TR 08-144

NATURAL RESOURCE HARVESTING AND DISTURBANCE IN COMMUNAL LANDS: ASSESSING THE ROLES OF LOCAL ECOLOGICAL KNOWLEDGE, DEPENDENCY AND MARKET ACCESS

A thesis submitted in fulfilment of the requirements for the degree of

MASTER OF SCIENCE

of

RHODES UNIVERSITY

by

MELITA ZOË STEELE

March 2008

ABSTRACT

A great deal of research has demonstrated that Non-Timber Forest Products (NTFPs) play a crucial role in the livelihoods of the rural poor, and are particularly important to the most marginalised people throughout the developing world. However, these livelihood benefits are not without cost to the natural resource base that rural communities depend so heavily upon. The continued dependence on NTFPs as a major livelihood source must be contingent upon the minimisation of the level of disturbance created through this dependency. This study assesses the level of disturbance created through natural resource harvesting in eight study sites around South Africa, and applies a predictive conceptual model created by Shankaar *et al.* (2004b) to try and ascertain under what conditions the level of disturbance created through natural resource harvesting will be high. It assesses the three key factors that Shankaar *et al.* (2004b) identified (level of Local Ecological Knowledge (LEK), level of dependency and access to markets) in relation to the level of disturbance found at each of the study sites. It was found that there was a statistically significant relationship between the level of dependency and the level of disturbance, but there was no statistically significant relationship between either access to markets or the level of LEK and disturbance. Regulation of landuse is a key issue, with weak local institutions in communal areas making effective resource management difficult. The significance of these findings is discussed, and priorities for future research are identified. This study adds to the body of knowledge related to NTFP harvesting and critically analyses the conflicts between the livelihood gains and the level of disturbance created through NTFP harvesting in an attempt to ascertain how livelihoods can be safeguarded. And in the longer-term, so that management strategies can be identified where resource extraction is not at the cost of undermining the very livelihoods that depend upon the natural resource base.

DECLARATION

I declare that this thesis is my own work, and that all other sources used or quoted have been fully acknowledged and referenced. It is being submitted for the Degree of Master of Science at Rhodes University, and has not been submitted for a degree or examination at any other university.

Melita Z. Steele

Signature ....

March 2008

ACKNOWLEDGEMENTS

I have learnt so much through the past few years, and there are a number of people who have been very instrumental in helping, encouraging and guiding me along the way. To Lesley, John and Laila: thank you for all the patience, love and support that you have given me over the years, even when things got difficult, it means more to me than words could ever say. My deepest gratitude goes to Charlie Shackleton who was an excellent supervisor. Thank you for all your patience, time, help and good advice. I feel very lucky to have been supervised by someone of your calibre. This research would have been impossible without all the people in my sample villages who were willing to be interviewed, and allowed me into their forests, and my sincere thanks go to them. I am also grateful to the National Research Foundation for providing the initial funding that got this study off the ground. My thanks go to Sarah Radloff for being willing to help with some tricky statistics, your help really was appreciated. Wayne Twine was very instrumental in helping me make contact and find interpreters in the villages in Limpopo Province. My thanks go to him, and to all the people at Wits Rural Facility who were so kind to me during my stay there. To all my friends and family who have encouraged me, given advice, listened to the kvetching, and told me to keep going: thank you. Tash, thank you for giving me the encouragement and support that I needed over the past few months.

But most of all, to Joyce: more than anything else, this is for you. I know that you would have been incredibly proud of me for finishing. You are always with me.

TABLE OF CONTENTS

Pencil, ink marks and highlighting ruin books for other readers.

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: General introduction and overview

1.1 Background and definitions

Forests are an incredibly important source of wild biological resources, and these resources are used around the world by subsistence communities for their daily needs, as well as to generate and supplement incomes (Emanuel *et al.*, 2005). Humans have depended on forests for both their livelihoods and quality of life for millennia, and this dependence continues today (Dovie, 2003) because forests provide a vast range of ecosystem goods and services that are vital to rural livelihoods across the developing world, including fuel, food, fibre, timber and other Non-Timber Forest Products (NTFPs) (Kant *et al.*, 1996; Higgins *et al.*, 1999; Dovie *et al.*, 2002; Twine *et al.*, 2003; Shackleton *et al.*, 2005; Neke *et al.*, 2006). The harvesting of NTFPs is now widely recognised to be an integral component of rural livelihoods throughout the developing world.

The Food and Agriculture Organisation (FAO) definition of forests refers to land with tree canopy cover of more than 10 percent; an area of more than 0.5 hectares; and trees reaching a minimum height of five metres. For the purposes of this study, the term 'dry forest' will be used, which implies that of a natural dry forest, composed of indigenous trees, and thus not classified as a forest plantation (within the South African context) and this includes savannas (FAO, 2000). Savannas are a very important inclusion in this definition, as they form one of the most widespread vegetation types in South Africa (Shackleton *et al.*, 2002a). It is estimated that just over one-third of South Africa is covered by the savanna biome, with approximately nine million South Africans residing in savannas and depending upon them for construction timber, fuel, medicine, food and fibre (Shackleton *et al.*, 2002a; Shackleton *et al.*, 2002b; Twine *et al.*, 2003). Indeed, millions of people depend upon the ecosystem services provided by savanna ecosystems for their livelihoods (Higgins *et al.*, 1999). The savanna biome in South Africa incorporates a significant proportion of the densely populated former homeland areas, and supports approximately 76 % of South Africa's rural population (Shackleton *et al.*, 2002a). Savannas are characterised by the co-dominance of trees and grasses, and woody cover is a key determinant of ecosystem properties (Sankaran *et al.*, 2005). Land-use practices can modify the structure and functioning of savanna ecosystems, and thus may also alter the type and quantity of ecosystem services that are produced (Higgins *et al.*, 1999). It is within this biome that the research upon which this thesis is based was conducted.

There is some debate around exactly what constitutes a NTFP, and there seems to be no comprehensive, consistent and globally acceptable definition. However, the term generally encompasses all biological materials that are extracted from forests for human use (other than timber), although there are many different interpretations (Belcher, 2003). For the purposes of this study, the term 'NTFP' refers to those resources extracted from dry forests in South Africa using simple technologies by people living in or near to the dry forest, for both household use and commercial sale, and thus includes the use of timber within rural livelihoods. Within the context of assessing levels of household Local Ecological Knowledge (LEK) and assessing how households use NTFPs, the term 'NTFP' implies a focus on woody products (specifically use and knowledge of fuelwood and wild fruit species is assessed). This particular focus is important, as it is impossible to measure knowledge related to all NTFPs (there are simply too many of them) and numerous valuation exercises have shown that woody products may be more important to low income rural households than many other woodland products (Campbell, 1991; Vermeulen, 1996). The rural poor often rely heavily on woody products as a source of energy for the household and it is estimated that wood fuel supplies nearly 20 percent of all energy needs across all developing nations. This implies a major contribution by woody products to economic welfare (Kant *et al.*, 1996). In addition, it is relatively easy to assess use-patterns of fuelwood and wild fruits (Campbell, 1991; Vermeulen, 1996).

NTFPs are one of the major extractable resources in the developing world and this has major implications for rural livelihoods (Shankaar *et al.*, 2004b). These resources are increasingly coming under pressure for reasons such as high human population densities, poverty and (in South Africa) a weakening of the level of influence wielded by the traditional authorities that were historically responsible for controlling access to natural resources (Twine *et al.*, 2003). According to a comprehensive review of NTFP studies, Ticktin (2004) maintains that many, but not all NTFPs are currently over-harvested as result of a host of factors including poor governance, growing commercialisation and market demand, competing uses for the land on which NTFPs are found, poor harvesting methods, and growing domestic demand as rural populations grow. This is evidenced by the low harvest limits presented by many of the reviewed studies, and the majority of studies seem to indicate that current harvest levels appear to be unsustainable over the long-term. Yet, there are many exceptions. For example, in South Africa, Shackleton (2001) summarised a number of case studies where over-harvesting was not the norm. More recently, research into marula (*Sclerocarya birrea*) fruits (Emanuel *et al.*, 2005) showed that harvesting is well within sustainable limits. Therefore, there is clearly some uncertainty about exactly what constitutes harvesting limits when it comes to NTFPs. Nevertheless, the literature appears to imply that many NTFPs will require some kind of management if they are to be able to withstand harvest pressures over the longer term (Ticktin, 2004). Understanding how dry forests are used by rural communities is increasingly important. This is because dry forests are not only experiencing increased pressures due to increasing rural populations combined with growing demands for agricultural land, they are also increasingly facing new pressures, such as the rise in commercialisation of woodland products and the changing face of rural communities as modernisation processes deepen and spread. It is vital to try to understand the impacts of such changes on these dry forests and on the way people make use of them (Campbell *et al.*, 2000).

1.1.1 The ecological impacts of NTFP harvesting

According to Hiremath (2004), it is often assumed that NTFP harvesting has little or no ecological impact, although there is evidence to the contrary, and indeed the ecological impacts of NTFP harvesting may be highly variable (Hiremath, 2004). Importantly, the current levels of human dependence on dry forests (and the associated livelihood gains) may have an increased number of negative interlinked impacts from the level of genes to that of the entire ecosystem (Hiremath 2004; Shankaar *et al.*, 2004a). The level of disturbance created by the harvesting of NTFPs could range from a general decline of the resources (Shankaar *et al.*, 2004b) to changes in the demography and population dynamics of harvested species (Sinha and Bawa, 2001; Hiremath, 2004; Shankaar *et al.*, 2004b). In addition, due to the loss or change of resources available there may over time be a gradual change in what exactly constitutes Local Ecological Knowledge (LEK) (Shankaar *et al.*, 2004b).

The ecological impacts of extraction are by no means uniform. In fact, the response of vegetation to anthropogenic pressures depends to a great degree on the intrinsic features of its flora. Specifically, the response of species to human-induced pressures would be dependent on the reproductive features and regeneration potential of the species. For example, species with a good coppicing ability are less likely to be vulnerable to human-induced pressures than non-coppicing species (Shankaar *et al.*, 2004a), prolific fruiters are less vulnerable to harvesting than species that produce low numbers of fruit (Emanuel *et al.*, 2005), fast growing species can withstand more frequent harvesting than slow growing species (Cunningham, 2001) and so on. Moreover, the effects of harvesting for any particular species are mediated by variations in environmental conditions over space and time, and by human management practices. There may also be ecological impacts from anthropogenic disturbances associated with NTFP extraction that are frequently overlooked (Hiremath, 2004). The enormous level of environmental variation on a global scale presents a challenge to our current understanding of the ecological impacts of NTFP extraction and to the development of effective resource extraction management strategies (Ticktin, 2004). These complexities make the assessment of the level of disturbance created by the harvesting of NTFPs even more difficult.

1.1.2 The safety net function of NTFPs

NTFPs provide important livelihood benefits to the rural poor just through the ordinary daily use of these resources (Shackleton and Shackleton, 2004b). They perform a vital role in meeting basic needs and contributing to livelihood security on a day-to-day basis (Shackleton *et al.*, 2002a) and act as a buffer against poverty (Twine *et al.*, 2003). However, in addition to meeting daily needs, NTFPs provide a very important second livelihood benefit, in that they often serve as a vital safety net in times of hardship (Kant *et al.*, 1996; Dovie *et al.*, 2002; Shackleton *et al.*, 2002a; Shackleton and Shackleton, 2004b). This means that NTFPs help households cope in times of adversity when there are sudden changes in the bio-physical, social or economic environments within which households function. This includes events such as drought, floods, the death/retrenchment of the head of the household/breadwinner, frosts or disease leading to death of livestock or crop failure, unanticipated/large increases in the cost of staple foods or major economic structural adjustment (Shackleton *et al.*, 1999; Shackleton and Shackleton, 2004b; Paumgarten, 2007). It is during these times that rural households turn to NTFPs to tide them over what is perceived to be a temporary setback, and it is at this time that NTFPs acquire an additional value, which is that of an emergency insurance fall-back during times of hardship.

According to Shackleton and Shackleton (2004b) the change in resource use during times of hardship may take three forms:

1. The consumption of types or species of NTFPs that are not commonly used by that household.
2. The increased consumption (either relatively or absolutely) of NTFPs that are already part of their livelihood.
3. The temporary sale of NTFPs locally and/or at regional markets.

In these types of situations "the changed or increased use of NTFPs is typically a coping strategy, with the products providing a 'safety' or 'emergency' net" (Shackleton and Shackleton, 2004b: 659).

1.1.3 The economic significance of NTFPs

NTFP extraction can have multiplier effects in the economy by generating income and employment through trading activities (Shankaar *et al.*, 2004b). In addition, it has been argued that while any individual NTFP is often substantially less economically significant than the commercial harvesting of timber, as a group NTFPs sometimes contribute more value per hectare than timber (Kant *et al.*, 1996). The harvest of wild NTFPs such as fuelwood, medicinal and edible plants, thatch grass, bark, resins, edible insects, honey, bushmeat and construction timber constitute an important source of income to millions of people in most human-dominated landscapes throughout the developing world (Kant *et al.*, 1996; Dovie *et al.*, 2002; Twine *et al.*, 2003; Shankaar *et al.*, 2004a; Ticktin, 2004; Shackleton *et al.*, 2005; Neke *et al.*, 2006). This implies that NTFPs are a very valuable resource and thus theoretically, collectors are unlikely to over-exploit the resource base as it is an important source of income and security (Kant *et al.*, 1996). However, over the past two decades the extraction of NTFP resources has gained a great deal of attention in conservation circles as the growing commercial trade of NTFPs (in particular plant medicines and crafts) has resulted in the harvesting of increasing volumes from plant populations in the wild (Ticktin, 2004; Shackleton 2005). This means that managing NTFP extraction and trying to assess the level of disturbance created by extraction is key to both conserving dry forest resources as a whole, together with ensuring that the livelihood needs of the rural poor can be met (Shankaar *et al.*, 2004a).

1.1.4 Poverty alleviation

There is also a broader poverty alleviation role that NTFPs play. The recognition of the value of NTFPs in both tropical and more arid systems has been the catalyst for the support for and development of numerous small-scale ventures for income generation facilitated by Non-Governmental Organisations (NGOs), donor agencies and governments around the world (Shackleton *et al.*, 2005). The primary aim of these enterprises has been the alleviation of rural poverty, which it is hypothesised will in turn lead to reduced land degradation and the enhanced conservation of the local natural resources (Ticktin, 2004). A number of case studies exist that demonstrate that there may be improved income and living standards for the participants in such small-scale enterprises, although there are many potential difficulties and some of the initial projections regarding real economic returns and the capacity to alleviate poverty have been questioned (Shackleton *et al.*, 2005).

1.1.5 The nature of dry forests

It is also important to acknowledge that in addition to the positive implications of harvesting NTFPs, few (if any) dry forests (or any other type of forest) are pristine systems. Their current structure and composition is a result of a number of factors, of which humankind is a key one (Hoffman, 1997; Shackleton, 2001). Humankind has played both positive and negative roles in savannas and forests around the world for millennia, and the genetic composition of these forests is to a large degree a result of those age-old anthropogenic influences, as many species have been actively or passively selected (Shackleton, 2001). Thus, the harvesting of NTFPs has both negative and positive connotations for the species contained within dry forests. Some species may benefit from being harvested, while others may not, which means that changes in the composition of forests may not always be negative (Shankaar *et al.*, 2004b).

1.1.6 The South African situation

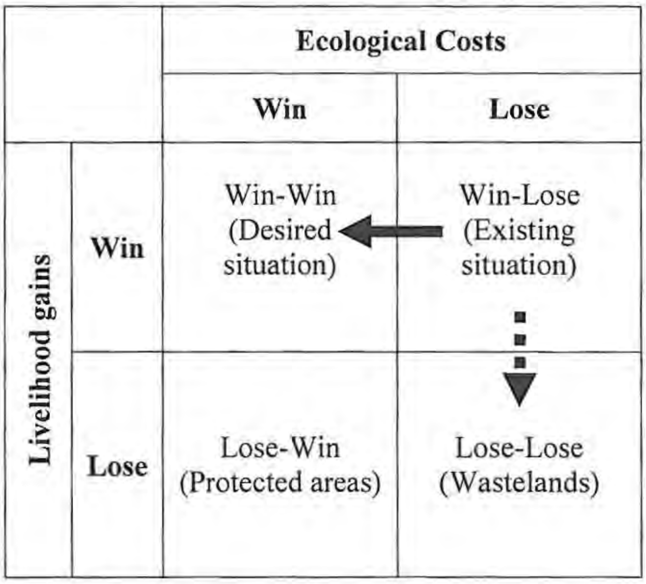
In southern Africa, there is extensive harvesting and trade in NTFPs (Shackleton and Shackleton 2004a), combined with increasing marketing through informal channels (Shackleton 2005). However, these kinds of channels lead to complex marketing scenarios that are difficult to account for (Dovie, 2003). The situation in South Africa is relatively similar to that of the rest of the developing world, in that a wide variety of NTFPs are harvested, and there is a high level of dependence on NTFPs (Shackleton *et al.*, 2002a; Dovie, 2003).

The majority of South Africans reside in rural areas that are characterised by limited infrastructure and employment opportunities; as a result, many people make extensive use of NTFPs as part of their daily livelihoods (Shackleton *et al.*, 2002a). Indeed, in the face of growing economic hardship, unemployment/retrenchments and HIV/AIDS, the poorest people in South Africa are increasingly turning to the natural resource base as a way to meet their livelihood requirements (Shackleton, 2004). On a national scale, according to Stewart (2005) the informal trade in indigenous medicinal plants is estimated to be approximately R270 million per year, and more than 700 plant species are known to be actively traded for medicinal purposes (not including other NTFPs that are sold). In 2003 the trade in indigenous plants for both medicinal and cultural purposes in the six major centres in the Eastern Cape alone was estimated to be 500 tons, with an approximate value of R27 million (Stewart, 2005).

In southern Africa, fuelwood is one of the most important NTFPs that are harvested/collected, as it is the dominant energy form (Shackleton *et al.*, 2003). South Africa is no different, as the majority of South Africa's rural population make extensive use of fuelwood as their primary energy source, regardless of increased electrification over the past decade (Shackleton *et al.*, 2003; Neke *et al.*, 2006). In 2003 it was estimated that annual fuelwood demand was approximately 11 million tons, which is within sustainable limits at a national level. However, there are imbalances in the supply and demand of fuelwood at a localised scale, which may result in progressive deforestation and increased potentially negative ecological impacts (Shackleton *et al.*, 2003). This is most apparent in areas with high population densities, although it is not ubiquitous to all of these areas (Shackleton *et al.*, 2003).

