MOPANE WOOD UTILISATION AND MANAGEMENT PERCEPTIONS OF RURAL INHABITANTS IN THE GREATER GIYANI MUNICIPALITY, LIMPOPO PROVINCE

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ABSTRACT

This study reports the findings about the utilisation and management of mopane woodland resources by rural inhabitants in the Greater Giyani Municipality, Limpopo Province. The main aim was to quantify the amount of wood and other non-wood products used by villagers and to determine their perceptions on woodland resources management. Mopane woodland is an essential source of firewood and poles used for construction of traditional structures. The role played by non-wood products in the socio-economic wellbeing of villagers was also assessed.

In six sampled villages in the Greater Giyani Municipality, a total of 180 villagers were interviewed, together with 13 traditional leaders and 10 conservation officials. Three villages were located in woodland depleted areas and three in woodland abundant areas. Semi-structured and participatory approaches were followed to obtain data on mopane woodland resources utilisation, conservation and perception of villagers on woodland resources management. The amount of wood used by villagers for firewood and construction was quantified by weighing and measuring the length, circumference and diameter of the poles. Mass and volume of wood used by a household for firewood and construction was also estimated.

Colophospermum mopane is the first choice for villagers for firewood and in construction of traditional structures. Villagers also obtain traditional medicines from woodland, and mopane worms as a nutritional supply and for generating household income. Notwithstanding the value of mopane woodland resources to rural life, woodland resources are over-harvested (as a result of poverty) and mis-managed. This was intensified by lack of responsibility in the management of woodland and lack of capacity within the municipality to enforce conservation regulation. Lower levels of participation in woodland management have resulted in higher levels of woodland degradation. Most villagers perceive woodland resources as common property, giving themselves rights over the use of such resources. These factors have increased the likelihood of illegal harvesting of woodland resources and overall depletion of the surrounding woodland resources, depriving communities from the full range of benefits that derived from woodland. Changes in woodland management regimes in rural areas were examined and possible options to promote sustainable use of woodland resources in rural areas were proposed.

Keywords**:** *Colophospermum mopane*, firewood, management, mopane worms, poles, woodland resources.

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DEDICATION

This dissertation is dedicated to my late uncle Mr France who passed away in the initial stage of this study (March, 2004). I will always miss his motivational support. May his spirit rest in peace.

DECLARATION

I hereby declare that the material presented within this dissertation is to the best of my knowledge and belief, original and my own work except as acknowledged in the text. This material has not been submitted either as a whole or in part for a degree at any other university.

Rudzani Albert Makhado

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Signature Date

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ABBREVIATIONS

ABET- Adult-based Education and Training

AusAID- Australian Agency for International Development

CAMPFIRE- Communal Areas Management Programme for Indigenous Resources

CBC- Community-based Conservation

CBD- Convention on Biological Diversity

CBNRM- Community-based Natural Resource Management

CIDA- Canadian International Development Agency

CIFOR- Center for International Forestry Research

CSIR- Council for Scientific and Industrial Research

DEAT- Department of Environmental Affairs and Tourism

DEDET- Department of Economic Development, Environment and Tourism

DFID- Department for International Development

DME- Department of Minerals and Energy

DPLG- Department of Provincial and Local Government

DST- Department of Science and Technology

DWAF- Department of Water Affairs and Forestry

EDF- Ecological Development Fund

EPA- Environmental Protection Agency

FAO- Food and Agricultural Organisation

FFI- Fauna and Flora International

HSRC-Human Sciences Research Council

INR- Institute of Natural Resource

JFM- Joint Forest Management

KNP- Kruger National Park

KNPSSS- Kruger National Park Scientific Services Section

LADA- Land Degradation Assessment in drylands

LEMA- Limpopo Environmental Management Act

LGA- Local Government Act

MEA- Millennium Ecosystem Assessment

NEMA- National Environmental Management Act

NEM:BA- National Environmental Management: Biodiversity Act

NFA- National Forestry Act

NGO- Non-Governmental Organisation

NISL-EI- National Information Society Learnership-Ecological Informatics

NRE- Natural Resources and the Environment

NRF- National Research Foundation

ISRDS- Integrated Sustainable Rural Development Strategy

OBE- Outcome-based Education

PFM- Participatory Forest Management

RDP- Reconstruction and Development Programme

RGBS- Rand Global Business Solution

SADC- Southern Africa Development Community

SAFIES- South African Forestry Industry Environmental Statement

SANPARK- South African National Parks

SEI- Stockholm Environmental Institute

SMMEs- Small, Medium and Macro Enterprises

SPWD- Society for Promotion of Wastelands Development

Statistics S.A- Statistics South Africa

UNCCD- United Nation Convention to Combat Desertification

UNDP- United Nation Development Programme

UNEP-United Nation Environmental Programme

UNESCO- United Nation Educational, Scientific and Cultural Organisation

USAID- United States Agency for International Development

WCED- World Commission on Environment and Development

WCS- World Conservation Strategy

WHO- World Health Organisation

ZFAP- Zambia Forestry Action Plan

CHAPTER 1

GENERAL INTRODUCTION

Mopane woodland at Makhuva village

1.1 Introduction

Colophospermum mopane (Benth.) J. Léonard, commonly known as mopane is one of the most important tree species in southern Africa. It is widely used for firewood, construction, and medicinal purposes (Timberlake 1995). *Colophospermum mopane* also hosts mopane worms, larvae of *Imbrasia belina*, which are consumed in large numbers by rural people (Palgrave 1983). It is the only species in the genus *Colophospermum* that belongs to the tribe Detarieae of the sub-family Caesalpinioideae in the Leguminosae/Fabaceae (Lock 1989).

Colophospermum mopane is one of the principal trees of hot, low-lying areas of south tropical Africa, reaching its southern most limits just south of the Olifants River in the Kruger National Park (KNP) (Werger & Coetzee 1978). It is widely distributed in southern Africa, ranging from southern Angola, northern Namibia to the Luangwa Valley in southern Zambia across Botswana into Zimbabwe to southern Malawi and northern Mozambique to northern South Africa (Figure 1.1). The total area in southern Africa under *C. mopane* and its associated vegetation is estimated to be 555 000 km^2 (Mapaure 1994). In South Africa, *C. mopane* dominates the hot arid-semi arid lowveld of the Limpopo River in the Limpopo and Mpumalanga Provinces (Mapaure 1994). The area covered by *C. mopane* in these provinces is estimated to be 23 000 km^2 (Mapaure 1994) and contributes to 50% of vegetation in the KNP (Fenton 1993).

Despite the value attached to *C. mopane*, Cunningham and Davis (1997) indicated that in some areas, this species is scarce, due to over-utilisation for firewood and construction purposes. Absence of management practices in most parts of southern Africa's mopane woodlands has resulted in minor degradation or the total devastation of woodlands with serious socio-economic and environmental consequences (Cunningham & Davis 1997). Kajembe and Monela (2000) indicated that a range of factors may be called to account for woodland degradation. Among these are technological and social changes, breakdown of traditional authority, commercialisation, modernity, urbanisation, and the intrusion of inappropriate state policies. Regulations related to woodland resource utilisation by local people created by past policies have also exacerbated woodland degradation at an alarming rate as a result of vandalism and poaching (Kayambazinthu 2000).

Owing to the above, many attempts have been made in southern Africa to conserve mopane woodland for future use. These include coppice management in Zimbabwe (Mushove 1996), seed storage in Mozambique (Ribeiro 1996), and traditional resource management in Namibia (Cunningham 1993; Conroy 1996), South Africa (Mabogo 1990) and Zimbabwe (Gumbo 1993). Forest policies and regulations such as the National Forestry Act No. 84 of 1998 in South Africa (DWAF 1998) have also been adopted, but with little success in conserving natural woodlands (Willis 2004).

1.2 Statement of the research problem

This research intends to study the utilisation and management of mopane woodland in the Greater Giyani Municipality of the Limpopo Province, in which its outcome will contribute knowledge that could assist in sustainable utilisation of mopane woodland of this area. It is envisaged that the high demand on *C. mopane* wood for construction, firewood, and medicinal purposes could ultimately result in a large scale loss of mopane woodland resources in the future, should appropriate management policies not be applied.

Although *C. mopane* could survive the annual effects of fire and uncontrolled utilisation through its coppice regrowth ability, its current ecological status, and management are uncertain in the Greater Giyani Municipality. In order to avoid the loss of this valuable tree species not only in the study area, but also in other areas of southern Africa, a study of the utilisation and management of mopane woodland by rural inhabitants is of utmost importance. This could help in developing conservation and management strategies that will complement or improve existing ones.

1.3 Description of *C. mopane*

Colophospermum mopane usually occurs as a small to medium-sized slow growing tree, between 4 and 8 m in height with a narrow crown. Under favourable conditions, it can attain heights exceeding 20 m (Palgrave 1983). The bark of *C. mopane* is fibrous, greyish-brown, very rough, deeply fissured and flaking, and so characteristic that it can be used to identify the tree when leafless (Palmer & Pitman 1972). The broad compound sclerophyll leaves consist of two sessile leaflets joined at their bases by a pulvinus. The leaflets are roughly narrowly triangular in shape, yellowish-green, shiny, and smell of turpentine when crushed (Werger &

Coetzee 1978). *Colophospermum mopane* is generally leafless from August to October until the new leaves sprout with the first rains (Timberlake 1995).

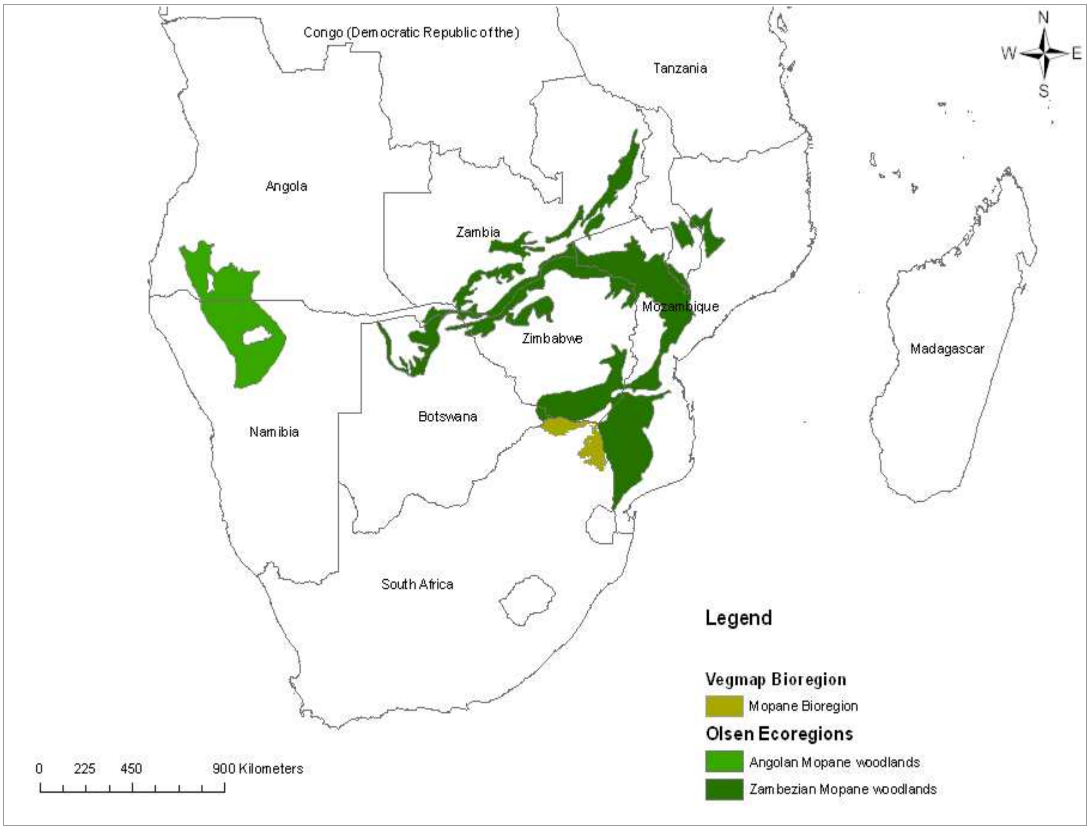


Figure 1.1 The distribution of mopane woodlands in southern Africa. This map is an extract from Mucina and Rutherford (eds) (2006) data on South African mopane bioregion and Olson *et al*. (2001) data on southern Africa mopane woodland ecoregions.

1.4 Determinants of *C. mopane* distribution

Colophospermum mopane is a drought tolerant species confined to areas of low to moderate rainfall (Timberlake 1995). Factors controlling the growth and distribution of *C. mopane* are uncertain, but seem to be influenced by edaphic and climatic factors (Madams 1990; O'Connor 1992). These include soil type, length of the growing season, minimum temperature and occurrence of other woody species that can out-compete *C. mopane* (Timberlake 1995). *Colophospermum mopane* is mostly distributed in soils such as alluvium and colluvium, which are essentially non-arable soils due to their shallowness, stoniness or poor drainage (Timberlake 1995).

The distribution of *C. mopane* in southern Africa is principally influenced by moisture availability expressed through altitude, rainfall and soil texture (Mapaure 1994; Okitsu 2005). It is normally distributed in areas ranging in altitude from 100 m to 1200 m (Werger & Coetzee 1978), typified by high temperature (~40 ºC) and an annual rainfall of between 200 and 800 mm (Werger & Coetzee 1978; Okitsu 2005). *Colophospermum mopane* also thrives in the transition of the Karoo-Namib region where annual rainfall is 100 mm (Werger & Coetzee 1978; Okitsu 2005). It mostly occurs in frost-free areas. Various reviews indicated that in areas where frost does occur, it becomes a limiting factor to *C. mopane* growth (Voorthuizen 1976; Werger & Coetzee 1978; White 1983).

1.5 Ecology of *C. mopane*

Colophospermum mopane is physiologically adapted to xeric (dry) conditions with low soil nitrogen and potassium (Dye & Walker 1980), but growth is more rapid when those factors are not limiting (Timberlake 1995). It grows in arid areas on relatively fertile/fine-grained soil, sandy-loamy soil, clayey soil, and deep soils having some calcrete layers on the surface. Soil under mopane woodland tends to develop high exchangeable sodium content (Werger & Coetzee 1978), which inevitably results in reduced permeability and increased susceptibility to soil erosion (Scholes 1997). *Colophospermum mopane* also survives on alkaline soils and is therefore considered as an indicator species of alkaline soil (Werger & Coetzee 1978). It grows up to 6 m in height on heavy impervious soils and up to 25 m in areas having sandy-loamy and alkaline soils receiving rainfall up to 1000 mm per annum (Werger & Coetzee 1978).

Colophospermum mopane grows in fire prone areas and can survive the effects of fire (Werger & Coetzee 1978). It generally occurs in almost exclusively dominant stands with very few other woody species, except for those associated with termitaria, drainage lines or rocky outcrops (Timberlake *et al*. 1993).

1.6 Aim and Objectives

1.6.1 Aim of the study

The aim of the study is to quantify the amount of wood and other non-wood products used by villagers within a resources management context.

1.6.2 Objectives of the study

The objectives of the study are to:

- quantify the amount of wood and other non-wood products used by communities;
- compare the utilisation and management strategies in villages that still have *C. mopane* trees and shrubs with those that have not;
- elucidate the willingness and perceptions of villagers to participate in proposed woodland management practices;
- determine the transfer of information on the utilisation and management of mopane woodland resources from one generation to another;
- draw up an inventory of species that villages use in mopane woodland in response to the scarcity of *C. mopane* resources; and
- make recommendations regarding woodland management.

1.6.3 Hypotheses

The hypotheses of the study are as follows:

- over-utilisation and mismanagement has led to the depletion of mopane woodland resources in the Greater Giyani Municipality;
- most youth do not have adequate knowledge about woodland management;
- where mopane woodland has degraded, alternative species are used, and
- proper woodland resource utilisation and management options can be developed.

1.7 Research assumption

The study area is dominated by coppice vegetation, from which wood is harvested daily for firewood purposes. This study examined whether woodlands degradation in communal land is a result of over-utilisation due to poverty, mismanagement, landuse development, grazing effect or frequent burning.

1.8 Justification of the research

Despite the ecological, social and economic significance of *C. mopane*, conservation data at local level is scanty or inaccessible to local people and relevant conservation agencies. Furthermore, limited information is available on the management of mopane woodland, which suggests that further studies are needed in order to conserve it (Timberlake 1996). Continued pressure such as over-utilisation of woodland results in the necessity to undertake this type of research in order to reduce woodland resource loss in future. It is envisaged that management practices that could emanate from this study and other similar studies, if properly implemented, could contribute to the sustained utilisation of *C. mopane* in the study area and other types of woodlands in southern Africa.

CHAPTER 2

LITERATURE REVIEW

Unemployed mother and her children in Mapayeni village

2.1 Ethnobotanical uses of mopane woodland

Woodland contribution of wood and non-wood products, in particularly to rural households is priceless (Shackleton *et al*. 2001). For many rural households, income generation from non-wood products is a supplementary activity, while for others it constitutes their primary source of income and livelihood (Shackleton & Shackleton 2004). *Colophospermum mopane* has numerous uses and is of considerable economic importance to millions of rural inhabitants throughout southern Africa. In southern Africa, particularly along the mopane belt, rural communities harvest several products from their surrounding woodlands and utilise them for construction purposes, energy, medicine and as cultural resources (Campbell *et al*. 1993; Cocks 2000) and to a lesser extent for crafting of hand hoes, furniture and musical drums (Grundy 1990). Mopane woodland is also nationally important for game farming, recreation and ecotourism industries. It provides habitat and food for a range of animal species (Styles 1996; Shackleton *et al*. 2002).

The ethobotanical and other uses of *C. mopane* are reported in the reviews of Timberlake (1995; 1996); Shackleton and Campbell (2000) in southern Africa, Grundy (1990; 1996; 2000) for Zimbabwe, Timberlake and Crockford (1994); Erkkilä and Siiskonen (1992) for Namibia, selected areas of South Africa (Shackleton *et al*. 2000b), for the Lowveld region of South Africa (Liengme 1981; 1983), for the Venda areas (Mabogo 1990; Madzibane and Potgieter 1999) as well as Mashabane *et al*. (2001) for the Giyani area of the Limpopo Province (see also Appendix 3).

2.1.1 Use of *C. mopane* for construction purposes

Where *C. mopane* is abundant, its wood is preferred for the construction of huts, animal kraals, maize granaries, fencing and household utensils (Erkkilä & Siiskonen 1992; Grundy 1996; Cunningham 1997). Its preference in construction is due to its durability and resistance to termites (Madzibane & Potgieter 1999). The VhaVenda (Mabogo 1990; Madzibane & Potgieter 1999) and Shangaan (Mashabane *et al.* 2001) people still utilise *C. mopane* poles in the construction of walls and roofing of traditional huts. The inner bark is used to make rope, which is used to tie poles and firewood during transportation (Mashabane *et al.* 2001) and in the construction of the roof structure of traditional huts (Van Wyk & Gericke 2000). In addition, *C. mopane* poles were historically used as railway sleepers and mine props (Palgrave

1983). The widespread use of *C. mopane* has resulted in a rapid depletion of mopane woodlands and their large-scale coppicing in many parts of southern Africa (Timberlake 1996).

2.1.2 *Colophospermum mopane* as energy source

Firewood is an important domestic energy source in developing countries (Monela *et al*. 1993). In southern Africa's mopane belt, rural inhabitants make extensive use of *C. mopane* for combustion-based heating and cooking (Liengme 1981, 1983; Winteringham 1992; Mashabane *et al.* 2001). *Colophospermum mopane* burns easily and emits less smoke than other species, making it a preferred species for cooking and heating in most rural areas (Liengme 1983; Mashabane *et al*. 2001). *Colophospermum mopane* composed an average of 39% of the weight of a total of 42 species harvested for firewood in the Giyani area (Liengme 1983). However, harvesting of firewood in some areas such as Giyani, Limpopo Province is intense, selective and unsustainable (Liengme 1983).

In *C. mopane* wood, the bulk of cells are thick-walled fibres and cells with calcium-oxidate crystals (Prior & Cutler 1992), resulting in slow burning fires (Tietema *et al*. 1991) and high temperature (>370°C) (Prior & Cutler 1992). Analyses at the Imperial College, London and Germany also found that *C. mopane* growing in hotter areas, had higher crystal concentrations than those occurring in cooler climatic zones (Prior & Cutler 1992). This results to *C. mopane* and *Combretum apiculatum*, both shallow-rooting trees, to contain more crystals and denser wood than *Acacia* species (Prior & Cutler 1992). When a piece of *C. mopane* wood is set alight, it tends to burn rapidly, producing carbon monoxide, which is flammable and raises the flame temperature. The released oxygen leads to fuller combustion of the carbon in the wood. This creates a "glowing" combustion, with the temperature ranging from 300 to 800°C. The result is a slow burning fire with glowing embers, which lasts for a long period (Prior & Cutler 1992).

2.1.3Medicinal use

Cunningham (1996) indicated that there is an increase in the demand for traditional medicine all over southern Africa to prevent and treat common illnesses (Vorster 1999). In South Africa, 70% of people use traditional medicines gathered from woodlands (Shackleton 2001).

This is a result of limited Western medical care in rural areas and their costs are prohibitive (Jaenicke 2004). This is also the case in the Venda area, where, despite all the advances in modern and orthodox medicine, traditional medicine still plays a significant role in the lives of many people (Mabogo 1990). Most investigations indicated that *C. mopane* leaves, barks and roots are used in the treatment of numerous diseases in southern Africa, as discussed below:

2.1.3.1 Leaves and bark

Young leaves and bark are used to relieve stomach pain, diarrhoea, whooping cough and sores/cancer (Mashabane *et al.* 2001). Leaves are also used as an anti-microbial agent in the treatment of septic wounds and in stopping excessive bleeding (Madzibane & Potgieter 1999). According to Van Wyk and Gericke (2000), the bark is also used to treat diarrhoea in cattle. Also, women travelling long distances by foot use *C. mopane* leaves as painkiller when treating chaffing of the inner thighs (Madzibane & Potgieter 1999). An extract from *C. mopane* bark is reported to be used for treatment of syphilis and inflamed eyes and dysentery (Timberlake 1995).

2.1.3.2 Roots

The roots are used to avoid gum bleeding, for treating kidney stones and bilharzia in humans, and swollen limbs in cattle (Madzibane & Potgieter 1999; Mashabane *et al.* 2001). Madzibane and Potgieter (1999) further indicated that thin *C. mopane* roots are used to stop diarrhoea and vomiting. The roots of *C. mopane* are also mixed with the roots of *Ziziphus mucronata* and *Senna italica* to treat women menstrual pains (Mashabane *et al.* 2001). In treating impotence, young roots of *C. mopane* are mixed with *Wrightia natalensis*, *Securidaca longipendunculata* and *Maerua edulis*. The roots of these plants are soaked overnight and the extract is taken three to four times a day. In the same way, the dry roots can also be pound into powder and mixed with alcohol, water or soft porridge. The patient drinks the mixture on a weekly basis (Madzibane & Potgieter 1999). It is further reported that Zambian use an infusion of roots to cure temporary madness (Palgrave 1956).

Moreover, rural people in southern Africa widely use *C. mopane* twigs to brush their teeth. It has been stated that a good chewing stick or toothbrush stick should have a fibrous texture, agreeable taste and some antibacterial activity that would protect teeth against toothache, dental decay and bleeding (Van Wyk & Gericke 2000). The gum obtained from the heated wood is believed to heal even the most stubborn wounds (Palmer & Pitman 1972).

2.1.4 Cultural resource

Colophospermum mopane trees are an important cultural resource in Namibia and few trees can match this veracity (Van Wyk & Gericke 2000). The Herero speaking people of Namibia use *C. mopane* trees during various special cultural and religions ceremonies. Only *C. mopane* wood is used for sacred fires and for the ceremonial removal of teeth (Van Wyk & Gericke 2000). Malan and Owen-Smith (1974) corroborate this by stating that during the customary extraction of the lower incisors of Herero children in Namibia, *C. mopane* leaves are utilised to promote healing of the lower jaw. Trees are still used in rural areas as shade during family gatherings, social gatherings and social drinking of traditional beer (e.g. marula beer) (Shackleton, 2005).

2.1.5 Recreation and ecotourism

Considerable parts of the largest and best-known national parks in southern Africa lie in the mopane belt. These include, most notably, the Limpopo Transfrontier Park between South Africa, Mozambique and Zimbabwe; the Mapungubwe-Tuli-Shashe Transfrontier Park between Botswana, South Africa and Zimbabwe, Chobe National Park in Botswana and the Etosha Park in Namibia. Mopane woodland is also important for game farming in southern Africa. Its existence contributes through the tourism, meat and leather industry to the economy of the relevant provinces (Venter & Venter 1996).

2.1.6 Food and habitat for animals

Mopane woodland provides palatable forage to wild animals such as elephants (Bonsma 1942; Ben-Shahar 1998; Styles & Skinner 2000) and kudu (Styles 1993); particularly in the dry season (Timberlake 1995). Its leaves and twigs form an important source of crude protein for animals (Timberlake 1995; Ben-Shahar & MacDonald 2002), and are eaten either dry or fresh, making it an important forage plant (Venter & Venter 1996; Grundy 1996). Crude protein values of the leaves range from 8.4% in September to 16.6% during leaf flush in November

(Bonsma 1942). “Although *C. mopane* leaves has high protein content in its green form, it is not very digestible. The dry leaves become more digestible as the tannins leach out. Also, the grasses under *C. mopane* are quite nutritious, but not productive” (RJ Scholes *pers. comm*. 2006).

Colophospermum mopane also provide habitats for many species such the mopane squirrel (*Paraxerus cepapi*) and the small stingless bees (*Trigonia* spp), which use hollows in the trunks as their shelter. The blackish honey produced by the bees is a delicacy to local people (Fenton 1983).

2.1.7 Mopane worms

Colophospermum mopane is the host tree of mopane worms, larvae of the moth *Imbrasia belina* (Ditlhogo *et al*. 1996). Mopane worms are considered a delicacy and are widely consumed by the rural and increasing urban populations across southern Africa, particularly in countries such as Botswana, Namibia, Zimbabwe and the Limpopo and Mpumalanga Provinces of South Africa (Palgrave 1983, Styles 1996). Mopane worms form an important protein source to many people (Voorthuizen 1976; Styles 1995).

Timberlake (1996) indicated that the sustainable exploitation of mopane worms could perhaps yield a larger financial return per hectare to some of the poorest rural communities than any other single form of land use. However, to achieve the above-mentioned requires sustainable use of mopane worms’ host trees (Ashipala *et al*. 1996).

2.2 Threats and effects facing mopane woodlands

Mopane woodland is under intense pressure from an increasing human population in southern Africa. More tall and single-stemmed mopane woodlands are being converted either into land for settlement and agriculture or into low and multi-stemmed mopane shrubland (Gelens 1996a). This is the result of continuous harvesting for a wide range of products used locally (Gelens 1996a). Unsustainable forms of landuse, particularly over harvesting for firewood and unsustainable agricultural development are some of the causes of woodland degradation in South Africa (DWAF 1997). Other threats affecting the sustainability of mopane woodland resources include over-utilisation, frequent fires and herbivory. Socio-economic activities are the primary driving forces of deforestation (Snel & Bot 2002; Meadows & Hoffman 2002). The following are threats in mopane woodlands.

2.2.1 Over-utilisation

Unsustainable use of woodland resources in developing countries is a problem that increasingly evokes worldwide concern, due to the need to balance conservation, development and the socio-economic aspects of rural communities. Conroy (1996) indicated that the collection of plant resources in rural areas of Namibia has already outstripped the vegetation around them as a result of population growth and resource demand.

