to share a finite resource base. Notwithstanding its history, cohesion is the 'social glue', which persuades people in spite of their differences, to act collectively to enhance mutual interest and represent it to others.

Demarcation

Cohesion sets social boundaries and determines membership. A parallel requirement is demarcation, which sets the boundaries of jurisdiction for the collective regime. This demarcation is commonly based on spatial criteria through the delineation of a fixed land area and the resources on it. It may however be drawn on the basis of socially sanctioned access to given resource categories as in the case of pastoralism or some fisheries. Definition of jurisdiction limits and reinforcing authority and responsibility for the collective grouping are necessary for efficient organizational activity.

Legitimacy

Collective organization requires demarcation and legitimacy for its processes and leadership, which needs to relate to both power and authority. External authority can confer legitimacy but this on its own tends to be a necessary but not a sufficient condition. More important is the requirement of internal legitimacy which arises from socio-cultural and socio-economic criteria. In many contexts, these criteria are inconsistent with those which modern African states currently seek to impose on rural populations. Not surprisingly, the persistent and adherence to them creates tension and conflict. Shared legitimacy endogenously by communities and sanctioned by the state is likely to produce a more robust base for organization and operation.

Resilience

In the rapidly changing context of rural Africa the components of social organization are dynamic. The roots of social cohesion may change in their substance and combinations. Boundaries of jurisdiction and affiliation may shift. The sources of legitimacy may change. Effective organization must accommodate this change, evolving over time. Resilience, namely the organizational capacity to adapt in content and structure is a key tool for the management of risk in uncertain environments and livelihood systems. This characteristic provides durability to organizations and creates scope for them to improve through processes of adaptive management.

These characteristics of cohesion, demarcation, legitimacy and resilience will need to be considered carefully by both the CRMC and the PFMC (Figure 6.2) if:

- the desired collaboration is to be achieved
- the spatial jurisdiction is to be unquestionably demarcated;
- legitimacy is to be achieved; and

- if the required resilience to cope with change is to exist.

This research has highlighted the importance of developing a framework that provides both the structure and the management system on which to base management for the sustainable use of natural resources. It shows that in the context of the study area, the structure and management processes to the extent that they exist, are inadequate. Furthermore, the research indicates that the approach adopted to empowerment is superficial and therefore not likely to yield the intended outcomes. It is necessary to acknowledge the complexity of the system (structure, management and empowerment) and design an approach that can operate effectively within such complexity. Systems thinking lies at the heart of achieving this.

6.3 Scale of cultivation

This study was a first step towards developing a structured approach to the cultivation of suitable species as alternative sources of wood for charcoal production and fuel wood. Within the context of sustainability, the intention is to retain harvesting of indigenous woodlands but at sustainable levels to benefit the people who depend on them. Cultivation on a household scale of suitable species can provide large volumes of fuel wood, timber, building poles and non-timber products. It helps local communities to meet their own tree product needs (Gregersen and McGaughey, 1985). The growth of suitable species provides a basis for increasing smallholding incomes and diversifying sources of income, while taking advantage of land that is not always well suited for other purposes (Hanking, 1987).

The government of Mozambique has opted for a participatory style of indigenous woodlands management to achieve a balance between the demand for energy and realistic projections of wood fuel supply (DNFFB, 1998). In Mozambique in the 1980s, a participatory approach to cultivation of suitable species by households was obligatory and there were incentives to encourage the participation of local communities. The result of this research show that participation was limited and the intended results were not achieved. This suggests that the approach adopted did not acknowledge the inherent complexity of the household production system and therefore, it was neither holistic nor sufficiently long term. The challenge posed this failure is to devise and implement a process founded on a shared mission and responsibilities that leads to a continuous and steady supply of wood fuel, while conserving the environment. Forestry legislation and associated regulations have been promulgated to help realize the full participation of the local communities (Table 6.2) in management for the sustainable use of indigenous woodlands through CBNRM (Matakala and Mushove, 2001; GOM, 1998). Changes in the roles of and behaviors of the partners in the forest sector are required to attain the desired goal of effective participatory management (Brouwer and Magane, 1999).

Table 6.2 Policy reforms 1990-2000 that support CBNRM in Mozambique.

Law	**Commitments to CBNRM**
Changes in the Constitution of Republic 1990	Gave place to multiparty democracy and promoted policies of decentralisation
Local Government Policy and Act 1990	Transferred powers to democratically elected local structures
Land Policy 1995	Guaranteed tenurial rights to local communities over land
Environmental Law 1997	Promoted community participation and planning in decision making and utilisation of natural resources
Land Law 1997	Guaranteed customary rights to access the land resources and promote the local authority in managing land and solution of conflicts
Autarchy Law 1998	Devolved municipality authorities to protect and generate benefits from natural resources while facilitating community involvement in collaboration with traditional authorities
Forest and Wildlife Act 1998	Emphasised role and rights of local communities in planning and management and benefits from natural resources
Forestry and Wildlife law 1999	Promoted community participation in managing sustainable use of resources
Decree on Decentralisation and Administration 2000	Recognised the local authority and value the community social organisation and improvement of conditions for their participation in public administration for cultural and socio-economic development of Mozambique in relation to decentralisation of administration

Source: adapted from (Hulme and Murphree, 2001; Da Cunha, 1998; DNFFB, 1998; Negrao, 1998).