1.2 A predictive conceptual model

Shankaar *et al.* (2004a) and Shankaar *et al.* (2004b) recently conceptualised a predictive model, which attempts to address the potential conflicts of forest use from the perspectives of the level of disturbance created and livelihood gains (Figure 1.1). According to this model, for the majority of current extractive NTFP practices, the gains to rural livelihoods result in a significant level of disturbance to the dry forests that people depend upon (i.e. a win-lose situation). Lose-win situations (with no apparent livelihood gain and therefore no level of disturbance) are probably only typical of nationally protected areas, where the extraction of NTFPs is prohibited. Lose-lose situations may be typical of areas (e.g. a degraded wasteland) where livelihood gains are absent and the area has already incurred major levels of disturbance due to past exploitative extraction.



		Ecological Costs	
		Win	**Lose**
Livelihood gains	**Win**	Win-Win (Desired situation)	Win-Lose (Existing situation)
	Lose	Lose-Win (Protected areas)	Lose-Lose (Wastelands)

Note: The bold arrow indicates the desired trajectory; the dotted arrow indicates the likely trajectory if disparities between 'gains' and 'costs' widen (Shankaar *et al.*, 2004a: 348).

Figure 1.1 A 2x2 matrix of livelihood gains and ecological costs

Clearly the most ideal scenario would be that of a win-win situation, where there are limited levels of disturbance, but significant livelihood gains. The challenge lies in reducing the distortion between gains and losses (in the win-lose situation), because it is assumed that unless this can be achieved, sooner or later a win-lose situation will be transformed into a lose-lose situation due to over-extraction of resources. The reduction of the distortion between gains and losses could well be the first step in redirecting the trajectories of change to that of a win-win situation (Shankaar *et al.*, 2004a; Shankaar *et al.*, 2004b).

Although conceptually the 2x2 matrix of gains versus losses (Figure 1.1) offers a relatively simple way of navigating options, in practice, success in reaching win-win situations has been meagre. Shankaar *et al.* (2004a) and Shankaar *et al.* (2004b) argue that against the backdrop of the theoretical framework presented above, if the long-term dependence of people on forest resources is to be safeguarded, it is imperative that livelihood gains are reconciled with the levels of disturbance created by the harvesting of NTFPs. If this does not occur, the long-term dependence of communities on forest resources (and the associated livelihood benefits) would be jeopardised, as would the ecological resource base itself.

Shankaar *et al.* (2004a) and Shankaar *et al.* (2004b) identified three key factors that are likely to influence reaching the ideal win-win situation. These are:

1. Extent of dependence on NTFPs
2. Level of Local Ecological Knowledge (LEK)
3. Market structure

They show that within the parameters of those three factors, it is possible to predict the outcomes that will conform to win-win or win-lose situations.

Shankaar *et al.* (2004b) went on to hypothesise the conditions under which levels of disturbance could be expected to be low or minimised, within a system of NTFP harvesting. It was hypothesised that high levels of dependence on NTFPs, combined with no or low levels of household LEK and a high degree of market failure could result in high levels of disturbance. Alternatively, if high levels of dependency are coupled with high levels of household LEK as well as effective market structures, then it is expected to lead to lower levels of dependence. When dependence on forest products is low, independent of the household LEK level or the market structure, the levels of disturbance are also bound to be low.

Essentially Shankaar *et al.* (2004b) argue that when dependence levels are high, the level of disturbance will primarily be determined by the level of LEK and the market structure and institutions and they make two specific predictions:

1. Communities/sites with higher dependence on NTFPs, but with high levels of household LEK will tend to impose a lower level of disturbance than those sites that exhibit a poor level of LEK.
2. Sites with a cooperative stakeholder-marketing regime will create lower levels of disturbance than would those where marketing is conducted through private traders who operate under short-term contract.

This study applies this model to the South African context, and does so within eight villages, situated in the savanna biome of South Africa.

1.3 Rationale for this study

There is increasing recognition of the variety of economic, social and political factors that influence the harvesting of NTFPs around the world (Hiremath, 2004), and the greatest barriers to sustainable levels of harvesting may fall within these domains. However, at the core of this issue, and of the many different agreements and policies at both national and international levels relating to the management of NTFPs, there lie two fundamentally important ecological questions: what are the levels of disturbance created by NTFP harvesting? And, under what conditions do these levels of disturbance impact negatively on NTFP populations? (Ticktin, 2004).

If the long-term livelihoods of those communities that depend on forest resources around the world are to be maintained or improved, the existing win-lose situations have to be transformed into win-win situations, where resource extraction is not at the cost of undermining the very livelihoods that are dependent upon the resources (Shankaar *et al.*, 2004a). This thesis aims to consider the levels of local disturbance created by communities around South Africa in relation to the three key variables identified by Shankaar *et al.* (2004b). The challenge that then has to be explored is how this kind of research can lead to a management strategy for NTFPs that minimises the consequences of extraction, and maintains long-term livelihoods. As Shankaar *et al.* (2004a) have pointed out, every effort that can reconcile the conflicts between the ecological costs and livelihood gains of NTFP extraction should be explored, as it is only this that will result in a win-win situation.

This thesis adds to the body of literature concerning the ecological impacts of NTFP harvesting. It will endeavour to determine under which conditions the levels of disturbance created by NTFP harvesting will be high, and under which conditions the levels of disturbance will be low, using the predictive model of Shankaar *et al.* (2004b). It will test the hypothesis that that the greater the dependence on the natural resources harvested from the communal dry forests, when combined with the other two key factors of market access and the level of household LEK, the greater the levels of disturbance will be (Shankaar *et al.*, 2004b).

1.4 Description of the study sites

Eight villages were selected to be the study sites upon which this study is based. The villages are Ntilini, Tidbury, Fairburn (Eastern Cape Province), Finale A, Mabins B, Willows, Thorndale and Mogano (Limpopo Province) (Table 1.1). These particular villages were selected because they represent a range of rural settlements from small, remote and poorly serviced ones to large, better serviced ones on major secondary routes, and also because of already existing research that has been conducted regarding the valuation of NTFPs, which should give an indication of the level of dependency on NTFPs (Shackleton *et al.*, 2002a; Shackleton *et al.*, 2002b; Dovie *et al.*, 2002; Twine *et al.*, 2003; Shackleton *et al.*, 2004b). Thus, one of the variables needed to apply the Shankaar *et al.* (2004b) model within the South African context had already been assessed in these villages.

The eight villages are located within the savanna biome of South Africa, within communal tenure areas, and are geographically situated in areas with low mean annual rainfall levels that range between 488 mm and 600 mm (Table 1.1). The villages are generally remote, but are varying distances from major centres of commercial activity. Land is mostly divided into arable and residential plots, and residents are allowed free access for grazing and the extraction of NTFPs in the remaining areas (Dovie, 2006). Thus, the savanna rangelands that surround each village are open to the harvesting of NTFPs by any household that may wish to do so (Shackleton *et al.*, 2002b).

The three Eastern Cape villages (Ntilini, Tidbury and Fairburn) are all located in the Kat River valley in the Mpofu district of the former Ciskei homeland. Ntilini is located closest to Fort Beaufort in the south and has approximately 180 households, Fairburn is situated closest to Seymour in the north with approximately 100 households, and Tidbury is positioned midway between the two with approximately 40 households (Shackleton *et al.*, 2002a). Population densities are higher than on the surrounding privately owned commercial citrus farms, employment levels are low, and basic infrastructure is unevenly and inadequately distributed. Ntilini and Fairburn have access to electricity, while Tidbury (the smallest of the villages) does not. The proximity of the Kat River to the villages does ensure a basic supply of water for irrigation and domestic use, although it must be collected by hand in Ntilini and Tidbury (Shackleton *et al.*, 2002a), Fairburn has recently installed taps on street corners within the village.

Three of the study villages (Finale A, Mabins B and Willows) are located in the Mametja Traditional Authority in Limpopo Province and under the apartheid government the area formed part of the homeland area of Lebowa. They represent a range of rural settlements, from a large, well serviced one on a major secondary route (Willows) with approximately 1000 households, to a small, remote and poorly serviced one (Finale A) with approximately 300 households. Mabins B is intermediate between the two, with approximately 550 households (Twine *et al.*, 2003). According to Twine *et al.* (2003) Mabins B and Willows were electrified in the mid-1990s, and Finale has no electricity.

Thorndale is situated in the Bushbuckridge Lowveld in Limpopo Province and it is bordered by the Manyeleti Game Reserve to the south. It is a remote village that is cut off from major commercial centres, and has limited access to social infrastructure. Aside from the teachers at the village primary school, and a small number of workers at the Manyeleti Game Reserve, there is no formal employment within several kilometres of Thorndale (Dovie *et al.*, 2002).

Mogano is situated 32 km southeast of Polokwane in Limpopo and is comprised of over 300 households. According to the local inhabitants, the formerly dispersed homesteads were consolidated into a formal village in the 1940s. This village is fairly well developed, and has relatively good employment opportunities and incomes (Shackleton *et al.*, 2002b).

Table 1.1 The bio-physical characteristics of the study sites

Village	Province	Latitude	Longitude	Vegetation type	Dominant species	Approximate mean annual rainfall (mm)
1.Ntilini	Eastern Cape	32° 42.4' S	26° 36.0' E	Eastern Thorn Bushveld (Low and Rebelo, 1996)	*Acacia karroo, Euphorbia* spp., *Diospyros dichrophylla, Olea europea* (Shackleton *et al*., 2002)	550
2.Tidbury	Eastern Cape	32° 38.6' S	26° 39.5' E	Succulent thicket (Low and Rebelo, 1996)	*Acacia karroo, Euphorbia* spp., *Diospyros dichrophylla, Olea europea* (Shackleton *et al*., 2002)	550
3.Fairburn	Eastern Cape	32° 33.6' S	26° 42.5' E	Eastern Thorn Bushveld (Low and Rebelo, 1996)	*Acacia karroo* (Shackleton *et al*., 2002)	550
4. Finale A	Limpopo Province	24° 24' 15" S	30° 42' 30"E	Arid Lowveld Savanna (Acocks, 1988)	*Sclerocarya birrea, Combretum apiculatum, Acacia nigrescens* (Twine *et al*., 2003)	488
5. Mabins B	Limpopo Province	24° 25' S	30° 33' E	Arid Lowveld Savanna (Acocks, 1988)	*Sclerocarya birrea, Combretum apiculatum, Acacia nigrescens* (Twine *et al*., 2003)	488
6. The Willows	Limpopo Province	24° 21' 30" S	30° 38' 30"E	Arid Lowveld Savanna (Acocks, 1988)	*Sclerocarya birrea, Combretum apiculatum, Acacia nigrescens* (Twine *et al*., 2003)	488
7.Thorndale	Limpopo Province	24° 39' S	31° 28' E	Lowveld (Acocks, 1988)	*Acacia burkei, Phoenix reclinata, Sclerocarya birrea* (Acocks, 1988)	550 to 600
8.Mogano	Limpopo Province	24° 2.9' S	44.8° 44.8' E	Pietersburg Plateau False Grassveld (Acocks, 1988)	*Acacia rehmanniana* Schinz, *A. tortilis* Hyne, *Dichrostachys cinerea* (Shackleton *et al*., 2002)	505

1.5 Aim of this study

As Shankaar *et al.* (2004b) have already indicated, the continued dependence on NTFPs as a major source of livelihood must be contingent upon the minimisation of the level of disturbance created by such dependence. This thesis attempts to assess the level of disturbance created by NTFP harvesting in eight villages around South Africa, and relate this back to the predictive conceptual model of Shankaar *et al.* (2004b). Shankaar *et al.* (2004b) hypothesised that the key factors influencing the ecological consequences of NTFP harvesting are:

1. The level of dependency on the resource base
2. Level of LEK
3. Structure of markets

The aim of this study is to determine how the level of disturbance in the communal forests of the fore-mentioned eight villages is related to these three key factors, within the South African context. An intensive vegetation survey around each study site, and an examination of how the above-mentioned variables are related to the state of the vegetation surrounding each particular village was therefore conducted.

This thesis also attempts to critically analyse the conflict between the livelihood gains and the level of disturbance created by NTFP harvesting, to ascertain how long-term livelihoods can be safeguarded.

1.6 Key questions

1. What levels of disturbance are created by NTFP harvesting around each village?
2. How does the level of dependency on the resource base affect the level of disturbance created by NTFP harvesting around each village?
3. How does the access to markets affect the level of disturbance created by NTFP harvesting around each village?
4. How does the level of LEK affect the level of disturbance created by NTFP harvesting around each village?

1.7 Thesis structure

This thesis is presented in a journal publication format (Chapters Two, Three and Four). However, there is a general abstract and an introduction (Chapter One) that precedes the three chapters, giving an overview of how and why NTFPs are important, a rationale for this study, and outlining the key objectives of the research. As a result, Chapters Two, Three and Four each have their own introduction sections, with some of the content and references overlapping with that of Chapter One, and the study site section in Chapter One also applies to Chapters Two, Three and Four, but is only presented once to avoid unnecessary repetition. In addition, the methodology section for LEK and Disturbance in Chapter Four refers back to Chapters Two and Three to avoid unnecessary repetition.

Thus, Chapter One is a general introduction and overview, Chapter Two deals with the assessment of LEK, Chapter Three deals with the assessment of disturbance and Chapter Four is a synthesis chapter that applies the Shankaar *et al.* (2004b) model to the South African context in the eight study sites.

CHAPTER TWO: Assessing levels of household Local Ecological Knowledge in eight villages around South Africa

2.1 Introduction

2.1.1 Background and definitions

Internationally, the level of interest in indigenous knowledge systems and livelihoods has been climbing steadily in recent years (Berkes *et al.*, 2000; Godoy *et al.*, 2005). Indigenous people are among the world's poorest populations (Godoy *et al.*, 2005), they account for a major proportion of the population in some countries, hold most of the world's traditional knowledge and have ownership rights to some of the world's most biologically diverse areas. Consequently, it is imperative that local people and their experiences and knowledge systems are integrated into natural resource management approaches and plans aimed at promoting sustainable resource use (Berkes *et al.*, 2000; Godoy *et al.*, 2005).

As the concept of 'indigenous people' has become an increasingly important category in international regulations and laws, so this has resulted in the constructed representations of certain kinds of knowledge as being local and authentic (and distinct from modern ('Western') science), which have begun to acquire greater importance in national as well as global arenas (Leach and Fairhead, 2002). A facet of the increased interest in indigenous peoples is that increasingly researchers and academics are beginning to recognise the value of LEK for ecosystem and species population management (Berkes *et al.*, 2000; Ford and Martinez, 2000; Reyes-Garcia *et al.*, 2007).

The term LEK is used to describe the knowledge that is held by indigenous cultures regarding their immediate environments, and also the cultural practices that build upon that knowledge (Ford and Martinez, 2000). It is knowledge that is unique to a specific society or culture, and is the basis for local-level decision-making in natural resource management by rural communities (Agrawal, 1995). According to Berkes *et al.* (2000) LEK is a knowledge-practice-belief complex based on an accumulation of observations. It represents multiple bodies of knowledge that have been amassed through many generations of close interactions between people and their environment (Drew, 2005). LEK is defined by

Berkes *et al.* (2000) as "a cumulative body of knowledge, practices and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (pg. 1252). It is a complex body of knowledge that can be site specific, and it represents the information necessary for survival that has been accumulated through trial and error over many decades (Drew, 2005; Pierotti and Wildcat, 2000). It is an attribute of societies with historical continuity in the practice of resource use (Berkes *et al.*, 2000) and indigenous people who retain LEK are holders of a complex body of knowledge that has been crafted over centuries by the specifics of surviving and completing tasks in the environment in which they have been living (Berkes *et al.*, 2000; Drew, 2005). LEK is generally shared among users of a resource, and/or passed down through an oral tradition (Agrawal, 1995; Huntington, 2000) or by shared practical experiences (Berkes *et al.*, 2000). Local knowledge is richest when it has accumulated over many generations, embedding observations of the environment and the corresponding cultural adaptations within a context of long-term ecological change (Ford and Martinez, 2000). Different forms of LEK, used and accumulated by indigenous people, are found throughout the world and these forms share similar approaches and themes (Pierotti and Wildcat, 2000). LEK is generally deeply socially embedded and knowledge and beliefs in rural areas are often closely tied to cosmology, local religion and social order (Leach and Fairhead, 2002). The term LEK is interchangeable with the term 'Traditional Ecological Knowledge' (TEK) in the literature, but for the sake of simplicity and because the term 'traditional' is a value-laden one (Berkes *et al.*, 2000), the term LEK will be used throughout this thesis.

According to Briggs (2005), viewing indigenous knowledge as a pristine, untainted knowledge system is unhelpful and simplistic. LEK is undoubtedly mediated by external influences from factors such as immigrants, extension workers and returning migrants. "A key element of LEK is that it tends to be deeply embedded within the society in which it has been developed, and must therefore be seen in its economic, political and cultural contexts" (Briggs, 2005: 109). Indeed, the levels of LEK within a community depends upon a variety of demographic characteristics. These include: gender, age, kinship relations, ethnicity, position in a social network and distance from natural resources or from cities. In addition, there is also a consistently negative association between LEK and characteristics generally associated with acculturation, such as schooling, fluency in the national language and academic skills (Berkes *et al.*, 2000).

The evolution of LEK is a dynamic and cumulative process, generated in the immediate context of the livelihoods of people (Agrawal, 1995). It is knowledge that builds upon practical experience, collective wisdom and adaptation to change. For example, LEK experts would generally have access to information dealing with the way past generations coped with environmental changes resulting from major shifts in rainfall and/or temperature (Bowers, 2005). In fact, far from being a static body of knowledge, LEK is constantly undergoing modifications as the needs of the communities change as a result of changes in their local and broader surroundings and livelihoods (Agrawal, 1995; Ford and Martinez, 2000; Pierotti and Wildcat, 2000). It accumulates, erodes and changes over time (Allison and Badjeck, 2004) and it is, in short, a continuously evolving way of thinking about and operating in the world (Pierotti and Wildcat, 2000). This fluidity is a reflection of the ongoing re-negotiations that occur between people and the environment they depend upon for their survival (Briggs, 2005) and by its very nature, LEK must be highly adaptive if it is to serve the different needs of human populations over long periods of time (Ford and Martinez, 2000). Indeed, many of the prescriptions of traditional knowledge and practice are generally consistent with that of adaptive management as a method for resource and ecosystem management. This is because LEK acknowledges that environmental conditions will always change, requiring societies to respond by adjusting to the changes and evolving (Berkes *et al*., 2000). LEK is linked to the long-range consequences of environmental change and human action; thus the people accumulating and using LEK should (in theory) always be able to modify their responses and activities if environmental conditions demand (Pierotti and Wildcat, 2000). LEK is all about social learning, which seems to be the way in which indigenous/local communities respond to uncertainty. "Often this involves learning not at the level of the individual but social learning at the level of society or institutions" (Berkes *et al*., 2000: 1260).