Throughout the developing world, woodlands have been replaced by unsustainable forms of land use, or totally destroyed. This resulted in deforestation and widespread denudation of woodlands (Meadows & Hoffman 2002), particularly in the former homelands of South Africa (DWAF 1998), Zimbabwe (Shaba 1993) and Mozambique (Bila 1993). A study in the Limpopo Province (South Africa) indicated that between 2001 and 2003, approximately 240 000 trees in mopane woodland have been lost while clearing 109 350 hectares for subsistence plots (Machena 2002).

2.2.1.1 Firewood utilisation

The firewood crisis faced by the world's poor countries was widespread since the late 1970's (Mercer & Soussan 1992). Currently, firewood collected from woodlands is by far the most important source of energy for the rural poor in South Africa. In the rural areas, firewood is used for a variety of purposes such as cooking, light and warmth, firing of clay plots (Palgrave 1983), traditional beer brewing (Coote *et al*. 1993) and in the preparation of medicine (Palgrave 1983). The choice of any particular plant species depends on the type of fire required. Wood from plants that produces little smoke and ashes are usually preferred (Mashabane *et al.* 2001) and due to its burning properties, *C. mopane* wood is preferred above other species.

Colophospermum mopane, as a tree of choice for firewood, is collected and traded on a large scale in many parts (rural and urban) of South Africa and even beyond the mopane belt in southern Africa (Van Wyk & Gericke 2000). In the Limpopo Province, firewood consumption was found to be the main cause of mopane woodland depletion (Mashabane *et al.* 2001). It was estimated that approximately 20 tonnes of firewood is being extracted daily by villagers in the Bushbuckridge, Limpopo Province (Machena 2002).

In addition, *C. mopane* wood is also excellent for the production of a good quality charcoal (Timberlake 1995; Cunningham 1996). Charcoal production from *C. mopane* wood is mostly produced in countries such as Botswana (Tietema *et al*. 1991), Zambia (Chidumayo 2000; 2001), Angola (Chidumayo 2001) and Mozambique (Brouwer & Falcão 2004). Charcoal is produced in rural areas and then sold in urban areas for income generation (Chidumayo 2001; Kammen & Lew 2005). Charcoal is a good energy source, particularly in urban areas because the energy content per unit mass is about twice that of wood. It is relatively clean-burning (MEA 2004), burns evenly for a long time (Kammen & Lew 2005), and the cost for transportation is relatively low (MEA 2004). A harvesting rate of between 25% and 50% of wood could yield mean masses of between 3 700 and 7 400 kg ha^{-1} with good charcoal potential (Cunningham 1996). Also, charcoal cannot be infected by insects. It is easy to extinguish charcoal and can be reheated (Kammen & Lew 2005). Selling of charcoal generates good income to rural people, but woodland resources depletion, for instance, central Zambia (Kammen & Lew 2005), can limit income opportunities (Chidumayo 2001).

2.2.1.2 Construction

Colophospermum mopane is by far the most important source of poles for construction in many rural parts of southern Africa (Van Wyk & Gericke 2000). The popularity of *C. mopane* poles is due to its hardness and durability (Venter & Venter 1996; Prior & Cutler 1992).

A study of *C. mopane* wood use in a homestead in northern Namibia showed that a single palisade fence, 302 metres long surrounding the main homestead, was made of 7 700 poles. The entire homestead required the removal of more than 100 m^3 of wood from the surrounding woodland (Cunningham & Davis 1997). In addition, about 15 m^3 of wood is used to erect an Owambo homestead (Cunningham & Davis 1997). This is five times more wood than the 3.02 m^3 used for construction purposes in Zimbabwe (Cunningham & Davis 1997).

By comparison, the mean timber volume of Tsonga huts in mopane woodland in the Limpopo Province of South Africa was 1.22 m^3 for round huts and 1.86 m^3 for square huts

(Cunningham & Davis 1997). Research by Madzibane and Potgieter (1999) in some villages of Venda (South Africa) indicated that people use between 1000 and 2 500 poles per household for fencing, which lasts for about 12 years.

2.2.1.3 Effects of deforestation

Some of the effects of deforestation on the environment include soil erosion, species extinction and loss of land productivity (Van Wyk 1993). Firewood is harvested daily in rural area, because other sources of energy are unaffordable (Banks *et al*. 1996). Scarcity of firewood could result in malnutrition and health problems for those unable to cook meals daily (Grundy 1996).

Observations on the effects of wood harvesting on mopane woodland showed a similar trend in both the Giyani and Venda areas of South Africa. These include the decrease of tree damage away from the perimeter of the village. The density of the trees increases away from the village and tends to be lower near the village (see Figure 4.19). This result to long distance travelled to collect firewood (Madzibane & Potgieter 1999). In some parts of northern Namibia, the effects of deforestation have now resulted in a scarcity of firewood. People are also using cow dung and millet stalks for cooking (Shanyengana 1994).

2.2.2 Fire

Fire is the most widespread ecological disturbance in the world (Trollope 2000). This is particularly relevant to the African savanna, where fire can have a significant effect on the botanical composition and structure of the vegetation (Trollope 2000). Walker (1990) indicated that fire has been a natural feature of southern African savannas throughout their evolution, and the affected species (e.g. *Colophospermum mopane*) have evolved mechanisms to cope, and benefit from it. However, high resin content in *Colophospermum mopane* foliage causes the tree to burn readily, even when the leaves are green (Scholes 1997).

2.2.2.1 Effects of fire

In Botswana, fire is still a major threat to the survival of forests, particularly in the northern parts of the country. Continuous burning kills tree seedlings (Hobana 1995), mature reproductive trees, and increases run-offs during rain. These factors influence on species survival (Owen-Smith & Danckwerts 1997).

A burning programme (1957 - 1993) in the Kruger National Park led to the loss of large trees and resulted in the overall homogenisation of the woody vegetation. Frequent exposure to fire causes a reduction in the height of *C. mopane* (KNPSSS 1995). The most common type of fire in savanna is surface fire, which causes a top kill of the stem and branches, forcing the plant to re-grow from underground parts. This changes the physiognomic structure of trees and shrubs (Trollope 2000). Burning at the end of the dry season causes severe damage to shrubs and trees (Walker 1990). In the Serengeti National Park (Tanzania) for instance, fire prevented the development of high canopy trees (Norton-Griffiths 1979).

Furthermore, frequent fire ensures that shrub mopane does not readily produce seeds. However, the tolerance of *C. mopane* against fire and the ability to re-grow is thought to favour its permanent existence in the savannas. Boughey (1961) indicated that frequent fires in the mopane shrub savanna led to increased *C. mopane* seedling mortality. Although mature *C. mopane* trees can survive, *C. mopane* trees younger than 5 years can be destroyed by fire (Pretorius 1996). When fire breaks out, *C. mopane* trees are said to burn like small candles, while increasing the intensity of fire (Van der Walt 1997).

Lewis (1987) undertook experiments on early burning in mopane woodland. Results indicated increases in the stem loss. More than 50% of the foliage was removed after a fire. The trees showed a mean loss of branch length due to tips being scorched by fire. Trees damaged by a light to moderate burn showed no significant loss in branch length (Lewis 1987).

2.2.3 Herbivory

The distribution range of elephant populations in southern Africa, where humans do not restrict elephants, largely overlaps with the distribution of mopane woodlands. *Colophospermum mopane* leaves and twigs are the principal components in the diet of elephants in southern Africa (Ben-Shahar & MacDonald 2002).

The browsing height of elephants is more than 1 m above ground level (Figure 2.1). This implies that any *C. mopane* tree above 1 m has a greater possibility to be browsed or destroyed by elephants (Smallie & O'Connor 2000). Not only elephants, but also other browsers such as kudu and eland, feed on *C. mopane* leaves, twigs, fruits and pods (Cunningham 1996). The leaves and young twigs of *C. mopane* also form an important source of browse for domestic animals (Timberlake 1996), which is common in communal areas. The foliage and seeds pods are essential sources of browse during the dry season, especially for cattle and goats (Styles & Skinner 1996). However, domestic livestock such as cattle, sheep and goats (Figure 2.2) are ranked second after wild animals as the major consumers of savanna vegetation in southern Africa (Owen-Smith & Danckwerts 1997). In communal land, domestic animals may influence mopane woodland negatively (Figure 2.2).

Figure 2.1 Elephants browsing *C. mopane* leaves and twigs in the KNP. Photo credit: K. Tshinavhe.

Figure 2.2 Goats feeding on fresh leaves. Photo credit: D.C.J. Wessels.

2.2.3.1 Effects of browsing

The impact of browsers includes uprooting (Figure 2.3), tree felling and stripping of bark. *Colophospermum mopane* trees are favoured by elephants due to their rich nutrient content. Intense utilisation of *C. mopane* trees by elephants results in alteration of the vegetation structure, a decline in species diversity (Ben-Shahar & MacDonald 2002) and the prevention of trees regeneration (Styles & Skinner 2000). Sustained pressure on *C. mopane* trees by elephants can result in the death of such trees (Kennedy 2000).

Figure 2.3 Uprooted *Acacia nigrescens* by elephant in the KNP.

2.4 Assessment of forest sustainability

As outlined by the National Forest Act (NFA) No. 84 of 1998, criteria, indicators and measures were developed to comply with forest sustainability (INR 2002), but currently, there are no specific measures available specifically for assessing sustainability of woodlands in South Africa (INR 2002).

In the past, the rates of land degradation in the drylands areas were mostly assessed using biophysical indicators, socio-economic indicators and institutional factors (Snel & Bot 2002; LADA 2002). In South Africa, key aspects such as environmental, social, economic and policy were used to measure the sustainability of forest management (INR 2002), which were also used in Germany, Indonesia, Brazil, Australia, Cameroon and USA (CIFOR C&I 1999).

It is essential that woodland sustainability and degradation indicators are developed for assessing the status of South African woodlands in the future.

2.5 Woodland management strategies

2.5.1 Traditional resource management and control systems

Indigenous African people have evolved systems, norms and religious beliefs to control access to and use of woodland and forest resources prior to European colonisation (Von Maltitz & Shackleton 2004). The traditional way of managing resources has been widely practiced in the Limpopo Province (Mabogo 1990; Mashabane & Potgieter 2001), Zimbabwe (Campbell *et al*. 1993; Chambwera 1996) and Namibia (Cunningham 1993). Historically, traditional chiefs had the power to manage the surrounding woodlands through the granting of permits for wood harvesting (NFA No. 84 of 1998). They could enforce restrictions over its utilisation (Mabogo 1990). In some instances, non-members (outsiders) within the villages were restricted from collecting wood by asking high prices for permits (Chambwera 1996) and restricting the harvesting of resources to certain days of the week (Timmermans 1999). For the collection of fallen dry dead wood for firewood, no permission was usually necessary (Mabogo 1990; Madzibane & Potgieter 1999). People who need wood for construction purposes must obtain a permit from either a local tribal authority office or the relevant division of nature conservation (Mabogo 1990). Failure to obey the rules set by traditional leaders can result in some sort of penalty or fine (Kajembe & Monela 2000).

In most instances, conservation of vegetation on communal lands used to be the sole responsibility of chiefs and headmen. This has now mainly been taken over by the Department of Environmental Affairs and Tourism (DEAT) in South Africa (Mabogo 1990). Poverty and loss of traditional authority has resulted in trespassing and cutting of non-dry wood for building material and firewood (Mashabane *et al*. 2001), resulting in an ineffective permit system. A breakdown of chief and tribal authority, coupled with uncertainty over who should actually be taking control of forest resources, further complicates woodland management (Von Maltitz & Shackleton 2004).

Consequently, deforestation in Zimbabwe has led to local people agreeing to pay royalties in exchange for the collection of firewood as a strategy to reduce pressure on the vegetation

(Gumbo 1993). Due to the effects of deforestation, traditional institutions created rules and regulations that govern ownership and access to surrounding resources. Some of the rules, for example, prohibit the cutting of certain trees (Gumbo 1993). The methods of wood harvesting were also regulated (Campbell *et al*. 1993). Prior to the cutting of wood, the guardian of the land (chiefs) has to issue a permit (Gumbo 1993). It is generally agreed that if an offence is committed, the offender will be expelled from the village (Gumbo 1993). Currently, however, people have the right to reside on and use land on which they live (Extension of Security of Tenure Act No. 62, 1997). Similarly in the Zambezi valley, if the chiefs declared a piece of woodland as sacred, any practice such as harvesting of firewood within this area can continue, but only after consultation with the chiefs. This practice reduced the widespread degradation of woodlands in the Zambezi valley of Zimbabwe (Grundy 1996).

In Owambo villages in Namibia, local people have the rights to their common property resources such as firewood, thatching grasses, building materials, and wild food resources. However, restrictions related to season, gender or private rights are traditionally placed on the use of these resources. This system has played a crucial role in the conservation of woody plant species in those areas (Cunningham 1993).

2.5.2 Thinning and coppicing management

Thinning and coppicing of woodland has been seen as a management strategy for sustainably meeting the daily needs of people, such as firewood and poles used for construction, with little degradation of the woodland (Tietema *et al.* 1991).

2.5.2.1 Thinning management

Studies on thinning management have been conducted by Scholes (1990), Coe (1991), Smit (1994), and Gelens (1996b). All argue that frequent thinning has an effect on tree height, growth form and basal growth. Similarly, Mushove (1992) established two thinning plots in Chivi (Zimbabwe), which all showed a positive mean annual increment in diameter, breadth and height. In eastern Botswana, a thinning experiment also showed an increase in the basal area growth of between 11 and 21% after one year, with only a marginal increase in the height of the remaining shoots (Mushove 1992).

In Malawi, thinning of *C. mopane* seemed to reduce inter-tree competition, which resulted in marked increases in flowering and fruit bearing of the remaining trees. The best high poles harvest was achieved with 50% thinning. Although this strategy leads to the increased production of the desired construction poles, this form of management is greatly influenced by what a particular individual or community aims to achieve from the woodland (Ramachela 2000). It should be noted that thinning increases a once-off high pole harvest, which decrease as a result of continuous thinning. However, tree thinning increases grass cover, which is essential to rural livestock farmers. It is therefore suggested that thinning can be used as a harvesting technique for coppice management (Mushove 1996).

2.5.2.2 Coppicing management

Coppice management is a strategy developed in response to large-scale over-exploitation of natural woodlands and involves new growth from stems or subterranean buds (Tietema *et al*. 1991; Mushove 1996). It was first introduced in Zimbabwe (Mushove 1992; 1996; Grundy 1995; 1996; Frost 1996) and in the Makuya Nature Reserve, Limpopo Province (Rathogwa *et al*. 1999).

The coppice regrowth of *C. mopane* is substantial. This is confirmed by various studies in southern Africa (Tietema 1989; Tietema *et al*. 1991; Mushove & Makoni 1993; Grundy 1995; Luoga *et al*. 2004). These studies showed that the production of poles from seedlings takes twice as long as production from shoot growth. The roots of adult *C. mopane* trees can produce root suckers, which enable the shoots to grow faster than newly established seedlings (Grundy 1995; Luoga *et al*. 2004).

Mushove (1992) established two coppicing experiments in 15 hectares of mopane woodland in Chivi, Zimbabwe. Results indicated that coppicing took place from subterranean buds and produced shoots suitable for pole production. Shoots produced from tall stumps were more suitable for firewood and multipurpose small timber pieces. Two years later, each stump had a mean of 14 shoots with a combined length of 9.45 m. Tall coppiced stumps produced significantly more shoots than short coppiced stumps (Mushove 1992). Coppicing experiments in Zimbabwe showed that effective coppicing depended on the season and stump height (Mushove & Makoni 1993). Results indicate that coppicing should not be done during the hot, dry season when plants are under drought stress. The best time for coppicing is just after the onset of the rains when adequate moisture becomes available. The best initial cutting height for many trees is between 30 and 50 cm above ground level (Mushove & Makoni 1993).

The desired pole classes of between 5 and 25 cm basal diameter can be achieved in approximately 5 to 10 years (Mushove & Makoni 1993; Tietema 1989), and pole production after five years is approximately 1000 kg ha^{-1} $year^{-1}$ (Tietema 1989). A similar study by Rathogwa *et al*. (1999) in Makuya Nature Reserve indicated that when *C. mopane* trees are cut 30 cm above the ground level, mostly in summer, it gives a 100% regrowth rate. Thompson (1960) and Smit and Rethman (1998) accredits the shallow root system of *C. mopane* as one of the reason for its high survival rate, since it can exploit soil moisture efficiently at extremely low soil water potential level.

In addition, coppice management maintains habitat diversity within a limited area (Peterken 1993) and also yields wood for use for different purposes (Grundy 1996; Okello *et al*. 2001). However, the success of the strategy requires the woodland to be fenced, monitored and managed, as any mismanagement can result in the complete destruction of the vegetation, particularly by browsers. It also requires regular cleaning and control of unwanted species (Peterken 1993).

2.5.3 Community forestry

Community forestry is a programme designed to meet people's needs (DWAF 1997). The strategy is implemented by the community and includes agroforestry, community or village plantation and woodland management by rural people as well as tree planting (DWAF 1997). However, in most African countries community forestry has showed little success due to the high demand for forest resources (DWAF 1997; DWAF 1998). Ham and Theron (1999) also argued that community forestry is more likely to fail than succeed due to the slow growth rates of indigenous trees, unpredictable weather conditions and frequent occurrence of drought.

2.5.3.1 Participatory Forest Management

Participatory Forest Management (PFM), which is also called Joint Forest Management (JFM) (Aumeeruddy-Thomas *et al*. 1999; Grundy 2000; Willis *et al*. 2000b) is a new approach to forest management that came into being as a result of the low benefits accrued by local people, the high cost of forest management by government and the ineffectiveness or impracticability of certain forest management laws (Coote 1995). This strategy has been widely practised in Malawi and reflects a global move towards greater involvement of local people and stakeholders in the management of their surrounding forests. A number of countries such as India, Nepal, and Mexico also practise PFM with success. The strategy focuses on the development of a multi-use management system on the basis of local people's experience and constraints. It also involves control in the use of forest products through community organisations backed by appropriate technical and legal support from the forestry department (Coote 1995).

Coote (1995) indicated that the success of PFM requires a considerable amount of planning, consultation, organisation, awareness campaigning, re-training and monitoring. Attention needs to be paid to people's access to resources (SPWD 1992), distribution of benefits, gender relation, conflict resolution (Aumeeruddy-Thomas *et al*. 1999), resource ownership, and management rights within the community (Coote 1995; Willis *et al*. 2000a). However, PFM is not always the best solution in forest management, especially in rural areas where poverty and hunger are very high. Although community rules prevent people from cutting wet wood, poor people who live by selling firewood and charcoal do not always respect these rules (Coote *et al*. 1993). They usually view woodland resources as their last hope to improve their socio-economic status.

2.5.3.2 Village re-forestation

Deforestation is one of the major problems, leading to a loss of woodlands in the SADC region. Consequently, re-forestation (tree planting) has become a priority as an option to restore degraded woodlands (Trollope 2000). Various countries in Africa have initiated re-forestation programmes. In 1960, Tanzania initiated the village re-forestation programme as a strategy to improve the quality of land and provide socio-economic benefits to local people. Village re-forestation is geared towards meeting rural people's basic needs such as firewood, poles, timber, fruits, medicine, honey, mushrooms, cash crops, fodder for domesticated animals and benefits related to environmental stability (Mgeni 1992). The main strategy was to supply the villages with tree seedlings, reared in government nurseries and to offer some technical advice. These seedlings were then planted around households, schools, and institutions (Mgeni 1992).

The village re-forestation programme failed to meet its objective due to a lack of staff and transportation. This resulted in limited delivery capacity of forest extension services. The top-down approach initiated by the Tanzanian government also contributed to the failure of the programme as it discouraged local people's participation (Mgeni 1992).

2.5.3.3 Agroforestry

Agroforestry is a management technique that was implemented in northern Namibia as a viable management solution to the problem of deforestation (Marsh 1994). With agroforestry, indigenous trees are deliberately cultivated together with traditional crops to increase crop production (Nair 1993) as well as short rotational systems, which include coppicing (Packham *et al*. 1992). Another recently introduced management system, which is practiced in Namibia and Zimbabwe, is the planting of various indigenous and exotic trees to reduce utilisation pressure on indigenous trees such as *C. mopane* (Marsh 1994).

Agroforestry contributes to socio-economic benefits (firewood and crops can be gathered within the farm forestry); it combats soil erosion and improves soil condition through a constant supply of nutrients from the plants (Saxena 1992). However, due to resource scarcity, it is suggested that forestry programmes should rather concentrate on improving the management of existing resources instead of pursuing woodcuts and plantation developments (Coe 1991).

2.5.4 Zambia Forestry Action Plan

The Zambia Forestry Action Plan (ZFAP) is a national strategy initiated by the government of Zambia in 1989 and implemented in 1993. The aim was to conserve forests while still gaining benefits from it. The strategy was developed based on full participation of the public and initiation of the grass roots policy. The ZFAP's success lay in the fact that it encouraged equal participation of women in forestry conservation. Although full participation of local people was difficult to obtain, this strategy helps to minimise the negative impact on woodlands (Henk 2000).

2.5.5 Community-based Conservation

Community-based Conservation (CBC) is a bottom-up approach implemented throughout the world as a means to save wildlife, but currently it is also applied to conserve many other natural resources for income generating possibilities (Grundy 1996). This conservation strategy allows local people to participate in land use policies and management decisions, thereby providing people with ownership over their resources and its economic benefits (Hackel 1999).

The CBC culminated in the enactment of the Community-based Natural Resource Management (CBNRM) throughout southern Africa, particularly in countries such as Botswana, Lesotho, Malawi, Namibia, South Africa, Tanzania, and Zimbabwe (Shackleton & Campbell 2000). Community-based Natural Resource Management is a way in which communities work together to protect their natural resources and at the same time bring long-lasting benefits to the community (DEAT 2003a). Rozemeijer and Van der Jagt (2000) stated that CBNRM needs to alleviate poverty and sustain socio-economic and ecological benefits. It is an approach that integrates rural development, natural resource conservation and empowers local communities (male and female) to participate in decision-making and benefit sharing mechanism (Rozemeijer & Van der Jagt 2000; DEAT 2003a).

Nevertheless, there are challenges in CBNRM programmes, which include conflict of interest, negativity and criticisms from people (DEAT 2003a), lack of capacity and lack of integrated and official CBNRM policy documents (DEAT 2003b). Some policy shortcomings in the implementation of CBNRM in South Africa include ignorance of existing institutions, lack of inter-agency cooperation and auditing, lack of information transfer to local people about the policy and its operation at provincial and national level, which is not suitable at local level (DEAT 2003b). Additional shortcomings in the existing CBNRM guidelines include lack of practicability of inter-departmental cooperation, involvement of illiterate people in decision-making, and a weak understanding of the function and value of local and traditional knowledge (DEAT 2003b). Addressing these challenges requires sharing of control and responsibility, keeping people informed, willingness to learn, continuous monitoring of relevant programmes, encouraging commitment, involvement and cooperation by the communities (DEAT 2003a).

One of the prominent examples of the CBNRM programme in Africa is the Zimbabwe Communal Area Management for Indigenous Resources (CAMPFIRE) (Murphree 1993; Shuma 2001a) and the Kruger National Park and Makulele Agreement in South Africa (Steenkamp & Urh 2000). These programmes were developed to give local people a voice in natural resource management and to meet their basic daily needs (Murphree 1993). Successful implementation of CBNRM can deliver benefits such as access to resources, job creation (through conservation projects and participatory forestry projects), empowerment, training and education, improved health and strengthening of cultural and spiritual values of the community (DEAT 2003a). Nonetheless, the implementation of the CBNRM guidelines needs to place emphasis on facilitating learning and adaptive management processes (Table 2.1).

Table 2.1 The 'blueprint' approach vs the 'learning and process' approach in CBNRM

CBNRM	The blueprint approach	Learning and process approach
First step	Data collection and planning	Awareness and action
Keyword	Strategic planning by expects	Local people involvement
Decision making	Centralized, ideas from capital city	Decentralized, ideas originate in villages
Assumptions and communication	Biased and vertical (orders down, reports up)	Holistic system and lateral (mutual learning and sharing of experience)
Evaluation and errors	External and errors buried	Internal, continuous and errors embraced
Relationship with people	Controlling, policing, inducing, motivating, dependency creating. People seen as beneficiaries	Enabling, supporting, empowerment. People seen as actors
Technical inputs	Normal professionalism	New professionalism
Output	1. Diversity in conservation 2. The empowerment of professionals	1. Production and conservation 2. The empowerment of rural people

Source: DEAT (2003b) (with acknowledgement to Michel Pimbert and Jules Pretty)

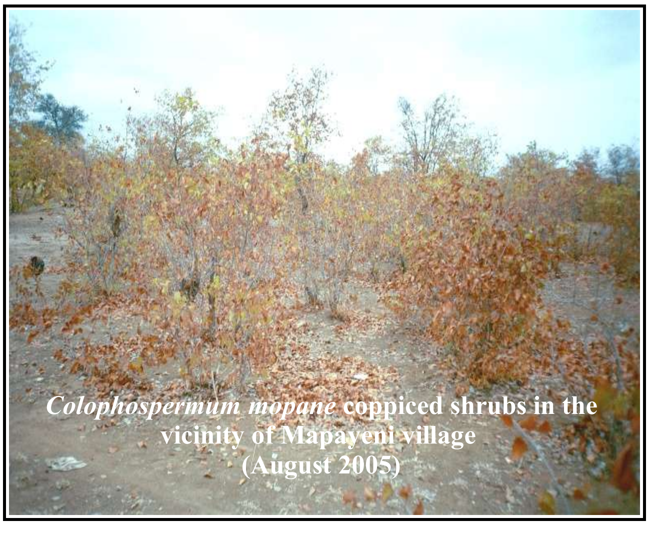
2.6 Forest and woodland conservation policies

In most African countries, past forestry policies were mostly implemented as a top-down approach. Such an approach has mostly resulted in failures, as it discourages participation by local people (Kolawole 2001). The state was having full ownership and control of the land and regulated its use while smallholder peasants were exempt from obtaining a permit for using the land for family agriculture and forest products (Lorbach 1996). More regulations were applicable on the use of forests for construction, firewood and charcoal for commercial purposes and the issuing of permits to utilise forestry resources (Lorbach 1996). The majority of the people, especially the poor, did not benefit from such policies (DEAT 1997) and the end result was the degradation of forests and woodlands (DWAF 1998). Shortly after 1994, the Department of Water Affairs and Forestry (DWAF) in South Africa, in collaboration with other departments such as the Department of Environmental Affairs and Tourism (DEAT), passed the National Forestry Act No. 84 (1998) from which a number of forest policies such as the White Paper on Sustainable Forest and Development emanated (DWAF 1998). The aims of these forestry acts and policies are to conserve and promote sustainable use of commercial forests, community forests and indigenous forest management. This brought a major shift in emphasis to encourage community participation in forest conservation with resultant benefit to the whole community (DWAF 1998; NFA 1998).