6.4 Conclusions

This research set out to establish the feasibility of intervention through cultivation of suitable species as an alternative source of wood for charcoal production. The extent to which this aim was achieved is considered in relation to the three objectives of the study:

- *conduct a 'desktop study' to determine whether there are suitable species which could be cultivated in the area to meet the demand for charcoal production and fuel wood;*

Environmental conditions were shown to be to be sub-optimal for silviculture. A review of literature included identification of suitable species that are both hardy and potentially suitable for charcoal production at the study site. Field trials are required to establish feasibility of cultivation.

- *Determine whether cultivation of trees would be acceptable to local people;*

Respondents from three villages held different views on the acceptability silviculture. These perceptions were evidently shared at least in part, by appreciation for the time taken for trees to grow to harvestable size. The findings indicate a need for committed and informed extension based on empathy for the plight of local people. This is particularly challenging because this study shows that most of those involved with charcoal production are not local people.

- *Determine whether silviculture for charcoal and wood fuel production would receive support from government by way policy, legislation and extension.*

The findings show a disjunct between the intentions of government to promote CBNRM and their ability to do so. It is shown that extension officers are not sufficiently empowered to be able t support and build capacity among local people. The need to adopt a framework that would serve to build a better understanding of government's role in community-based silviculture and of the processes and skills is highlighted. A framework for integrated management is proposed.

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Smith, C., 2001. *Personal Communication.* Expert in silviculture, Institute for Commercial Forestry ResearchPietermaritzbuig.

Xigogwane, M., 2001. *Personal Communication.* Local resident in the study area.

Zandamela, 2001. *Personal Communication.* Local secretary of ManhanganeUm village.

APPENDIX I: Research questions

Charcoal production:

1. What are your thoughts about charcoal production? ***(Probe benefits/difficulties/reasons for charcoal production, i.e. its role in the community)***
2. In your opinion, does Catuane have suitable tree species for charcoal production? ***(Probe on size - big/medium/small trees; abundance or scarcity).***
3. Are there preferred tree species normally used for charcoal production? (Probe for example name and reasons if possible)
4. Is any one allowed to make charcoal? Can somebody from another village make charcoal in this area?*(Probe reasons for either allowing or not allowing; and whose responsibility it is to allow/ deny* access)
5. Do you make charcoal?

Problems:

Charcoal Makers	**Non-charcoal Makers**
6. Do you have sufficient wood to make charcoal?	Do you have sufficient wood for (probe: fuel wood; construction purposes, etc.)
7.Do you experience any problems in charcoal production?	Is harvesting of wood for charcoal production creating any problems for you (probe: fuel wood; construction purposes, etc.)
8. Do you travel further distances/hardship to charcoal production sites	
9. If the distance to charcoal production sites is further than before:	
▪ How are charcoal makers responding?	▪ How is the community responding?
10. What initiatives would help to resolve charcoal production related problems?	

Social acceptability:

11. Are trees cultivated in Catuane? ***(If 'Yes', what for; if Not, probe for the reasons)***

12. If yes what species are currently grown?

13. How suitable are the trees for fuel wood; construction/ building; medicinal; timber/ firniture; fencing, etc. (***Probe to get idea of perceptions about forestry as an intervention***)

14. If 'Yes' (i.e. cultivated trees being suitable for charcoal making); would people be willing to cultivate them for charcoal? ***(Probe reasons for either case)***

15. What will be the potential problems with cultivation of trees?

Extension services (Policy and legislation):

16. What would be the role of the following in tree planting initiatives? Government; NGOs/ CBOs; Community and the tribal authority.

17. Would the tribal authority support? Yes/No, (unwritten policy) – ***(ask traditional leaders what they see as being their role and whether they would support such initiatives – if yes, probe how they would do this; If 'No' probe the reasons for not supporting such an initiative***).

APPENDIX II: Key informants contacted during field research

Person contacted	Institution
Peter Gardner	Mondi Forestry, Pietermaritzburg
Collin Smith	Institute for Commercial Forestry-ICFR, Pietermaritzburg
Carla Ruas	Direcção Nacional de Florestas e Fauna Bravia-DNFFB, Maputo
Helio Neves	Provincial Services of Forestry and Wildlife-SPFFB, Maputo
Mabote	HELVETAS-Matutuine District
Jaimito	Agriculture District extension officer-Matutuine District
Antonio Reina	Forum para a Natureza em Perigo (FNP), Maputo
Habibo Manuel	Catuane Community Game Guard
Tembe	Local authority (secretary), Catuane