For the purposes of this thesis, LEK is taken to mean the ethnobotanical insights and knowledge acquired through an accumulation of observations of an area or species. More specifically, knowledge of the species of trees used for fuelwood and wild fruit was used as a broad index of the extent of LEK at each site. This would include knowledge shared among users of a resource, or passed down through an oral tradition (Huntington, 2000).

2.2 The difficulties associated with assessing LEK

Assessing LEK is a complex task, particularly because it is dynamic in time and space (Agrawal, 1995; Bowers, 2005). In addition, LEK is not a unitary knowledge system (Briggs, 2005; Drew, 2005). Instead, it is a term that represents a heterogeneous body of knowledge gained from undertaking a wide variety of different activities including (but not limited to) the collection of resources for medicinal uses, hunting, use in spiritual/cultural ceremonies, sale and/or the subsistence of a household (Drew, 2005). This poses methodological difficulties, and assessing the level of LEK within a particular village becomes more complicated, as it would be very time consuming to attempt to assess the level of knowledge acquired through all the above-mentioned activities. As a result, a very specific assessment of LEK was made in the eight study sites, focusing specifically on the level of household LEK of trees used for fuelwood and wild fruit within each village as an index of broader multifaceted LEK. The assessment of household LEK is based primarily on species identification and classification (ethnobiology) and does not focus a great deal on ecological processes and their relationships with the environment (Berkes *et al.*, 2000).

In addition, it may be difficult for researchers to ascertain who is in possession of the LEK being assessed (Huntington, 2000; Davis and Wagner, 2003). Knowledge is not shared equally across all members of the community (Briggs, 2005; Drew, 2005). Indeed, LEK is distinctly uneven, and often mediated and fragmentary in nature. Such knowledge can become distinctly differentiated across a community. "The concept of a shared community knowledge, as well as seeming to ignore individual agency, is cut across by factors such as age, experience, wealth, production priorities, household circumstances, political power and, not least, gender" (Briggs, 2005: 105). The fore-mentioned factors would clearly have an impact both on an individual's access to and ability to use such knowledge (Briggs, 2005).

Despite the growing levels of interest in LEK, there has been little quantitative research about the rate of loss and acquisition of LEK, and the causes for this. Some researchers have linked the loss of LEK to the market economy's expansion (Godoy *et al.*, 1998; Reyes-Garcia *et al.*, 2005). Other researches have found a persistence in LEK despite large socio-economic changes. For example, Guest (in Reyes-Garcia *et al.*, 2007) found that integration into the market economy through an economic activity that is based in the natural environment, could actually accelerate the acquisition of LEK. This is an important debate for policy-makers, because if integration into the market economy erodes LEK, there would be no possibility of simultaneously achieving economic development and conservation of local knowledge. On the other hand, if integration into the market does not affect or does not always affect LEK, then it is foreseeable that some forms of market incorporation could occur without eroding LEK (Reyes-Garcia *et al.*, 2007).

2.3 Binary tensions between Western science and indigenous knowledge systems

Although both Western science and LEK are forms of knowledge based on an accumulation of observations, according to Berkes *et al.* (2000), LEK is fundamentally different from Western science in a number of important ways. Indeed, there are major binary tensions between Western science and indigenous knowledge systems, and they are often portrayed as two completely different, competing knowledge systems. Western science is perceived by Westerners to be more objective, substantive, systematic and open, whereas indigenous knowledge is perceived to be closed, primitive, insular and unintellectual. Additionally, LEK is perceived to use subjective methods, which makes LEK appear less rigorous than Western scientific methodology. The perception is that Western science searches for knowledge that is of universal significance and is not context-related, while LEK is deeply site and culturally specific (Briggs, 2005).

Agrawal (1995) summarised the three main arguments distinguishing LEK from Western science:

1. Substantive – there are differences in the characteristics and subject matter of indigenous versus Western knowledge.
2. Methodological and epistemological – the two knowledge systems possess different world-views and use different methods to investigate reality.
3. Contextual – Western and local knowledge differ because local knowledge is more deeply rooted in its own context.

The language of scientific/Western discourse is not the language of LEK, and LEK flows from epistemologies that are very different from Western science. LEK has moral, ethical and spiritual dimensions (because it is grounded in ethical, moral and spiritual world views), and this seems to make the practitioners of 'rationalist scientific traditions' most uncomfortable (Ford and Martinez, 2000). Indigenous worldviews, in contrast to the temporal orientation of Western historical and political thought, can be considered to be spatially oriented, because LEK is powerfully tied to specific physical localities (Pierotti and Wildcat, 2000).

The difficulty inherent in using indigenous knowledge is that researchers feel the need to describe LEK in Western scientific terms (Huntington, 2000) and there is a pervasive belief that LEK must in some way be related to formal science and that for LEK to be accepted, there must be a way to test the knowledge scientifically (Briggs, 2005). Using the scientific method to check on the validity of indigenous practices implies a belief in the superiority of Western science (Agrawal, 1995). According to Agrawal (1995) a number of authors have downplayed the distinctions between LEK and Western knowledge, but then contradictorily asserted the need to collect and evaluate a community's level of environmental knowledge using the scientific method. This means that for all the respect accorded to LEK systems, they must first pass a "scientific criterion of validity before being recognized as usable knowledge" (Agrawal, 1995: 430).

2.4 The current paradigm shift

However, it is increasingly being recognised that one knowledge system is not necessarily superior to the other (Briggs, 2005). A number of commentators have pointed out that there are numerous problems in upholding a strict division between LEK and scientific knowledge (Agrawal, 1995). The reality is that Western science is just as socially constructed as LEK, and is not necessarily transferable (Briggs, 2005). All knowledge is socially produced, which, it can be argued, dissolves the barriers between scientific/indigenous and lay/expert knowledge and instead creates a plethora of site-specific practices and partial perspectives in a wide range of social situations (Leach and Fairhead, 2002). This means that LEK is not necessarily completely separate from scientific knowledge. No village is a closed system and rural communities are not bounded and static (Agrawal, 1995; Allison and Badjeck, 2004). Indeed, knowledge systems are bound to be influenced by a variety of factors, including increased access to information and changing levels of migration from rural areas (Allison and Badjeck, 2004). Theoretically, Western knowledge is guided by abstract principles and empirical measurements that help order measured observations to facilitate the testing of hypotheses. And yet, many elements separated by this artificial divide between 'Western' and 'indigenous' knowledge share substantial similarities. Both systems are in fact open ones and are influenced by a myriad of different factors, including each other.

Agrawal (1995) cautions against overemphasising the differences between traditional knowledge and Western science, and questions whether the dichotomy is in fact real. According to Agrawal (1995), a classification of knowledge systems into indigenous and Western is bound to fail, not only because of the inherent heterogeneity of the elements, but also because it seeks to fix and separate in time and space (fix as stationary and unchanging, and separate as independent), systems that cannot ever be fixed or separated. This kind of separation requires the two forms of knowledge to have completely divorced historical sequences of change, which they do not. In the face of evidence that suggests contact, transformation, exchange, communication, variation and learning over the last several centuries, it is extremely difficult to adhere to a view of Western and indigenous forms of knowledge being untouched by each other. Indeed, evidence suggests that indigenous knowledge systems have been in intimate contact and interaction with Western knowledge since as far back at the fifteenth century (Eckholm, 1980; Abu-Lughod, 1987). Agrawal (1995) argues that an attempt must be made to go beyond the omnipresent dichotomy of indigenous versus scientific knowledge. Despite the so-called distinctions between Western and indigenous knowledge systems, these systems also share substantial similarities. Instead of trying to group all non-Western knowledge into an indigenous category, and all Western knowledge into an alternative category, perhaps it is more sensible to accept that there will be differences between categories, and instead search for similarities across them (Agrawal, 1995). Fundamentally, both LEK and Western science should ideally be seen as developing and emerging through historically located practices, in specific institutional and social contexts, which subverts any fundamental theoretical divide between them (Agrawal, 1995; Leach and Fairhead, 2002). Acknowledging this level of similarity and equality requires that Western science explores and recognises the validity of alternative explanations. Instead of placing Western science and LEK as competing knowledge systems, a more valuable way of talking about LEK might be as a complement to existing (formal) knowledge (Allison and Badjeck, 2004; Briggs, 2005).

2.5 Context

The original aim of this thesis is to assess the level of disturbance created by NTFP dependence and harvesting in eight villages around South Africa. Shankaar *et al.* (2004b) created a conceptual model, which hypothesises that the key factors influencing the level of disturbance created through NTFP harvesting are:

1. The level of dependency on the resource base
2. Structure of markets
3. Level of LEK

This thesis focuses on assessing how the level of disturbance in the communal forests of the fore-mentioned eight villages is related to these three key factors within the South African context. This chapter focuses specifically on assessing levels of LEK. The outcome of this assessment of LEK is inserted into the Shankaar *et al.* (2004b) predictive model in Chapter Four.

2.6 Aim

To obtain a mean overall level of household LEK score for each of the eight villages (study sites).

2.7 Methodology

LEK comprises many sub-domains (including animals, plants, insects or soils) (Reyes-Garcia *et al.*, 2007). This paper proxies individual ecological knowledge with theoretical ethnobotanical knowledge (specifically knowledge related to the species of trees useful for the harvesting of fuelwood and/or wild fruit). It is however, important to note that the villages occur in different vegetative zones in South Africa so the species of tree varies from village to village (although the actual questions themselves do not).

According to Godoy *et al.* (1998) integration into the market economy through the sale of forest goods is associated with more knowledge of wildlife (Godoy *et al.*, 1998), and the "sale of forest and farm products is associated with greater ethnobotanical skills and with greater theoretical ethnobotanical knowledge" (Reyes-Garcia *et al.*, 2007: 376). This means that the people in each village who sell fuelwood can be seen as 'specialists' and it is expected that they would have greater theoretical ethnobotanical knowledge than the average village member. In light of the debate regarding the binary tensions between indigenous knowledge systems and Western science a conscious decision was made not to compare the answers given by households to 'conventional/Western' science, but rather to the 'specialists' residing within the villages themselves.

Research on the transmission of LEK suggests that people acquire the majority of their theoretical ethnobotanical knowledge before adolescence (Zarger, 2002). Based on the assumption that once theoretical knowledge is acquired, it will in general be retained, one would expect low levels of variation in the theoretical ethnobotanical knowledge of adults. Practical skills are acquired at a later stage, and thus one can expect more variation in practical skills than in theoretical knowledge (Reyes-Garcia *et al.*, 2007). Thus, a random selection of thirty households were interviewed in each study site (eight villages), and the respondents were asked a variety of questions related to the species of trees that they harvest for fuelwood and/or wild fruit.

Before the fieldwork began in 2005, it was already known from the previous resource valuation studies in these villages that most households did use fuelwood and wild fruits (Shackleton *et al.*, 2002a; Dovie *et al.*, 2002; Shackleton *et al.*, 2002b and Twine *et al.*, 2003). To obtain a 'mean level of household LEK' per village, 30 randomly selected households were interviewed in each of the eight villages, and they were asked a set number of questions regarding key fuelwood and wild fruit tree species in their particular area. The only village where fewer than 30 households were interviewed was Tidbury, this was because Tidbury is so small that every occupied household was interviewed, and it still only created a total of 24 households. Each village was divided into three sections, and a random selection of ten households (with every fourth household being selected) was made in each section, ensuring an even spread throughout each village. Specialists (i.e. those involved in the selling of fuelwood) were then identified through a question posed to the households asking them which member/s of their village are involved in the sale of fuelwood. The number of specialists varied from village to village, depending on how many people were involved in the sale of fuelwood. The specialists were then interviewed using the same set of questions posed to the randomly selected households.

This assessment of LEK is therefore based on household and individual key-informant (the specialists) interviews. The assumption was made that the people being interviewed were honest in their answers, and unbiased. In all instances, interviews were in the local language by means of an interpreter. Respondents gave informed consent to be interviewed after being provided with details of the purpose of the interview, their rights to confidentiality and to withdraw at any stage. If possible, the head of the household was interviewed; otherwise an adult residing in the household was interviewed. The first household interviewed in each village was asked to list the most widely used/preferred fuelwood and wild fruit species, and the questions were then related to these species throughout the village. The questions posed were then separated into those related to fuelwood, and those related to wild fruit, with three questions analysed for each.

The questions analysed regarding wild fruit species were:

1. When do the fruits for this particular species ripen? (Q1)
2. When does this particular species flower? (Q2)
3. What colour are the flowers of this particular species? (Q3)

The questions analysed regarding fuelwood species were:

1. Does cutting the stem at the base kill this particular species? (Q4)
2. Does this particular species have any specific requirements to grow? If so, what are they? (Q5)
3. What are the other uses of this particular fuelwood species, apart from fuelwood? (Q6)

The answers given by the households were then compared to those given by the specialists, with the main focus being on the level of agreement between the households and the specialists. A mean level of household LEK was obtained for each village for:

1. Wild fruit (households compared to specialists) (Table 2.1).

Mean level of household LEK for wild fruit for each village = Mean of the 'Agree' column (Table 2.1) (Q1 + Q2 + Q3) (Table 2.1). .... **A**

2. Fuelwood (households compared to specialists) (Table 2.2) plus uses of fuelwood trees, excluding fuelwood (Table 2.3).

Mean level of household LEK for fuelwood for each village = Mean of the level of agreement (Q4 + Q5 + Q6) (Table 2.2 and Table 2.3). .... **B**

A single composite score of the level of household LEK at each site was then calculated as the mean of the two individual mean scores for wild fruit and fuelwood (Table 2.5).

Composite score for each village = Mean (**A** + **B**).

This mean score was then used in testing the Shankaar *et al.* (2004b) model (Chapter Four).

2.8 Results

Table 2.1 shows that in terms of wild fruit, Willows has the highest level of household LEK with a mean of 77.8 %. In stark contrast is Ntilini in the Eastern Cape, which has the lowest mean level of household LEK out of the eight study sites, with a mean of 25.6 %. The three villages in the Eastern Cape clearly have relatively low levels of household LEK, with Fairburn being ranked fourth, Tidbury being ranked sixth and Ntilini being ranked eighth. However, one of the villages in Limpopo Province (Mabins B) has a mean level of LEK of 27.8 %, which is similar to that of Ntilini's.

The mean 'Don't Know' scores are relatively low, however Ntilini has a 'Don't Know' score of 51.1 %, and Tidbury has an overall 'Don't Know' score of 40.3 %, which are relatively high. This means that a large proportion of the households interviewed had no knowledge of the species at all, or were simply unable to answer such specific questions related to wild fruit.

Table 2.1 Extent of household LEK with respect to key wild fruit species

Village	**Level of correspondence between randomly selected households and specialists**	**(Q1) When do fruits ripen? (%)**	**(Q2) When does the tree flower? (%)**	**(Q3) What colour are the flowers? (%)**	**Mean (%)**	**Rank**
Ntilini	Agree	36.7	26.7	13.3	25.6	8
	Disagree	3.3	23.3	43.4	23.3	
	Don't Know	60.0	50.0	43.3	51.1	
Tidbury	Agree	4.2	45.8	50.0	33.3	6
	Disagree	29.1	20.9	29.2	26.4	
	Don't Know	66.7	33.3	20.8	40.3	
Fairburn	Agree	70.0	50.0	40.0	53.3	4
	Disagree	30.0	50.0	60.0	46.7	
	Don't Know	0.0	0.0	0.0	0.0	
Mabins B	Agree	0.0	10.0	73.3	27.8	7
	Disagree	100.0	86.7	20.0	68.9	
	Don't Know	0.0	3.3	6.7.0	3.3	
Finale A	Agree	80.0	73.3	53.3	68.9	2
	Disagree	3.3	0.0	36.7	13.3	
	Don't Know	16.7	26.7	10.0	17.8	
Willows	Agree	100.0	53.3	80.0	77.8	1
	Disagree	0.0	26.7	16.7	14.5	
	Don't Know	0.0	20.0	3.3	7.8	
Thorndale	Agree	60.0	50.0	76.7	62.2	3
	Disagree	26.7	6.7	3.3	12.2	
	Don't Know	13.3	43.3	20.0	25.5	
Mogano	Agree	100.0	23.3	23.3	48.9	5
	Disagree	0.0	60.0	50.0	36.7	
	Don't Know	0.0	16.7	26.7	14.5	

Table 2.2 indicates that in terms of household LEK related to fuelwood, Mabins B has consistently low levels of LEK, with a level of household LEK of 36.7 %, and is ranked eighth. Willows in Limpopo Province has electricity and is situated off a major secondary route (Twine *et al*., 2003), and this seems to translate into a low level of household LEK related to fuelwood, with a mean of 43.3 % and a ranking of seventh. However, Ntilini is no longer ranked last, in fact it has a level of household LEK (fuelwood) of 71.7 % and is ranked second, despite the fact that it is electrified, and is situated close to Fort Beaufort off a major secondary route (Shackleton *et al*., 2002a). The other two Eastern Cape villages (Fairburn and Tidbury) are ranked third and sixth respectively. These two villages have relatively consistent levels of household LEK in terms of rankings, although their mean levels of LEK are higher for fuelwood than for wild fruit.

The 'Don't Know' category is low for all villages, with the highest mean being 10.0 % at Fairburn. This implies that households had some knowledge regarding the questions being asked, even if the answer given was in disagreement with the answer given by the specialists.