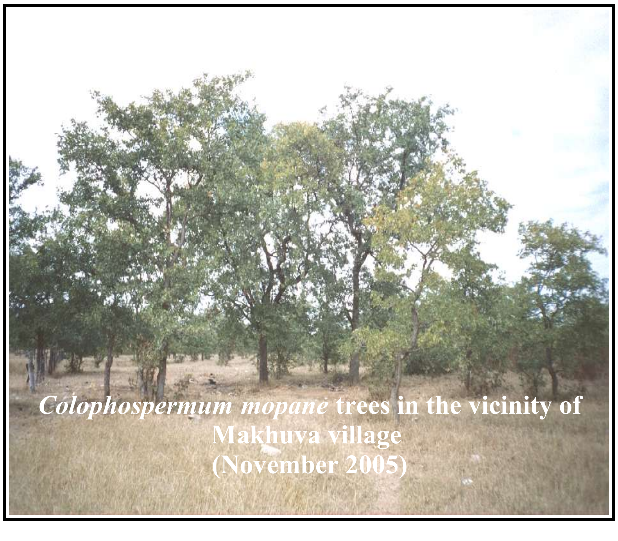
As a result of the afore-mentioned challenges, government aims to involve local people in the implementation of the policy in an effort to enhance their socio-economic status (DWAF 1998). Previously disadvantaged people such as women are now also legally entitled to some land rights just as men. In some instances, the traditional council were responsible for land administration if their community recognised such a council, but one member within the administration committee needed to represent the interests of women, children, the youth, the elderly and the disabled (DEAT 2003a). Furthermore, local people are encouraged to plant indigenous trees in gardens and fields, on streets, parks and in managed plantations in order to build a resource base and improve the environment. Policy emphasis is on sustainable use and management of forest and woodland resources, rehabilitation, protection of degraded forests and woodland, and awareness through dissemination of information (DWAF 1998). According to the NFA (1998) and NEM:BA (2004) no person is allowed to cut, disturb, damage or destroy any indigenous living tree except when he/she has a permit. The permit can also be suspended if any activity does not promote sustainable forest management. Any person who contravenes the prohibitions of the forestry act may be fined or imprisoned for a period of up to three years.

CHAPTER 3

METHODOLOGY



Colophospermum mopane coppiced shrubs in the vicinity of Mapayeni village (August 2005)



Colophospermum mopane trees in the vicinity of Makhuva village (November 2005)

3.1 Study area

3.1.1 Locality

Research was conducted in six rural villages of the Greater Giyani Municipality, which is located in the northeastern part of South Africa. It is within the Mopane District of the Limpopo Province, and is located approximately 170 km northeast of Polokwane and 70 km northeast of Tzaneen. The Sabie and Letaba Rivers are major rivers flowing through the Greater Giyani Municipality. The Greater Giyani Municipality borders the Kruger National Park on the eastern side and towns such as Thohoyandou lie to the north and Phalaborwa to the south. The major town of the Greater Giyani Municipality is Giyani, which is located at 23º18'36" S and 30º43'12'' E. Altitude in the Greater Giyani Municipality range from 300 m to 500 m above sea level.

3.1.2 Climate

The climate of the Greater Giyani Municipality is characterised by low rainfall, mild winters, and high summer temperatures. Rainfall and temperature data was obtained from the South African Weather Services and represent a period of 23 years (1980 - 2003). The mean annual temperature ranges from a minimum of 15 ºC to a maximum of 29 ºC per annum (Figure 3.1). Frost does not occur (Werger & Coetzee 1978; White 1983). The Greater Giyani Municipality is situated in a summer rainfall area. The mean annual rainfall of the study area is 386 mm per annum (Figure 3.2).

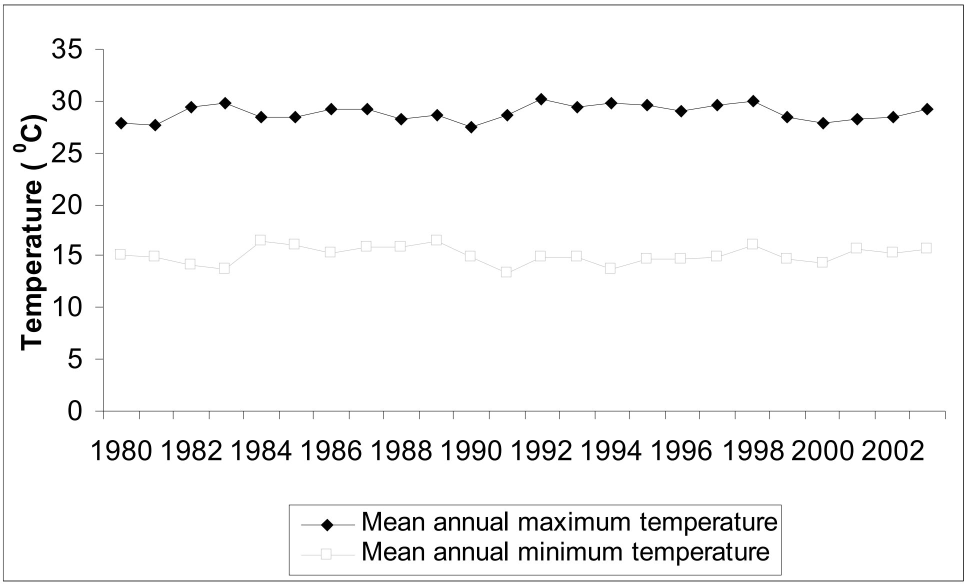


Figure 3.1 Mean annual maximum and minimum temperature (1980 - 2003). Data stations (0724260 2 and 0724379 4). Data source: www.weathersa.co.za.

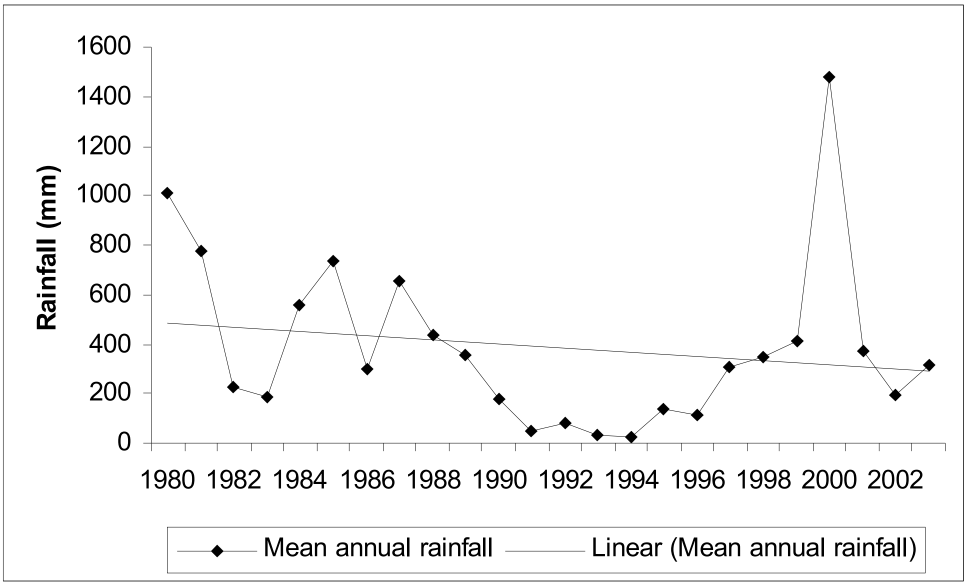


Figure 3.2 Mean annual rainfall (1980 - 2003). Data stations (0724260 2 and 0724379 4). Data source: www.weathersa.co.za.

3.1.3 Population and socio-economic activities

Giyani is the hometown of the Shangaan who descended from the Nguni people and Ndwandwe group. The majority of the inhabitants in the Greater Giyani Municipality are Shangaan and their language is Xitsonga (Peltzer 1998). The geographical area of the Greater

Giyani Municipality is about 2 967 km^2, with a population estimated as 217 454 in 1996 that increased to about 237 438 people in 2001 (Statistics S.A.: Census 2001). This implies that the increase in the number of people from 1996 to 2001 was 19 984, which is about 2% per year. From this, 55% are unemployed and 54% have no electricity. Even where there is electricity, people still rely mainly on wood for energy and poles for construction purposes (Statistics S.A.: Census 2001).

Approximately 82% of the people in the Greater Giyani Municipality do not have a steady monthly income and 55% of them have no formal education (Statistics S.A.: Census 2001). About 60% of the dwellings are traditional and the number of huts ranges between three and four $household^{-1}$ (Statistics S.A.: Census 2001). The majority of the rural inhabitants depend on old age pensions, subsistence agriculture, and on harvesting woodland resources for household nutrition and income generation.

3.1.4 Geology and Biodiversity

The physiography of the Greater Giyani Municipality is characterised by gentle undulating valleys of the Soutpansberg mountain range (Acocks 1988). The area forms part of the savanna biome in the Lowveld of the Limpopo Province and has soils that vary from loamy sands to clayey soils. The underline geology of the area is characterised by the metasediments of the Giyani Greenstone Belt. Common rocks are granite, sandstone, shale and basalt (Rutherford *et al*. 2006).

The vegetation of the Greater Giyani Municipality is classified as semi-arid savanna (Acocks 1988), characterised by a mixture of trees, shrubs, and grasses. In this area, *C. mopane* occurs in abundance together with other tree species such as *Acacia* species, *Cassine aethiopica*, *Combretum apiculatum*, *Commiphora* species, *Dalbergia melanoxylon*, *Dichrostachys cinerea*, *Diospyros mespiliformis*, *Sclerocarya birrea* and *Terminalia sericea* (Appendix 2).

Paraxerus cepapi, *Trigonia* spp and a variety of tree frogs and bird species also form part of the biodiversity of this area. However, land use transformation has resulted in the decline of species diversity, particularly at the edges of villages (Figure 4.19).

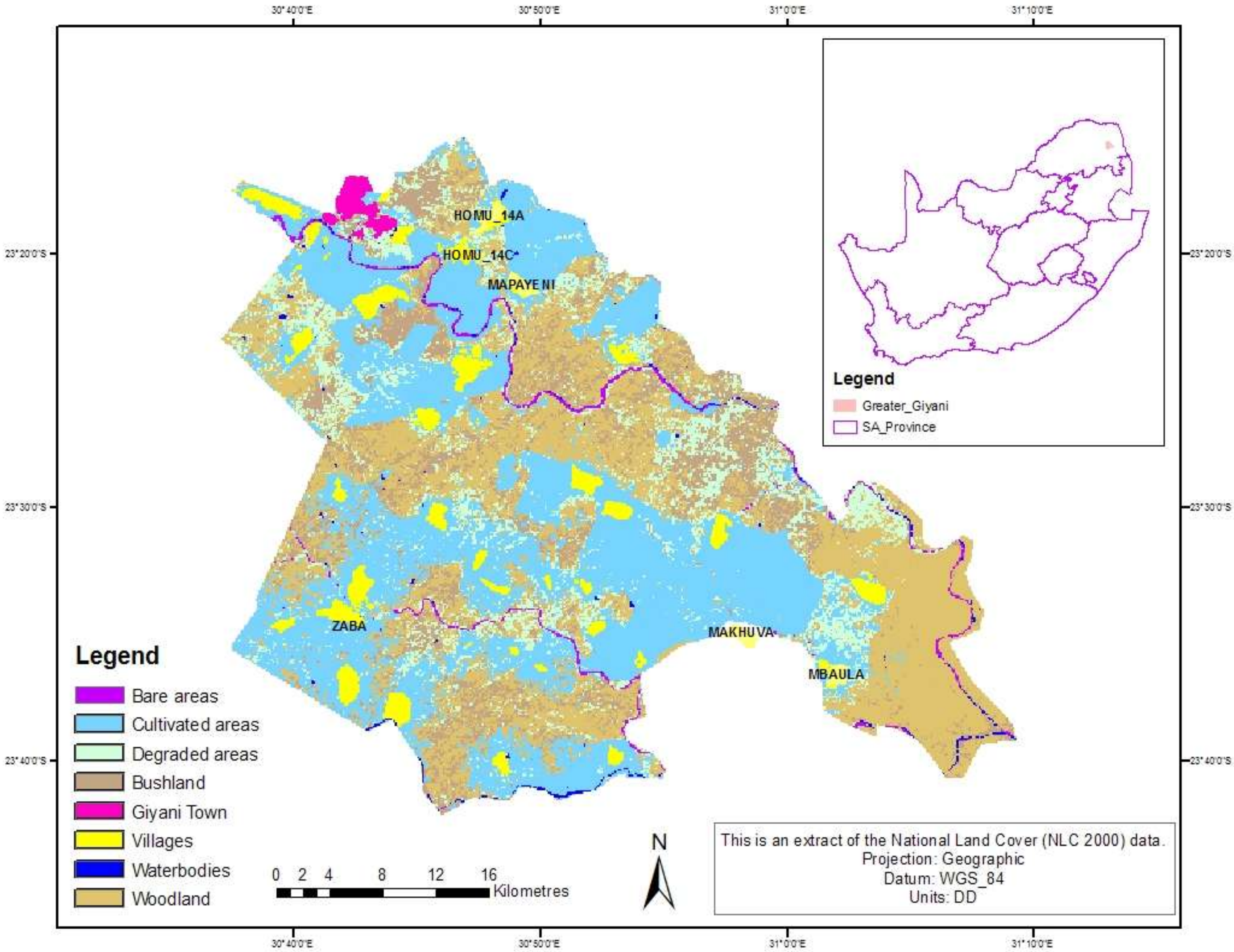


Figure 3.3 The selected villages in the Greater Giyani Municipality. This map is an extract from the National Land Cover 2000 data and shows different land cover types in the Greater Giyani Municipality.

3.2 Sample selection

Interviewees included villagers (randomly sampled), traditional leaders (chiefs and headsmen), and relevant officials from the conservation section in the Greater Giyani Municipality and from the private sector. Both genders were represented within the sampling frame. The gender split of respondents was 60% women and 40% men in the woodland depleted villages versus 59% women and 41% men in the woodland abundant villages.

Stratified random sampling was used to sample six villages (Figure 3.3). Three were woodland depleted villages [Homu 14A (23.30385º S; 30.80417º E), Homu 14C (23.31561º S; 30.740526º E) and Mapayeni (23.35412º S; 30.82297º E)] and three woodland abundant villages [Makhuva (23.58236º S; 30.97446º E), Zaba (23.57581º S; 30.70878º E) and Mbaula (23.60878º S; 31.03742º E)]. A baseline study was conducted with conservation officials at the Greater Giyani Municipality. Based on this, six villages were selected according to their homogeneity or differences in the occurrence and abundance of woodland resources around the villages.

3.3 Data collection

Data was collected between August 2004 and May 2005. Data collection was based on individual household surveys; participatory group interviews in each selected village as well as other secondary information gathered from the literature, ground based truth and satellite images. The satellite image of the study area (Figure 4.19) was produced from the Google Earth version 4, 2006 (http://earth.google.com/). Data on population, education level, employment rate, energy used for cooking, number of huts per household in the Greater Giyani Municipality was obtained from the Statistics S.A.: Census 2001 (http://www.statssa.gov.za), and the meteorological data (rainfall and temperature) from the South African Weather Service (www.weathersa.co.za). The National Land Cover 2000 data was also used to produce the map of the study area (Figure 3.3).

Semi-structured interviews (open and closed-ended questions) were randomly conducted with 180 villagers within six selected villages (30 people household^{-1} village^{-1}). Traditional leaders (n=13) and conservation officials (n=10) were also interviewed. A questionnaire was used to capture data from the respondents. The questionnaire was divided into three sections, one was for the local people, the second was for traditional leaders or chiefs and the third for the municipality and private sector officials (Questionnaire attached in Appendix 1). Villagers were asked to identify and rank other plant species used due to scarcity of *C. mopane* (Appendix 2).

The officials from Department of Economic Development, Environment and Tourism (DEDET) in the Greater Giyani Municipality were consulted prior to the surveys. The purposes of these consultations were to ascertain the roles and strategic plans of conservation departments in terms of woodland conservation and management. Researchers from the Council for Scientific and Industrial Research (CSIR, NRE) were also interviewed to obtain information that could aid in the proposed establishment of better management of mopane woodland.

Before interviewing local people, written permission was obtained from the appropriate traditional authorities (see Appendixes 4A, 4B and 4C). The youth were interviewed in order to determine the extent of their conservation knowledge and perceptions of mopane woodland utilisation, conservation, and management. Chiefs and headsmen were also interviewed in order to obtain their perceptions regarding the management of mopane woodland. Interviews were conducted in Tsonga language to avoid misunderstanding with the respondents.

3.4 Data computation

The amount of wood and poles used by villagers for firewood and construction purposes was quantified by measuring the length, circumference and diameter of poles, and also weighed, expressed as kilograms using a portable mass balance. The number of poles used for firewood and construction purposes was also quantified. The number of samples collected to determine the amount of firewood used for daily cooking was 30, and 15 for the amount of poles used for the construction of traditional structures per village. The volume of wood used for firewood and construction was calculated as: $V (m^3) = l \times \pi \times (^1/_2 d)^2 \times n$. Where V = volume, l = length, π = 3.1428, d = diameter and n = number of poles. The underground portions of inserted poles in the soil were included in the calculations through estimation gathered from the householders. Quantification of firewood used by villagers per day was based on the amount of wood used for cooking porridge once per day, which was multiplied by total number of days per year (365) to give annual totals. (E.g. Tons of firewood consumed per year per family was expressed as: $T = u\ d^{-1}\ c$ (kg) x number of days in a year /1000. Where T = Annual firewood used (tons), $u\ d^{-1}\ c$ = use per day cooking).

Volume of wood used for cooking year^{-1} household^{-1} was calculated as: $VWY^{-1}H^{-1} = vwh^{-1}d^{-1}$ x number of days in a year. Where $VWY^{-1}H^{-1}$ = Volume of wood used for cooking per year per household, $vwh^{-1}d^{-1}$ = volume of wood used per household per day. Volume of wood used for cooking per year in a village was calculated as: $VWY^{-1}V^{-1}$ = % of people using wood in the village x estimated total population x volume of firewood used year^{-1} household^{-1} /100. Where

$VWY^{-1}V^{-1}$ = Volume of wood used for cooking per year per village. The number of adults benefiting from selling woodland resources was estimated by multiplying the fraction selling by the total population in the village or simply expressed as: N = total percent selling x total population /100.

3.5 Data analysis

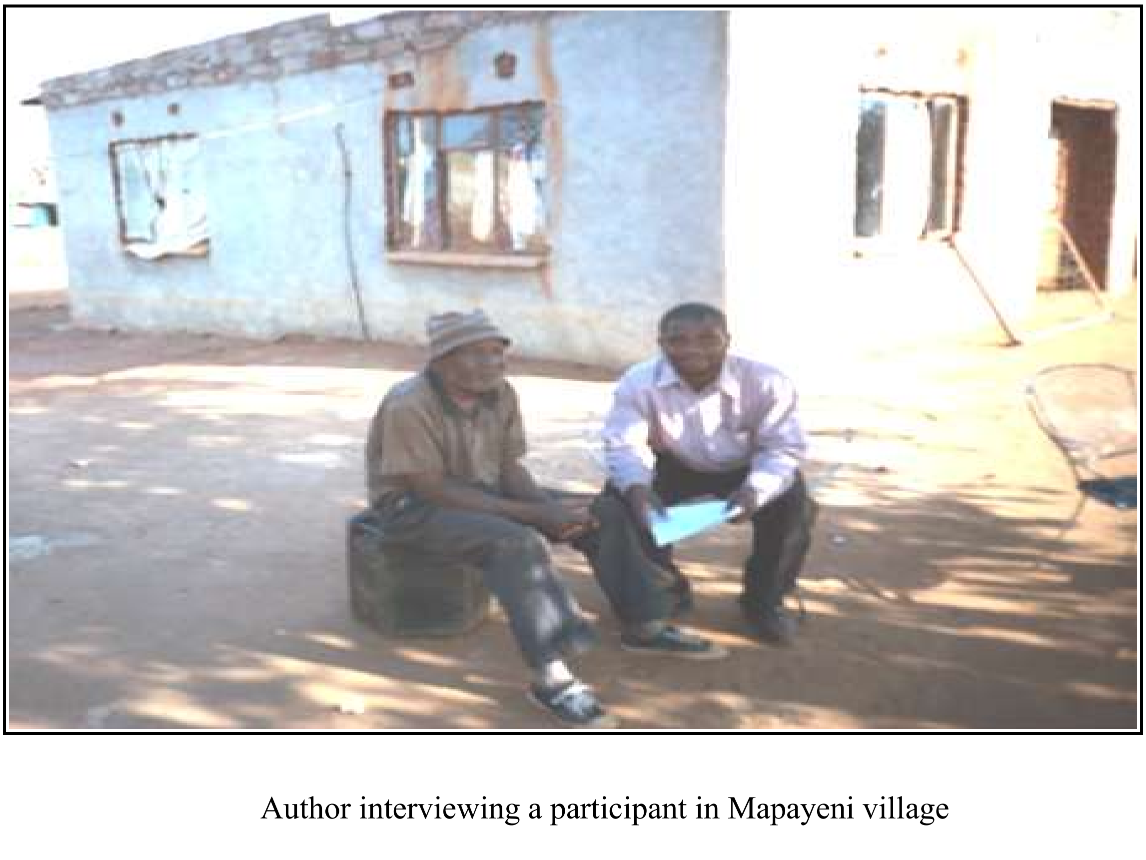
Descriptive statistics were used in this study to describe the basic features of collected data. Data were analysed quantitatively and presented in the form of frequency tables, which were expressed as percent, central tendencies (mean), and also plotted as graphs using clustered columns and lines to compare values across categories between grouped villages. Data were checked for normality and the appropriate test was conducted. Analysis of variance (ANOVA) and a t-test for two samples assuming unequal variance were used to examine differences between means. The SPSS ver. 12 statistical programme was used to analyse the data. The percentages were rounded to the nearest total number of people interviewed. In some cases, it doesn't add up to 100%, due to lack of answers by some of the participants. The variation of data was presented in the form of frequency data tables. The land cover types in the Greater Giyani Municipality were extracted from the National Land Cover 2000 data and the ArcView ver. 3.2 was used to produce the map of the study area (Figure 3.3). The percentage cover of each land type class in Figure 3.3 was analysed using the SigmaScan Image Analysis ver. 5 (Build number 3981, 1987-1999 SPSS Inc.) (see Table 4.2).

CHAPTER 4

RESULTS

AND

DISCUSSION



Author interviewing a participant in Mapayeni village

4.1 Socio-economic characteristics

The socio-economic characteristics of the study population are described in terms of age frequencies, years of residence, gender, and level of education (Table 4.1).

4.1.1 Social characteristics

Thirty eight percent of the respondents in the woodland depleted villages and 46% in the woodland abundant villages were between 20 and 39 years old. Little difference existed in terms of people who had resided in the sampled villages for more than 30 years. Forty one percent of participants in the woodland depleted villages and 42% in the woodland abundant villages had lived in their respective villages for more than 30 years. Sixty percent of the interviewees in the woodland depleted villages and 59% in the woodland abundant villages were females. The level of education varied between males and females, but it was not significant difference (woodland depleted villages, $P = 0.123$ and woodland abundant villages, $P = 0.353$). Twelve percent of males and 32% of females residing in the woodland depleted villages had no formal education, compared to 4% of males and 26% of females in the woodland abundant villages (Table 4.1).

Previous research indicated that a lack of conservation knowledge (DEAT 1997; CBD 2001) and information about the value of biodiversity (DEAT 1997) are some of the main obstacles threatening biodiversity conservation, a fact also noted in this study. Lack of knowledge makes it difficult for the community to understand the necessity to conserve or manage their resources (Cromhout 2002). The fact that the majority of people in the sampled villages are illiterate makes it difficult for the community to implement conservation initiatives. Therefore, conservation education programmes are necessary to educate local people (young and old) about the need for conservation and its subsequent benefits. Such programmes need to target females as they constitute the majority of the illiterate people in the studied villages (Table 4.1). Villagers having more than 30 years of residency within their villages can serve as mentors for sharing indigenous knowledge as they have vast local knowledge and experience on the dynamics of the surrounding woodland. The implementation of ABET is also essential to improve the standard of education at village level. The first priority for such programmes is to target people without formal education, particularly women as they were illiterate in the studied villages.

4.1.2 Population pressure

Woodlands occur around populated areas (Shackleton *et al*. 2001; see also Figure 4.19). As a result, the sustainability of woodland is hampered by high population pressure (Hackel 1999) coupled with poverty (Gandar 1983; Watson & Dlamini 2003). The estimated number of people in the woodland depleted villages is approximately 19 500 (Mapayeni = ~8 500, Homu 14A = ~5000 and Homu 14C = ~6000) and in the woodland abundant villages is approximately 16 000 (Makhuva = ~8000, Zaba = ~5000 and Mbaula = ~3000; Table 4.1). Population increase correlate with resource demand and woodland transformation, as the population increases, it consequently result in the expansion of human settlements (Figure 4.19) and cultivated areas (Figure 3.3; Table 4.2) to meet basic needs.

A study in the Bushbuckridge area of the Limpopo Province also showed that woodland use is unsustainable, mainly as a result of high population pressure (DWAF 2000). The increase in the population also increases the demand for resources, which, at some point, will ultimately exceed the supply and therefore negatively affect the surrounding woodland resources (Lawes *et al*. 2004c). This was evident in this study (see Figure 4.19). The major cause of high population growth in the study area and perhaps in all African countries is uncertain, but seems to be a result of a high fertility rate which can be linked to the level of socio-economic under-development. This is supported by a study in developing countries (Lucas 2003), which predicted an increase in the number of people in the near future as the cohort of fertile females is getting larger each year. The practice of polygamy and limited knowledge on birth control in rural areas will certainly increase human population growth. This will consequently reduce the surrounding woodland resources, as people will demand more resources from woodland and more space for settlement and cultivation purposes.

Table 4.1 Demographic characteristics of the study population

Characteristics	**% of respondents in the woodland depleted villages (n = 90)**		**% of respondents in the woodland abundant villages (n = 90)**	
Age (Years)[a]				
<15	2		0	
15 - 19	6		18	
20 - 39	38		46	
40 - 59	32		22	
60 - 79	14		14	
>80	6		0	
Years of residence[a]				
<10	13		1	
10 - 19	26		23	
20 - 29	20		33	
>30	41		42	
Gender				
Females	60		59	
Males	40		41	
Level of education[a]	**Males**	**Females**	**Males**	**Females**
No schooling	12	32	4	26
Primary	11	10	6	9
Secondary	11	19	21	31
Tertiary	1	1	1	3
Human population*	**Woodland depleted villages**		**Woodland abundant villages**	
	Mapayeni	8500	Makhuva	8000
	Homu 14A	5000	Zaba	5000
	Homu 14C	6000	Mbaula	3000
	Total	19500	**Total**	16000

n = number of people interviewed

* = estimated by the community leaders

[a] = percentages do not always add up to 100 due to rounding off and lack of answers by some of the participants

4.1.3 Economic characteristics

Large areas of South Africa's savanna woodlands are concentrated in the former homelands where poverty is common, high unemployment rates prevail and limited economic activities exist. The rate of unemployment in the sampled villages is indicated by employment types (Figure 4.1) and monthly household incomes (Figure 4.2).

4.1.3.1 Types of employment

Figure 4.1 Employment types of respondents in the sampled villages.

The majority of the females interviewed in the sampled villages were unemployed (Figure 4.1). Fifty two percent of females interviewed compared to 25% of males in the woodland depleted villages were unemployed, versus 62% of females compared to 15% of males in the woodland abundant villages. Six percent of interviewed females and 8% males in the woodland depleted villages were self employed or hawkers and others were builders, versus 3% of females and 1% males in the woodland abundant villages. In woodland depleted villages, 1% of females and 2% males were government employees as opposed to 5% of females and 3% males in the woodland abundant villages. Two percent of interviewed females and 1% males in the woodland depleted villages worked in the private sector, versus only 1% of female respondents in the woodland abundant villages (Figure 4.1). There was no significant difference in the types of employment between grouped villages (woodland depleted villages; P = 0.040 and woodland abundant villages; P = 0.498).

4.1.3.2 Monthly household income

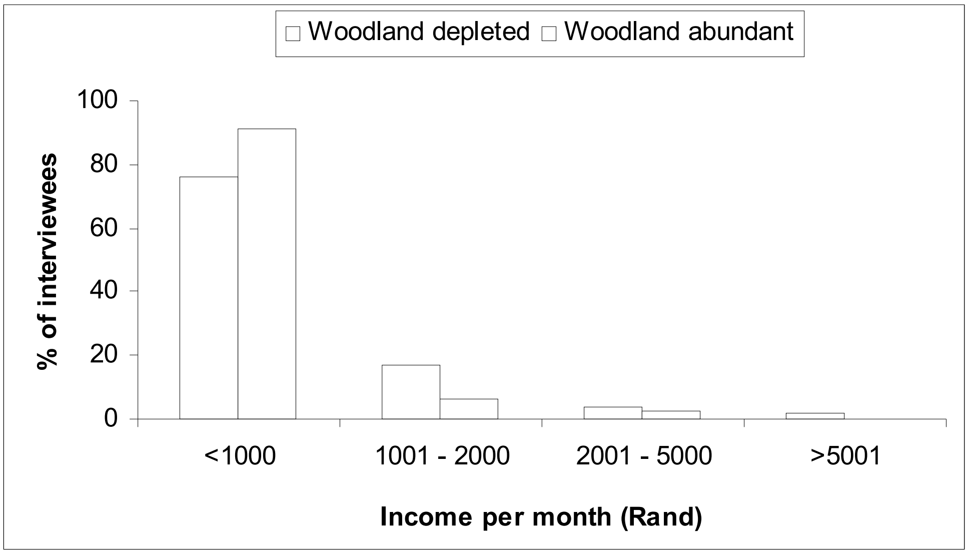


Figure 4.2 Monthly household incomes of respondents in the sampled villages.

Seventy six percent of the respondents in the woodland depleted villages and 91% in the woodland abundant villages earned an income of less than R1000 per month. The poverty line in South Africa is less than R1000, which implies that 66% of respondents in the woodland depleted villages and 91% in the woodland abundant villages live below the poverty line. It is further estimated that about 77% of households in the Limpopo Province live below the poverty line (HSRC 2004 cited in DEDET 2006). Seventeen percent of the participants in the woodland depleted villages and 6.4% in the woodland abundant villages earned between R1001 and R2000 per month. In the woodland depleted villages, interviewees earning between R2001 and R5000 accounted for 4% and 26% in the woodland abundant villages. Only 2% of the respondents in the woodland depleted villages earned more than R5001 per month, and none in the woodland abundant villages (Figure 4.2). Statistically, no significance difference exists in the monthly household incomes between the grouped villages ($P > 0.5$).

The majority of people in the study area, in particular females, were unemployed (Figure 4.1). High unemployment is a widespread problem in most rural areas of South Africa. It is estimated that 70% of people in South Africa's rural areas are poor (UNCCD 1994), with the population heavily dependent on woodland resources (Shackleton *et al*. 2000b; DME 2003; DEDET 2006). Reliance on woodland resources is also apparent in the sampled villages as more than two thirds of the people were unemployed (see Figure 4.1) and could not afford to purchase sources of energy such as electricity and paraffin (see Table 4.6). In the Bushbuckridge area, for example, a depressed economy has resulted in few opportunities for employment (DWAF 2000) and an over-reliance on natural resources. Poverty leads to an over-utilisation of woodland resources for short-term benefits (Rowe *et al*. 1992) and ultimately severe long-term degradation (Casey & Muir 1986; Mac Neely *et al.* 1995), a predictable situation in the study area. This study suggests that the initiation of natural resource management projects at village level as an option to reduce woodland degradation. But, based on this study, the first people that should be employed in such projects are the unemployed, especially women. Employing women could encourage participation of women in sustainable woodland practices, promote efficient use of wood and supplement household incomes.

4.2 Threats to mopane woodland resources

A hundred percent of all of the interviewees in the woodland depleted villages and 33% in the woodland abundant villages stated that the major threat to the surrounding woodland is deforestation caused by over-utilisation of woodland resources (Table 4.2). Unsustainable use of woodland resources is a result of high unemployment rate (Figure 4.1), which is widespread in the study area. Forty four percent of the officials from the Greater Giyani Municipality conservation section and the private sector also ranked deforestation through over-utilisation as a major threat to mopane woodland resources in the study area (Table 4.2). Woodland fires occur often and are ranked by 67% of respondents in the woodland abundant villages as the major threat to the surrounding woodland. Conservation officials ranked wildfires second after deforestation as a major threat to woodland resources (Table 4.2).

4.2.1 Over-utilisation

Vegetation that was once regarded as common property in communities has come under pressure due to cutting for firewood and commercialisation of woodland products (Rowe *et al*. 1992; Vorster 1999). Likewise, mopane woodland resources in the study area are over-utilised due to increasing demand for poles used for construction of traditional structures (Figures 4.6 - 4.11), household firewood (Figure 4.12) and the sale of firewood for income generation (Figure 4.13).

Woodlands degradation is severe in many areas of South Africa (Low & Rebelo 1996; DME 2003) with severe ecological and social consequences (Skottke & Mauambeta 2000). The impacts of deforestation include irreversible loss of topsoil, species extinction, loss of land productivity (Eberhard 1990; Van Wyk 1993) and environmental degradation (Casey & Muir 1986; Campbell *et al*. 1993).

Reports show that the possible causes of deforestation include expansion of arable land, demands for firewood and construction poles, and clearing of vegetation for urban expansion (Mac Garry 1987; Chipika & Kawero 2000). A similar situation occurs in the study area, where 59.4% of the total area of the Greater Giyani Municipality consists of cultivated areas, 26.5% is covered by woodland and 3.0% by bushland. The town of Giyani accounts for 0.7% of the total area, while 5.4% is taken up by villages. The degraded areas account for approximately 5.0% (Table 4.2). Transformation of woodland into areas used for cultivation and settlement is also evident in Figure 4.19. In addition, the high demand for firewood and poles for construction (Tables 4.5A and 4.5B) is leading to severe deprivation of mopane woodland resources around the studied villages (Figure 4.19).

4.2.2 Fire

Sixty seven percent of respondents in the woodland abundant villages indicated that fire is a major threat to mopane woodland in communal areas (Table 4.2). Fire has a significant effect on the composition and structure of vegetation in the African savanna (Trollope 2000), which is also evident in most areas of the Limpopo Province (Figure 4.3 and Figure 4.16). In most communal lands, including the study area, fires caused by humans are common. Natural fires (caused by lightning) seldom occur. During the dry season, men made fires are likely to occur, while natural fires occur during the onset of rains. Men made fires are ignited by people who have no knowledge about the impact fires have on the environment, a similar situation reported in Botswana by Watson and Dlamini (2003). DWAF’s veld fire rating system (Figure 4.3) was used in this study to show the susceptibility of the study area to fire hazard. The system (DWAF’s veld fire rating system) shows that the whole of the Limpopo Province is an extremely high risk area for veld fires (Figure 4.3).

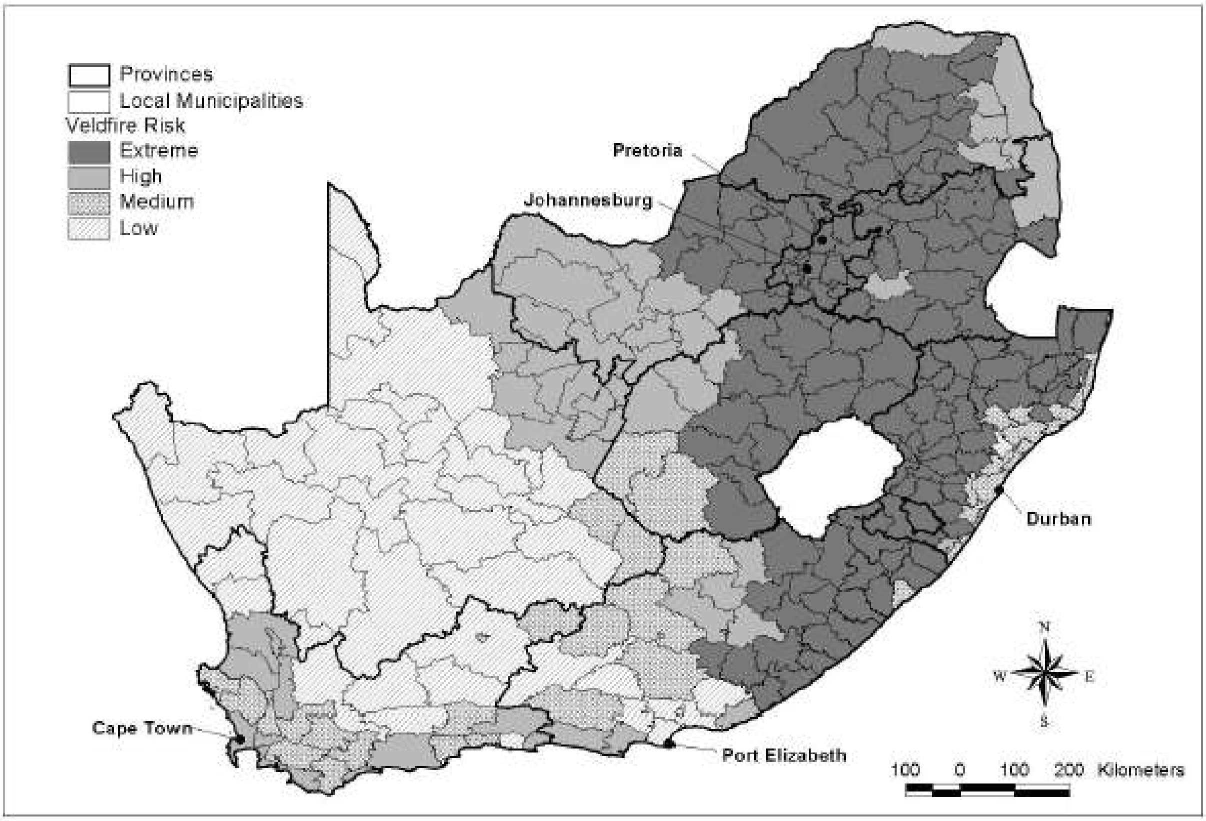


Figure 4.3 South African municipalities classified by veld fire risk. The figure shows the veld fire risk areas in South Africa, categorized as low, medium, high and extreme high risk. Source: DWAF (2003), modified by Kruger *et al*. (2006).

Plant species such as *C. mopane* can survive the impacts of fires through their regrowth ability. Yet, frequent fires leads to negative effects such as the burning of leaves, which lowers photosynthetic capacity (Scholes 1997), killing of tree seedlings (Boughey 1961; Hobana 1995), destruction of trees younger than five years (Pretorius 1996), complete destruction of mature trees (Walker 1990; KNPSSS 1995; Clarke 1997), decreases in the chances of species survival (Owen-Smith & Danckwerts 1997) and ultimate degradation of significant portions of the woodland (Alidi 1990). An effect of fire on *C. mopane* leaves also affect supply of mopane worms (Greyling 2000). Burning in the African savanna also results in the emissions of greenhouse gases such as carbon dioxide, carbon monoxide, sulphur (Scholes & Walker 1993), dimethyl sulphide and methyl nitrates (Swap *et al*. 2003) into the atmosphere. However, it is likely that most of carbon emitted during a fire burn, is trapped again during the flush of regrowth following fire (Scholes & Walker 1993). Even though wildfires may be destructive, periodic burning is also necessary to achieve optimal productivity in the savannas (Trollope & Trollope 1999).

4.3 Over-utilisation as the driving force

As discussed below, the main driving forces of woodland depletion, identified in the study area, include the demand of wood for fire, poles for construction and unsustainable use of non-wood products.

4.3.1 Firewood

The majority (84%) of the respondents in the woodland depleted villages and 76% in the woodland abundant villages use firewood for cooking and heating purposes (Table 4.2). This makes wood a primary source of energy for cooking and heating in the studied villages. A study in Malawi showed that wood is the primary source of domestic energy requirements in rural areas (Abbot & Lowore 1999), while in Namibia, 85% of households (Erkkilä & Siiskonen 1992) and between 95 and 100% in Zimbabwe (Mac Garry 1987) use wood more than any other energy source for cooking and heating. It is also the main source of energy for most rural households in South Africa (Gandar 1994; Hassan 2002; DME 2003). Despite the large-scale electrification drive in South Africa, firewood is still the primary source of energy for rural communities (Shackleton *et al*. 2004). The demand for firewood was predicted to rise by 50% in 2030 (MEA 2004). Firewood use in the study area is far higher than the estimated one third of rural households in South Africa that rely on wood for energy supply (DWAF 1996), which is indicative of the high levels of poverty and some cultural aspects in rural areas. Considering population growth and poverty, firewood demands in rural areas will probably increase in the future.

Table 4.2 Perceived threats to mopane woodland in the study area

Mopane woodland utilisation		% of respondents in the woodland depleted villages (n = 90)	% of respondents in the woodland abundant villages (n = 90)
Threats			
Over-utilisation		100	33
Fire		0	67
Utilisation[a]			
Firewood		84	76
Construction		11	18
Medicinal		3	4
Use of *C. mopane* in construction			
Yes		72	92
No		28	8
Rating of threats to *C. mopane*		**% of respondents in the Greater Giyani Municipality conservation section and private sector (n = 10)**[a]	
Over-utilisation		44.4	
Fire		11.1	
Overgrazing		11.1	
Landuse types in the Greater Giyani Municipality		**Estimated percent cover of landuse types in the Greater Giyani Municipality***	
Cultivated areas		59.4	
Woodland		26.5	
Villages		5.4	
Degraded areas		5.0	
Bushland		3.0	
Giyani Town		0.7	

n = number of people interviewed

[a] = percentages do not always add up to 100 due to rounding off and lack of answers by some of the participants

* = SigmaScan Pro Image Analysis results of Figure 3.3

4.3.1.1 Reasons for the reliance on firewood

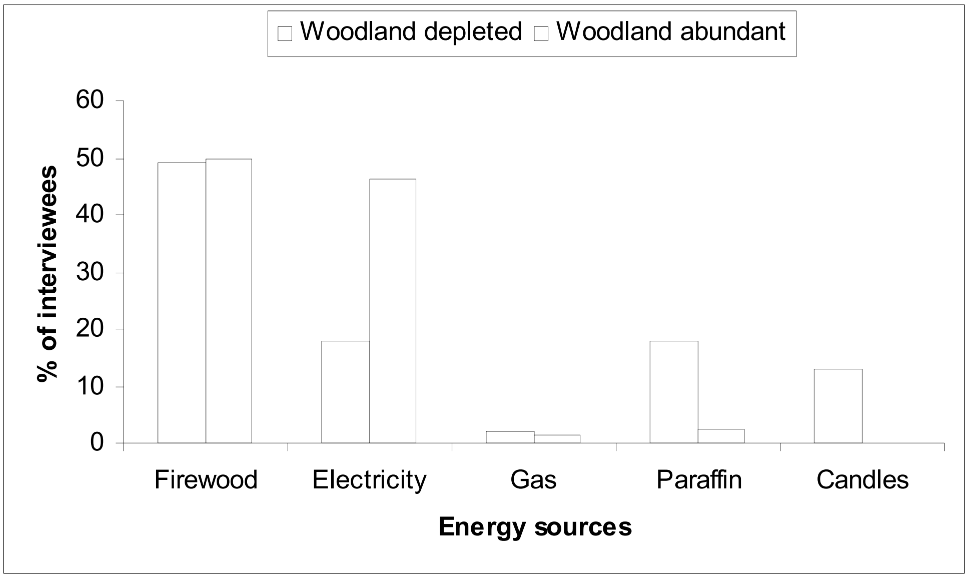


Figure 4.4 Utilisation of energy resources in the sampled villages.

Forty nine percent of the respondents in the woodland depleted villages and 50% in the woodland abundant villages use firewood as a source of energy for cooking and heating. Other sources of energy used for cooking, heating and lighting in the studied villages include electricity, and to a lesser extent paraffin and gas, with candles only used for lighting (Figure 4.4). Approximately 18% of the participants in the woodland depleted villages and 46.2% in the woodland abundant villages use electricity, 2% in the woodland depleted villages and 1.3% in the woodland abundant villages use gas, 18% in the woodland depleted villages and 2% in the woodland abundant villages use paraffin. In the woodland depleted villages, 13% use candles for lighting (Figure 4.4). Villages in the study villages prefer to use firewood for cooking than other sources of energy ($P < 0.0001$).

The use of other sources of energy is predominantly determined by affordability (Table 4.6). Sixty eight percent of respondents from the woodland depleted villages and 71% from the woodland abundant villages indicated that they cannot afford to buy other sources of energy other than wood. In addition to subsistence use of *C. mopane* wood, firewood of this species is also sold along the main roads of urban areas for income generation (Figure 4.13). In 2005, a 10 kg pile of *C. mopane* firewood was sold for R8 at the Sibasa market near Thohoyandou, Limpopo Province.

A study by Willis (2004) indicated that large numbers of rural poor people live in marginal lands without affordable energy sources, except for wood. Wood is the cheapest and most accessible source of energy to the majority of people in rural areas (Okello *et al*. 2001; Mercer & Soussan 1992), and is even traded in urban areas (Figure 4.13). Although villagers in the studied villages use electricity and paraffin mostly for lighting, they indicated that it is too expensive to use for cooking and heating purposes. Affordability of alternative energy sources other than wood is common in most rural areas of Africa (Lowore *et al*. 1995; Banks *et al*. 1996; Van Wyk and Gericke 2000; MEA 2004). The end result is a high demand of wood for cooking and heating, which has intensified woodland deprivation in most rural areas of southern Africa (Banks *et al*. 1996; Rathogwa *et al.* 1999).

4.3.1.2 Preferences for firewood

Culture influences people's perception, values, and beliefs (FAO 1983) to use certain resources over others. It is a widely held belief among the VhaVenda and Shangaan elders that porridge cooked using wood has a better taste than that cooked using electricity. These perceptions increase the demand for wood as a first choice energy source for cooking by elders in rural areas. Wood is also used as an energy source because it is found in the proximity of villages.

Colophospermum mopane is also the dominant species and can be repeatedly harvested due to its regrowth ability, factors that strengthen its preference and demand. In addition, a study by Prior and Cutler (1992) showed that *C. mopane* and *Combretum apiculatum* are highly preferred for firewood in Zimbabwe, owing to the factors discussed above.

4.3.1.3 Volumes of firewood used

There is a significant difference in the amount of firewood used for cooking family^{-1} day^{-1} in the studied villages ($P < 0.0001$). The mean amount of firewood used by a family of between 5 and 8 people for cooking porridge day^{-1} is 6.8 ± 0.05 kg in the woodland depleted villages, resulting in about 2 482 kg (2.5 tonnes) of firewood used year^{-1} family^{-1} (Table 4.5A). In contrast, a similar-sized family in the woodland abundant villages uses 8.2 ± 0.16 kg of firewood day^{-1} for cooking porridge, resulting in about 2 993 kg (2.9 tonnes) of firewood used year^{-1} family^{-1} (Table 4.5B). In contrast to woodland abundant villages, villagers in the woodland depleted villages use as little firewood as possible to save for the next day. Mercer and Soussan (1992) showed that cooking consumes most of the firewood used by a household, a fact supported by results from Van Wyk and Gericke (2000) and Mashabane *et al*. (2001). The volume of firewood used for daily cooking household^{-1} in the woodland depleted villages is 0.022 m^3 (approximately 8.03 m^3 year^{-1}) compared to 0.032 m^3 (approximately 11.68 m^3 year^{-1}) of firewood used in the woodland abundant villages (Tables 4.5A and 4.5B).

Table 4.2 indicates that approximately 84% of respondents in the woodland depleted villages use wood for firewood, compared to 76% in the woodland abundant villages. It was estimated that 84% of respondents in the woodland depleted villages use approximately 131 531 m^3 of firewood annum^{-1}, compared to 76% of the respondents using approximately 142 029 m^3 of firewood annum^{-1} in the woodland abundant villages (Table 4.3). Also, data from Census 2001 indicates that approximately 80% of the people in the Greater Giyani Municipality use firewood for cooking, which implies that they use approximately 2 634 612 m^3 of wood for cooking year^{-1} (Table 4.3).

Firewood utilisation varies among villages and is predominantly determined by availability of wood from the surrounding woodlands (see Table 4.4). A study by Madzibane and Potgieter (1999) in the Venda area showed that 8 people, constituting an average family, utilise approximately 7.8 kg of firewood for cooking meal^{-1}. A related study by Van Wyk and Gericke (2000) showed that the amount of firewood used by the communities in Giyani to be 14.9 kg day^{-1} family^{-1} or 7.7 tonnes year^{-1} family^{-1}. Additionally, in 2001, a study in the Giyani area found that approximately 7.5 kg of firewood is utilised by a family of 7 people day^{-1} (Mashabane *et al*. 2001). All these reports are from the same locality and showed a variation in terms of firewood used for cooking family^{-1}. The possible causes for this variation are uncertain. It is probably due to reduced availability of wood, increased distance and time to harvest wood, electrification programmes and increased awareness on woodland depletion. If the results of this study and previous studies on firewood utilisation are combined (Table 4.4), it is estimated that a family consisting of a mean of 7 people household^{-1} in the rural areas of Limpopo Province mopane belt, uses approximately 9.04 kg of firewood for cooking meal^{-1} (Table 4.4), resulting in an estimated 3.3 tonnes of wood used for cooking household^{-1} annum^{-1}. This estimation might have been influenced by a high mean (14.9 kg) calculated by Van Wyk and Gericke (2000). A better estimation might be obtained by using a median, to avoid overestimation of the reviewed data. This estimates that approximately 7.8 kg of firewood is used for cooking day^{-1} household^{-1} in the Limpopo Province mopane belt, resulting in approximately 2.8 tonnes of firewood used for cooking household^{-1} annum^{-1} (Table 4.4).

Table 4.3 Estimated volume of firewood used for cooking in a village year^{-1} in the study area

Volume of firewood used in the study area	Number of people calculated as % from the total population	Volume of wood used per annum (m^3)
Woodland depleted villages	**19 500# (100%)**	156585 m^3
	16380 (84%)	**131531 m^3**
	15600 (80%)	**125268 m^3**
	11700 (60%)	**93951 m^3**
	7800 (40%)	**62634 m^3**
	3900 (20%)	**31317 m^3**
Woodland abundant villages	**16 000# (100%)**	186880 m^3
	12800 (80%)	**149504 m^3**
	12160 (76%)	**142029 m^3**
	9600 (60%)	**112128 m^3**
	6400 (40%)	**74752 m^3**
	3200 (20%)	**37376 m^3**
Greater Giyani Municipality	**237 438## (100%)**	3293265 m^3
	189950.5 (80%)	**2634612 m^3**
	142462.8 (60%)	**1975959 m^3**
	94975.2 (40%)	**1317306 m^3**
	47487.6 (20%)	**658653 m^3**

= estimated by community members ## = Statistics S.A.: Census 2001 data

Table 4.4 Estimated mean amount of firewood used for cooking day^{-1} household^{-1} in the Limpopo Province mopane belt. Data derived from this study and from previous studies on firewood utilisation

Date	Study area	No. of people family^{-1}	Amount of wood used for cooking day^{-1} (kg)
This study	Giyani^{+}	5-8 (6.5)	6.8
This study	Giyani^{++}	5-8 (6.5)	8.2
2001***	Giyani	7	7.5
2000**	Giyani	7	14.9
1999*	Venda	8	7.8
Mean		7	9.04
Median		7	7.8

*** = Mashabane *et al*. (2001) $^{+}$ = Woodland depleted villages

** = Van Wyk and Gericke (2000) $^{++}$ = Woodland abundant villages

* = Madzibane and Potgieter (1999)

The use of firewood as the primary source of energy is growing in urban areas of developing countries (Flower *et al*. 1996), but despite of its growth, rural household consumption still dominates (Mercer & Soussan 1992). In South Africa, the total annual consumption of firewood by low income households was estimated by Gandar (1994) to be 11 million tonnes in 1994, of which 6.6 million tonnes was used in the former homelands. Shackleton *et al.* (2001) estimated it to be 10 million tonnes year^{-1}. This clearly shows a high demand in the utilisation of wood for energy purposes. For the foreseeable future, the demand for firewood will remain high due to increasing population growth and poverty (Shackleton 2001). In addition, wood regeneration rate in the southern African countries is close to the consumption rate, but in the vicinity of habitations, the demand usually exceeds the supply (Scholes 1997). The afore-mentioned factors pose a serious threat for the survival of highly preferred species used for firewood and construction purposes.

Table 4.5A Mean values of the uses of *C. mopane* wood for firewood and poles used for construction purposes by villagers in the woodland depleted villages

Uses		**Length (m)**	**Circumference (m)**	**Diameter (m)**	**Mass (kg)**	**No. of poles**	**Volume (m^3)**
Fuelwood		1.1	0.18	0.05	6.8	10	0.022
Types of traditional huts							
Kitchen							
Roofing:	Main beams	4.0	0.18	0.06	5.7	18	0.204
	Brandering	3.5	0.1	0.04	1.7	56	0.246
	Roof support	2.65	0.55	0.20	10	16	1.332
Wall (plastered with mud)*		2.7	0.5	0.18	9.5	66	4.536
Children							
Roofing:	Main beams	4.0	0.19	0.05	6.0	19	0.149
	Brandering	3.2	0.12	0.03	1.8	68	0.154
Adults							
Roofing:	Main beams	3.5	0.25	0.07	8.9	20	0.269
	Brandering	4.3	0.09	0.03	1.9	70	0.213
Fencing							
	Main poles	1.72	0.8	0.3	12.5	94	11.433
	Supporting poles**	1.32	0.11	0.04	5.9	749	1.243
Types of maize grain stores							
Outside hut granary							
Foundation		1.05	0.55	0.18	2.2	10	0.267
Floor		2.65	0.2	0.06	3.0	35	0.262
Wall		2.2	0.11	0.06	2.40	138	0.273
Roofing:	Main beams	2.8	0.16	0.05	2.30	22	0.121
	Brandering	2.47	0.09	0.03	2.4	27	0.047
Granary in the roof of a kitchen							
Foundation		2.6	0.42	0.15	12.2	12	0.552
Floor		2.7	0.23	0.1	5.3	33	0.700
Wall		1.5	0.2	0.06	2.0	85	0.361
Animal kraals (Main poles)**							
Cattle		2.4	0.6	0.27	13.9	125	17.183
Goat		2.1	0.55	0.15	6.2	130	4.826
Pigsty		1.8	0.45	0.13	6.0	39	0.932
Others:	Mortar	0.99	0.74	0.33	30	1	0.085
	Pestle	1.25	0.20	0.05	6.8	1	0.002

* = estimated as the poles were plastered with mud

** = vertical poles

Table 4.5B Mean values of the uses of *C. mopane* wood for firewood and poles used for construction purposes by villagers in the woodland abundant villages

Uses		Length (m)	Circumference (m)	Diameter (m)	Mass (kg)	No. of poles	Volume (m^3)
Fuelwood		1.6	0.20	0.06	8.2	05	0.032
Types of traditional huts							
Kitchen							
Roofing:	Main beams	4.2	0.20	0.06	6.2	20	0.238
	Brandering	3.7	0.09	0.04	1.8	60	0.279
	Roof support	2.70	0.55	0.20	10	18	1.527
Wall (plastered with mud)*		2.7	0.5	0.18	9.2	70	4.811
Children							
Roofing:	Main beams	4.2	0.22	0.06	10	25	0.297
	Brandering	3.5	0.1	0.04	1.7	56	0.246
Adults							
Roofing:	Main beams	4.0	0.24	0.07	9.5	20	0.308
	Brandering	3.9	0.12	0.04	2.2	70	0.343
Fencing							
	Main poles	1.74	0.84	0.36	12.5	84	14.883
	Supporting poles**	1.34	0.11	0.04	5.4	786	1.324
Types of maize grain stores							
Outside hut granary							
Foundation		1.0	0.50	0.17	2.0	12	0.272
Floor		2.78	0.35	0.1	3.4	38	0.830
Wall		1.9	0.1	0.09	2.25	132	1.596
Roofing:	Main beams	2.5	0.15	0.05	2.6	28	0.137
	Brandering	2.6	0.42	0.15	12.2	12	0.552
Granary in the roof of a kitchen							
Foundation		3.0	0.37	0.14	12.0	12	0.554
Floor		2.6	0.55	0.15	5.4	37	1.701
Wall		1.85	0.19	0.04	2.3	156	0.363
Animal kraals (Main poles)**							
Cattle		2.45	0.55	0.27	14.2	272	38.170
Goat		2.1	0.29	0.10	6.7	118	1.947
Pigsty		1.9	0.23	0.06	5.2	85	0.457
Others:	Mortar	1.0	0.79	0.35	34	1	0.096
	Pestle	1.26	0.22	0.06	7.2	1	0.004

* = estimated as the poles were plastered with mud

** = vertical poles

Figure 4.5 Adult mopane worms. *Colophospermum mopane* trees host mopane worms, which are widely utilised by villagers for subsistence and commercial purposes.