Table 2.2 Extent of household LEK with respect to key fuelwood species

Village	**Level of correspondence between randomly selected households and specialists**	**(Q4) Does cutting at the base of this species kill it? (%)**	**(Q5) Does this species have specific requirements to grow? (%)**	**Mean (%)**	**Rank**
Ntilini	Agree	76.7	66.7	71.7	2
	Disagree	13.3	30.0	21.7	
	Don't Know	10.0	3.3	6.7	
Tidbury	Agree	70.8	16.7	43.8	6
	Disagree	20.8	83.3	52.1	
	Don't Know	8.3	0.0	4.2	
Fairburn	Agree	73.3	66.7	70.0	3
	Disagree	6.7	33.3	20.0	
	Don't Know	20.0	0.0	10.0	
Mabins B	Agree	70.0	3.3	36.7	8
	Disagree	30.0	96.7	63.4	
	Don't Know	0.0	0.0	0.0	
Finale A	Agree	90.0	100.0	95.0	1
	Disagree	6.7	0.0	3.4	
	Don't Know	3.3	0.0	1.7	
Willows	Agree	53.3	33.3	43.3	7
	Disagree	36.7	66.7	51.7	
	Don't Know	10.0	0.0	5.0	
Thorndale	Agree	73.3	40.0	56.7	4
	Disagree	20.0	60.0	40.0	
	Don't Know	6.7	0.0	3.4	
Mogano	Agree	3.3	100.0	51.7	5
	Disagree	93.3	0.0	46.7	
	Don't Know	3.3	0.0	1.7	

Ntilini shows inconsistency, as once again in Table 2.3 it is one of the lowest ranked villages (despite being one of the highest ranked villages in Table 2.2 which measures LEK related to fuelwood). Mabins B has been attaining consistently low rankings (seventh in Table 2.1, and eighth in Table 2.2), however in Table 2.3 Mabins B is ranked first.

Table 2.3 Extent of household LEK with respect to additional uses of fuelwood trees (excluding the use of fuelwood itself)

Village	**(Q6) Mean household LEK score (uses of fuelwood trees)**	**Rank**
Ntilini	19.4	7
Tidbury	47.9	2
Fairburn	18.7	8
Mabins B	50.8	1
Finale A	32.2	3
Willows	19.7	6
Thorndale	26.2	4
Mogano	22.7	5

Table 2.4 shows the overall mean levels of household LEK for both wild fruit and fuelwood in the eight study sites. Most villages show correspondingly similar levels of household LEK for both wild fruit and fuelwood. For example: Finale A has a mean level of household LEK of 68.9 % for wild fruit, and 63.6 % for fuelwood. The one exception to this is Willows, which has the highest level of household LEK for wild fruit (77.8 %) and the lowest level of household LEK for fuelwood (31.5 %). STATISTICA was used to run a correlation matrix between the mean wild fruit score, and the mean fuelwood score. It was found that there is no correlation between the two means ($r = -0.050$; $p > 0.05$) for the eight study sites and there is no relationship between the two LEK scores, and they are totally independent of one another.

In terms of the final composite household LEK score (Table 2.4) the villages in Limpopo Province show relatively high rankings, with only Mogano (ranked fifth) and Mabins B (ranked seventh) having low rankings. Fairburn has an intermediate ranking of fourth, but both Tidbury and Ntilini have low rankings of sixth and eighth respectively.

Table 2.4 Overall household LEK scores

Village	Mean household LEK score (wild fruit)	Mean household LEK score (fuelwood)	Final composite household LEK score	Final household LEK rank
Ntilini	25.6	45.6	35.6	8
Tidbury	33.3	45.9	39.6	6
Fairburn	53.3	44.4	48.9	4
Mabins B	27.8	43.8	35.8	7
Finale A	68.9	63.6	66.3	1
Willows	77.8	31.5	54.7	2
Thorndale	62.2	41.6	51.9	3
Mogano	48.9	37.2	43.1	5

The percentage of households only collecting fuelwood (i.e. not buying it too) was generally high, ranging from 33.3 % (Willows) to 100 % (Thorndale) (Table 2.5) (refer to Appendix Two for the questions upon which Table 2.5 is based). The percentage of households only collecting wild fruit was correspondingly high, ranging from 46.7 % (Fairburn) to 100 % (Mabins B). This appears to indicate a high level of dependency on these natural resources in the sample villages. In terms of wild fruit, there is a clear geographical grouping of the villages, with a noticeably smaller percentage of households in the Eastern Cape only collecting wild fruit, this is probably related to differences in vegetation and the availability of wild fruit.

Intuitively, it makes sense that how households obtain both fuelwood and wild fruit should have some impact on levels of household LEK. The more households collecting both these resources, the higher the composite household LEK score is expected to be. The vast majority of houses in Finale A collect both fuelwood and wild fruit (Table 2.5), and one would expect a correspondingly high level of household LEK (and indeed, Finale A is ranked first in Table 2.4). Thorndale also has very high levels of collecting both fuelwood and wild fruit, and this is translated to a ranking of third in Table 2.4.

A correlation was run between the composite level of household LEK and the percentage of households collecting fuelwood/the percentage of households collecting fruit. No correlation was found between the level of household LEK and the percentage of households collecting fuelwood (r= -0.08), and no correlation was found between the level of household LEK and the percentage of households collecting fruit (r= 0.26).

Table 2.5 How households obtain fuelwood and wild fruit

Village	Fuelwood – three most preferred species			Wild fruit - three most preferred species			Percentage of households that do not collect or buy any wild fruit at all
	Buy one or more species (%)	Collect one or more species (%)	Both for one or more species (%)	Buy one or more species (%)	Collect one or more species (%)	Both for one or more species (%)	
Ntilini	43.3	70.0	6.7	13.3	60.0	16.7	20.0
Tidbury	8.3	91.7	0.0	16.7	79.2	0.0	8.3
Fairburn	23.3	73.3	26.7	13.3	46.7	6.7	30.0
Mabins B	3.3	96.7	0.0	0.0	100.0	0.0	0.0
Finale A	0.0	93.3	6.7	0.0	96.7	0.0	3.3
Willows	20.0	33.3	46.7	0.0	93.3	10.0	0.0
Thorndale	0.0	100.0	0.0	0.0	96.7	0.0	3.3
Mogano	20.0	70.0	30.0	3.3	96.7	6.7	0.0

***Note:** The percentages in this table will not necessarily add up to 100 %, as it looks at the three most preferred species listed by each household for both fuelwood and wild fruit. Some households only collect/buy some species, and do both for others.

2.9 Discussion

LEK is important because it is the basis for decision-making related to natural resources and their management in rural areas such as the eight study sites that are the focus of this study (Agrawal, 1995). However, LEK is a complex body of knowledge (Pierotti and Wildcat, 2000; Drew, 2005) that is mediated by external influences which are difficult to quantify (Briggs, 2005), and is dynamic in time and space (Agrawal, 1995; Bowers, 2005), which means that it is difficult to assess. In addition, because knowledge is not shared equally across all members of the community (Briggs, 2005; Drew, 2005) 'specialists' (i.e. people involved in the sale of fuelwood, who were expected to have greater ethnobotanical knowledge and skills than the average household) were identified. These specialists then provided the benchmark against which the answers given during household interviews were compared. Consciously deciding to assess LEK this way, instead of comparing answers to conventional Western knowledge is not a conventional approach, and no similar approaches were found in the literature. In fact, very little is known about how to go about assessing levels of LEK. Thus, assessing LEK and obtaining a composite LEK score is clearly a complex task.

This study shows that it is in fact possible to obtain a composite household LEK score when one proxies household LEK with theoretical ethnobotanical knowledge, which is benchmarked with 'specialist' knowledge at the same site. However, it is important to acknowledge that this is a very specific analysis, with a very limited focus. This means that it is difficult to compare this assessment to other studies in the literature because of the specificity of the study. In addition, due to the complex nature of LEK, if more variables were added and one were not just assessing levels of knowledge related to fuelwood and wild fruit, the composite score may change substantially. Indeed, the composite score is based on the answers given to a total of six questions, and it is acknowledged that more in-depth questioning may also have resulted in a different composite score, but time restraints did not allow for greater detail in terms of the questions posed to households. However, selection of appropriate questions is clearly very important. Ideally, questions need to be unambiguous, have clear, discrete answers and cover broadly observable phenomena.

The results also show that levels of household LEK may vary considerably in terms of different resources. For example, Willows has the highest level of household LEK for wild fruit (77.8 %) (Table 2.1) and the lowest level of household LEK for fuelwood (31.5 %) (Table 2.2). This difference implies that there is a considerably higher level of knowledge related to wild fruit, than there is related to fuelwood. This is counter intuitive, as one would expect that if villages are highly dependent on fuelwood, levels of household LEK should be higher for this particular resource. Indeed, Twine *et al.* (2003) found that consumption of fuelwood was significantly higher in Willows than in either Finale A or Mabins B ($p < 0.05$), while the consumption of wild fruit was both considerably, and significantly ($p < 0.05$) lower in Willows than in Mabins B and Finale A. This discrepancy between the levels of household LEK related to fuelwood and wild fruit may be explained through how the fuelwood is obtained (Table 2.5). A total of 66.7 % of households in Willows either buy and collect fuelwood, or only buy fuelwood. Only 33.3 % of households in Willows were engaged in only collecting fuelwood. It seems reasonable to assume that when over half of the households in a village are engaged in buying fuelwood, there would be a lower level of household LEK related to fuelwood. Whereas 93.3 % of the households engaged in obtaining wild fruit collected their own and did not buy any. Again, it seems reasonable to hypothesise that if 93.3 % of the households that consume wild fruit are collecting it, there would be a higher level of household LEK related to wild fruit.

Overall, Willows is rated as having a high mean level of household LEK, and is ranked second.

Finale A is a poorly serviced and remote village (Twine *et al.*, 2003), and over 90 % of households interviewed were involved in collecting the three most preferred species of both fuelwood and wild fruit (Table 2.5). This is translated into consistently high rankings for this village, in terms of both wild fruit (ranked second) (Table 2.1) and fuelwood (ranked first and third) (Table 2.2 and 2.3). These consistently high rankings are eventually translated into a composite household LEK score of 66.3 %, and a ranking of first out of the eight study sites (Table 2.5). In contrast, Mabins B is ranked consistently poorly in terms of wild fruit and fuelwood (Tables 2.1 and 2.2), and has low overall mean household LEK scores for both fuelwood and fruit (Table 2.4), despite the fact that over 90 % of households interviewed were involved in collecting the three key species of both fuelwood and wild fruit. Thus, collecting these key resources does not always translate into a high composite household LEK score.

The three Eastern Cape sites (Fairburn, Ntilini and Tidbury), situated in the Kat River valley of the Mpofu district of the former Ciskei homeland in the Eastern Cape (Shackleton *et al.*, 2002a) show relatively low levels of mean household LEK. The village with the highest composite household LEK score being Fairburn 48.9 % (ranked of fourth) (Table 2.4), and the lowest ranked village from the Eastern Cape being Ntilini (ranked eighth), with a composite household LEK score of 35.6 %. Ntilini is situated closest to Fort Beaufort out of the three villages, which appears to be translated into more households being inclined to buy either fuelwood or wild fruit, or both (Table 2.5). Indeed, 43.3 % of households in Ntilini buy fuelwood (with an additional 6.7 % of households buying and collecting fuelwood) (Table 2.5).

On the other hand, the five villages in Limpopo Province (Finale A, Mabins B, Willows, Thorndale and Mogano) have relatively high rankings in terms of the composite household LEK score (Table 2.4), with only Mogano (43.1 %) and Mabins B (35.8 %) obtaining rankings lower than fourth. The highest ranked village from this group being Finale A (ranked first), followed by Willows (ranked second), and Thorndale (ranked third). All three of these villages have over 90 % of the households interviewed involved in collecting both fuelwood and wild fruit (Table 2.5). The one exception being Willows, which has only

33.3 % of households involved in the collecting of fuelwood (although over 90 % of households in Willows are involved in the collecting of wild fruit) (Table 2.5).

However, whether households collect or buy the key resources assessed in this study seems to have a varying impact on how the village scores in the composite household LEK score. There are clearly other factors at work, potentially including the level of disturbance that harvesting these resources has created in the communal forests (the level of disturbance created through the harvesting of natural resources in the communal dry forests will be addressed in Chapter Three of this thesis). No correlation was found between the fuelwood mean and the wild fruit mean, despite the fact that they are the key resources that the LEK assessment was based upon.

The level of household LEK per village is important because it would influence how resources are managed, and may challenge the 'Tragedy of the Commons' (Hardin, 1968) view of communally managed resources (Allison and Badjeck, 2004). However, it is important to note that while assessing levels of household LEK is in itself difficult, the situation is further complicated by the fact that not all traditional practice and belief systems are ecologically adaptive/wise. This means that it would be ill-advised to view high levels of LEK as something that inevitably leads to good management of resources. For example, Diamond (1993) in Berkes *et al.* (2000) discovered that although New Guinea natives possess detailed knowledge of the animals and plants that they depend upon, some of the groups have had, and continue to have, a heavy impact on their native biota. Thus, high levels of LEK do not necessarily always result in ecologically adaptive management strategies (there are other factors at work, which must be taken into account) (Berkes *et al.*, 2000). The relationship between the levels of household LEK and the levels of dry forest disturbance is assessed in Chapter Four.

2.10 Conclusion

This research advances the overall understanding of LEK at both the theoretical and methodological levels. Due to the binary tensions between Western knowledge systems and LEK systems, this study has consciously avoided describing LEK in scientific terms, or comparing the answers given to Western/conventional/ 'scientific' knowledge. This was done in an attempt to recognise that one knowledge system is not necessarily superior to another (Briggs, 2005).

As Reyes-Garcia *et al.* (2007) found, this study shows that the way ethnobotanical knowledge is defined and measured at the methodological scale is important. The results showed that when household LEK is proxied with theoretical ethnobotanical knowledge, it is possible to obtain a composite household LEK score, which is representative of the varying levels of LEK at different study sites. However, due to the complex nature of LEK, if more variables that contribute towards overall levels of household LEK were assessed in greater detail the composite score may change substantially. Indeed, it is recognised that this is a very specific analysis, with a very narrow focus and while it may be an accurate reflection of knowledge related to fuelwood and wild fruit, LEK is made up of many more variables that have not been measured in this study. In addition, external factors such as migration and immigration would more than likely affect levels of household LEK. However, these kinds of factors are very difficult to quantify. A more broad-based assessment of LEK (which captures both the theoretical and practical dimensions of LEK more effectively) would improve the measure of individual (and thereby a village's) level of LEK.

LEK is still a relatively new concept within Western scientific thinking, and although the idea of LEK is gaining importance on an international scale, there is much scope for further study. As the levels of recognition of indigenous people and LEK continue to climb internationally (Berkes *et al.*, 2000; Godoy *et al.*, 2005), so research aimed at assessing levels of LEK has become more important. This study clearly shows that even within a narrow focus, mean levels of LEK may vary substantially depending on the resource being assessed. In addition, LEK is a dynamic cumulative body of knowledge (Agrawal, 1995; Ford and Martinez, 2000; Pierotti and Wildcat, 2000; Allison and Badjeck, 2004), and this study has shown that ideally LEK assessments should evaluate both theoretical and practical levels of knowledge, and they should be ongoing in nature.

It is however essential to note that although the concept of LEK is gaining in popularity on an international scale, it must be recognised that not all traditional practice and belief systems are ecologically adaptive/wise, and it would be ill-advised to view high levels of LEK as something that inevitably leads to good management of resources (Berkes *et al.*, 2000). Thus, this study does not assume an *inevitability* in the relationship between household LEK and so-called 'good management of resources', but does hypothesise that high levels of household LEK should lead to lower levels of disturbance in communal forests. The relationship between household LEK and the level of disturbance in communal dry forests is examined further in Chapter Four.

CHAPTER THREE: Assessing the levels of disturbance in the communal dry forests of eight villages around South Africa

3.1 Introduction

3.1.1 Background

There is a growing body of research that indicates that natural resources play a very important role in the livelihoods of rural communities in southern and South Africa (Vermeulen, 1996; Campbell *et al.*, 1997; Shackleton and Shackleton, 2000; Twine *et al.*, 2000; Letsela *et al.*, 2002). Throughout the world, rural communities use wild biological resources for subsistence, as well as to generate income (Emanuel *et al.*, 2005). In South Africa it is the poorest (and often the most marginalised) people, who are faced with problems such as HIV/AIDS, escalating economic hardship and high unemployment levels, that are increasingly turning to the natural resources found in their communal dry forests to meet their daily livelihood requirements (Shackleton, 2004).

Due to cost and access problems associated with other energy sources, small-scale wood harvesting is an important economic and energy resource in developing countries. Purely from an energy perspective, although Africa accounts for a smaller total percentage of global wood fuel production (29.9 %) than Asia (45.8 %), it is the continent with the most intensive use of fuelwood in per capita terms. Fuelwood accounts for 40 % of energy needs in Africa, as opposed to 7 % in tropical Asia (Campbell, 2005). Thus, rural African communities are highly dependent upon fuelwood harvested from communal areas as their most important energy source, as there are few alternative energy sources available (Shackleton, 1993; Shackleton *et al.*, 2003). It has also increasingly been established that due to population increases these communal resources are under escalating exploitation pressures and that in some cases, current extraction levels are not sustainable over the long term (Shackleton, 1993; Twine *et al.*, 2003; Sagar, 2003; Shackleton *et al.*, 2003; Ticktin, 2004; Campbell, 2005).

In South Africa the majority of people living in rural areas make extensive use of fuelwood, despite increased electrification over the past decade (Shackleton *et al.*, 2003; Madubansi and Shackleton, 2006; Neke *et al.*, 2006; Madubansi and Shackleton, 2007). Annual demand was estimated to be approximately 11 million tons in 1996, which is within sustainable limits at a national level (Shackleton *et al.*, 2003). However, at a localised scale in many rural areas there is a major imbalance between the supply and demand of fuelwood, which results in progressive disturbance and deforestation. This is most apparent in areas with high population densities, although it is not ubiquitous to all of these areas (Shackleton *et al.*, 2003).

3.1.2 The savanna biome

Savanna biomes are characterised by the co-dominance of grasses and trees (Sankaran *et al.*, 2005), with savannas typically consisting of a mosaic of tree, shrub and grass components (Furley, 2007). Approximately 40 % of the African land surface is covered by savannas, and millions of people throughout Africa depend on the wide variety of ecosystem services provided by savannas for their survival (Higgins *et al.*, 1999; Sankaran *et al.*, 2005). Although the type and distribution of the savanna biome is largely determined by climatic and edaphic factors, savannas are also modified by local landuse practices (Higgins *et al.*, 1999). Indeed, African savannas are an example of how humans have modified the ecology of ecosystems to meet human requirements over thousands of years (Lovett and Poudyal, 2006). Sustainability questions related to small scale wood harvesting are particularly important in dry forests within the savanna biome, as due to the mosaic nature of savannas the availability of woody species is already lower than in other types of forests (Campbell, 2005), and within savannas, woody cover is a very important determinant of ecosystem properties (Sankaran *et al.*, 2005).