Photo credit: D.C.J. Wessels

Figure 4.6 A traditional maize grain store. The size of outside grain stores sampled is between 2.4 and 2.5 m^2. The mean number of poles and sizes required to construct an outside maize grain store are indicated in Tables 4.4A and 4.4B.

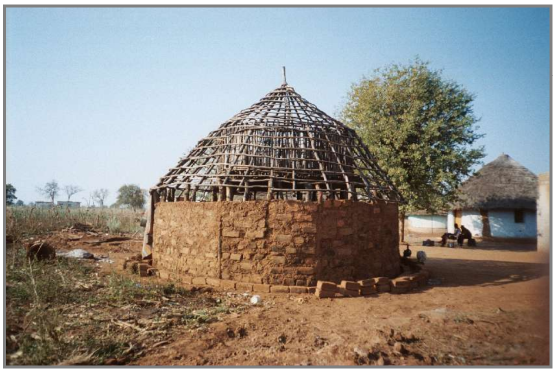


Figure 4.7 A kitchen and a maize grain store within the roof. The radius of a kitchen is approximately 2.6 m from the centre. The mean number of poles and the sizes required to construct a kitchen and the inside maize grain store are indicated in Tables 4.4A and 4.4B.

Figure 4.8 A traditional hut. The radius of the hut is approximately 3 m. The mean number of poles and sizes required to construct a hut are indicated in Tables 4.4A and 4.4B.

Figure 4.9 Fencing. The mean number of poles used to fence a yard of approximately 25 m^2 and the sizes required are indicated in Tables 4.4A and 4.4B.

Figure 4.10 A medium to large sized cattle kraal. The size of the kraals ranges from about 5 m^2 to 15 m^2, but some are not absolute square. The mean number of inserted poles in the soil and the sizes required to construct a cattle kraal are indicated in Tables 4.4A and 4.4B.

Figure 4.11 A small to medium sized goat kraal. The size of a small kraal is about 1.2 m diameter from the centre to about 3 m for medium kraal. The mean number of main poles and sizes required to construct a goat kraal are indicated in Tables 4.4A and 4.4B.

Figure 4.12 Piles of firewood in a yard of Mapayeni village. Firewood is used as the primary source of energy for cooking and heating. Villagers harvest non-dry wood from the surrounding woodland and dry them at home. A list of other species used for firewood appears in Appendix 2.

Figure 4.13 Woman selling *C. mopane* firewood. Villagers sell *C. mopane* firewood for income generation. The photograph was taken along the main road at Sibasa Shopping Complex, Limpopo Province.

Figure 4.14 Grandmother pounding maize. A mortar and a pestle are still used for pounding maize, peanuts and preparation of medicine.

Figure 4.15 Headload of firewood. Women and girls transporting harvested wood to their yard in Maphopye village, Limpopo Province. The mass of a headload ranges from approximately 10 kg for young girls to approximately 30 kg for women.

Figure 4.16 Fire in mopane woodland. Fire has a negative effect on trees less than 3m tall, but *C. mopane* survive fire through its coppicing ability. The image was taken between Musina and Pontdrift, shortly after a fire.

Photo credit: D.C.J. Wessels

4.3.1.4 Harvesting of *C. mopane* wood

Harvesting wood is physically hard and time-consuming work especially for women, who are also responsible for the collection of water, caring for children and doing agricultural work (Mercer & Soussan 1992).

4.3.1.4.1 Distance travelled to harvest firewood

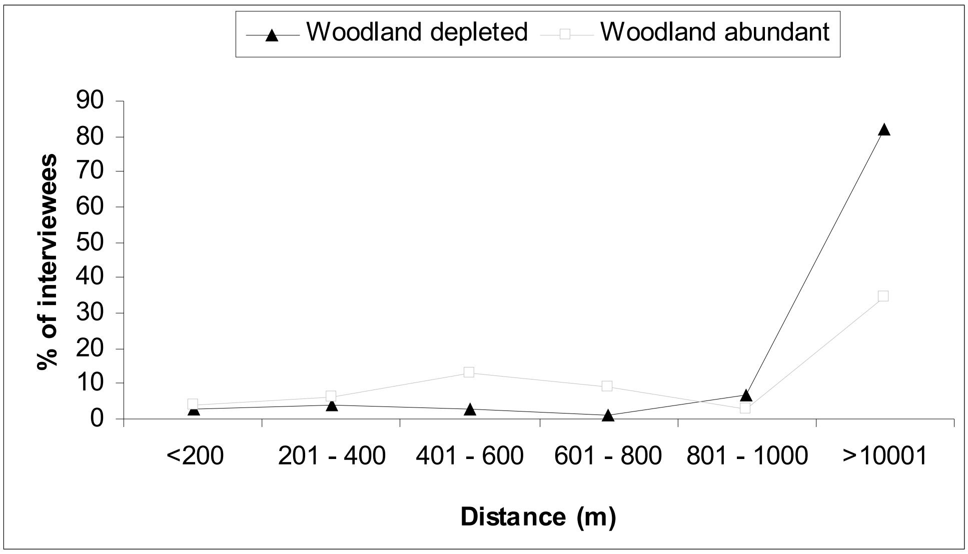


Figure 4.17 Distance travelled to harvest firewood in the sampled villages.

Little firewood is harvested closer than 800 m from the residential area in the sampled villages (Figure 4.17). Firewood harvesters (women and girls) travel further than a kilometre to harvest firewood. Distance travelled to harvest firewood was more significant in woodland depleted villages ($P = 0.001$) than for woodland abundant villages ($P = 0.010$). As pressure on the local firewood supply develops (Gandar 1983), there is also an increase in the distance travelled (Mercer & Soussan 1992) by women to collect firewood (Watson & Dlamini 2003). In Malawi, women travel between 3 and 5 km to harvest firewood, while those in the Owambo area of Namibia travel between 8 and 10 km daily (Erkkilä & Siiskonen 1992). However, if the wood is carried by head-load, the radius over which wood is harvested shrinks to about 5 km (MEA 2004).

4.3.1.4.2 Time taken to harvest firewood

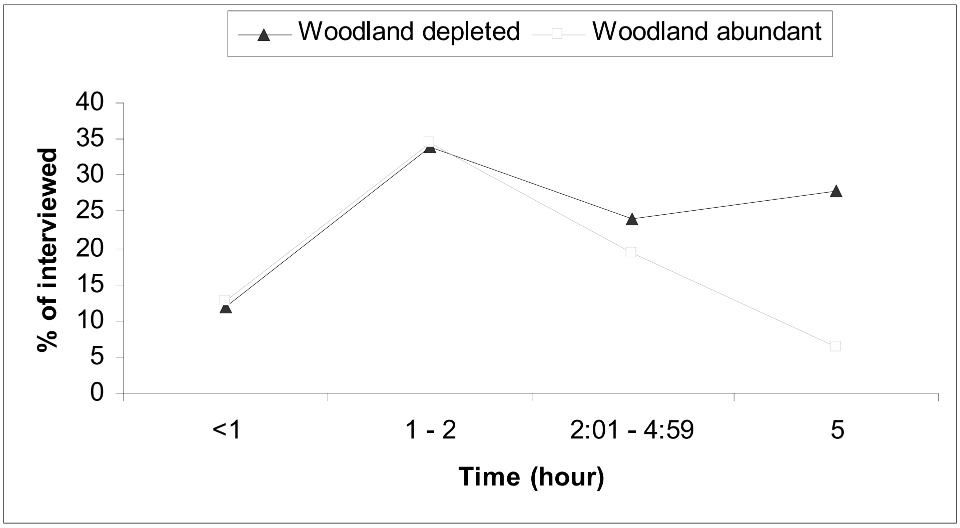


Figure 4.18 Time taken to harvest firewood in sampled villages.

Time taken to harvest firewood by villagers in the woodland depleted villages is between one and five hours (mean = 4, P = 0.001), while those from woodland abundant areas take between one and four hours fifty nine minutes (mean = 3, P = 0.024) to collect firewood (Figure 4.18). Between one and five hours women spent on harvesting firewood in the woodland depleted villages is highly significant (P = 0.001), but compares favourably with the mean of two hours spent by woman in certain woodland depleted villages of Zimbabwe (Campbell *et al*. 1993), four hours spent by women in Mametja, Limpopo Province (Twine *et al*. 2003), and five hours on average spent by women in rural areas of South Africa (DWAF 1996).

In countries such as Malawi, women spent approximately five hours collecting firewood (Erkkilä and Siiskonen 1992), while in India, it takes between three and six hours a day to collect firewood (UNESCO U.D.). When the distance increases to more than 10 kilometres, villagers in the sampled villages use donkeys as a means of transporting firewood to their settlement, while other villagers who can afford to pay the transport fees use *bakkies* (pickup vehicles). Similar modes of transport also exist for the transportation of poles for construction purposes. Clearly, the distance travelled and time taken to harvest firewood is gradually increasing every year, as shown by the tendency of villagers to go further a-field every year to harvest firewood. This was indicated by 81% of the respondents in the woodland depleted villages and 66% in the woodland abundant villages (Table 4.6). This situation was also observed in some rural areas of Zimbabwe (Campbell *et al*. 1993).

Table 4.6 Use of firewood in the sampled villages

Tendency and affordability		% of respondents in woodland depleted villages (n = 90)	% of respondents in woodland abundant villages (n = 90)
Tendency to go further a-field every year to collect firewood			
Yes		81	66
No		19	34
Affordability of alternative energy sources other than firewood [a]			
Yes		32	20
No		68	71

[a] = percentages do not always add up to 100 due to rounding off and lack of answers by some of the participants

n = number of people interviewed

4.3.1.4.3 Social impacts of firewood gathering

As the distance and time taken to harvest firewood increase, negatively affects firewood collectors, mainly women and girls. In Gambia, the collection of firewood by women is done on a daily basis (WCS 1984), and the time spent on firewood harvesting represents a high social and economic cost to the family and society (DME 2003). In South Africa, Madzibane and Potgieter (1999) showed that women suffer from back and leg pains as a result of travelling long distances to collect firewood. The time spent by woman collecting firewood limits their involvement in other socio-economic activities.

Scarcity of firewood also increases the use of non-preferred species for firewood and burning of wet wood. This can increased the emission of nitrous oxide (MEA 2004), carbon (Swap *et al*. 2003), sulphur, carbon monoxide and smoke particulates, which are between 2 and 10 times higher than WHO standards (Terblanche *et al*. 1994). Inhalation of these gases could lead to health hazard to firewood main users, mostly women and girls (Terblanche *et al*. 1994; Mika 2004). In Tanzania, the denudation of woodland has resulted in a situation termed “the poor man’s energy crisis”, with circles of deforestation and depletion of preferred firewood species occurring around villages (Primack 1993), similar to results of this study (Figure 4.19). A study in South Africa showed that firewood consumption is probably at unsustainable levels at localized sites, although there is a potential surplus in other areas (Von Maltitz & Scholes 1995). This is also illustrated in Figure 4.19, which indicates that woodland resources are abundant far from the edges of villages. It also indicates over-harvesting and transformation of woodland to open areas near villages.

Figure 4.19 Denudation of woodland around the villages in the Greater Giyani Municipality. Satellite image produced from the Google Earth, version 4, 2006. Green colour = vegetation, Light grey colour = settlement and cultivation areas.

As the shortage of firewood increases, more fundamental social and environmental changes are likely to occur. These include excessive pruning of surrounding trees by villagers, destruction of valuable trees, and utilisation of animal dung and crop residues for energy resources (FAO 1983; Ham & Theron 1999). Use of less desirable plant species for firewood and construction purposes is also more likely to occur (see Figures 4.20 and 4.22; Appendix 2).

4.3.2 Construction of traditional structures

Although modernisation has takes place in most rural areas, poor people still rely on *C. mopane* wood for the construction of traditional structures. This was shown by 72% of the respondents in the woodland depleted villages and 92% in the woodland abundant villages (Table 4.2). *Colophospermum mopane* is the favoured species for the construction of traditional structures, but other tree such as *Combretum apiculatum* is also used. In the southern African mopane belt, *C. mopane* accounts for more than 90% of timber used for construction of traditional structures (Van Wyk & Gericke 2000). This was also noted by researchers such as Erkkilä and Siiskonen (1992) in Namibia; Madzibane and Potgieter (1999) in the Venda area and Mashabane *et al*. (2001) in the Giyani area. See also a review by Timberlake (1995) and Appendix 3.

4.3.2.1 Traditional huts

The majority of the inhabitants in the studied villages still build their huts using wood. A rectangular-shaped hut is built using *C. mopane* and *Combretum apiculatum* poles. A hut constructed from *C. mopane* poles was found to have a durability of between 10 and 15 years, while Mashabane *et al*. (2001) report a lifespan of at least 25 years. The variations of these results are unknown, but this could be influenced by the availability and density of the wood.

More wood is used in the construction of traditional structures in the woodland abundant villages than in the woodland depleted villages. These illustrate that wood consumption for construction declines as their availability decreases. Mean volume of poles used to construct main beams of a kitchen roof in the woodland depleted villages is 0.204 m^3, 0.149 m^3 for children's hut and 0.269 m^3 for an adult's hut (Table 4.5A), opposed to 0.238 m^3 for a kitchen, 0.297 m^3 for children's hut and 0.308 m^3 for an adult's hut in the woodland abundant villages (Table 4.5B). The branderings of a kitchen roof in the woodland depleted villages requires a mean of 0.246 m^3, 0.154 m^3 for a children's hut and 0.213 m^3 for an adult's hut (Table 4.5A), opposed to 0.279 m^3 for a kitchen, 0.295 m^3 for a children's hut and 0.343 m^3 for an adult's hut in the woodland abundant villages (Table 4.5B). A mean volume of poles utilised to construct the roof support of the kitchen (e.g. Figure 4.8) is 1.332 m^3 in the woodland depleted villages (Table 4.5A), compared to 1.527 m^3 in the woodland abundant villages (Table 4.5B).

The poles used for erection of a kitchen wall are placed closer to each other in order to strengthen the structure. The mean volume of poles used to construct the wall of a kitchen hut is approximately 4.536 m^3 in the woodland depleted villages (Table 4.5A), compared to 4.811 m^3 in the woodland abundant villages (Table 4.5B).

This study showed that the mean amount of poles required to construct a round hut in the woodland depleted villages totals 1.315 m^3, versus 1.405 m^3 in the woodland abundant villages, which is not significantly different ($P > 0.5$). However, this is less than 3.02 m^3 of wood used to construct a hut in Zimbabwe (Cunningham & Davis 1997), but can be compared to the 1.22 m^3 of wood used by Tsongas in the Limpopo Province (Cunningham & Davis 1997). The number of huts per household in the Greater Giyani Municipality is between three and four (Statistics S.A.: Census 2001). This study estimated that three huts $household^{-1}$ requires a mean wood volume of 3.95 m^3, while four huts per household requires 5.26 m^3 of wood in the woodland depleted villages. By comparison, three huts per household in the woodland abundant villages require a mean wood volume of 4.22 m^3 and 5.62 m^3 for four huts.

4.3.2.2 Traditional maize granaries

Villagers still construct granaries to preserve harvested maize. Before constructing a granary, poles are slightly scorched by fire and then debarked to make them resistant to the effects of termites and wood borers. The granary can be either constructed as a square outside the huts (Figure 4.6) or in the roof of a kitchen hut (Figure 4.7). The smoke produced by kitchen fires limits insect infestations (Mashabane *et al*. 2001). A mean wood volume of 0.273 m^3 is utilised when building the wall of an outside granary and 0.361 m^3 for a granary in the roof of a kitchen in the woodland depleted villages (Table 4.5A), compared to 1.596 m^3 for building the wall for an outside hut granary and 0.363 m^3 for a granary in the roof of a kitchen in the woodland abundant villages (Table 4.5B). The estimated mean amount of poles used to construct a medium sized outside hut granary in the woodland depleted villages is approximately 0.563 m^3 and 0.537 m^3 for a granary in the roof of a kitchen; while in the woodland abundant villages, it is approximately 0.309 m^3 for the construction of an outside hut granary and approximately 0.873 m^3 for a granary in the roof of a kitchen. There was no significant difference in the mean amount of poles used to construct an outside hut granary ($P = 0.140$) and a granary in the kitchen roof ($P = 0.517$) between the grouped villages.

The lifespan of a granary constructed in the roof of a kitchen was estimated to be between 10 and 15 years, which is the same as a hut. Maize granaries built outside huts last for less than five years, which supports the finding of Mashabane *et al*. (2001). Outside hut granaries are more exposed to negative environmental and termite's effects than granaries constructed in the roof, which in turn impact negatively on the durability of such a structure. However, the construction of a granary in the roof of a kitchen is difficult and requires traditional skills, which are now lacking in the youth, implying an additional demand on wood as a result of constructing less durable outside granaries.

4.3.2.3 Animal kraals

Kraals are constructed either square or rectangular (Figures 4.10 and 4.11). It requires more poles to construct a cattle kraal than goat and pig kraals, as their sizes vary. The mean amount of wood required to construct a cattle kraal in the woodland depleted villages is 17.183 m^3, compared to 38.170 m^3 in the woodland abundant villages, which is statistically significant ($P = 0.025$). The mean amount of wood required for the construction of a goat kraal is 1.947 m^3 and 0.457 m^3 for a pig kraal in the woodland depleted villages (Table 4.5A), compared to 4.826 m^3 for a goat kraal and 0.932 m^3 for a pig kraal in the woodland abundant villages (Table 4.5B).

The choice of species to use when constructing a kraal is less important as these structures are annually removed to avoid animals being trapped by mud during the rainy season, and to limit foot diseases in animals (Lowore *et al*. 1995). This implies that, new poles are harvested annually to replace rotten poles or to construct new kraals. During the renovation of the kraals, old and rotten poles are utilised for firewood purposes.

4.3.2.4 Fencing

Mashabane *et al*. (2001) stated that not all poles used for fencing are from *C. mopane* trees. This study found that villagers also use *Acacia nigrescens*, *Combretum apiculatum*, *Dalbergia melanoxylon*, *Terminalia sericea*, *Dichrostachys cinerea* and *Combretum hereroense* poles for fencing (Appendixes 2 and 3). For the fencing of a stand, poles tend to be spaced further apart than when constructing kraals (Mashabane *et al*. 2001). In this study, the spacing between supporting poles was found to be approximately 0.7 m (Figure 4.9). Construction of a fence in the woodland depleted villages required a mean of 11.433 m^3 for the main poles and 1.243 m^3 for the supporting poles (Table 4.5A), as opposed to about 14.883 m^3 used to construct the main poles and 1.324 m^3 for supporting poles in the woodland abundant villages (Table 4.5B). Villagers indicated that such a fence could last for more than 10 years if there is regular replacement of old and rotten poles every year, especially when species other than *C. mopane* are used. The estimated mean amount of poles used for fencing a household is 6.338 m^3 in the woodland depleted villages and 8.104 m^3 in the woodland abundant villages, which is not significant difference between the grouped villages ($P > 0.5$).

4.3.2.5 Utensils

Colophospermum mopane wood is also used for making tools such as mortars, pestles, spoons, walking sticks for the elderly, and hand hoes used for ploughing. The mean volume of wood used to construct a mortar in the woodland depleted villages is 0.085 m^3 and 0.002 m^3 for a pestle (Table 4.5A), while in the woodland abundant villages it is 0.096 m^3 for a mortar and 0.004 m^3 for a pestle (Table 4.5B). A mortar and pestle (Figure 4.14) are traditionally used for pounding maize, peanuts and in the preparation of medicine. The uses of *C. mopane* wood for the construction of utensils in the Giyani area were also mentioned by Liengme (1981; 1983) and Mashabane *et al*. (2001).

4.3.2.6 Preference of *C. mopane* for construction

During construction of traditional structures such as huts, villagers preferred to use *C. mopane* because it produces durable and relatively straight poles, which are resistant to wood borers. The durability of *C. mopane* wood is due to the fact that it has a high wood density of around 1200 kg/m^3 (Goldsmith & Carter 1981). It also contains chemicals that resist the effects of termites and wood borers (Cunningham 1993). The wood cell of *C. mopane* and *Combretum apiculatum* are packed with crystals of calcium oxalate, which results in a dense wood, as opposed to *Acacia* species (Prior & Cutler 1992). Also, the "secondary metabolites collectively known as extractives, contributes to the final density of wood. *Colophospermum mopane* occurs in relatively harsh, dry growing environments, which increases the content of extractives in the plant" (Wesley-Smith *pers. comm*. 2005). This contributes to the durability of *C. mopane* poles and they therefore last for longer period. However, the declining availability of *C. mopane* poles in the sampled villages has resulted in the use of less preferred species such as *Acacia nigrescens*, which has a less dense wood compared to *C. mopane*. Poles from tree species other than *C. mopane* do not last long due to the effects of termites and wood borers, which implies a shorter lifespan of structures leading to a much faster replacement rate of structures and thus a higher demand.

4.3.3 Non-wood products in the study area

Non-wood products include mushrooms, grass for thatching, honey, edible insects, and wild fruits. The most important wild fruit eaten in the study area is the marula (*Sclerocarya birrea*), which is eaten as a fresh product by villagers or processed to produce "Amarula's" (traditional marula beer or locally known as "*Vukanyi*"). Currently, the marula beer is traded in most local towns of the Limpopo Province, including Bushbuckridge (Shackleton 2005), Thohoyandou and Giyani. Marula fruits are also processed to make jams and the nuts are used to produce oil (South Africa Info 2002). Even though there are few industries involved in indigenous products processing in South Africa, the Marula Natural Products (Pty) Ltd located in the Limpopo Province is one of the few industries empowering people in rural areas (South Africa Info 2002). Many reports indicated that non-wood products provide substantial inputs to the livelihoods of the majority of rural people in developing countries (Campbell *et al*. 1993; Arnold & Peréz 1995; Grundy 1996; Mangue & Oreste 1999; Grundy 2000; Shackleton *et al*. 2001). The non-wood product examined in this study, is mopane worms, the larvae of the moth *Imbrasia belina* (Figure 4.5).

4.3.3.1 Mopane worms

Mopane worms are utilised by villagers in the sampled villages for subsistence and commercial purposes (Table 4.7). Forty eight percent of the people interviewed in the woodland depleted villages indicated that adults are responsible for mopane worm collection, while 55% of the respondents in the woodland abundant villages indicated that children, youth, and adults are involved in the collection of mopane worms. Five percent of participants in the sampled villages expressed the view that mopane worm collectors are doing little damage to *C. mopane* trees (Table 4.7). However, researchers in Botswana (Mpuchane *et al*. 2001; Watson & Dlamini 2003), Zimbabwe (Shuma 2001b) and in Namibia (Ashipala *et al*. 1996) indicated that harvesting of mopane worms leads to cutting of trees, branches and climbing of trees, but the extent of the damage is not known. An increase in such practices can destroy the habitat of *Imbrasia belina*, leading to fewer mopane worms during its outbreaks, which will certainly have a negative effect on the sustainability of this resource.

Table 4.7 Harvesting of mopane worms

Mopane worms utilisation	**% of respondents in the woodland depleted villages (n = 90)**	**% of respondents in the woodland abundant villages (n = 90)**
Purpose of mopane worm collection		
Subsistence	72	71
Commercial	28	29
People responsible for mopane worm collection		
Children	3	1
Youth	10	14
Adults	48	30
All	39	55
Trees damaged during mopane worm collection [a]		
Trees damage	5	5
No damage caused	92	94

n = number of people interviewed

a = percentages do not always add up to 100 due to rounding off and lack of answers by some of the participants

4.3.3.1.1 Utilisation of mopane worms

Although 72% of the respondents in the woodland depleted villages and 71% in the woodland abundant villages collect mopane worms for subsistence purposes, about 28% of respondents in the woodland depleted villages and 29% in the woodland abundant villages sell dried mopane worms for income generation (Table 4.7). Utilisation of mopane worms is widespread in southern Africa (Palgrave 1983; Styles 1995; Ashipala *et al*. 1996) for nutrition (Mpuchane *et al*. 2001; Shuma 2001b) and income generation (Styles 1994; Shackleton *et al*. 2000b; Kozanayi & Frost 2002). Mopane worms contain protein at a concentration of between 47 and 65%, and 51% fats (Voorthuizen 1976; Styles 1995). Mopane worms are regarded as a staple diet by local people and have the potential to boost their nutritional needs. They also contribute to food security for the majority of people in rural areas (Mangue & Oreste 1999), and are as such highly regarded across southern Africa.

4.3.3.1.2 Availability of mopane worms

Mopane worm outbreaks occur twice a year, from December to January and April to May. Their availability creates both temporary (few days) and medium-term (few months) employment opportunities for the majority of unemployed women (Styles 1995). The abundance of mopane worms in the study area is determined by rainfall, temperature during larva growth and the presence of host tree leaves. Low rainfall limits the abundance of mopane worms (Styles & Skinner 1996) due to the shortage of fresh *C. mopane* leaves, the primary source of food for mopane worms. A decline in the number of mopane worms could also be the result of over harvesting of *C. mopane* trees for firewood and construction purposes, which could eventually decrease the financial return that can be generated from selling the mopane worms and leading to a loss of food security.

4.3.3.1.3 Harvesting of mopane worms

Women, children, and men are involved in the harvesting of mopane worms (Table 4.7). Harvesting of mopane worms was traditionally the duty for women and children (Kozanayi & Frost 2002), but in recent years, men have begun to participate in the gathering of non-wood products, attracted by the income earning opportunities (Stack *et al*. 2003). Currently, there are no rules to regulate harvesting of mopane worms, and this can increase the competition for mopane worm harvests during outbreaks. This could possible result in over-utilisation of mopane worm, thereby posing uncertainties about the future availability of mopane worms. However, it should be noted that income from non-wood products are seasonal (Grundy 1996), and one way to overcome seasonality fluctuation is to preserve those resources so that they can be sold throughout the year, as also put forward by Mpuchane *et al*. (2001).

4.3.3.1.4 Trading of mopane worms

Products derived from woodlands play an important role in meeting rural people's needs (Shackleton *et al*. 2000b). Currently, trading of mopane worms is a commercial business in southern Africa (Styles 1994; Hobane 1995; Ditlhogo *et al*. 1996) with good economic return (Mpuchane *et al*. 2001). Mopane worms are cooked, dried in the sun and then sold in urban areas due to low demand in the villages. However, selling of woodland resources in a local town (closer to villages) is less expensive due to low transport costs and results in higher incomes (Grundy 1996). Mopane worms are also sold in areas where old people receive their pension, as also reported by Shackleton *et al*. (2000b) and along the streets in urban areas. In 2005, mopane worm traders at Thohoyandou market indicated that an 80 kg maize bag of dried mopane worms sold for between R1 200 and R1 600. A five litre bucket filled with dried mopane worms sold for R150 and a 10 litre bucket for R300. Mopane worm traders indicated that they can generate an income of approximately R20 000 per year. Although there is a lucrative trade in mopane worms (Van Wyk & Gericke 2000), the price is mostly determined by the number of buyers and the abundance of the resource. High abundance of mopane worms results in the drop of mopane worm prices, due to low demand and an oversupply on the market, a situation which is reversed during low abundance. All these factors also determine the income that can be generated from selling mopane worms.