Within the South African context, it is estimated that two-thirds of South Africa's poor reside in rural areas, largely within the savanna biome (Shackleton *et al.*, 2002b). These areas are generally characterised by high levels of poverty, very high unemployment levels, and a continued heavy dependency on a limited and declining resource base, which means that natural resources contribute extensively to livelihoods (Shackleton *et al.*, 2002b; Neke *et al.*, 2006). In densely populated areas, the pressure exerted on dry forests from local people is high and these dry forests are increasingly threatened. When local people collect deadwood for fuel, it most likely has a negligible impact on the dry forest (Chidumayo, 2002). However, it is estimated that already as much as 93 % of the current demand for fuelwood is not met by deadwood, but is harvested unsustainably as livewood instead (Shackleton and Shackleton, 2000).

According to Shackleton (1993b), communal savanna areas appear to be resilient. However, frequent but low intensity disturbance (which would include fuelwood extraction) may involve the combined effect of a myriad of factors, and thus may strongly impact upon both dry forest structure and the capability of understory species to regenerate in the disturbed area (Ramirez-Marcial *et al.*, 2001). In fact, disturbance factors "often override the dominant abiotic variables determining local species composition and community structure" (Shackleton *et al.*, 1994: 157). Depending on how severe the disturbance is, it may have both beneficial results such as increased diversity, nutrient cycling and seedling establishment, but also negative impacts such as increased soil erosion, and reduced canopy cover (Shackleton *et al.*, 1994). However, the harvesting of fuelwood and wild fruit can change both the composition and functioning of savanna ecosystems (Chidumayo, 2002). Communal lands are characterised by the intensive use of a variety of resources and these areas provide an opportunity to investigate what the responses of savannas are to intense and prolonged disturbance (Shackleton, 1993b).

Cutting or other damage to trees is a common occurrence throughout all African savannas. This research is an attempt to assess how subsistence activities such as fuelwood collection (usually involving the selective removal of specific individuals (sizes and/or species)) (Shackleton, 2000) disturbs the dry forest ecosystems on which the inhabitants of South African savannas depend. This kind of resource exploitation may have considerable impacts on the potential productivity of communal dry forest areas.

3.1.3 Context

The primary aim of this research is to assess the level of disturbance created by NTFP dependence and harvesting in eight villages around South Africa. Shankaar *et al.* (2004b) created a conceptual model, which hypothesises that the key factors influencing the level of disturbance created through NTFP harvesting are:

1. The level of dependency on the resource base
2. Level of LEK
3. Structure of markets

This chapter focuses specifically on assessing levels of disturbance, which is the key dependent variable in the Shankaar *et al.* (2004b) model. This measure is then assessed in terms of the Shankaar *et al.* (2004b) model in Chapter Four.

3.2 Methodology

3.2.1 Field methods

Understanding vegetation dynamics is important for assessing whether resources are being sustainably exploited (Dahdouh-Guebas, 2004), and the study of dry forest structure requires that structural parameters such as basal circumference and density are measured. Most studies involve measuring vegetation characteristics at the individual tree level, and for this there are a number of different plot-based and plot-less methods. Plot-based methods involve plots within a known area, in which vegetation is characterised. On the other hand, plot-less methods measure distances, and they are based on a random distribution of trees (Dahdouh-Guebas and Koedam, 2006). The point-centred quarter (PCQ) method of Cottam and Curtis (1956) is a plot-less method that has been considered to effectively characterise woody vegetation. This method yields quantitative data by sampling trees nearest to transect points as an estimate of distribution and numbers (Dahdouh-Guebas and Koedam, 2006), and this is the method that was chosen for this study.

Various studies in southern Africa have shown that the impacts of tree cutting diminish with increasing distance from settlements, and that increasing distance from settlements correlates positively with woody biomass (Tietema *et al.*, 1991; Shackleton *et al.*, 1994; Chidumayo, 2002). Tree species diversity declines with increasing disturbance (Rao *et al.*, 1990), there is spatial variation inherent in the harvesting of wild resources (Vermeulen, 1996) and the intensity of collection of NTFPs tends to decline with increasing distance from people's homes (Grundy *et al.*, 1993; Luoga *et al.*, 2001). If there is insufficient fuelwood near the villages, then a zone of depletion radiating out from the village would be apparent. This zone would manifest as a reduced standing crop, as well as possibly increased signs of breakage or chopping on preferred species. Evidence of chopping/breakage would indicate that there is insufficient deadwood to meet localised demand (Shackleton *et al.*, 2003).

According to Shackleton (1994) the analysis of community structure along a disturbance gradient may provide considerable insights into the dynamics of these systems. Thus, this study used transects along a disturbance gradient, to account for potential differences in stem density with decreasing levels of harvesting and/or disturbance further away from the villages (Emanuel *et al.*, 2005). This study involved the siting of three transects per village radiating out from the periphery of each settlement. Each transect consisted of three PCQ lines ('near' 'mid' and 'far'), with 25 points per line, 20 metres apart.

The disturbance gradient was flexible to ensure that 'most impacted upon', 'mid' and 'least impacted upon' vegetation was assessed, and emulated the pattern set by Shackleton *et al.* (1994). The near PCQ line was sited 250 m from the last field or residential stand marking the edge of the village. The far PCQ line was sited parallel to the near line and was situated in a representative stand of relatively undisturbed vegetation for that settlement. This line represents the highest density of woody stems available to fuelwood harvesters and the distance from the village was variable. The mid PCQ line was situated mid-way between the near and far ones. The distance from the lines to the village was variable, ranging from 250 m to 4.7 km.

Each sampling point along the PCQ line was divided into four quarters, at right angles to the line direction. In each of the quarters, the nearest tree was measured. The distance from the sampling point to the tree stem was measured using a tape measure, and if the distance from the PCQ line was greater than 50 metres, then it was given a zero rating (i.e. no tree was listed in that quarter).

At each PCQ point the following variables were recorded (refer to Appendix One for a sample PCQ transect sheet):

1. The species of the nearest tree or shrub present.
2. Distance of that tree/shrub from the PCQ point.
3. Basal stem circumference (if there were multiple stems, the largest stem was measured). Following the example of Emanuel *et al.* (2005) basal circumference was measured in preference to breadth at breast height because many stems were shorter than breast height, or divided into multiple stems below breast height.
4. The number of stems cut.
5. A visual estimate of the amount of wood removed through cutting as a proportion of the total was made using the Walker scale (1976). The proportion was first estimated in terms of one of eight classes using the Walker scale (1976). Once the class was established, providing an upper and lower limit for the visual estimation thus reducing variability, a final percentage of wood removed through cutting was estimated.
6. The number of stems broken.
7. A visual estimate of the amount of wood removed through breakage as a proportion of the total was made using the Walker scale (1976). The proportion was first estimated in terms of one of eight classes using the Walker scale (1976). Once the class was established, providing an upper and lower limit for the visual estimation thus reducing variability, a final percentage of wood removed through breakage was estimated.
8. The number of dead stems.
9. A visual estimate of the amount of standing deadwood as a proportion of the total was made using the Walker scale (1976). The proportion was first estimated in terms of one of eight classes using the Walker scale (1976). Once the class was established, providing an upper and lower limit for the visual estimation thus reducing variability, a final percentage of deadwood on the tree was estimated.

The absolute density of trees per hectare in the communal dry forests of the eight study sites was obtained using the methods outlined in Mueller-Dombois and Ellenberg (1974), where Absolute Density = Area/D^2 where D = mean distance. In addition, composite soil samples representing 0-10 cm depth were collected following the example set by Rao *et al.* (1990). The soils were collected at the eighth, sixteenth and twenty-fourth PCQ point along each PCQ line and were sampled from a total of 27 sites in each village. The soils were then analysed under standardised laboratory conditions for Organic Carbon and Nitrogen, with the assumption being that one of the impacts of harvesting would be the reduction of the soil Carbon due to lowered inputs (Shackleton, 1993).

3.2.2 Statistical analyses

Descriptive statistics (i.e. size class profiles) were calculated for the combined near, mid and far transects of each village to allow a visual comparison of the distribution of trees in the different size classes. Basal circumference values were categorised into size classes of 5 cm increments. Size class one represented the smallest size class, with stems up to a circumference of 5 cm, the next size class included all stems greater than 5 cm, up to a circumference of 10 cm, and so on until a circumference of 25 cm. Thereafter, the size class increments corresponded to an increment of 40 cm in basal circumference.

A number of different impact measures were measured in the field: % stems broken; % stems cut; % removed through breakage; % removed through cutting; % standing deadwood; % dead stems; absolute density; % in smallest size class; % Organic Carbon in the soil and % Nitrogen in the soil. To avoid analysing many different measures that were in fact correlated with one another, a correlation matrix was run, and one member of any two significantly correlated measures was omitted. The measure that was selected was the one with the lowest loading on an exploratory Principle Components Analysis (PCA) and this resulted in seven impact measures being entered into the final analytical PCA. The PCA was used for data simplification. The expectation from performing a PCA is that the correlations among the original variables are big enough so that the first few new variables or principal components account for most of the variance. If this holds true, no crucial insight is lost by applying the first few principal components for further analysis, and parsimony and clarity in the structure of the relationships are achieved (Shackleton *et al.*, 2002b). The PCA was performed using the statistical package STATISTICA.

The main aim of this analysis was to obtain one final impact score, so an equation drawing from the seven impact measures had to be derived using a PCA. Thus, a PCA was run to determine the loadings and factor scores derived from each of the remaining seven impact measures. Using the factor scores along the first axis, accounting for 50.7 % of the variance, a Multiple Stepwise Regression was performed to identify those impact variables correlated with the first axis and their relative contributions (Figure 3.4).

3.3 Results

Figure 3.1 shows the absolute density per hectare for the near, mid and far transects of each village, and gives an overall indication of what the dry forests of the eight study sites are like. It shows that apart from in Mogano, all transects had an absolute density of below 10 000 trees per hectare. In general, there is a higher average absolute density of trees in the far transects than in the near transects in all the villages (as would be expected along a disturbance gradient). However, in Ntilini and Fairburn, there is a higher absolute density in the mid transects, than in the far transects. The village with the biggest difference between near and far transects, in terms of density, was Mogano.

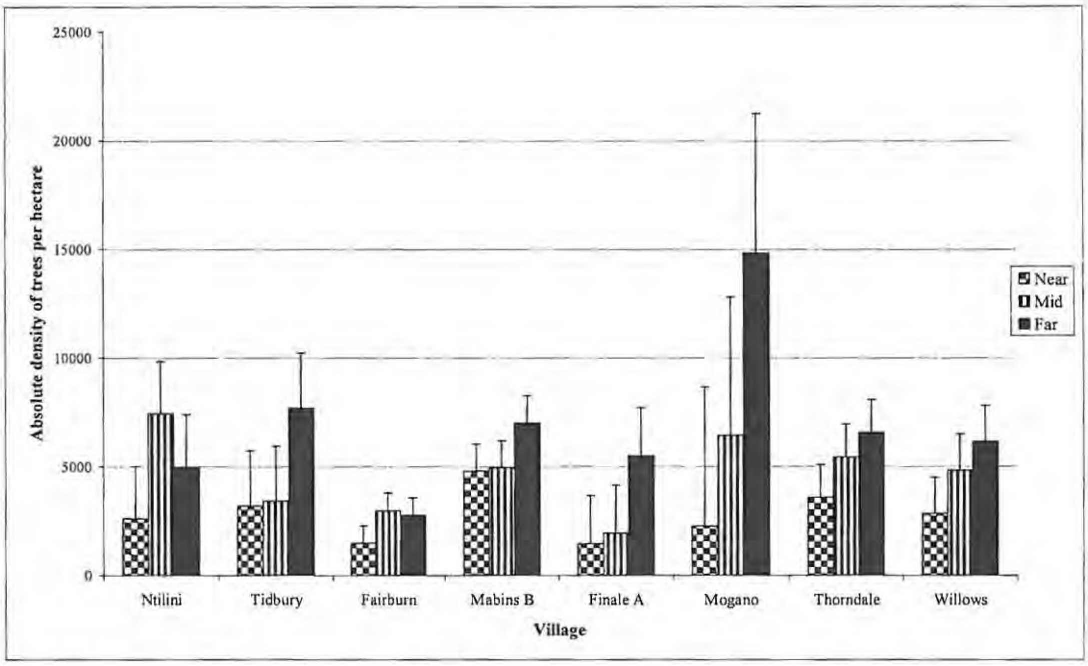
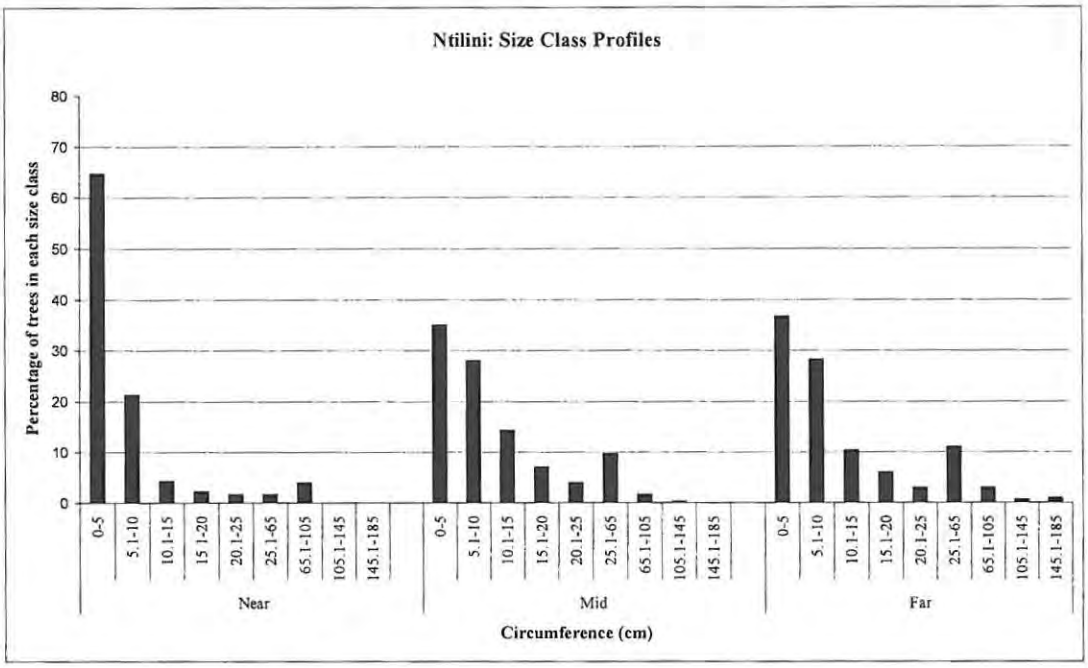


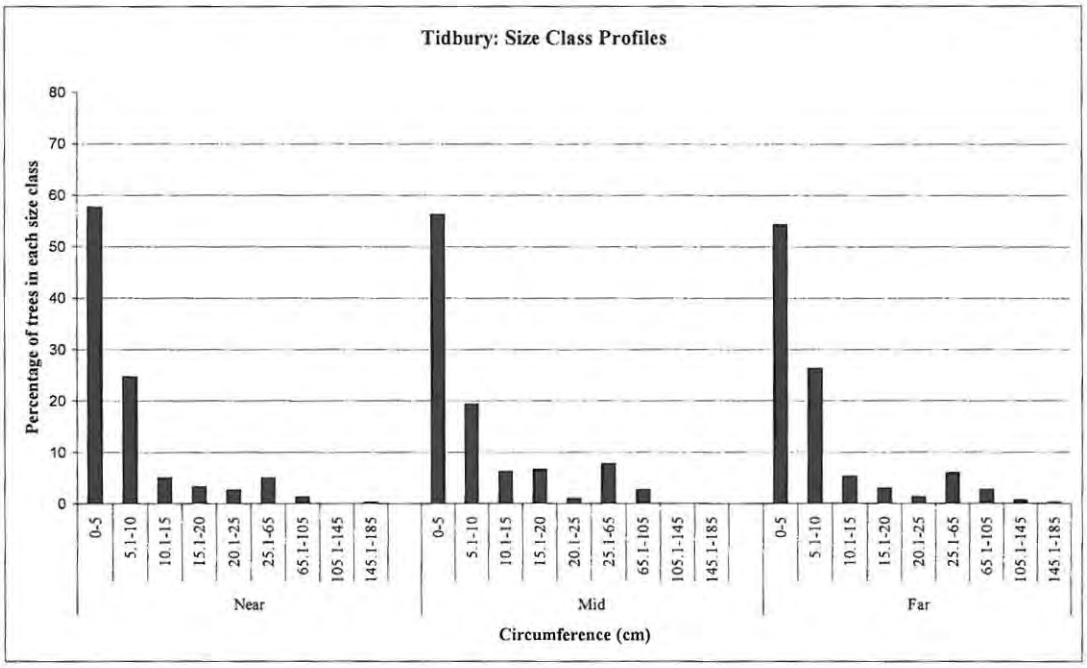
Figure 3.1 Absolute tree density in each of the eight villages (per hectare) – error bars indicate the standard deviation

In Figure 3.2 the a-g size class profiles are reverse J-shaped curves, indicative of relatively stable communities. All these profiles indicate a high percentage of trees in the smallest size class, ranging from 74.7 % in Mabins B (near) to 28.3 % in Mogano (near). Although many of the profiles seem to have a relatively large percentage of trees in the 25-65 cm range, it should be remembered that this is the first size class with a 40 cm increment, and this larger percentage is to be expected. The difference would, however, not be as exaggerated if the profiles continued to increase in 5 cm increments.