This study estimated that 28% of villagers in the woodland depleted villages and 29% in the woodland abundant villages benefited from selling mopane worms (Table 4.7). Economic benefits from selling mopane worms were also reported by Watson and Dlamini (2003) in northern Botswana. Styles (1994) estimated that an annual population of 9500 million mopane worms in South Africa's 20 000 km^2 of mopane woodland is worth £57 million, of which approximately 40% goes to poor rural women. Styles (1995) also indicated that trading in mopane worms provides employment to over 10 000 people. However, the depletion of *C. mopane* trees at the edges of villages (Figure 4.19) will probably increase the scarcity of mopane worms and the distance travelled by villagers to harvest mopane worms during outbreaks.

4.4 Other species used due to the scarcity of *C. mopane*

Figure 4.20 indicates plant species other than *C. mopane*, which are used for firewood, medicine (Figure 4.21) and construction (Figure 4.22). Shepherd (1985) states that the most preferred species are those that yield the best firewood, poles, fruits and products used in craftwork. However, due to scarcity of preferred species, villagers also use other plant species available to meet their daily needs (see also Appendix 3).

4.4.1 Plant species used for firewood

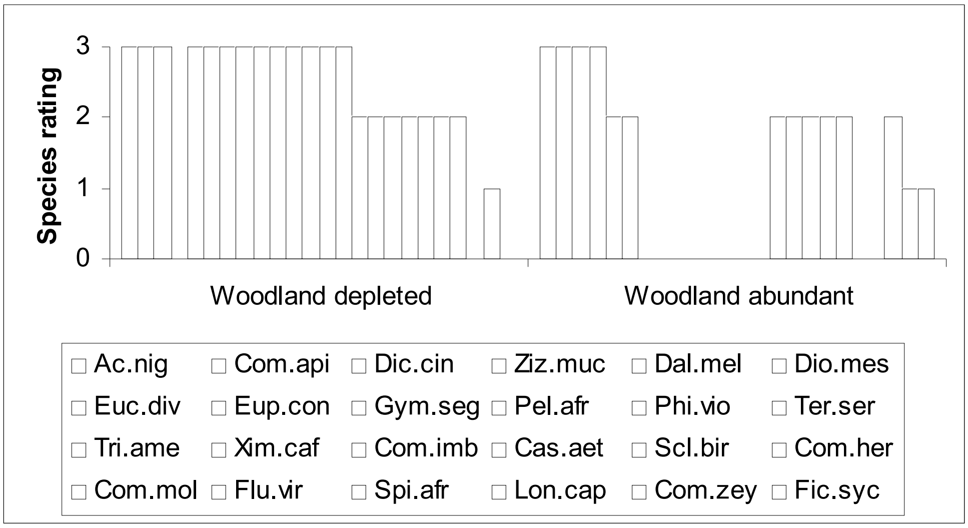


Figure 4.20 Other plant species used for firewood. The uses of the identified species for firewood were rated as: 1 = low, 2 = moderate and 3 = high. Refer to Appendix 2 for full species names.

Due to the scarcity of *C. mopane* in the sampled villages, a total of 35 firewood plant species are used. Villagers in the woodland depleted villages identified 21 plant species that are used for firewood, and 14 were identified in the woodland abundant villages. The mean rating of other species used for firewood in the woodland depleted villages is 2.57 out of a possible 3; while it is 2.21 in the woodland abundant villages. This could possibly imply that in the woodland depleted villages, the scarcity of preferred species is higher than in the woodland abundant villages, and as such villagers are using every species available for firewood.

Other species that are mainly used for firewood in the woodland depleted villages includes *Acacia nigrescens*, *Combretum apiculatum, Dalbergia melanoxylon, Dichrostachys cinerea, Diospyros mespiliformis, Euclea divinorum, Euphorbia confinalis, Gymnosporia senegalensis, Peltophorum africanum, Philenoptera violecea, Terminalia sericea, Tricelia emetica* and *Ximenia caffra*. Villagers in the woodland abundant villages use *Acacia nigrescens*, *Combretum apiculatum, Dichrostachys cinerea* and *Ziziphus mucronata*.

4.4.2 Plant species used for medicine

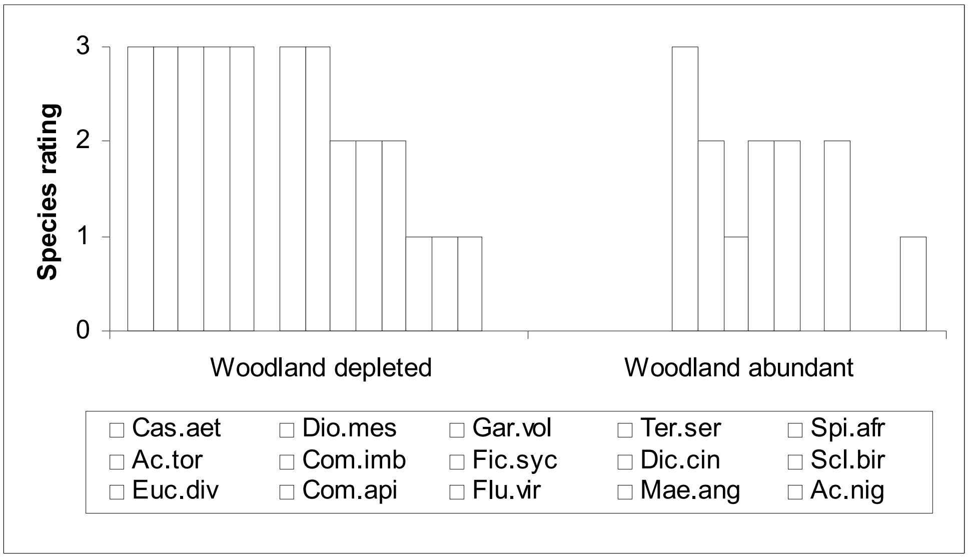


Figure 4.21 Other plant species used for medicine. The uses of the identified species for medicinal purposes were rated as: 1 = low, 2 = moderate and 3 = high. Refer to Appendix 2 for full species names.

A total of 20 medicinal plants were identified in the sampled villages. From this, 13 were identified in the woodland depleted villages and 7 in the woodland abundant villages. The mean rating of other species used for medicinal purpose in the woodland depleted villages is 2.153 and 1.857 in the woodland abundant villages.

Other species used for medicine in the woodland depleted villages includes *Cassine aethiopica, Diospyros mespiliformis, Combretum imberbe, Ficus sycomorus, Gardenia volkensii, Terminalia sericea, Dichrostachys cinerea, Euclea divinorum, Sclerocarya birrea* and *Spirostachys Africana*. Villagers in the woodland abundant villages identified *Acacia tortilis, Sclerocarya birrea, Combretum imberbe, Combretum apiculatum* and *Dichrostachys cinerea* as medicinal plants.

4.4.3 Plant species used for construction

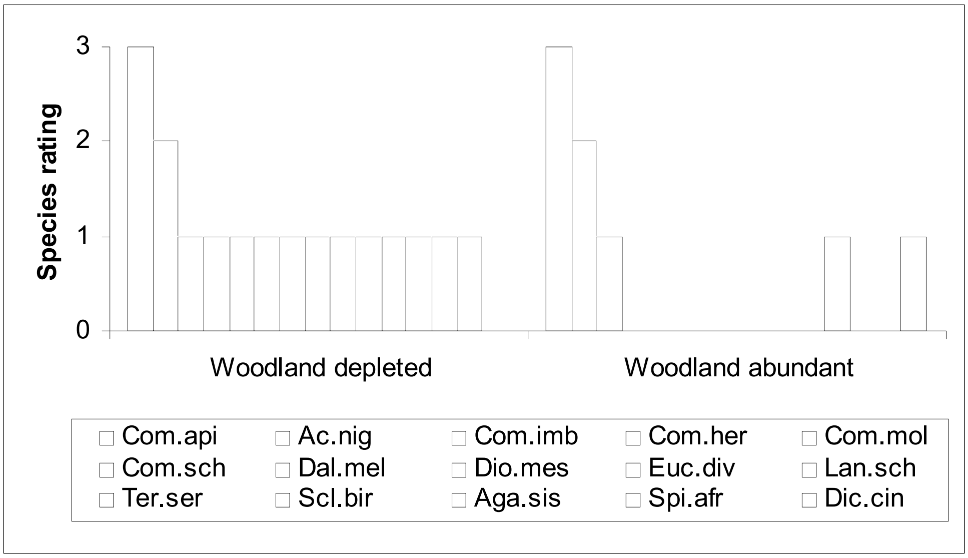


Figure 4.22 Other plant species used for construction. The uses of the identified species for construction purposes were rated as: 1 = low, 2 = moderate and 3 = high. Refer to Appendix 2 for full species names.

Due to the scarcity of *C. mopane* in the sampled villages, a total of 19 other plant species are used for construction of traditional structures. Villagers in the woodland depleted villages identified 14 of this species, while only 5 species were identified by villagers in the woodland abundant villages. The mean rating of other species used for construction in the woodland depleted villages is 1.2 and 1.6 in the woodland abundant villages, which shows dependence on *C. mopane* for construction.

Combretum apiculatum followed by *Acacia nigrescens* were rated as the main species used for construction purposes during the scarcity of *C. mopane* (Figure 4.22). *Combretum apiculatum* has higher wood density, which is similar to *C. mopane* (Prior & Cutler 1992), which could implies that *Combretum apiculatum* wood have high durability similar to *C. mopane* wood. This could be the main basis for extensive use of *Combretum apiculatum* wood for construction purposes by villagers in the studied villages (Figure 4.22). It is therefore deduced that *Combretum apiculatum* is the second preferred species from *C. mopane* for construction of traditional structures in the studied villages.

4.4.4 Ranking of *C. mopane* use together with other species

The rankings of *C. mopane* use for firewood, construction and medicine together with other plant species are presented in Table 4.8. Eighty four percent of the respondents in the woodland depleted villages (variance = 0.510) and 76% in the woodland abundant villages (variance = 1.927) indicated that they highly prefer to use *C. mopane* for firewood. Ninety percent of the interviewees residing in the woodland depleted villages (variance = 0.097) and 72% in the woodland abundant villages (variance = 0.205) indicated that they still utilise *C. mopane* for construction purposes. Only 3% of respondents in the woodland depleted villages and 4% in the woodland abundant villages use *C. mopane* for medicinal purposes (Table 4.8).

Table 4.8 Ranking of *C. mopane* use with other species

Ranks		**% of respondents in the woodland depleted villages (n = 90) [a]**	**% of respondents in the woodland abundant villages (n = 90) [a]**
Use of *C. mopane*			
Firewood		84	76
Construction		11	18
Ethnomedicinal		3	4
Use of *C. mopane* in construction			
Yes		90	72
No		8	28

n = number of people interviewed

a = percentages do not always add up to 100 due to rounding off and lack of answers by some of the participants

The value of *C. mopane* as a tree for multipurpose use was reported in various studies in southern Africa (Liengme 1981; 1983; Prior & Cutler 1992; Cunningham 1993; Timberlake 1995; Grundy 1996; Van Wyk & Gericke 2000; Mashabane *et al*. 2001). In general, decreases in the availability of *C. mopane* wood led to increase use of less preferred species such as *Combretum apiculatum* and *Acacia nigrescens* in most rural areas. See also Appendix 3 for a review of *C. mopane* uses with other tree species.

4.5 Traditional leaders' perceptions towards villager's participation in woodland management

Table 4.9 presents data on the willingness and perception of traditional leaders towards villager's participation in woodland management practices, conservation methods, and about the decline of *C. mopane* around their villages. The willingness of villagers to participate in woodland management differs from villages. Sixty seven percent of traditional leaders in the woodland depleted villages and 100% in the woodland abundant villages indicated that local people participated in the current woodland management practices. However, 33% of the traditional leaders in the woodland depleted villages indicated that some of the youth do not participate in woodland management practices. Sixty seven percent of the traditional leaders in the woodland depleted villages and 100% in the woodland abundant villages agree that traditional conservation methods are still in place. Fifty percent of the traditional leaders in the woodland depleted villages and 67% in the woodland abundant villages perceive that the condition of their woodland is steadily deteriorating (Table 4.9). Fifty percent of traditional leaders in the woodland depleted villages and 33% in the woodland abundant villages perceive that the regrowth ability of *C. mopane* will ensure its availability for future use.

In the woodland depleted villages, 67% of the traditional leaders and 100% in the woodland abundant villages indicated that the chiefs are responsible for transferring traditional conservation knowledge to the villagers. Eighty three percent of respondents in the woodland depleted villages indicated that conservation knowledge is transferred to the youth through talks, given by chiefs at tribal meetings, while 57% of respondents in the woodland abundant villages indicated that knowledge is transferred during cultural ceremonies and community meetings (Table 4.9).

Barrow (1995) stated that people's attitudes and perceptions to modify the environment are not similar. Equally, studies conducted in Germany, Austria, and Switzerland showed that the environment is shaped by people's aspiration towards it (Schmithüsen *et al*. 1997). The attitude and perceptions of people toward their woodland determines its management, and a positive attitude and perception of people could result in better management of natural resources.

Table 4.9 Traditional leaders' perception on mopane woodland management

Traditional conservation practices in mopane woodland		% of respondents in the woodland depleted villages (n = 6)	% of respondents in the woodland abundant villages (n = 7)
Willingness to participate in woodland management practices			
Yes		67	100
No		33	0
Traditional conservation method practiced			
Yes		67	100
No		33	0
Decline of mopane woodland			
Yes		50	67
No		50	33
People responsible for transfer of traditional conservation practices			
Chiefs		67	100
Father		33	0
Ways of transferring knowledge			
Oral talks		83	43
Others (cultural ceremonies and community meetings)		17	57
Level of education (Traditional leaders)			
No schooling		17	30
Primary		50	15
Secondary		33	51
Tertiary		0	4

n = number of people interviewed

Even though the traditional leaders in the study areas showed that there is participation of villagers in woodland management practices (Table 4.9), in reality there is a negative perception towards that. It is perceived by the author that traditional leaders were just trying to create a positive picture of good citizenship, as it is unclear as to what villagers do constructively through their participation. In most cases, villagers do not participate in such initiatives since they perceive that such initiatives are useless and fail to address the socio-economic welfare of villagers. Sometimes, a lack of conservation information might be an additional reason for this negativity (INR 2002).

Villagers have a negative perception toward woodland management. They perceive natural resources as open access with everybody having the right to use them. Open access system has no exclusion rules and access to resource is open to anybody (Scoones & Matose 1993). This has eventually led to an abuse and vandalism of resources, evident in many areas of South Africa (Lawes *et al*. 2004a). As a contrast to open access system, common property natural resource management is viewed as an option for successful local management of natural resources (Scoones & Matose 1993; Crouch & Edwards 2004). However, there is a cynical perception amongst villagers and changing that perception could contribute to a wiser use of the surrounding woodland resources. Some villagers in the sampled villagers perceive that the regrowth ability of species in the surrounding woodlands will ensure species availability in future. This is, however, doubtful due to over-utilisation and lack of coppice management. The possible outcomes could be: failure of conservation initiatives (Bembridge 1990; Ham & Theron 1999) and infringement of conservation laws, over-utilisation and depletion of woodland resources. Training of villagers and traditional leaders on common property natural resource management is essential, but such initiatives require full participation of villagers, which is currently lacking in most rural areas of South Africa and many rural parts of the world.

4.6 Woodland management in the Greater Giyani Municipality

4.6.1 Resource harvesting permits

Forty five percent of the officials from the Greater Giyani Department of Economic Development, Environment and Tourism indicated that a permit is required to harvest woodland resources (Table 4.10). Permits are available from the local tribal authority and their costs range from R10 to R150. Villagers pay R30 to harvest wood for fencing and R10 for materials used for construction purposes. No permit is required to collect dry wood, but outsiders (people staying in another village) pay R20 to collect firewood in a 1 tonne *bakkie* (pickup vehicle). The permit is valid for 90 days and no limit on the amount collected is specified in the permit.

The use of permits to regulate the use of natural resources in the study area is common to most areas of southern Africa (Mabogo 1992; Chambwera 1996; Timmermans 1999; Madzibane & Potgieter 1999). Use of permits appeared to be ineffective in the study area, a major reason being the high rate of unemployment. Sixty seven percent of the officials from the Greater Giyani Department of Economic Development, Environment and Tourism indicated that people disobeying conservation rules are punished (Table 4.10). It was indicated that the tribal authorities are responsible for enforcing such punishment, which is mostly in the form of a fine. A fine for a headload of non-dry wood is R100 and R500 for a *bakkie* (pickup vehicle) load. Failure to pay the fine to the traditional authority can result in a jail sentence for two months by an official court of law. However, the implementation of the law remains questionable as to how many villagers have really been sentenced for breaking conservation laws and regulations.

About five rangers are deployed in the sampled villages to monitor unsustainable practises in the woodland (Table 4.10). More attention is given to woodland depleted villages due to the high rate of deforestation as opposed to woodland abundant villages. It is perceived that there is less deforestation in the woodland abundant villages because those villages are far for commercial collectors of woodland products. Deployment of rangers does not fully reduce illegal harvesting of woodland resources, because some people, particularly outsiders from the village, do harvest and transport non-dry wood at night. However, due to the unavailability of transport and the apathy of some rangers for working after hours, catching these night poachers is extremely ineffective.

4.6.2 Environmental education

Sixty seven percent of the officials from the Greater Giyani Department of Economic Development, Environment and Tourism (DEDET) indicated that environmental education programmes are presented to the community leaders. The theme of the programmes includes community-based natural resource management and community development projects (Table 4.10). Community leaders (chiefs and elected civics members) are invited to attend environmental education programmes so that they in turn can educate the villagers under their jurisdiction. Traditionally, the transfer of natural resource information, use and management to villagers was the duty of the traditional leaders (Mabogo 1990). Currently, legislation does not define the institution responsible for this role. Nevertheless, 56% of villagers in the woodland depleted villages indicated that the local municipality should be responsible. In comparison, 67% of villagers in the woodland abundant villages indicated that the local people should be responsible (Table 4.11). This indicates a shift in authority, particularly in the woodland depleted villages, and might eventually weaken the role of traditional leaders in knowledge transfer to villagers.

The weakening of traditional leaders' authority is widespread in southern Africa (e.g. Mabogo 1992; Steenkamp & Urh 2000; Von Maltitz & Shackleton 2004), but the responses from the traditional leaders in the sampled villages show that they still play a role in the transfer of traditional conservation knowledge. This was shown by 67% of traditional leaders in the woodland depleted villages and 100% in the woodland abundant villages (Table 4.9). However, on close examination, the results appear to be suspicious. There is a general lack of traditional knowledge, especially amongst the youth. Young people tend to question their traditional leaders' roles in their conservation knowledge transfer to villagers. The failure of traditional conservation knowledge transfer to the youth is probably due to a lack of trust and respect by the youth for traditional leaders, unwillingness and apathy of the youth to participate in traditional activities. The legitimacy downward and accountability of traditional leaders is also questionable (Von Maltitz & Shackleton 2004). This might be the main reason for the diminished authority of traditional leaders.

Perhaps active involvement and empowerment of all groups within the community (Skottke & Mauambeta 2000) could assist in knowledge transfer (LGA 1998) and increase people's participation in conservation programmes (Shepherd 1985; Skottke & Mauambeta 2000). However, knowledge transfer could not just happen; it requires better communication between villagers, traditional leaders, and conservation officials from the local municipalities.

Table 4.10 Existing woodland management strategies

Woodland management strategies		Responses from conservation officials (n = 10)
Number of rangers in all villages		5
Environmental education programme		**% of responses**
Agree		67
Disagree		11
Uncertain		22
Stumbling blocks to implementation of conservation programmes		
Agree		45
Disagree		44
Uncertain		11
Permits to harvest woodland resources		
Agree		45
Disagree		33
Uncertain		22
What happens to contraveners of conservation rules		
Punished		67
No punishment		11
Uncertain		22

n = number of people interviewed

4.6.3 Regulation enforcement

Table 4.11 presents data on individuals that have the authority to enforce conservation rules. Fifty six percent of respondents in the woodland depleted villages indicated that the municipality should be responsible for law enforcement, but 67% of respondents in the woodland abundant villages indicated that it is the local people's responsibility (Table 4.11). However, the legislative basis of this responsibility is unclear since 1994. The law enforcement authority of traditional leaders has been drastically reduced, even though they are still responsible for the issuing of permits for woodland resources utilisation. The weakening of the traditional authority is a result of modernisation and transformation, lack of communication between chiefs and villagers, power conflicts between chiefs and elected leaders (civics and ward counsellors) and reduced trust (benefit sharing) between the traditional leaders and the villagers. The role of traditional leaders in areas such as land administration and resource management seems to have been taken over by the civics and ward counsellors operating under the municipality. The weakening of traditional leaders' authority in the management of natural resources (Mabogo 1992; Steenkamp & Urh 2000; Jones & Mosimane 2000; DPLG 2002; Von Maltitz & Shackleton 2004; Lawes *et al*. 2004a) has resulted in the over-exploitation of woodland resources (Kayambazinthu 2000). It is unclear at present, whether the loss of traditional authority is the main factor contributing to woodland resource over-exploitation and depletion in the rural areas. There are other factors, such as population increases and high rates of poverty, which have contributed significantly towards woodland resource depletion. It seems that, historically, (during the traditional leaders' rule) degradation of the surrounding woodland was relatively low, as a result of various factors such as;

a) lower population pressure on the surrounding woodland resources;
b) reduced technology available that can destroy large areas of woodland, as people were using traditional tools to cut poles;
c) relatively low stocking density of livestock, and
d) monetary value of woodland products was relatively low; people were harvesting resources only for subsistence use.

Population increases, advances in modern technology and increase value of woodland products for income generation has led to large scale alteration of woodland resources, even before the onset of democratic rule in South Africa. Vast woodland areas, which occur in the semi-arid to subhumid parts of South Africa, have been depleted over the past three centuries as a result of unsustainable forms of landuse and over-harvesting of woodland resources (DWAF 1996). It is not clear whether the loss of traditional authority has contributed significantly to woodland depletion.

Currently in the Greater Giyani Municipality, it is the conservation section within the municipality striving to enforce conservation rules at village level (Table 4.11). The shift in authority from traditional leaders has caused considerable tension and confusion at village level. It also subordinates the status of traditional leaders in the eyes of villagers and eventually weakens the roles of tribal authorities (Steenkamp & Urh 2000; Von Maltitz & Shackleton 2004; Lawes *et al*. 2004a). It is perceived that the weakening of traditional leaders' authority has hindered attempts to transfer forestry management to the local people (Lawes *et al*. 2004a). This, in turn, leads to disobedience of traditional conservation norms, continuous over-exploitations of woodland resources (Kayambazinthu 2000) and increased irresponsibility in the management of natural resources by villagers (Evans *et al*. 2000; Von Maltitz & Shackleton 2004). Furthermore, the proposed land board of South Africa continues to erode the rights of traditional leaders over land allocation, even if the traditional leaders are represented in the National Cabinet (DPLG 2003). Recent legislation on traditional leadership has attempted to restore traditional authority over natural resource management, but such legislation lacks the scope of traditional authority (Jones & Mosimane 2000). Section 212 of the Constitution does not include the finer details regarding the issue of traditional leadership in the legislation (DPLG 2003). This results in little to no action being taken to restore the roles of traditional leaders. It is predicted that traditional authorities will continue to be weakened, mainly through their rejection as legitimate institutions and a lack of clarity regarding their role and responsibility relative to local government (Von Maltitz & Shackleton 2004).

Dewees (1994) identified a need (as also confirmed in Table 4.11 by the woodland abundant villagers) to place customary control to manage natural resources at local level, as they have the greatest potential in resource management. However, it should be noted that previously the traditional leaders ruled by means of fear. Currently, villagers no longer fear their traditional leaders. It is uncertain whether reinstatement of the traditional authority could minimise over-exploitation of woodland resources. Perhaps the establishment of closer cooperation between villagers, traditional leaders, and conservation officials in the management of resources could promote sustainable use of resources. However, the socio-economic status of villagers needs to be taken into consideration when developing woodland resource management options. It appears that the involvement of local people in conservation law enforcement can contribute significantly to sustainable use of woodland resources, but this requires support from all conservation stakeholders and greater cooperation, full participation and determination from the villagers.

Sixty one percent of respondents in the woodland depleted villages (variance = 1.080) and 47% in the woodland abundant villages (variance = 1.297) indicated that regrowth shoots from trees are allowed to re-grow for about one to four years before harvesting can commence (Table 4.11). Villagers in the woodland depleted villages have realised a need for woodland management, while villagers in woodland abundant villages do not feel the pressure and continue as usual. Although villagers have shown that there is harvesting management, close observation during field surveys showed that the coppices are frequently harvested for firewood purposes. Theoretically, giving local people power to manage the surrounding woodland seems to be a feasible option, but its application is a big challenge. The challenges might arise from high illiteracy level, poverty and resource demand. Strict regulations are, however, essential and those measures need to be agreed upon with the local people.

Table 4.11 Authority in the management of woodland in rural areas

Woodland management strategies	**% of respondents in the woodland depleted villages (n = 90)**	**% of respondents in the woodland abundant villages (n = 90)**
Rules enforcement		
Local people	22	67
Traditional leaders	22	33
Municipality	56	0
Harvesting management (years) [a]		
<1	6	26
1 - 4	61	47
5 - 9	17	14
10 - 14	11	6

n = number of people interviewed

a = percentages do not always add up to 100 due to rounding off and lack of answers by some of the participants

4.6.4 Challenges

Forty five percent of the officials from the Department of Economic Development, Environment and Tourism in the Greater Giyani Municipality indicated that there are various stumbling blocks in the implementation of conservation programmes (Table 4.10). These include the lack of participation by community members, high levels of poverty in the community, lack of funds, lack of capacity and insufficient transport for rangers to monitor and enforce conservation laws and for environmental educators to train villagers on woodland conservation.

4.7 Woodland management strategies suggested by the villagers in the Greater Giyani Municipality

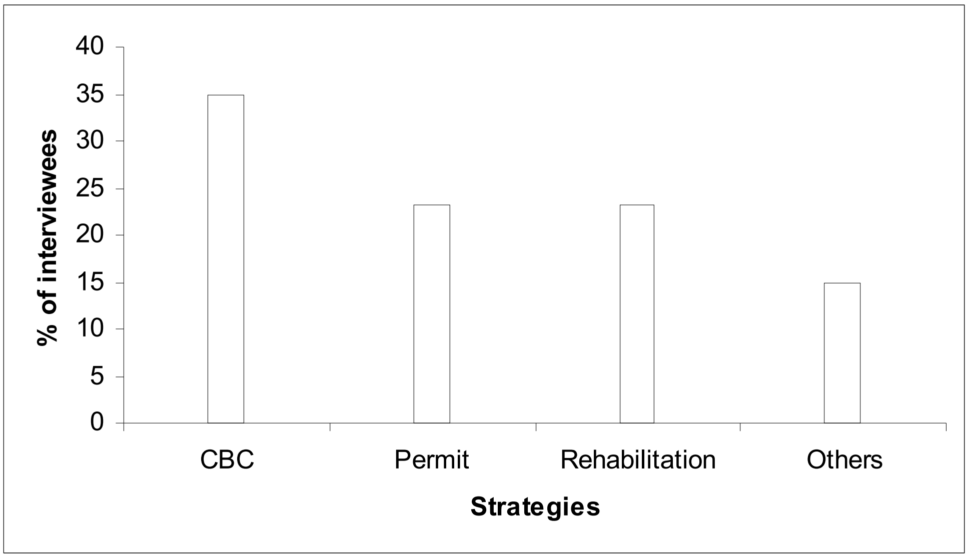


Figure 4.23 Woodland management strategies suggested by villagers in the Greater Giyani Municipality. CBC = Community-based Conservation.

Thirty five percent of the respondents proposed community-based conservation (CBC) programmes, 23.2% were of the opinion that permits for harvesting should be issued and enforced, another 23.2% proposed the rehabilitation of degraded woodland and 15% suggested various strategies such as environmental education to local people, funding of developmental projects, and the establishment of social forestry programmes within the community (Figure 4.23). Community-based programmes seem to be a better option, as it could lead to socio-economic empowerment of the majority of unemployed women in the study area. Villagers need to be trained to sustain such programmes. Conceivably, initiation of community-based projects could create jobs for villagers and promote conservation at the same time. This could strike a balance between human needs and conservation (Hackel 1999). However, mechanisms to share benefits accrued from the projects need to be developed to encourage full participation of villagers. Chapter 5 provides detailed proposed resource management options at village level.

CHAPTER 5

PROPOSED RESOURCE MANAGEMENT STRATEGIES

Interviewing a grandmother in Mapayeni village

The management of mopane woodlands in the sampled villages is hampered by socio-economic obstacles, capacity related obstacles, and judicial impediments. This study has identified major challenges for sustainable woodland management from village level up to municipal level. Provincial and national environmental laws were reviewed and, based on the aforementioned, some suggestions are presented.

5.1 Mopane woodland management strategies

Over-utilisation and commercialisation of woodland resources have increased the pressure on woodland persistence (Mpuchane *et al*. 2001). As such, there is an urgent need to instil conservation attitudes in local people to ensure woodland resources availability for the future (Mpuchane *et al*. 2001). Proposed woodland management strategies are discussed below.

5.1.1 Mopane woodland management at village level

5.1.1.1 Permit system

The use of permits to harness woodland resources has been practised for years in southern Africa as a regulating measure (Timmermans 1999), which, in theory, should restrict woodland degradation. However, the implementation of the permit system was found not to be effective enough for ensuring sustainable woodland use in the sampled villages due to various factors. These include inadequate numbers of rangers to enforce the system, a large population in relation to resource availability, a high rate of poverty, unclear responsibility for woodland management, and disempowerment of traditional council structures. The permits are also viewed by villagers as a tax mechanism for the use of woodland resources. Permits may in concept take away a sense of local ownership (GP von Maltitz, *pers. Comm*. 2006). Also, the demand for firewood far outstrips the production of dry wood in mopane woodland, resulting in people violating the permit system.

Similarly, the R20 paid to obtain a permit by outsiders for a 1 tonne *bakkie* (pickup vehicle), full of dry wood is not enough. This encourages over-utilisation and high consumption of wood. A study in the Eastern Cape also indicated that if the price of permit is low, it encourages over-utilisation of resources (Cocks 2000). The following strategies are therefore recommended to improve the effectiveness of the current permit system:

- Increasing price of a permit to harvest wood to residential villagers and outsiders. A differential price mechanism can be used for residents and outsiders. In addition, resource value needs to be based on resource availability;
- Setting-up of appropriate judicial procedures for offenders;
- Enforcement mechanism for punishing deviant behaviour (Scoones & Matose 1993);
- Appointment of villagers to monitor and report any infringement of the permit system within their jurisdiction;
- A permit with harvesting limitations (e.g. harvesting a selected number of coppice shoots per stem);
- The validity of a permit needs to be less than a week. Currently it is three months;
- The administration of the permit needs to be performed by a village-elected committee to encourage ownership of land by residents;
- Money generated from permits needs to be administered in a transparent and auditable manner by a locally-elected committee or the traditional council (Jones & Mosimane 2000) and used for developmental projects such as payment of the above-mentioned person/s, replanting programmes, coppicing management programmes, educational programmes and creation of eco-tourism projects;
- Villagers need to agree to a benefit sharing mechanism and if there is conflict of ideas, a democratic way (voting) of taking decisions needs to be employed (LEMA 2003: sec 12), and
- Regular reviews of the permit system needs to be undertaken by village environmental committees, traditional councils and conservation agencies and revised where needed.

Nevertheless, it is very difficult to deal legally with people who are not able to pay a transgression fine and who do not have property to exchange for a fine (Lowore *et al*. 1995). Also, local communities are unable to protect their resources because the perpetrators are armed (Von Maltitz & Shackleton 2004). To deal with this situation, guilty parties should be able to do community services (e.g. planting of trees, managing coppice outgrowth or picking up waste) for the benefit of the community.

5.1.1.2 Coppice management

Although participants in the sampled villages indicated that coppice shoots are left for approximately four years before harvesting commences, in reality most of the coppice shoots are continuously cut for firewood and construction purposes. Such practices are less than the prescribed 4 to 7 years to enable the underwood to resist damage (Mushove 1996).

Even though villagers are aware of a decline in the biomass of the surrounding woodland, ineffective management of the coppice shoots still exists. Management of shoots is important for firewood and multipurpose small timber pieces (Mushove 1992) and to maintain habitat diversity (Peterken 1993). Coppice management is a necessary option to sustain mopane woodland (Luoga *et al*. 2004), when taking into account constricting factors such as seed dispersal distance (Chidumayo 1992), seed predation, drought stress (Grundy 1995), and sporadic fruit production of *C. mopane* (Chidumayo 1997). For effective coppice management it is proposed that:

- There should be an education awareness programme on the advantages of coppice shoot management to the community. It should be implemented by the appropriate nature conservation agencies. However, villagers need to understand that *C. mopane* is slow growing and therefore, any management scheme would represent a long-term investment (Grundy 1996);
- The density of coppice shoots needs to be reduced to two (Erkkilä & Siiskonen 1992) to supply firewood and construction poles (Conroy 1996) and to avoid intershoot competition (Shackleton 2000);
- Cutting of shoots needs to be done just before the onset of the rains (Pawlick 1989) to facilitate recovery from harvesting (Grundy 1996) and promote vigorous new coppice regrowth during the summer season (Mushove & Makoni 1993; Flower 1996);
- When harvesting wood, the cutting height needs to be between 30 cm and 1 m above ground level to encourage maximum regrowth (Mushove & Makoni 1993; Shackleton 2000), to enhance coppice regrowth competition (Grundy 1996; Rathogwa *et al*. 1999) and to avoid fungal infestation (Luoga *et al*. 2004);
- Cutting needs to be done only on plants with a diameter between 10 and 20 cm to encourage an effective regrowth rate (Luoga *et al*. 2004);

- Woodlands need to be zoned to facilitate rotational harvesting (Grundy 1996), usually between 5 and 25 years after cutting (Peterken 1983; Mushove & Makoni 1993). Other species occurring in mopane woodland such as *Combretum* can be managed in 5 year cycles for firewood and between 10 and 15 year cycles for pole production (Abbot & Lowore 1999). It should be noted that rotational harvesting strategies require an understanding of the knowledge of the socio-economic circumstances of the harvesters (Lawes *et al*. 2004c);
- Woodlands need to be fenced for a period of between 4 and 7 years, until the underwood can resist damage (Mushove & Makoni 1993), caused by grazing or browsing animals. Fenced woodland zones will promote rotational harvesting and grazing. However, fencing of communal woodland need to be done with community consultation backed by financial support from the local municipality, and
- Rivers and mountains can be used as alternative natural boundaries to divide woodlands into different sections, to facilitate rotational use of resources.

5.1.1.3 Additional recommendations

Over-harvesting of mopane woodland by villagers has resulted in the decrease of woodland products. The following are additional suggestions for woodland management at village level.

5.1.1.3.1 Wood utilisation

Due to the extensive over-utilisation of *C. mopane* wood in the study area and in rural areas of Namibia (Erkkilä & Siiskonen 1992), Zimbabwe (Grundy 1996) and Botswana (Mpuchane *et al*. 2001) mainly for firewood and construction purpose, research into alternative sources is necessary.

5.1.1.3.1.1 Alternatives for construction poles

Studies indicate that community forestry (Saxena 1992) and agroforestry (Erkkilä & Siiskonen 1992; Marsh 1994) can reduce the over-utilisation of natural woodland products, and has the potential for income generation by selling poles. Another alternative includes the building of bricks houses, but this also requires relevant departments' (e.g. Local Housing, Land Affairs) intervention through the supply of sustainable RDP houses to those who cannot afford to build their own houses.

5.1.1.3.1.2 Alternatives for firewood as a source of energy

The majority of people in the studied villages rely on firewood as their primary source of energy for cooking and heating. Currently, the rate of firewood demand in these villages far exceeds the supply and replenishment. This has led to an increase in the distance and time taken to collect firewood and high social impacts, as a consequence. Given this scenario, a logical solution could be the use of alternative sources of energy or efficient use of firewood as explained below:

5.1.1.3.1.2.1 Non-wood sources of energy

Non-wood sources of energy include the use of solar panels, electricity, gas and paraffin. The use of solar energy seems to be relatively cheap and could also lead to generation of income (e.g. baking) (SEI 2004). But, when assessing the socio-economic state of villagers in the study area, the use of solar panels in rural areas need to be supported by subsidisation for the cost of installation and other appliances. Therefore, effective implementation of solar energy in rural areas needs long-term investment from relevant government departments, energy service companies or from international organisations. Once implementation is completed, the relevant department/s in the local municipality needs to regulate and monitor its effectiveness and be responsible for replacing damaged panels. It should be noted that the use of sources of energy other than wood will not happen overnight due to the poor socio-economic status of rural people.

5.1.1.3.1.2.2 Efficient use of firewood

Considering the socio-economic status in the study area, efficient use of firewood could be an immediate option for ensuring frugal use of woodland resources. It is unsustainable to consume more firewood or to waste firewood. To avoid the overuse or waste of firewood requires practical demonstrations of efficient use of firewood to the villagers, as explained below:

- Multi-use of fire; cooking food and boiling water using the same fire;
- Avoiding cooking in an open windy space, as more wood is consumed;
- Extinguishing the fire immediately after cooking, and
- Use of improved wood stoves (e.g. use of Chulas in India), which consume less wood as opposed to an open fire, promote energy conservation and use of rural technologies and is a time saving device (UNESCO U.D.). These simple stoves increase fuel efficiency and decrease firewood requirements by 50% (Harrison 1987 cited in Lawes *et al*. 2004c).

5.1.1.3.2 Sustainable use of mopane worms and its host tree

Selling of non-wood products such as mopane worms can uplift the socio-economic status of villagers in the study area, as supported by Styles (1996) in South Africa and Mpuchane *et al*. (2001) in Botswana. Conversely, over-harvesting of mopane worms and over-utilisation of *C. mopane* trees hampers the opportunities that could derive from woodland products. To improve this, the following approaches are suggested:

- Showing villagers posters, photos or videos of mopane worm life cycles to raise awareness on sustainable harvesting of mopane worms;
- Harvesting worms at the 4th or 5th instar stage to increase the number of individuals that will pupate (Letsie 1996);
- Allowing some worms to complete their life cycles by discouraging villagers to collect worms already on the ground (Mpuchane *et al*. 2001);
- Conserving the worm's host trees;
- Discouraging bad harvesting practices of mopane worms. This includes avoiding the cutting of *C. mopane* branches during mopane worms harvest (Letsie 1996);
- Establishment of regulatory mechanisms for harvesting of mopane worms by people outside the village (Mpuchane *et al*. 2001);
- Initiating mopane worm processing projects and empowerment of mopane worm harvesters with financial management skills for socio-economic development, and
- Educating villagers about cheap and proper storage methods of mopane worms (see also Mphuchane *et al*. 2001; Stack *et al*. 2003; Jaenicke 2004).

5.1.1.3.3 Empowerment of villagers

The majority of people in the sampled villages are unemployed, have no formal education and heavily depend on surrounding woodlands for their basic needs such as firewood. This is driven by poverty, which is common in most rural areas (UNCCD 1994; Lawes *et al*. 2004b). Therefore socio-economic empowerment of the villagers can make a meaningful contribution to the sustainability of woodlands, as villagers will consider themselves owners of woodland resources (Mangue & Oreste 1999). Empowerment processes need to include skills development, involvement of disadvantaged groups (Versfeld & Nduli 1998), meeting of the basic needs of people, establishment of the ethics of responsibility (Mercer & Soussan 1992) and benefit sharing mechanisms (Everson & Hatch 1999).

It is perceived that by giving management responsibility to villagers might significantly reduce illegal harvesting of woodland products, which include night harvesting when rangers are off-duty. Members of the community will police each other, including outsiders, against any infringement of their resources. This type of responsibility needs to be operated via recognised community representatives to avoid conflict among the villagers (Coote 1995). It is also essential to have cooperation between the villagers and the relevant conservation agencies for technical and legal support in woodland management (Coote 1995).

5.1.2 Woodland management challenges in the Greater Giyani Municipality

The Department of Economic Development, Environment and Tourism (conservation section) of the Greater Giyani Municipality is faced with many difficulties to enforce woodland management at village level. These include the lack of transport and capacity to implement conservation laws. Similarly, local government departments in South Africa are faced with problems such as minimal capacity (Lawes *et al*. 2004b; DEDET 2006) and lack of infrastructure and resources to implement biodiversity regulations (DEAT 1997).

5.1.2.1 Enforcement

Enforcement of conservation policies, which are either traditional or formal laws, is a major challenge for conservationists (Jones & Mosimane 2000). The current problems hindering law enforcement in the Greater Giyani Municipality are insufficient vehicles and fuel, and under-staffing to effectively monitor woodlands. Similar challenges also exist in Malawi, where a lack of funds resulted in the failure of law enforcement (Coote 1995).

5.1.2.2 Environmental education

The Community Development Section, under the Department of Economic Development, Environment and Tourism in the Greater Giyani Municipality, provides community leaders with training and environmental information to transfer back to their respective villagers or constituencies. However, environmental education is failing to reach all villagers due to the lack of enough environmental educators to facilitate such initiatives.

Although environmental education is being implemented as part of the education curriculum in South Africa (DEAT 2003c), such initiatives are still absent in most rural areas. Perhaps, the implementation of environmental education as part of the ABET and OBE programmes could instil environmental awareness in the rural areas.

5.1.2.3 Suggestions for addressing conservation challenges

The following suggestions could help to address conservation challenges in the Greater Giyani Municipality.

5.1.2.3.1 Funding

Allocation of extra funds to the Greater Giyani Municipality (conservation section) is necessary to address the lack of adequate transport and under-staffing problems. Allocation of adquate resources in all conservation departments is suggested as an option for effective capacity building and effective implementation of environmental policy (DEAT 1998). Lack of funds at the Greater Giyani Municipality, therefore, means sourcing extra funds for environmental conservation. This can be achieved by applying for additional funds from the provincial or national government or from international organisations such as EPA, UNEP, USAID, WWF, DFID, UNDF, CIDA, EDF, FFI, and AusAID. Such organisations can be found at http://www.bothends.org/service/forestfunds.htm.

The available budget could also be used to employ villagers to work as rangers for monitoring the woodland. However, the conservation department at the Greater Giyani Municipality or interested conservation agencies need to equip them with training and transport and monitor their effectiveness. As part of the overall initiative, environmental awareness needs to be raised at village level to encourage participation. For instance, the awareness campaigns need to include demonstrations of the impact of frequent fire on the woodlands (SAFIES 1995). This was effective in the reduction of frequent burning in Botswana (Arntzen & Veenendaal 1986). In addition, woodlands are often perceived as a 'free' resource (Scoones & Matose 1993; Willis 2004) and awareness campaigns need to focus on changing people's perceptions to consider woodland as finite resources and on how they can reduce its over-exploitation. During training, practical methods relating to natural resource management need to be demonstrated; these can be taught using videos, maps and the participatory approach to give a sense of ownership, facilitating and sharing of information and knowledge (Everson and Hatch 1999).

5.1.2.3.2 Initiation of community-based development projects

The major cause of woodland deforestation is severe levels of poverty within the communities (Everson & Hatch 1999). Other effects include irresponsibility in the management of woodland and unclear benefit sharing mechanisms. Because of that, initiation of community-based projects can reduce over-utilisation of wood (CBD 2001). This could lead to the creation of a balance between human and conservation needs (Hackel 1999). However, lack of clear government policy regarding CBNRM, alienation of women and youth (Versfeld & Nduli 1998) and lack of CBNRM project information in the study area have resulted in ineffective implementation of community-based conservation projects. The current perception is that CBNRM will not, on its own, lift communities out of poverty (GP von Maltitz, *pers. comm*. 2006). Because of that, remedial actions to be taken include the following:

- CBNRM projects need to be a grassroots driven approach to empower the previously disadvantaged groups (poor, disabled, women and youth) (DEAT 2003a);
- Villagers need to have access to resources and ownership thereof (DEAT 2003a). Allocating exclusive rights to single individuals must be avoided (Scoones & Matose 1993);

- Furthermore, there are steps that need to be followed during the implementation of CBNRM (see Table 2.1) (DEAT 2003a). There should be clearly defined guidelines for resource use by the community (Scoones & Matose 1993);
- Funding for community projects such as bee keeping, indigenous fruit and food processing, wood crafting, alien invasive species eradication projects, brick making, sewing projects, nursery projects, coppice management, and eco-tourism projects. An example is the mopane worm processing project initiated by the CSIR Biosciences in the Dzumeri area of the Greater Giyani Municipality, and
- CBNRM needs to be implemented as an integrated approach with relevant conservation agencies to source funds and together with established institutional structures, preferably from the village level (Von Maltitz and Shackleton 2004).

5.1.3 Environmental management at the Provincial Level

Deforestation, fire, pollution, habitat fragmentation and invasive organisms are major problems affecting the Limpopo Province's biological diversity (LEMA 2003; DEDET 2006). Ignorance of conservation practices by local people as influenced by lack of information about LEMA or NEMA also increased resource over-utilisation. Therefore, raising awareness of the environmental acts within the general public, particularly at village level, before the implementation of the act, can lessen law infringements. However, access to environmental information is a major challenge in rural areas (DST 2005).

It is therefore essential that an integrated approach be adopted to raise environmental awareness. This includes the use of the media (television, radio, and newspapers), use of face-to-face meetings, and use of posters to disseminate information. However, most of the emphasis needs to be placed on community meetings (Steenkamp & Urh 2000) to encourage local peoples' participation and compliance with environmental legislation (DEAT 1998). This could give them an opportunity to raise questions on issues that they do not understand (Cromhout 2002).

Chapter 8 of LEMA (2003) stated that indigenous plants need to be protected. However, no option is available on how local people could sustainably utilise their resources. Allowing villagers to use woodland resources need to be addressed via policies. Policies need to change from protection to conservation stance to emphasise on the improvement of socio-economic wellbeing of the villagers. Section 64 of LEMA (2003) states that any person guilty of an offence, related to indigenous plants, will be fined (not exceeding R150 000) or imprisoned (not exceeding 7 years) or both. Quite often, this is not realistic or practicable, as offenders are usually poor people who cannot afford to pay a fine. Likewise, it would not be fair to sentence poor people to seven years for illegal harvesting of resources. It is therefore proposed that management and control of indigenous plants be taken over by villagers through the establishment of village environmental steering committees or trusted traditional authority. The above-mentioned committees should amend punishment suitable to the situation and in line with community needs.

5.1.4 Forest management at National Level

Forest laws and policies such as the National Forest Act (84 of 1998) were passed to regulate the use of forests and woodlands in South Africa. Most importantly, the National Environmental Management Act (107 of 1998) was also passed to serve as the general framework within which environmental management and implementation plans must be formulated (Willis 2004). Contravention of the act is an offence and the perpetrator can be fined (not stated) or sentenced for one to two years, or both.

Regardless of the act, woodlands are over-harvested (Shackleton *et al*. 2001) indicating a lack in the effectiveness of the act (Jones & Mosimane 2000). In the study area, woodlands are predominately transformed to other land uses such as cultivation and residential areas (see Figure 3.3). However, much of what was also proposed in the National Forest Action Programme has proved difficult to implement due to a lack of capacity within DWAF and other institutions and differing priorities in terms of time and budgetary commitments (Willis 2004).

Moreover, woodlands in South Africa are administered in a fragmented fashion, at all levels of government, and under several departments (Shackleton *et al*. 2001; Von Maltitz & Shackleton 2004) with no direct mandate to take total control of woodlands (Von Maltitz & Shackleton 2004). This resulted in the overlapping of responsibilities among departments, gaps, lack of coordination in the way resources are administered (Willis *et al*. 2001; Von Maltitz & Shackleton 2004) and a lack of capacity to implement environmental policies (Shackleton *et al*. 2001; Willis 2004; DEDET 2006). A lack of capacity to manage the forests and woodlands is the result of taking new responsibilities and changing roles requiring different skills (Willis 2004). The following is proposed:

- A national biodiversity framework needs to provide an integrated, co-coordinated and uniform approach to biodiversity management in all spheres of government, NGOs, private sector, local communities, and by all stakeholders (UNCCD 1994; NEM:BA 2004);
- Integrating all role players, including intra-departmental cooperation and involvement of the communities (Shackleton *et al*. 2000a);
- Assigning responsibilities in the management of natural resources;
- As proposed by Willis (2004), the role of relevant national government departments needs to be coordinated to promote sustainable management of forest resources at all levels of governance. Moreover, government needs to work primarily with local authorities, local co-ordinating bodies and Community Development Facilitators to ensure that forest programmes fit into local development programmes (Willis 2004);
- Promotion of sustainable use of resources (Sharma *et al*. 1992) by providing incentives to people (Willis 2004);
- Recruiting Private Sectors to train and mentor current conservation officials in biodiversity management for capacity building, and
- Development of criteria and indicators to monitor the sustainability of woodlands.

5.1.5 Biodiversity management at SADC region

In 2002, the SADC protocol on forestry was adopted in order to promote the development, conservation, management, and sustainable utilisation of all types of forests. The idea of the protocol was to ensure that trading in forest products would alleviate poverty, create economic opportunities, ensure effective protection of the environment, and safeguard the interests of both present and future generations (SADC 2002).

Nonetheless, the SADC region is faced with several biodiversity threats such as deforestation, climate change, forest fires, and invasive alien species (SADC 2002). Major constraints to implement biodiversity conservation strategies include lack of technical capacity, inappropriate policies and poverty (Shuma 2001a). These constraints were also identified in the study area (see Chapter 4). Even though South Africa shows progress in the implementation of SADC protocol agreements, there are SADC countries, notably Zimbabwe, which are still faced with major challenges to implement it (Shuma 2001a).

Countries in the SADC region have agreed to assist and support each other to address challenges of biodiversity conservation through cooperation, capacity building, technical assistance, sharing of information, establishment of a funding mechanism, and cross-sector contribution towards poverty alleviation (SADC 2002; Shuma 2001a). Although there are these agreements, their implementation is still lacking. Because of that it is suggested that the implementation of a bottom-up approach in policies can give hope to resource conservation, promoting community participation and empowerment in natural resource conservation (LGA 1998). In addition, woodland sustainability options need to reflect local, national, and regional priorities (Putz 1994), but be implemented within a local context.

5.2 Proposed guideline for a resource management plan

Step 1: Strategic discussion

Step 1 involves identification of the resource problem, its cause/s and the development of management objectives (Figure 5.1). All stakeholders such as local people and specialists (environmentalists) (Grundy 2000; Maundu *et al*. 2001), relevant departments, funding organizations and relevant NGO's need to be invited (Yeatman 2004). This step helps in the generation of ideas on how the identified problem could be solved.

A management plan needs to state the benefits sharing mechanism and outline the budget and time for implementation processes. The roles and responsibilities of villagers, traditional authorities, municipalities, and donors need to be clearly stated and agreed upon. It is upon this step that the criteria, indicators or measures of the problem are developed and adopted. This needs to cover the social, economic, environmental, and policy issues affecting local people, which are further illustrated in the CIFOR C&I (1999) and the INR (2002).

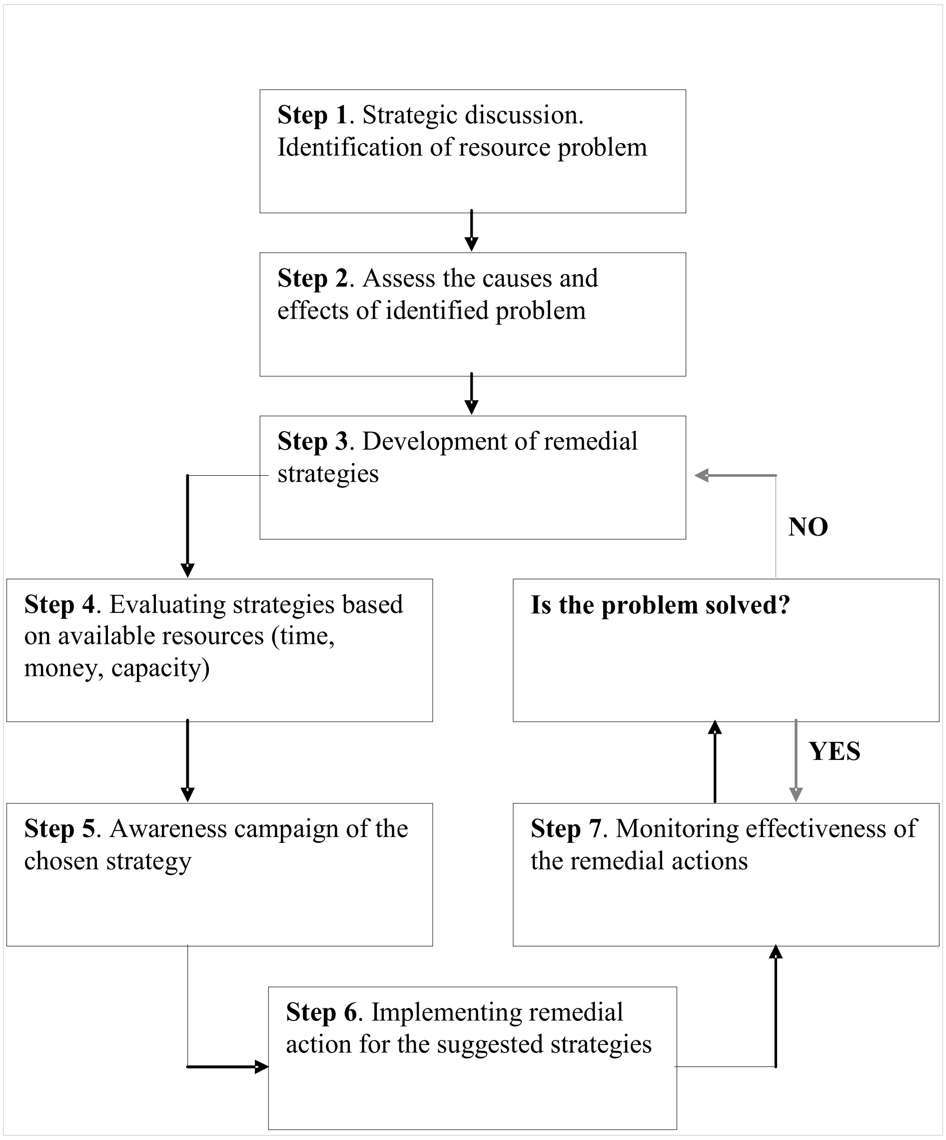


Figure 5.1 A summary flowchart of steps for a resource management plan.

Step 2: Assessment

In this step, data is gathered and assessed to identify the nature and extent of the resource problem. The problem could be short or long term, and its extent could range from local to provincial or nationally, urgent or not. It also involves the assessment of financial and human resources required to implement the management plan. This step is undertaken with resource users and conservation staff. Problem and pattern of resource use need to be presented to the wider community (Yeatman 2004).

Step 3: Development of remedial strategies

This step needs to be based on the available resources (budget and capacity). The strategies must aim at meeting the objectives of the plan and be cost effective, practicable, promote gender equity, informative, and address benefits sharing mechanism/s and the socio-economic welfare of the local people. All stakeholders need to participate during this stage.