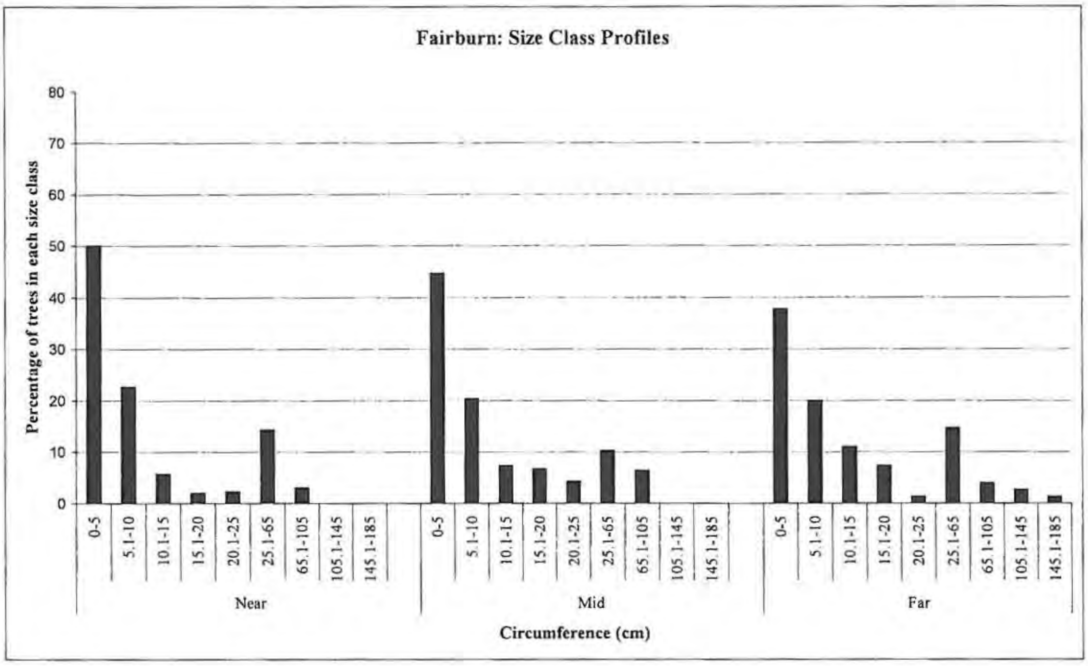
Most of the profiles indicate a relatively high percentage of trees in the second size class (i.e. approximately 20 %), which indicates a good rate of survival from the first size class to the next size class. The exceptions to this are (d) Mabins and (g) Thorndale, which both show relatively low percentages in the second size class. Mogano (h) represents the village with the smallest percentage of trees in the first size class in the near transect (28.3 %). Interestingly, Mogano has a substantially higher percentage of trees in the first size class in the far transect (50.7 %).


Ntilini: Size Class Profiles
Percentage of trees in each size class
80
70
60
50
40
30
20
10
0
0-5
5.1-10
10.1-15
15.1-20
20.1-25
25.1-65
65.1-105
105.1-145
145.1-185
Near
Mid
Far
Circumference (cm)

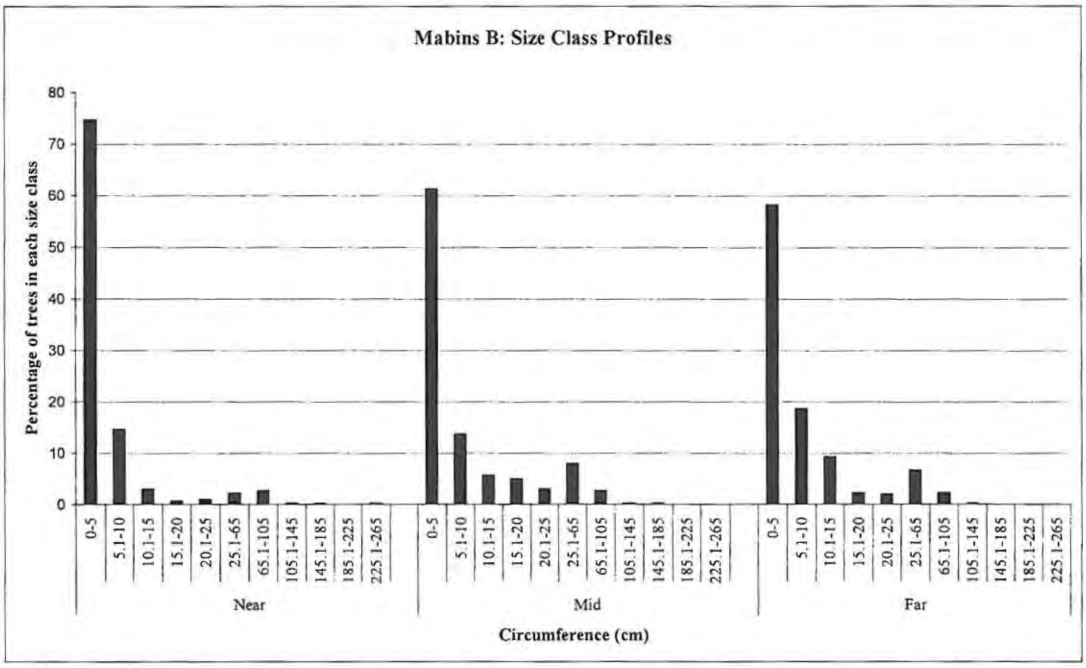
(a)


Tidbury: Size Class Profiles
Percentage of trees in each size class
80
70
60
50
40
30
20
10
0
0-5
5.1-10
10.1-15
15.1-20
20.1-25
25.1-65
65.1-105
105.1-145
145.1-185
Near
Mid
Far
Circumference (cm)

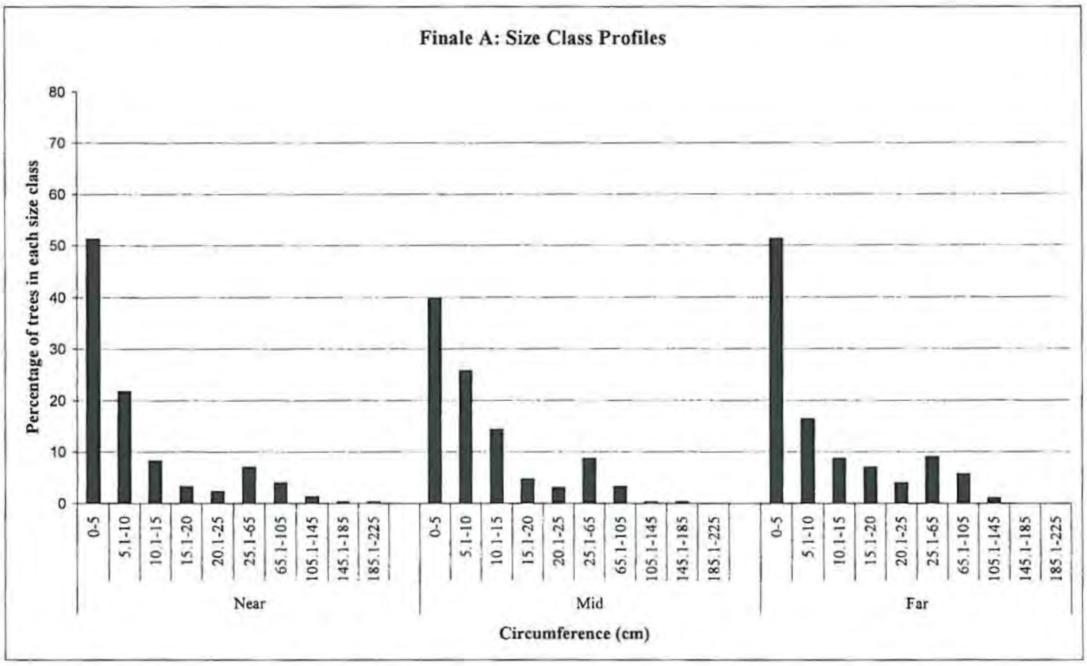
(b)


Fairburn: Size Class Profiles
Percentage of trees in each size class
80
70
60
50
40
30
20
10
0
0-5
5.1-10
10.1-15
15.1-20
20.1-25
25.1-65
65.1-105
105.1-145
145.1-185
Near
Mid
Far
Circumference (cm)

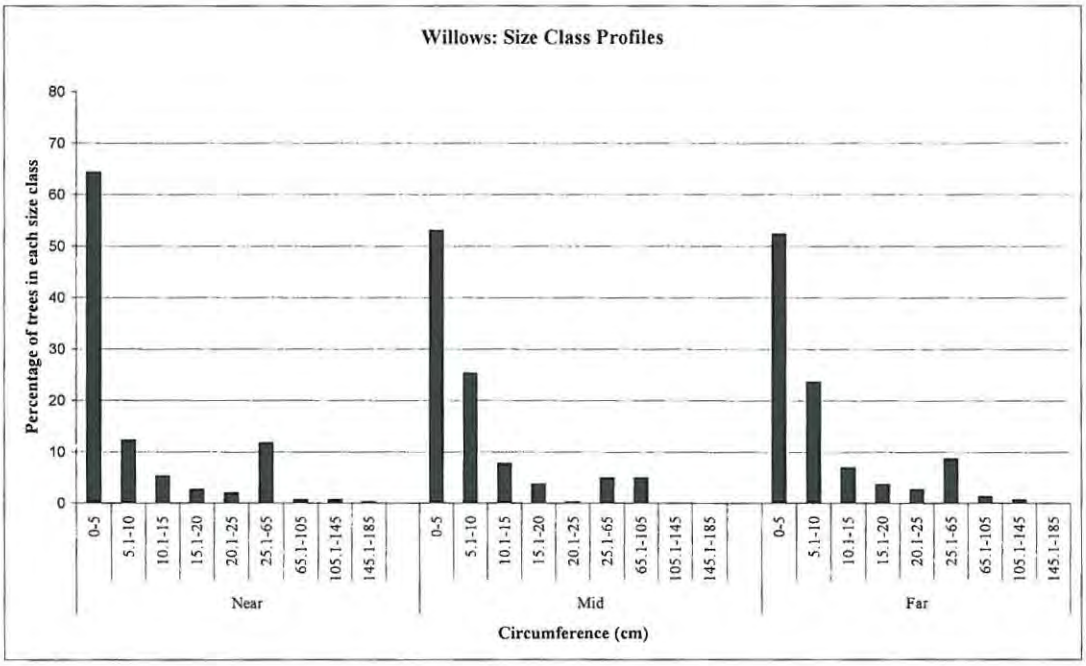
(c)


Mabins B: Size Class Profiles
Percentage of trees in each size class
80
70
60
50
40
30
20
10
0
0-5
5.1-10
10.1-15
15.1-20
20.1-25
25.1-65
65.1-105
105.1-145
145.1-185
185.1-225
225.1-265
Near
Mid
Far
Circumference (cm)

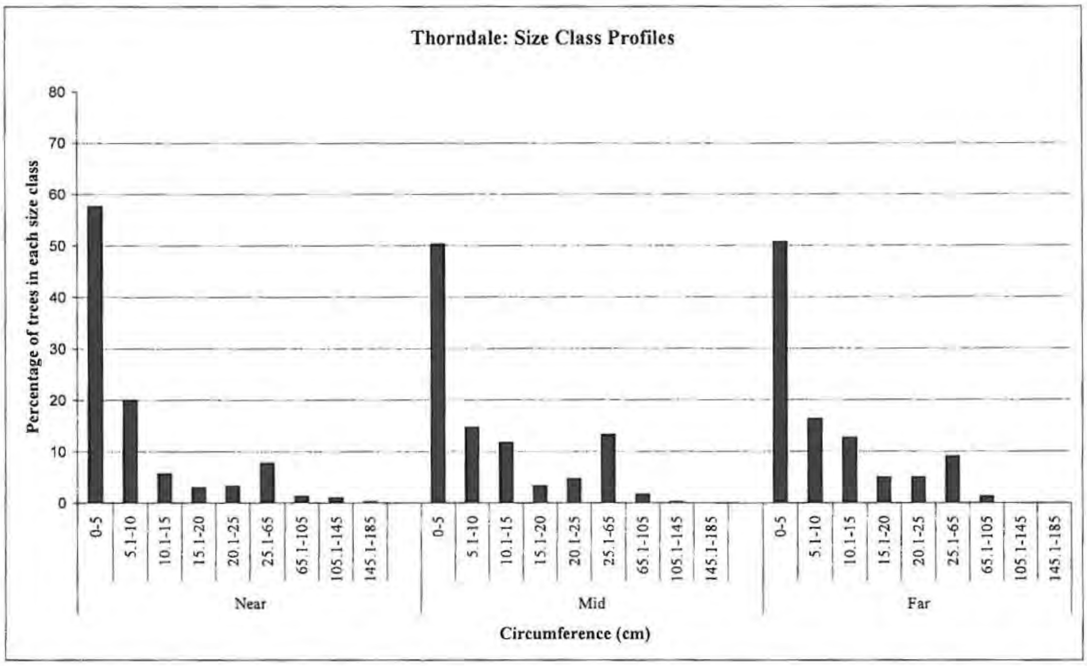
(d)


Finale A: Size Class Profiles
Percentage of trees in each size class
0
10
20
30
40
50
60
70
80
0-5
5.1-10
10.1-15
15.1-20
20.1-25
25.1-65
65.1-105
105.1-145
145.1-185
185.1-225
Near
Mid
Far
Circumference (cm)

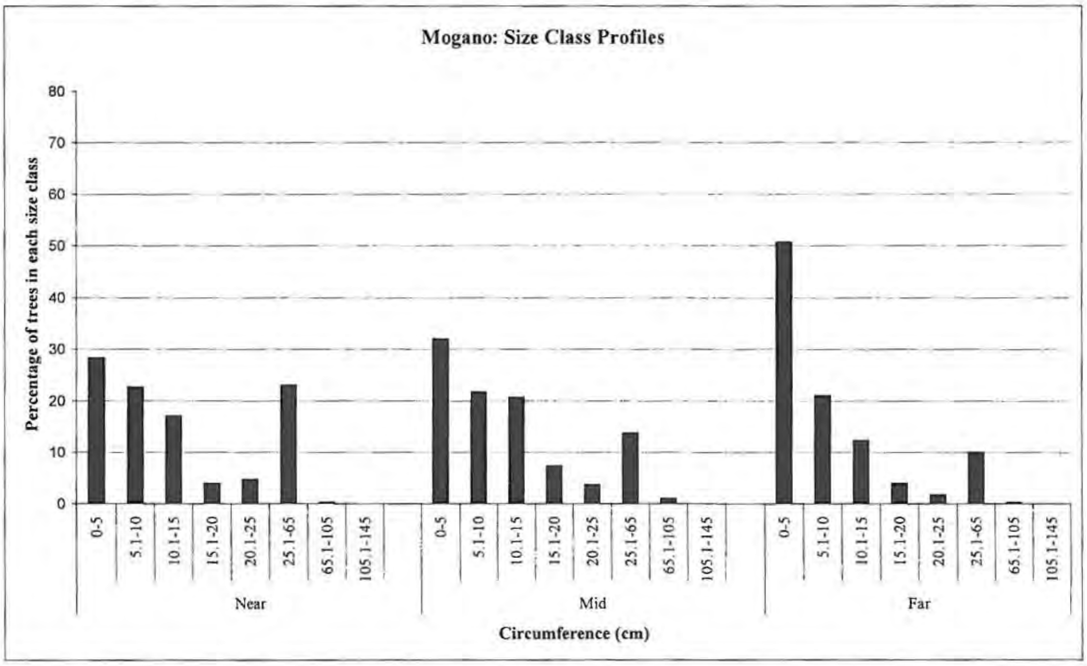
(e)


Willows: Size Class Profiles
Percentage of trees in each size class
0
10
20
30
40
50
60
70
80
0-5
5.1-10
10.1-15
15.1-20
20.1-25
25.1-65
65.1-105
105.1-145
145.1-185
Near
Mid
Far
Circumference (cm)

(f)



(g)



(h)

Figure 3.2 Size class profiles of the sample villages (a) to (h)

Table 3.1 shows that Mabins B has the highest mean percentage of trees in the smallest size class (64.8 %). All of the villages apart from Mogano show a trend of a high percentage of seedlings in the near transects, with fewer (or an equal number in Finale A's case) trees in the smallest size class at the furthest transect. Mogano is the inverse of this trend.

Table 3.1 Percentage of trees in the smallest size class per sample village

Village	Near	Mid	Far	Mean ± STDEV
Ntilini	64.7	35.0	36.7	**45.5 ± 16.68**
Tidbury	57.7	56.3	54.3	**56.1 ± 1.71**
Fairburn	50.0	44.7	37.7	**44.1 ± 6.17**
Mabins B	74.7	61.3	58.3	**64.8 ± 8.73**
Finale A	51.3	39.7	51.3	**47.4 ± 6.70**
Willows	64.3	53.0	52.3	**56.5 ± 6.74**
Thorndale	57.7	50.3	50.7	**52.9 ± 4.16**
Mogano	28.3	32.0	50.7	**37.0 ± 12.01**
Mean ± STDEV	**56.1 ± 13.76**	**46.5 ± 10.45**	**49.0 ± 7.70**	

In terms of soil analysis, both soil Organic Carbon and Nitrogen were low (Table 3.4). Organic Carbon was less than 2 % at all sites other than Ntilini mid and far, and Ntilini was the village with the highest mean percentage of Organic Carbon in the soil (2.1 %). There was no difference in Organic Carbon related to increasing distance from the settlements. Ntilini mid and far also had the highest soil Nitrogen other than Tidbury's far measurement. For most sites soil Nitrogen was less than 0.01 %, and both Ntilini and Tidbury had the highest mean percentage of Nitrogen in the soil (0.13 %). There was no trend in soil Nitrogen relative to distance from the settlements.

A two way ANOVA was run on the Organic Carbon and Nitrogen data. In terms of the Organic Carbon data, no significant difference was found between either the villages, distances or interaction between the two ($F = 1.70$; $p>0.05$). Overall, ANOVA shows a significant difference between the villages related to Nitrogen ($F = 7.21$; $p<0.0001$), with Tidbury having the highest and Thorndale the lowest, but no no effect was found for distance or interaction between the two.

Table 3.2 Soil measures per sample village

	Village	**Near**	**Mid**	**Far**	**Mean ± STDEV**
Mean % Organic Carbon	Ntilini	1.5	2.4	2.2	**2.1 ± 0.47**
	Tidbury	1.5	1.7	1.5	**1.5 ± 0.12**
	Fairburn	1.5	1.4	1.6	**1.5 ± 0.11**
	Mabins B	1.3	1.9	1.8	**1.7 ± 0.34**
	Finale A	1.8	1.5	1.7	**1.7 ± 0.13**
	Willows	1.3	1.3	1.6	**1.4 ± 0.18**
	Thorndale	1.2	1.0	1.0	**1.1 ± 0.09**
	Mogano	1.3	1.7	2.0	**1.6 ± 0.35**
	Mean ± STDEV	**1.4 ± 0.19**	**1.6 ± 0.42**	**1.7 ± 0.36**	
Mean % Nitrogen	Ntilini	0.11	0.14	0.13	**0.13 ± 0.02**
	Tidbury	0.07	0.09	0.23	**0.13 ± 0.09**
	Fairburn	0.05	0.08	0.07	**0.07 ± 0.02**
	Mabins B	0.04	0.04	0.08	**0.05 ± 0.02**
	Finale A	0.03	0.02	0.04	**0.03 ± 0.01**
	Willows	0.03	0.04	0.04	**0.04 ± 0.01**
	Thorndale	0.02	0.03	0.02	**0.02 ± 0.01**
	Mogano	0.05	0.02	0.04	**0.04 ± 0.02**
	Mean ± STDEV	**0.1 ± 0.03**	**0.1 ± 0.04**	**0.1 ± 0.07**	

The intensity of cutting was assessed by counting the cut trees (following the example of Vermeulen, 1996), and noting what percentage of the tree had been removed through cutting and breakage. The average percentage of stems that had been broken was much higher than the percentage of cut stems. There is a clear decreasing trend in the mean percentage of broken stems from near to far from the village, and this trend is duplicated in the percentage of cut stems. The mean percentage removed per cut stem was generally low. The village with the highest percentage of trees that had been broken was Fairburn (57.7 %), and it was also the village with the highest percentage removed due to breakage (8.7 %), with Mogano following closely at 8.1 % (Table 3.3). Mogano had the highest percentage of cut stems (11.5 %), and was also the village with the highest percentage removed through cutting (11.6 %). In terms of a finer scale of measurement, the village with the highest percentage removed per cut stem was Thorndale (0.5 %).

A two way ANOVA was run on the different damage variables. In terms of percentage lost through breakage, significant differences were found for distance ($F = 7.38$; $p < 0.0001$), but not between villages ($F = 1.28$) or interaction between the two. A significant difference was found between villages related to the percentage of stems cut ($F = 7.81$; $p < 0.0001$), but not distance ($F = 1.50$) or interaction between the two. A significant difference was found between villages related to the percentage of stems broken (F = 6.95; $p < 0.0001$) and also between the distances (F = 8.52; $p < 0.001$), but no significant interaction was found between the two. A significant difference was found between villages for the percentage removed through cutting (F = 7.82; $p < 0.0001$), but not distance (F = 1.55) or interaction between the two. The final damage variable that was measured is percentage removed per cut stem, and a significant difference was found between villages (F = 7.04; $p< 0.0001$), but not distance (F = 1.83) or interaction between the two.

Table 3.3 Cutting and breakage variables per sample village

	Village	**Near**	**Mid**	**Far**	**Mean ± STDEV**
Mean % stems broken	Ntilini	29.2	17.4	15.6	**20.7 ± 7.39**
	Tidbury	45.9	46.6	27.5	**40.0 ± 10.83**
	Fairburn	65.0	53.6	54.5	**57.7 ± 6.34**
	Mabins B	51.3	44.3	42.9	**46.2 ± 4.50**
	Finale A	49.6	31.4	29.4	**36.8 ± 11.13**
	Willows	55.9	40.1	24.1	**40.0 ± 15.90**
	Thorndale	50.2	50.0	45.1	**48.4 ± 2.89**
	Mogano	58.7	56.0	42.9	**52.5 ± 8.45**
	Mean ± STDEV	**50.7 ± 10.57**	**42.4 ± 12.77**	**35.3 ± 13.03**	
Percent removed through breakage	Ntilini	10.5	6.4	4.8	**7.2 ± 2.94**
	Tidbury	7.2	6.1	4.4	**5.9 ± 1.41**
	Fairburn	11.9	7.9	6.3	**8.7 ± 2.88**
	Mabins B	7.8	6.5	6.1	**6.8 ± 0.89**
	Finale A	8.3	5.1	4.8	**6.1 ± 1.94**
	Willows	7.6	5.9	3.2	**5.6 ± 2.22**
	Thorndale	7.2	7.9	7.8	**7.6 ± 0.38**
	Mogano	9.2	8.6	6.5	**8.1 ± 1.42**
	Mean ±STDEV	**8.7 ± 1.71**	**6.8 ± 1.20**	**5.5 ± 1.45**	
Mean % stems cut	Ntilini	0.8	1.4	1.9	**1.4 ± 0.55**
	Tidbury	2.9	3.0	1.5	**2.5 ± 0.85**
	Fairburn	0.8	1.4	1.9	**1.4 ± 0.55**
	Mabins B	4.9	4.8	1.1	**3.6 ± 2.17**
	Finale A	7.5	4.5	3.4	**5.1 ± 2.12**
	Willows	7.3	16.7	5.8	**9.9 ± 5.91**
	Thorndale	8.2	11.1	7.0	**8.8 ± 2.11**
	Mogano	16.0	9.5	8.9	**11.5 ± 3.94**
	Mean ± STDEV	**6.1 ± 4.98**	**6.6 ± 5.42**	**3.9 ± 2.93**	
Percent removed through cutting	Ntilini	1.7	0.8	1.7	**1.4 ± 0.52**
	Tidbury	1.9	2.2	1.5	**1.9 ± 0.35**
	Fairburn	11.1	7.7	7.8	**8.9 ± 1.93**
	Mabins B	4.6	5.7	6.3	**5.5 ± 0.86**
	Finale A	4.4	2.4	1.9	**2.9 ± 1.32**
	Willows	8.3	10.1	6.4	**8.3 ± 1.85**
	Thorndale	8.6	7.9	7.4	**8.0 ± 0.60**
	Mogano	15.6	12	7.1	**11.6 ± 4.27**
	Mean ± STDEV	**7.0 ± 4.81**	**6.1 ± 4.03**	**5.0 ± 2.79**	
Mean % removed per cut stem	Ntilini	0.3	0.1	0.2	**0.2 ± 0.10**
	Tidbury	0.1	0.1	0.2	**0.1 ± 0.06**
	Fairburn	0.4	0.3	0.2	**0.3 ± 0.10**
	Mabins B	0.4	0.4	0.4	**0.4 ± 0.00**
	Finale A	0.2	0.2	0.3	**0.2 ± 0.06**
	Willows	0.4	0.3	0.4	**0.4 ± 0.06**
	Thorndale	0.5	0.4	0.5	**0.5 ± 0.06**
	Mogano	0.3	0.4	0.3	**0.3 ± 0.06**
	Mean ± STDEV	**0.3 ± 0.13**	**0.3 ± 0.13**	**0.3 ± 0.11**	

While the other variables are an indication of disturbance/damage, the mean percentage of standing deadwood is a measure of intactness, as one would expect households to harvest deadwood first, thus higher levels of standing deadwood is indicative of lower harvesting pressure. Both standing deadwood and the percentage of dead stems were measured, as even if an entire stem is not dead, portions of the tree (standing deadwood) may be. Table 3.4 indicates that Mogano had the highest mean percentage of standing deadwood (18.6 %); although it did display an interesting trend of decreasing from a near percentage of 21.8 % to a far percentage of 13.3 % (Table 3.4), as did Ntilini (12.4 % to 8.0 %), Tidbury (7.7% to 4.6 %) and Fairburn (16.4 % to 10.4 %). This is probably because the deadwood was inaccessible (i.e. high up on large trees). Most of the other villages showed the inverse of this trend (i.e. the percentage of deadwood increased with increasing distance from the settlement). The mean percentage of dead stems was very low overall, although Mogano did have a marginally higher mean percentage (0.2 %) than the other villages (Table 3.4).

A two way ANOVA was run on both deadwood variables, and it was found that for the percentage deadwood on the trees there is a significant difference between the villages ($F = 8.94$; $p < 0.0001$), but not between distances or the interaction between the two. In terms of the percentage of dead stems no significant differences were found between the villages, or distances, or interaction between the two ($F = 1.24$; $p > 0.05$).

Table 3.4 Deadwood measurements per village

	Village	**Near**	**Mid**	**Far**	**Mean ± STDEV**
Mean % of standing deadwood (still on the tree)	Ntilini	12.4	9.4	8.0	**9.9 ± 2.25**
	Tidbury	7.7	5.2	4.6	**5.8 ± 1.64**
	Fairburn	16.4	12.8	10.4	**13.2 ± 3.02**
	Mabins B	6.9	11.1	13.8	**10.6 ± 3.48**
	Finale A	6.9	6.1	9.7	**7.6 ± 1.89**
	Willows	9.0	11.2	7.9	**9.4 ± 1.68**
	Thorndale	13.0	12.3	13.4	**12.9 ± 0.56**
	Mogano	21.8	20.7	13.3	**18.6 ± 4.62**
	Mean ± STDEV	**11.8 ± 5.29**	**11.1± 4.77**	**10.1± 3.26**	
Mean % of dead stems	Ntilini	0.1	0.1	0.1	**0.1 ± 0.00**
	Tidbury	0.2	0.1	0.1	**0.1 ± 0.06**
	Fairburn	0.1	0.1	0.1	**0.1 ± 0.00**
	Mabins B	0.0	0.1	0.1	**0.1 ± 0.06**
	Finale A	0.1	0.1	0.1	**0.1 ± 0.00**
	Willows	0.1	0.1	0.1	**0.1 ± 0.00**
	Thorndale	0.1	0.0	0.1	**0.1 ± 0.06**
	Mogano	0.2	0.2	0.1	**0.2 ± 0.06**
	Mean ± STDEV	**0.1 ± 0.06**	**0.1 ± 0.05**	**0.1 ± 0.00**	

Table 3.5 shows that with a mean ranking of 2.4 in terms of the 'damage' variables (i.e. variables that are indicative of harvesting/anthropogenic pressure), Mogano has the highest damage ranking, and one would therefore expect Mogano to have the highest composite impact score in Table 3.7. And indeed, there is relatively good level of consistency between the rankings in this table and the overall impact scores in Table 3.7. Mogano is the village with the highest composite impact score, this correlates with the overall 'damage measurement rankings' for each village, where Mogano is ranked as the village with the highest level of disturbance (2.4) followed by Fairburn (2.9). According to these rankings, Tidbury is the least disturbed village (5.1).

Table 3.5 Damage measurement rankings

Village	**Damage measurement ranking**							**Mean rank**
	% stems broken	**% stems cut**	**% removed through cutting**	**% removed through breakage**	**Mean % removed per dead stem**	**Mean % Organic Carbon in the soil**	**Mean % Nitrogen in the soil**	
Ntilini	7	7	6	4	4	1.0	1.5	**4.4**
Tidbury	5	6	7	7	5	4.5	1.5	**5.1**
Fairburn	1	7	2	1	3	4.5	2.0	**2.9**
Mabins B	4	5	5	5	2	2.5	3.0	**3.8**
Finale A	6	4	6	6	4	2.5	5.0	**4.8**
Willows	5	2	3	8	2	5.0	4.5	**4.2**
Thorndale	3	3	4	3	1	6.0	6.0	**3.7**
Mogano	2	1	1	2	3	3.0	4.5	**2.4**

Table 3.6 is an indication of 'intact' measure rankings (i.e. these measures are indications of the level of intactness of the dry forests). Mogano had the highest damage ranking in Table 3.5, but when only the 'intact' variables are considered, Mogano also has the highest ranking (1.0), which indicates that it had the highest measure of intactness, which is interesting in itself. Tidbury had the lowest damage ranking in Table 3.5, however, in terms of the intact measures, it is ranked the second highest (indicating a low level of intactness).

Table 3.6 Intact measurement rankings

Village	**Intact measurement ranking**			**Mean rank**
	% standing deadwood	**% dead stems**	**Absolute density**	
Ntilini	5	2.5	4	**3.8**
Tidbury	8	2.5	5	**5.2**
Fairburn	2	2.5	8	**4.2**
Mabins B	4	2.5	2	**2.8**
Finale A	7	2.5	7	**5.5**
Willows	6	2.5	6	**4.8**
Thorndale	3	2.5	3	**2.8**
Mogano	1	1.0	1	**1.0**

The Principle Components Analysis (PCA) indicated a rough geographic grouping of the eight villages (Figure 3.3). The northernmost site, Mogano, was separated from the rest of the villages; the four southern Limpopo Province sites were grouped together at the base with the lowest scores on the *y*-axis (factor 2), and the three Eastern Cape sites were situated towards the upper left. The variance accounted by the first factor was 50.5 %, and the second one was 22.6 %.

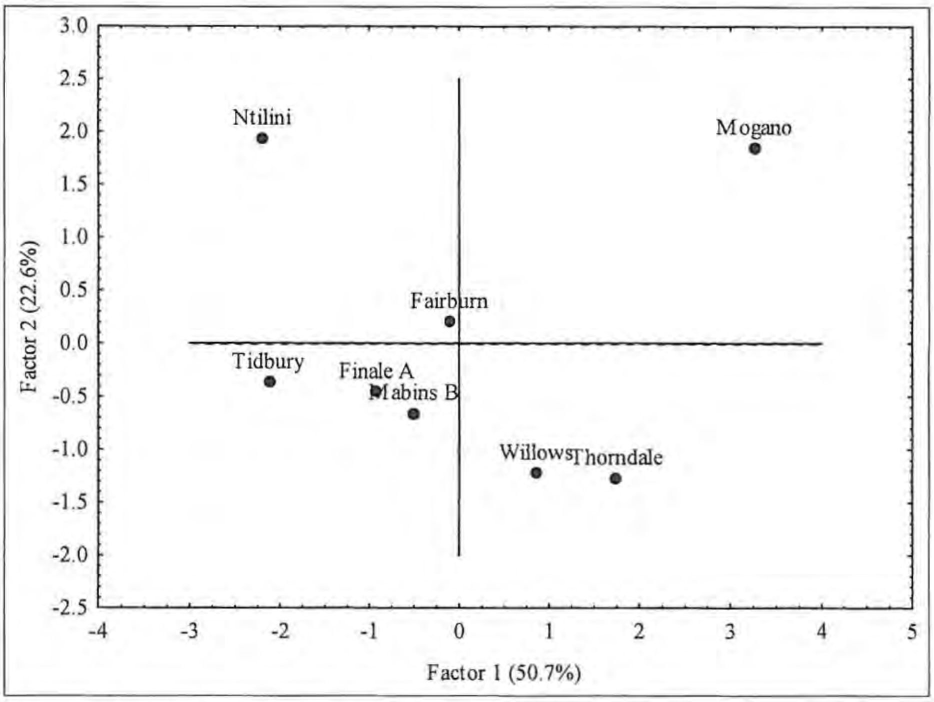


Figure 3.3 PCA scatterplot of the sample villages

Of the seven variables entered into the Stepwise Regression, two were identified as significantly correlated ($F = 385.3$; $r^2 = 0.99$; $p < 0.005$) with the first axis, namely the proportion (%) of stems cut and the amount (%) of deadwood, in the form:

$$Score = (0.10 * \% \, cut) + (0.11 * \% \, dead) - 1.07 \text{ .... Eq.1}$$

Consequently, Equation 1 was used to derive a final, composite impact score for each village (Table 3.7) which was then carried over to Chapter Four.

Table 3.7 shows the final composite impact score that was obtained for each village, which indicates that Mogano is the site with the highest overall level of disturbance (with a score of 2.126), and that Tidbury is the site with the lowest overall disturbance (with a score of -0.182). Overall, the sites show a roughly geographical grouping again. In the Eastern Cape, the villages obtained relatively low composite impact scores (Ntilini ranked seventh and Tidbury ranked eighth), although Fairburn had an intermediate ranking (fourth). The villages in Limpopo Province had fairly high rankings (Thorndale: second; Willows: third; Mabins B: fifth and Finale A: sixth), and once again the northernmost site (Mogano) is separated from the rest of the villages with the highest ranking and composite impact score.

Table 3.7 Composite impact score for each sample village

Village	**Composite Impact Score**	**Rank**
Ntilini	0.159	7
Tidbury	-0.182	8
Fairburn	0.522	4
Mabins B	0.456	5
Finale A	0.276	6
Willows	0.954	3
Thorndale	1.229	2
Mogano	2.126	1

3.4 Discussion

Apart from Mogano, the villages had relatively similar absolute densities of trees (i.e. for all the transects the absolute density of trees is below 10 000 trees per hectare). Mogano had a particularly high density of trees in the far transect, this is indicative of high harvesting pressure near to the village. Previous studies have indicated that stem density declines with disturbance, which may be due to small-scale wood harvesting (Sagar *et al.*, 2003; Ramirez-Marcial *et al.*, 2001). Shankaar *et al.* (1998) illustrated that intensive NTFP harvesting seems to lead to declining stand density and basal area, and the skewing of communities towards smaller size classes. Indeed, most of the sample sites followed the expected trend (of increasing densities along the disturbance gradient), and this is illustrated in Figure 3.1, where six out of the eight study sites showed lower absolute density of woody trees in the most disturbed (near) transects, and increasing absolute density in the least disturbed (far) transects (i.e. increasing along the disturbance gradient). This implies that anthropogenic pressures are indeed having some effect on the communal dry forests of these villages, and that the density of trees does vary with disturbance, as found by Rao *et al.* (1990).

Chidumayo (2002) found that sites closest to human settlements had the highest density of cut stems and this trend can also be found in the eight sample study sites (Table 3.3), although in some villages the percentage of cut stems increases from the near transects to the mid transects (Ntilini, Tidbury, Fairburn, Thorndale, Willows). The average proportion of broken stems was much higher than the proportion of cut stems; this may be because human harvesting is not the only factor that can cause breakage (i.e. it may be a result of livestock browsing and movement through the dry forests). The village with the highest mean percentage of cut stems is Mogano (11.5 %), which is consistent with the findings in Table 3.7 that Mogano is the village with the highest composite impact score. Theoretically this high percentage of cut stems implies that there is insufficient deadwood, despite the fact that Mogano had the highest percentage of standing deadwood (21.8 %) and the highest percentage of dead stems (0.2 %) (Table 3.4). However, it is possible that the inconsistencies between the level of cutting in Mogano and the percentage of standing deadwood is actually a result of a breakdown in the management of the communal dry forests (i.e. local institutions are not able to manage the dry forests effectively), which has resulted in a *de facto* open access system.