Step 4: Evaluation

This is the process of evaluating strategy to be implemented based on the outcomes from Step 3. Once a strategy has been approved by relevant stakeholders, a plan of action can be developed and then people responsible for implementation of the plan could be identified (Miller *et al*. 1995).

Step 5: Awareness campaign

Before a strategy can be implemented, local people need to be fully aware of it. Information can be disseminated through workshops and community meetings (Skottke & Mauambeta 2000). The widespread dissemination of information can also be done through the local media (radio, newspapers, television etc.) (Diouf 1995), preferable, using the local language.

Step 6: Implementation

The implementation of the remedial action/s for the suggested strategy needs to be in accordance with the plan (ISRDS 2000) (Step 2). Agreements of the plan need also to identify those responsible for implementation (Yeatman 2004). It is essential that human capacity to implement the remedial option/s derive from the communities to encourage their participation (UNCCD 1994) and to enhance their socio-economic development (Kapungwe 2000).

Step 7: Monitoring

This stage involves detecting and measuring changes in the biodiversity and to assess the successes and failures of strategies (Miller *et al*. 1995). Monitoring can help in the identification of adverse impacts and the remedial actions can be taken (DEAT 1997). However, monitoring needs to be based on the criteria, indicators, and measures developed at Step 1.

If the strategy implemented is not effective enough, it will require answering "how" it can be improved, which involves the re-development of strategies (Step 3). But if the strategy is effective in addressing the problem, monitoring should continue. As the process of monitoring continues, reports about the status of the resources need to be written to identify gaps in the plan, solutions, and future predictions.

5.3 The roles of NGO's in biodiversity conservation

Non-governmental Organisation (NGO's) play a crucial role in providing technical assistance, raising conservation awareness among local people and funding of socio-economic development projects (Jones & Mosimane 2000). They also assist as the watchdog for ensuring that environmental legislations are implemented (Shackleton *et al*. 2001; Von Maltitz & Shackleton 2004), and that resources are not being degraded (Von Maltitz & Shackleton 2004). The involvement of NGO's could ensure a profitable operation of community projects and improvement of quality of life (DWAF 1997). However, the barring of the NGO's roles has resulted in the NGO's either absence or passive participation in natural resource management (Jones & Mosimane 2000). This study proposes that solutions to biodiversity threats need to be addressed as an amalgamated approach among all conservation agencies.

5.4 The role of researchers in biodiversity conservation

Researchers play a crucial role in the idenfication of resource problems at the grass roots level and are able to suggest scientific solutions. Researchers contribute to an enhanced understanding of forest and woodland management issues (Von Maltitz & Shackleton 2004). However, the work of researchers is not fully recognised, resulting in the need for cooperation between researchers, villagers and policy makers to address challenges facing environmental sustainability in South Africa and all over the world.

5.5 Recommendations for further research

The following topics are recommended for further research:

- Undertaking of ecological surveys along the edges of villages. Such a study could help to determine the effects of human activities (e.g. settlement, cultivation) on the surrounding woodland and also help to identify the extent of woodland depletion at village level. It could also help in the establishment of benchmarks for woodland degradation at village level.
- Monitoring the status of mopane woodland in communal areas. This study could help in identifying the utilisation and management trends of mopane woodland resources. It could also help to judge whether the strategies, plans or policies implemented are effective or passive in the management of the resources.
- Development of ecological criteria and indicators for sustainable woodland management starting from village level. Such a study could help to assess the sustainability of woodlands at a local scale.
- Harvesting and management strategies of coppiced shoots in communal land. This study could assist to determine the response of *C. mopane* to frequent harvesting and how to manage the coppiced shoots in communal land.
- Assessment of deadwood production in the savanna woodland types. This study could help to estimate the volume of wood produced ha^{-1} $year^{-1}$ and how firewood consumption could be optimised.
- Impacts of mopane worms harvesters on the host trees.
- An inventory of wood and non-wood products. This study could help to identify wood and non-wood products used by villagers and their contribution to socio-economic wellbeing of rural people.

5.6 Conclusion

This study has provided some basic information on the amount of wood and non-wood products used by villagers in the Greater Giyani Municipality. Rural inhabitants in the study area extensively use *C. mopane* wood for firewood and poles in the construction of traditional structures. The study showed that a large volume of wood is used for cooking. Non-wood products (e.g. mopane worms) have the potential of contributing to the socio-economic wellbeing of rural inhabitants. Nevertheless, the sustainability of woodland resources is uncertain in most rural areas as a result of the high rate of unemployment coupled with poverty, population growth, irresponsibility in the management of woodland resources, and land use transformation. Changes in woodland management regimes were extensively discussed and possible options for ensuring sustainable woodland resources management suggested.

Lack of technical capacity and resources required within the Greater Giyani Municipality's conservation section to enforce conservation regulations, and to manage the woodland, has increased the probability of over-harvesting of woodland resources by villagers and illegal harvesting by people from outside the villages. This was exacerbated by weakening the traditional leaders' authority and unwillingness of some villagers to participate in traditional conservation practices. Loss of traditional leaders' authority has caused confusion between villagers, civics representatives, traditional leaders, and the municipality on who should take the responsibility for woodland management. The consequence is continuous dwindling of mopane woodland resources along the edges of villages. Villagers are using non preferred species for firewood and construction purposes as a coping mechanism against the scarcity of highly preferred species such as *C. mopane*. This has resulted in the increased social cost for wood harvesting and construction of inferior structures.

In the light of this study, the following options are recommended:

a) Implementation of means that would ensure efficient use of woodland resources;
b) Initiation of community projects that aims at conservation of natural resources and eradication of poverty in rural areas;
c) Greater cooperation between conservation departments, private sectors, traditional leaders and villagers in the sharing of skills and knowledge for ensuring sustainable use of resources and collaboration in attempts to conserve woodland resources;
d) Setting up of committees such as village-based environmental steering committees comprised of the above-mentioned people to take responsibility for the management of woodland and being responsible for the amendment of permits, which are in line with villagers' needs and resource availability;
e) Sourcing of funds to raise conservation awareness at village level and for training of conservation officials and villagers in sustainable use of resources and regulation

enforcement. The awareness campaign needs to incorporate coppice management, method and season for wood harvesting;

f) Subsidisation of alternative sources of energy instead of wood in rural areas, and
g) Implementation of environmental acts and policies need to contain more of a conservation stance for the benefit of the communities.

It could be too early to state if the above options will guarantee the sustainable use of resources, but an integrated approach of all these options could reduce the capacity gap in woodland management in South Africa, and therefore, contribute significantly to the sustainable use of woodland resources at village level.

GLOSSARY

Biological Diversity or Biodiversity- 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 part; this includes diversity within species, between species, and of ecosystems (DEAT 1997).

Criterion- The point to which the information provided by the indicators can be integrated and where an interpretable assessment crystallizes (Prabhu *et al*. 1996).

Coppicing management- The cutting of trees to encourage new stems to grow from the stump. The new growth is known as coppice shoots and the stump as a stool (Laming 2003).

Communal land- Land shared between members of the community.

Community- A group of people living in one area and having common interests.

Conservation- The management of human use of the biosphere to yield the greatest benefit to present generations while maintaining the potential to meet the needs and aspirations of future generations. Conservation thus includes sustainable use, protection, maintenance, rehabilitation, restoration, and enhancement of the natural environment (DEAT 1997).

Deforestation- The excessive removal of forest/woodland products as a result of developmental activities (e.g. agricultural and settlement expansion), wood harvesting (e.g. firewood and poles for construction), effects of grazing and browsing animals and frequent fire.

Degradation- The deterioration in the quality of natural vegetation cover.

Forest Management Plan- A document used to describe how the forest management unit would be managed (CIFOR C&I Team 1999).

Indicator- Any variable or component of the forest ecosystem of the relevant management system used to infer attributes of the sustainability of the resources and its utilisation (Prabhu *et al*. 1996).

Monitoring- Regular or irregular surveillance to ascertain the extent of compliance with predetermined standards (Heywood & Watson 1995).

Permit- Any license, document or certificate issued (LEMA 2003).

Resource- A substance required by an organism for its growth, maintenance and reproduction (Heywood & Watson 1995). Resource is anything that has a value to human wellbeing.

Sustainable development- Development that meets the needs and aspirations of the current generation without compromising the ability of the future generation to meet their own needs (WCED 1987). It is a process of meeting and sustaining social and economic requirements of people without deteriorating the biophysical part of the environment.

Sustainable use- The use of components of biological resources diversity in a way and at a rate that does not lead to its long-term decline, thereby maintaining its potential to meet the needs and aspirations of present and future generations (DEAT 1997).

Village- Residential area, normally rural.

Woodland- A land dominated by shrubs and trees. NFA (1998) defined it as a group of indigenous trees, whose crowns cover more than 5% of the area bounded by trees.

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Researcher and participants in Mbaula village

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APPENDIX 1

QUESTIONNAIRE

COLLECTION OF DATA IN MOPANE WOODLAND DEPLETED VILLAGES AND MOPANE WOODLAND ABUNDANT VILLAGES

1 LOCAL PEOPLE

Aim: To collect data on the socio-economic status of villagers, *C. mopane* utilisation, perceptions and management practices

1.1 Personal details

<table>
<tr><td colspan="4">Gender:</td><td colspan="2">1. Male</td><td colspan="2">2. Female</td></tr>
<tr><td colspan="4">Village:</td><td colspan="4">Population:</td></tr>
<tr><td colspan="3">Years resident in village</td><td>< 10yrs</td><td>10 - 19yrs</td><td colspan="2">20 - 29yrs</td><td>>30yrs</td></tr>
<tr><td>Age</td><td>< 15</td><td>15 - 19</td><td>20 - 39</td><td>40 - 59</td><td colspan="2">60 - 79</td><td>>80</td></tr>
<tr><td colspan="2">Level of education</td><td>0. No formal schooling</td><td colspan="2">1. Primary education</td><td colspan="2">2. Secondary education</td><td>3. Tertiary education</td></tr>
<tr><td colspan="2">Employment type</td><td>0. Unemployed</td><td>1. Self employed</td><td colspan="2">2. Government employment</td><td colspan="2">3. Private sector</td></tr>
<tr><td colspan="8">Specify, if self employed: ____</td></tr>
<tr><td colspan="3">Monthly household income</td><td><R1000</td><td>R1001 - R2000</td><td colspan="2">R2001 - R3000</td><td>>R3001</td></tr>
</table>

1.2 Utilisation

1.2.1 Rate the uses of *C. mopane*

<table>
<tr><td colspan="2">USES</td><td colspan="3">RATING</td></tr>
<tr><td colspan="2">Fuelwood</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="2">Construction</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="2">Medicinal</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="2">Other</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>Rating score:</td><td>1 = less important</td><td colspan="2">2 = important</td><td>3 = more important</td></tr>
</table>

1.2.2 Mean measurements for different uses of *C. mopane*

Uses	Length (m)	Circumference (m)	Diameter (m)	Mass (kg)	No. of poles	Volume (m^3)
Firewood						
Types of traditional huts						
Kitchen						
Roofing: Main beams						
Branderings						
Roof support						
Wall (plastered with mud soil)						
Children						
Roofing: Main beams						
Branderings						
Adults						
Roofing: Main beams						
Branderings						
Fencing						
Main poles						
Supporting poles						
Types of maize grain stores						
Alongside hut granary						
Foundation						
Floor						
Wall						
Roofing: Main beans						
Branderings						
Granary in the roof of a kitchen						
Foundation						
Floor						
Wall						
Animal kraals (Main poles)						
Cattle						
Goat						
Pigsty						
Others: Mortar						
Pestle						

1.2.3 Do people travel more than 1km to harvest dry wood?

1. Yes	0. No

1.2.4 How many meter(s) traveled to harvest fuelwood?

<200m	201 - 400m	401 - 600m	601 - 800m	801 - 1km	>1km

1.2.5 What is the time taken to harvest fuelwood?

<1hour	1 - 2 hours	2:01 - 4:59 hours	5 hours

1.2.6 Trend: - Is there a tendency to go further every year for harvesting of wood?

1. Yes	0. No

If yes, state possible reasons

____

1.2.7 Do people still use *C. mopane* wood for construction?

1. Yes	0. No

If yes, why (e.g. durability, quality) ____

1.2.8 What do villagers do to enhance the resistant of poles? ________________________

1.2.9 Rate other plant species that are used as substitutes of *C. mopane*

Species	**Uses**										
Common names	**1. Fuelwood**				**2. Medicinal**				**3. Construction**		
1	1	2	3		1	2	3		1	2	3
2	1	2	3		1	2	3		1	2	3
3	1	2	3		1	2	3		1	2	3
4	1	2	3		1	2	3		1	2	3
5	1	2	3		1	2	3		1	2	3
1 = less important	2 = important				3 = more important						

1.2.10 Do people collect dry wood continuously from the same area?

1. Yes	0. No

If yes, why____

If no, why____

1.2.11 Do people continuously harvest wet wood from the same tree?

1. Yes	0. No

If yes, why____

If no, why____

1.2.12 Are alternative sources of energy other than fuelwood used?

1. Yes	0. No

If yes, state source(s)? ____

1.2.13 Can people afford to use other sources of energy other than fuelwood?

1. Yes	0. No

If yes, why____

If no, why____

1.2.14 What are the means of transporting wood to the homestead? _________________

1.2 Perceptions

1.3.1 Is there any transfer of traditional conservation knowledge from one generation to the next?

1. Yes	
0. No	

If yes, how____

If no, why____

1.3.2 Why villagers prefer to firewood than any other energy sources? _______________

1.4 Mopane worms

1.4.1 For what purpose is mopane worms collected?

1. Subsistence	2. Commercial	3. Other, specify

1.4.2 Who are the people responsible for the collection of mopane worms?

1. Children (<18 years)	2. Youth (18 - 35 years)	3. Adult (>35)

1.4.3 Do people cut down/damage *C. mopane* trees during mopane worm harvesting?

1. Yes	0. No

If yes, specify the damage____

1.4.4 What determines the availability of mopane worms? _______________________

1.4.5 When are the outbreaks of mopane worms? ______________________________

1.4.6 Where is the market for mopane worms? ________________________________

1.4.7 How much can be generated from selling mopane worms per year?

____

1.4.6 What is the amount of *C. mopane* firewood per bundle? _____________ Mass of the bundle_________________

1.4.7 List other non-wood products harvested by villagers from mopane woodland____

____

____

__

1.5 Management practices

1.5.1 If a tree is cut, for how long is it left to re-grow before harvesting can commence?

Years	<1	1 - 4	5 - 9	10 - 14

1.5.2 What strategies can be implemented to conserve mopane woodland?

____

____

____

1.5.3 What could be done to empower local people to participate in mopane woodland conservation and management?

2 TRADIONAL LEADERS/CHIEFS

Aim: To collect data on perceptions and mopane woodland management practices

2.1 Personal details

Gender:				1. Male		2. Female	
Position in the society:							
Village:							
Years resident in village			< 10yrs	10 - 19yrs	20 - 29yrs	>30yrs	
Age	< 30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	>80	

Level of education	0. No formal schooling	1. Primary education	2. Secondary education	3. Tertiary education
Employment type	0. Unemployment	1. Self employed	2. Government employment	3. Private sector
Specify, if self employed: ______________________________				

Monthly household income	<R500	R501 - R1000	R1001 - R2000	R2001 - R3000	>R3001

Perceptions

2.2.1 Is there any transfer of traditional conservation knowledge from one generation to the next?

1. Yes	
0. No	

2.2.1.1 If yes, who transfers this knowledge?

1. Grand father	2. Grand mother	3. Father	4. Mother	5. Chief	6. Other

2.2.1.2 If no, why____

2.2.1.3 By which means?

1. Singing	2. Talks	Other

2.2.2 Are traditional conservation methods still in place?

1. Yes	
0. No	

If no, state possible reason____

2.2.3 Is the youth participating in traditional conservation methods?

1. Yes	
0. No	

If no, state possible reason____

2.2 Management practices

2.3.1 Rate the following activities in order of threats to the sustainability of mopane woodlands?

ACTIVITIES	RATING		
Deforestation through cultivation, settlement expansion	1	2	3
Fire	1	2	3
Grazing	1	2	3
Rating score: 1 = High impact	2 = Medium impact	3 = Low impact	

2.3.2 What is the occurrence of fire (e.g. once or twice per year)? ______________ and in which season? _______________________________

2.3.3 What is the main cause/s of wildfires? ___________________________________

2.3.4 Is there a decline in mopane woodlands over the past five years?

1. Yes	0. No

If yes, indicate possible cause(s)

____

2.3.5 If a tree is cut, is it allowed to re-grow before harvesting can commence?

1. Yes	0. No

2.3.6 If yes, for how long is a tree left to re-grow before harvesting can commence?

Years	<1	1 - 4	5 - 9	10 - 14

2.3.7 What are the strategies that can be implemented to improve the management of mopane woodlands?

Strategies	**Ranking**		
1. Reforestation	1	2	3
2. Social forestry camps	1	2	3
3. Conservation campaign	1	2	3
4. Community-based Conservation (Local participation in conservation)	1	2	3
5. Permits to harvest	1	2	3
6. Other: (state strategy)	1	2	3
Ranking score: 1 = High priority	2 = Medium priority		3 = Low priority

2.3.8 Who enforces the rules in the management of woodlands?

1. Local people	2. Chief	3. Municipality	4. Other

2.3.9 What can be done to empower local people to participate in woodlands conservation and management? ____

2.3.10 **Any additional information**____

____

____

____

3 MUNICIPALITY/PRIVATE SECTOR

Aim: To collect data on conservation and management practices on mopane woodland

3.1 Personal details

Gender:	1. Male			2. Female		
Province:						
Department/Company:						
Position:						
Age	< 24	25 - 34	35 - 44	45 - 54	55 - 64	>65
Employment type		1. Government employment		2. Private sector		

3.2 Nature conservation education

3.2.1 Is there an environmental education program in the area?

1. Yes	
0. No	

If yes, how are local people brought into the program? ____________________________

____

If no, how do local people obtain knowledge in woodland management?

____

3.2.2 Are there any stumbling blocks in implementing a conservation program?

1. Yes	
0. No	

If yes, what are those stumbling blocks? ____

3.3 Conservation/restoration

3.3.1 How many nature conservators visit the area per month? ______________________

3.3.2 Is there degradation in mopane woodland?

1. Yes	
0. No	

If yes, what are the strategies implemented or that can be implemented in combating woodland degradation?

Strategies	Tick
1. Reforestation	
2. Rehabilitation	
3. Permits to harvest	
4. Community-based Conservation	
5. Other	

3.3.3 Is a permit necessary to harvest mopane woodland resources?

1. Yes	
0. No	

If yes, what is the nature of the permit and amount paid? ___________________________

____

3.3.4 What happens to people who transgress conservation rules?

____

____

3.4 Management Practices

3.4.1 Is there a management policy in place for woodland conservation?

1. Yes	
0. No	

If yes, state the strategies? ____

3.4.2 Who is responsible in management of the woodland? _________________________

3.4.3 What are the major impacts on mopane woodland? ___________________________

3.4.4 Any additional information

3.4.4.1 Which woodland/forest policy could be implemented to conserve mopane woodland? ____

____

3.4.4.2 What can be done to empower local people to participate in woodland conservation and management? ____
____

3.4.4.2 What are the challenges in the implementation of conservation programmes?
____
____
____

APPENDIX 2

OTHER PLANT SPECIES USED DUE TO SCARCITY OF *C. MOPANE*

2.1 Woodland depleted villages (Mapayeni, Homu 14A and Homu 14C)

SPECIES		USES		
Local name	Scientific name	**Firewood**	**Medicinal**	**Construction**
Swikwenga	*Agave sisalana*			1
Nkaya/Xighathu	*Acacia nigrescens*	3		2
Xikayi	*Cassine aethiopica*	2	3	
Xikukutsu	*Combretum apiculatum*	3	1	3
Mondzo	*Combretum imberbe*	2	3	1
Mbvuva/ Ndzhuva	*Combretum molle*	2		1
Xikavi	*Combretum hereroense*	2		1
Mafamba-a-borile	*Combretum zeyheri*	1		
Xifhata	*Commiphora schimperi*			1
Xipaladzi	*Dalbergia melanoxylon*	3		1
Ndzenga	*Dichrostachys cinerea*	3	2	
Ntoma	*Diospyros mespiliformis*	3	1	1
Hlangulo/ Nhlangula	*Euclea divinorum*	3	2	1
Xunguxungu	*Euphorbia confinalis*	3		
Nkuwa	*Ficus sycomorus*		3	
Sangasi	*Fluggea virosa*	2	1	
Xitsalala	*Gardenia volkensii*		3	
Xihlangu	*Gymnosporia senegalensis*	3		
Gankomo	*Lannea schweinfurthii*			1
Xinyima-na-murhi	*Maerua angolensis*		1	
Nxuva	*Peltophorum africanum*	3		
Mbhandwa/ Mbhandzu	*Philenoptera violacea*	3		
Magonono	*Terminalia sericea*	3	3	1
Nkuhlu	*Trichelia emetica*	3		
Nkanyi	*Sclerocarya birrea*	2	2	1

Ndzopfori	*Spirostachys africana*	2	3	1
Ntsengele	*Ximenia caffra*	3		

Importance rating

1 = Low

2 = Moderately

3 = High

2.2 Woodland abundant villages (Makhuva, Zaba and Mbaula)

SPECIES		USES		
Local name	**Scientific name**	**Firewood**	**Medicinal**	**Construction**
Nkaya	*Acacia nigrescens*	3	1	2
Sesani	*Acacia tortilis*		3	
Xikayi	*Cassine aethiopica*	2		
Xikukutsu	*Combretum apiculatum*	3	2	3
Xikavi	*Combretum hereroense*	2		
Mondzo	*Combretum imberbe*	3	2	1
Mbvuva/ Ndzhuva	*Combretum molle*	2		
Mafamba-a-borile	*Combretum zeyheri*	1		
Xipaladzi	*Dalbergia melanoxylon*	2		
Ndzenga	*Dichrostachys cinerea*	3	2	1
Ntoma	*Diospyros mespiliformis*	2		
Kuwa	*Ficus sycomorus*	1	1	
Mbhandwa/ Mbhandzu	*Philenoptera violacea*	2		
Nkanyi	*Sclerocarya birrea*	2	2	1
Phasha mbala	*Ziziphus mucronata*	3		

Importance rating

1 = Low

2 = Moderately

3 = High

APPENDIX 3

REVIEW OF ETHOBOTANICAL USES OF *C. MOPANE* COMPARED WITH OTHER PLANT SPECIES

	SPECIES					
ETHNOBOTANICAL USES	*Colophospermum mopane*	*Combretum apiculatum*	*Acacia nigrescens*	*Sclerocarya birrea*	*Terminalia sericea*	*Dichrostachys cinerea*
Firewood	1,9,10,19,20,21,24,26,41,45,47,48	21,33,20,37,45,47	33,39,41,47	41,42	35,44	33,35,37,41,42,44,45,47,48
Charcoal	1,3,11,30,31					
Hut construction poles	2,9,10,19,20,24,26,27,32,47,48	21,45,47	33,48		36,44,45	37,44
Fencing poles	2,9,10,19,20,24,26,32,48	45,47	33,47,48		45,47	33,41,42,47,48
Mine props	2,28,47		47			
Railway sleepers	2,28					
Crafts	2,9,24,26,40,47	33,47	39,47	33,34,38,39,41,42,48	39,41,45,47	37,41,44,47
Rope from barks	8,9,10,26				44,45	48
Fertilizers - wood ash	8					
Browse	4,12,13,14,22,43,47,49	43,46,49	46,48,49	46,48,49		44,47,48,49
Diet of mopane worms	3,13,15,16,17,18,22,25					
Medicine – to treat:						
-syphilis	5				41,44	44
-inflamed eyes	5					41
-diarrhoea	9,10,27			45,47	41,45,47	
-madness	6					
-intestine worm	7,10					
-wounds	8				41	41
-stomach aches	9,10,27	47		41	45	41
-whooping cough	10					
-gout	10					
-bilharzia	10					
-menstrual pain	10				41	
-meningitis	10					
-sores	9,10					37
-kidney stones	9					
-vomiting	9					
-impotence	9			41	41	41
-swollen limbs	9					
-toothache	27,29			41,44		41,44,47,48
-dental decay	27					
-bleeding	27,29					
-dysentery				44,47		44
-cough					44	44
-diabetes and heartburn				47		
-malaria and fever				48,49		

Sources: **1** =Tietema *et al*. (1991); **2** =Piearce (1986); **3** =Timberlake (1995); **4** =Bonsma (1942); **5** =Watt & Breyer-Brandwijk (1962); **6** =Palgrave (1956); **7** =Gomes (1966); **8** =Palmer & Pitman (1972); **9** =Madzibane & Potgieter (1999); **10** =Mashabane *et al*. (2001); **11** =Chidumayo (2000); **12** =Styles (1993); **13** =Styles & Skinner (2000); **14** =Ben-Shahar (1998); **15** =Ditlhogo *et al*. (1996); **16** =Styles (1993); **17** =Styles (1994); **18** =Styles (1996); **19** =Liengme (1981); **20** =Liengme (1983); **21** =Prior & Cutler (1992); **22** =Lewis (1986); **23** =Styles (1995); **24** =Conroy (1996); **25** =Ashipala *et al*. (1996); **26** =Erkkilä & Siiskonen (1992); **27** =Van Wyk & Gericke (2000); **28** =Palgrave (1983); **29** =Malan & Owen-Smith (1974); **30** =Chidumayo (2001); **31** =Kammen & Lew (2005); **32** =Cunningham & Davis (1997); **33** =Moshe (2004); **34** =McCracken (2004); **35** =Shackleton (1993); **36** =Geldenhys (1997); **37** =Ellery *et al*. (2004); **38** =Yeatman (2004); **39** =Shackleton (2005); **40** =Grundy (1990); **41** =Mabogo (1990); **42** =Rankoana (2000); **43** =Jarman (1971); **44** =Von Maydell (1986); **45** =Van Wyk & Gericke (2000); **46** =Scholes (1997); **47** =Palgrave (1977); **48** =Moffat *et al*. (2003); **49** =Henley & Henley (2005)

APPENDIX 4

CONFIRMATION LETTERS TO UNDERTAKE SURVEYS

4.A Homu Traditional Authority (Mapayeni, Homu 14A and Homu 14C villages)

64

Homu Traditional Authority
P.O. Box 1689
ENQ. M.R Mathevula. GIYANI
0826.
31 August 2004

The Department Of Botany
University of the North.
P/Bag x 1106 Sovenga
0727

We Certify and Confirm that Mr Rudzani Makhado is the Masters Degree Student at the University of North.

Our chief and Our Councillors has no Objection to do research at Our Settlement

1. Vuhehli, Block 12.
2. N'wa Khuwani BL 13B.
3. Mapayeni 13.
4. Homu 14B.
5. Homu 14A.
6. Homu 14C.
7. Makoxa BL 15.

We hope that Our request should be taken into Consideration

Yours faithfully.
J. Mathevula.

HOMU TRADITIONAL COUNCIL
MOPANI
2004-08-31
GIYANI DISTRICT
P.O. BOX 1689
LIMPOPO PROVINCE

4.B Dzumeri Traditional Authority (Zaba village)

DZUMERI TRADITIONAL AUTHORITY
P.O. BOX 971 GIYANI 0826
2004 -09- 0 2
TEL: 015 812 0744
LIMPOPO PROVINCE

Ref 18/3
Eng Mashele:

The undermentioned CSIR:
Permitted to visted at Dzumeri
area for reserch. [Rudzani Makhado]

4.C Makhuva/Mathebula Traditional Authority (Makhuva and Mbaula villages)

D.E Baloyi

. 0158125600

WHOM IT MAY CONCERN:

nu va lavo va nyikiwile permission hi

al office ku va endla research eka

nsinya ya misanyatsi.

tirhisano wa nhina wu ta nkhenseka.

latsalani