The results indicate (Figure 3.2) that there is a relatively high percentage of trees in the smallest size class in all the study sites, producing reverse J-shaped size class profiles, this appears to demonstrate that the regeneration capacity from seed of these areas remains strong, and is indicative of stable communities (Shackleton, 1993). Indeed, if there were high levels of grazing and trampling in the near transects one would expect lower percentages of seedlings in the smallest size class (Ramirez-Marcial *et al.*, 2001). "Typically, an inverse J-shaped curve that shows a very high proportion of seedlings and saplings in relation to adult trees is considered to represent a healthy regenerating population" (Shahabuddin and Prasad, 2004: 239). It is the sharply declining densities of individuals in the successively larger size classes that produces the inverse J-shaped size class profiles (Shahabuddin and Prasad, 2004). The reverse J-shaped curves in Figure 3.2 indicate relatively stable communities. The high proportion of stems in the second size classes in most of the villages (Figure 3.2) shows that there is ongoing seedling recruitment. It is, however important to note that NTFP harvesting may provoke considerable changes to rates of reproduction, growth and survival of individuals in a range of size classes that are not subject to harvesting. Thus, the increased mortality of the size class that is actually being harvested is not the only demographic consequence of harvesting, and there may in fact be a number of knock-on effects that are difficult to measure (Ticktin, 2004).

There has been little research into what the effects of harvesting wild fruits of any of the numerous indigenous fruit species found in South Africa may be (Emanuel *et al.*, 2005). However, according to Ticktin (2004), the type of plant part harvested affects the potential for different species to tolerate harvesting. Destructive fruit harvesting, that involves techniques such as branch cutting can lead to the decline of fruit tree species. The data implies that many trees are unable to withstand even very low rates of harvest when harvesting leads to mortality of the individual. A further complication is that rates of growth and demographic responses to harvesting may also vary significantly over soil or climatic gradients.

According to Schulte-Bisping *et al.* (1999) there is a global tendency in developing regions towards satisfying energy needs by means of fuelwood at the cost of overexploitation of the natural resource base. However, despite the common belief that common property regimes are responsible for the overexploitation and destruction of natural resources, Chidumayo (2002) found that regulation of landuse is more important than changing land tenure for the proper management of *miombo* woodland. A key factor in assessing the level of disturbance created through harvesting of fuelwood and wild fruit is the political and socio-economic context in which such harvesting/management of communal resources occurs (Hiremath, 2004). Frequent, but low-intensity disturbances such as the harvesting of NTFPs may involve the combined effect of multiple-factors that may strongly affect the structure of communal dry forests (Ramirez-Marcial *et al.*, 2001), and it must be recognised that there are a wide range of economic, social and political factors that influence the rate of extraction of NTFPs (Hiremath, 2004). A key factor influencing the level of disturbance in these study sites is the weak local institutions and levels of resource management; it is these weak local institutions that mean that effective resource management is difficult (Campbell *et al.*, 2000; Twine *et al.*, 2003).

Communal landuse and increasing population pressure are often perceived to be serious threats to forest conservation in the dry forests of southern and central Africa (Chidumayo, 2002). However, the results indicate that although harvesting pressure may indeed result in disturbance, the overall levels of disturbance in different study sites are far from uniform (Table 3.7). This is because each village is influenced by a number of different socio-economic and political factors. In addition, there are many different variables that are indicators of disturbance, and multiple inter-related factors that result in disturbance (Higgins *et al.*, 1999).

3.5 Conclusion

It is very important to note that harvesting of NTFPs in the savanna biome may have unpredictable impacts on the vegetation (Vermeulen, 1996). Indeed, this study has shown that the impacts of harvesting are far from uniform within the different biological and socio-economic contexts around South Africa (Table 3.7). In South Africa, there are a wide variety of economic, social and political factors that influence the rate of extraction of NTFPs (Hiremath, 2004). Within this context, frequent but low intensity disturbances such as fuelwood extraction may involve the combined effect of multiple factors, and may affect both dry forest structure and the ability of understory species to regenerate in the disturbed area (Ramirez-Marcial *et al.*, 2001). There is certainly much still to learn about how savanna vegetation is impacted by the harvesting of NTFPs, and in the eight sample villages high levels of poverty and weak local institutions seem to be key factors influencing the levels of disturbance. However, it is known that savannas are highly resilient (Shackleton, 2000) and in the longer term, the impacts that this study has measured may change a great deal. If we want to understand the dynamics of the savanna biome, then it is likely that longer term studies are necessary (Ticktin, 2004).

Despite the significant contribution of dry forests to meeting the local demand for fuelwood and other wild resources, there is insufficient empirical knowledge to guide their sustainable utilisation (Neke *et al.*, 2006). Indeed, despite various studies over the past few decades, the sheer size of savanna areas has resulted in a relative scarcity of ecological and environmental data related to South Africa. This is only slowly being rectified (Furley, 2007) and further studies are clearly required.

CHAPTER FOUR: The relationships between disturbance and the level of dependency, level of LEK and access to markets

4.1 Introduction

Since the 1970s there has been growing recognition of the actual and potential value of forest products (in that they provide a wide range of products and services to rural communities) on an international scale. There has also been an increasing acknowledgement of the value of a range of resources that had been undervalued and under-appreciated in the past (Belcher, 2003; Ticktin, 2004). NTFPs tend to be accessible, often growing in communal lands or areas with open access systems, and the harvesting and/or marketing of these products requires low levels of capital investment and skills, which means that they play an important role in rural livelihoods in terms of general subsistence and income generation (Shackleton *et al.*, 2002b; Belcher, 2003; Neke *et al.*, 2006). Indeed, over time, NTFPs have increasingly become valued as important commodities, integral components of rural livelihoods and key resources for achieving aims such as poverty alleviation and local development (Belcher, 2003; Shackleton *et al.*, 2005). However, despite the growing international appreciation of the important role of NTFPs in rural subsistence and development, many uncertainties remain, particularly in the drier and densely settled dry forests of South Africa (Shackleton and Shackleton, 2004b).

Approximately two-thirds of South Africa's poor live in rural areas (mainly in dry forests within the savanna biome). These areas are generally characterised by limited service delivery, high unemployment levels and insufficient infrastructure (Shackleton *et al.*, 2002a; Neke *et al.*, 2006). Within the context of escalating economic hardship in South Africa, NTFPs contribute considerably to livelihoods, providing a range of products and services, including the provision of fuel, fodder and food security (Neke *et al.*, 2006). In densely populated areas (such as the former homeland areas) pressures on dry forests from local households are high, and these resources are increasingly threatened as the poorest people in South Africa increasingly turn to the natural resource base as a means to meet their livelihood requirements (Shackleton, 2005; Neke *et al.*, 2006). Most rural households derive at least some livelihood benefit from NTFPs, either directly or indirectly (Shackleton and Shackleton, 2004a; Shackleton *et al.*, 2002b). Indeed, it is the most marginalised members of rural society (female-headed households, young unemployed men, female members of households and the ultra poor) who tend to be most reliant on NTFPs for both subsistence use, and for cash income. Additionally, the importance of NTFPs as a 'safety net' for poorer and more vulnerable households cannot be underestimated (Paumgarten, 2007). The ability to turn to open access 'free' resources in times of need is often a means of last resort for households facing severe financial difficulties, and the high rates of unemployment/retrenchment in South Africa are contributing to the importance of the opportunities offered by NTFPs. Indeed, NTFPs make a major contribution to decreasing livelihood risk by allowing for reduced cash expenditure (Shackleton and Shackleton, 2004a; Shackleton and Shackleton, 2004b). However, the value of directly consumed secondary resources such as NTFPs by rural populations is often neglected when accounting for livelihoods of rural households, and this underestimation of value can undermine the desired development of these communities (Dovie, 2004).

Typically, rural households use a number of different NTFPs to meet their everyday livelihood needs. The range and number of NTFPs used differs between communities and households for a number of local and external contextual conditions, such as the availability of substitutes, availability of labour to collect these resources, resource endowment, local prices, proximity and access to local markets, education and disposable income. It is estimated that rural communities in the savannas of the northern provinces of South Africa frequently use more than 200-300 plant species, while fewer plant species appear to be used in the Eastern Cape (Shackleton and Shackleton, 2004a).

For many households the income generation from NTFPs constitutes their primary source of cash and livelihood, while for others it is a supplementary activity (Shackleton and Shackleton, 2004a). Just as households and communities are economically and socially differentiated, so too is their access to and use of NTFPs. While there has been little research in South Africa that has specifically disaggregated resource use and income data based on socio-economic characteristics, it has emerged that poorer and more isolated communities, as well as households that are headed by women or the less well off are often more dependent on the natural resource base (Shackleton and Shackleton, 2004a; Ticktin, 2004). This finding is consistent with a number of studies across the tropics that have demonstrated that it is generally the poorest households that are most directly and heavily reliant on NTFPs, both for cash and subsistence income (Cavendish, 2000; Campbell *et al.*, 2002; Dovie, 2001; Twine *et al.*, 2001; Shackleton and Shackleton, 2004a). It has been found that more well-off households in South Africa often substitute collected resources (e.g. fuelwood) with purchased alternatives (e.g. gas). It has also been found that wild foods frequently contribute proportionately more towards the diets of poorer households than to better-off households. Another interesting trend that has emerged in South Africa is that households with better access to disposable income often buy NTFPs from traders and/or neighbours rather than collect them themselves (Shackleton and Shackleton, 2004a).

In the past, there has been the belief that local human populations could harvest NTFPs with relatively little impact on the natural resource base. However, a growing number of studies have challenged this contention (Velásquez Runk *et al.*, 2004; Ticktin, 2004; Shankaar *et al.*, 2004a; Shankaar *et al.*, 2004b). Increasingly, there has been concern at a global scale that the impacts of extraction may be greater than was previously thought, creating both direct and indirect impacts that are difficult to measure (Shankaar *et al.*, 2004b). This has resulted in the argument for 'sustainable utilisation'. Sustainable resource use can be defined as "the maintenance of an undiminished flow of benefits from the resource to its users over time" (Shahabuddin and Prasad, 2004: 237). However, this deceptively straightforward definition is complicated by the fact that the various benefits provided by any dry forest resource to its different users are usually not simultaneously maximised. According to Shahabuddin and Prasad (2004), in exclusively ecological terms, NTFP harvesting can be considered sustainable if the harvesting has no long-term negative effect on the regeneration and reproduction of populations being harvested in comparison to the equivalent non-harvested natural populations, and if the harvest has no discernable adverse impact on other species in the community, or on ecosystem functioning or structure. From the above definition, it seems clear that 'sustainability' is a simple term for a complex internationally recognised goal, that is difficult to attain, and to measure. Indeed, it is because of this complexity that very little is known about the sustainability of current patterns of resource utilisation and the implications of harvesting for sustainable resource management and rural livelihoods in South Africa (Shackleton and Shackleton, 2004a).

Velásquez Runk *et al.* (2004) found that not only are the ecological effects of harvesting immensely different for each species, but the spatial, social, temporal and political variables differ as well. This makes the effective management of NTFPs an even more complex task. Increasingly researchers are attempting to take into consideration the temporal, spatial and socio-political variables of NTFP harvesting, use and management. The incorporation of these variables allows a more complete view of NTFPs and how they fit into complex bio-physical, cultural and historical landscapes. Although it is a complex and rather daunting task, failure to include considerations of temporal changes, spatial variation, social differentials and larger power relations into NTFP research may well lead to inappropriate management recommendations and results that are of limited usefulness to users (Velásquez Runk *et al.*, 2004).

4.2.1 A predictive conceptual model

Shankaar *et al.* (2004b) conceptualised a predictive model related to three key factors that influence livelihood gains and the level of ecological disturbance resulting from NTFP harvesting (refer to Chapter One for a detailed exposition of this model). However, this model is specifically related to NTFP harvesting in India, and this chapter is an attempt to apply this model within the South African context of communal lands within the savanna biome.

4.2.2 Key questions

1. What levels of disturbance are created by NTFP harvesting around each village? (See Chapter Three)
2. How does the level of dependency on the resource base affect the level of disturbance created by NTFP harvesting around each village? (See Chapter Four)
3. How does the access to markets affect the level of disturbance created by NTFP harvesting around each village? (See Chapter Four)
4. How does the level of LEK affect the level of disturbance created by NTFP harvesting around each village? (See Chapter Two and Chapter Four)

4.3 Methodology

4.3.1 Dependency

The 'level of dependency' measure used in this study is based on previous studies conducted in the eight sample villages, where the gross annual direct-use values (R) of

NTFPs was determined across all households (users of NTFPs and non-users) (Shackleton *et al.*, 2002a; Shackleton *et al.*, 2002b; Dovie *et al.*, 2002; Twine *et al.*, 2003; Shackleton and Shackleton, 2004a). All of these studies used the same interview schedule, and in all instances 30 or more households were sampled per village, complemented by group participatory rural appraisal exercises and interviews with key informants (Shackleton and Shackleton, 2004b). This measure is specifically based on the direct-use values of resources that are used by rural households, and not the resource value per hectare. Direct-use values were determined as a product of the amount used and the local, or farm-gate, price. Where prices were not obtainable for some of the resources within the local community, replacement values, or the price at the closest point to the target community were used (Shackleton and Shackleton, 2004b). Data were collected within two years across the eight sites; hence no adjustment was made for inflation between the earliest and latest Rand values.

4.3.2 Access to markets/percentage of households buying and selling fuelwood

Although the Shankaar *et al.* (2004b) model specifically relates to market structure/chains, the context in South Africa is somewhat different to that of India. There were no marketing chains to speak of within the eight study villages, and NTFPs were not sold by private traders or cooperatives. They are generally sold by households from within each village, within the villages themselves on an ad hoc basis. Thus, a proxy for 'market structure' had to be found. The proxy used was 'distance to local and regional markets', with the hypothesis being that the closer villages are to local or regional markets, the more likely there is to be a greater market/external demand for NTFPs, the more likely households are to sell NTFPs, the greater the pressure on the local resource base would be, and the greater the resulting level of disturbance. In addition to this 'distance' data, data were collected through household interviews as to whether households bought or sold the three most important fuelwood and wild fruit species (as indicated by the households themselves). In addition, the regularity of these transactions was noted, and whether these NTFPs were sold within or outside the village was also noted. In each of the eight sample villages, 30 randomly selected households were interviewed, and they were asked a set number of questions regarding key fuelwood and wild fruit tree species in their particular area. The only village where fewer than 30 households were interviewed was Tidbury (this was because Tidbury is so small that every occupied household was interviewed, and it still only created a total of 24 households). Each village was divided into three sections, and a random selection of ten households was made in each section, ensuring an even spread throughout each village.

4.3.3 Level of household LEK

Refer to Chapter Two (methodology section) for an exposition of the methodology related to assessing levels of household LEK in each village.

4.3.4 The composite impact score

Refer to Chapter Three (methodology section) for an exposition of the methodology related to determining a composite impact score for each village.

4.4 Results

Table 4.1 gives a gross annual direct-use value (R) of NTFPs in the eight sample villages. This value is used as a proxy for the level of dependency on NTFPs in each of the villages. Table 4.1 clearly indicates that Mogano has the highest gross annual direct-use value (R7 238), with Tidbury having the lowest, and being ranked last (R1 607). In fact, according to the Rand values, the three villages in the Eastern Cape are (as a group) less dependent on NTFPs than the villages situated in Limpopo Province (whether this is in fact an accurate assessment is an issue that requires further attention, and will be dealt with in the Discussion section of this chapter). The range in gross annual direct-use values within the eight study sites is large, and this is probably a reflection of both differences in quantities consumed, unit prices and possibly the vegetation type itself (Shackleton and Shackleton, 2004a).

Table 4.1 Levels of dependency on NTFPs in the sample villages

Village	**Province**	**Level of dependency (R)***	**Rank**	**Reference**
Ntilini	Eastern Cape	1 645	7	Shackleton *et al.*, 2002a
Tidbury	Eastern Cape	1 607	8	Shackleton *et al.*, 2002a
Fairburn	Eastern Cape	2 526	6	Shackleton *et al.*, 2002a
Mabins B	Limpopo	5 019	2	Twine *et al.*, 2003
Finale A	Limpopo	3 576	3	Twine *et al.*, 2003
Willows	Limpopo	3 280	5	Twine *et al.*, 2003
Thorndale	Limpopo	3 435	4	Dovie *et al.*, 2002
Mogano	Limpopo	7 238	1	Shackleton *et al.*, 2002b

* **Note:** Gross annual direct-use values (R) across all households (users and non-users) for the eight study sites. All the research was conducted within a year or two of each other, therefore values were not adjusted for inflation or to a 2007 level, as they are comparable as they stand.

Table 4.2 shows the distance from the villages to the local and regional markets, with the hypothesis being that the closer the villages are to the local/regional markets, the greater the accessibility of these markets and thus the more likely households are to sell NTFPs. Fairburn was the village with the closest local centre (11 km) followed by Ntilini (16 km).

Table 4.2 Distance to local and regional markets

Village	**Distance to markets**			
	Distance to local centre		**Distance to regional centre**	
	Centre	**Distance (km)**	**Centre**	**Distance (km)**
Ntilini	Fort Beaufort	16	Grahamstown	86
Tidbury	Fort Beaufort	26	Grahamstown	96
Fairburn	Seymour	11	Queenstown	96
Mabins B	Tzaneen	58	Tzaneen	58
Finale A	Tzaneen	73	Tzaneen	73
Willows	Tzaneen	48	Tzaneen	48
Thorndale	Acornhoek	45	Hazyview	89
Mogano	Polokwane	32	Polokwane	32
Mean ± SDEV		**38.6 ± 21.26**		**72.3 ± 23.93**

One of the assumptions of the Shankaar *et al.* (2004b) model is that the greater the access households have to markets for NTFPs, the more likely they are to sell/buy NTFPs, consequently placing more pressure on the resource base. Thus, it is important to look at whether households are buying or selling these resources, and if so, from where. Table 4.3 shows that Ntilini has the highest percentage of households who are buying one or more of the most preferred species of fuelwood (43.3 %). In general, the numbers of households buying fuelwood were relatively low, ranging from none in Thorndale, to 13 in Ntilini. In addition, of those households that are buying one or more of the preferred species of fuelwood, the majority buy the fuelwood from within the village. This appears to indicate that external markets are not a major factor in the sample villages. A minority of the sampled households sold fuelwood either regularly or on an ad hoc basis, ranging from a total of eight households in Willows, to no households in Ntilini. Of the households that did sell, the majority of them sold on an ad hoc basis.

Table 4.3 The percentage of households buying and selling fuelwood

Village	Percentage of households (hh) buying one or more species	Of those households buying, percentage of households buying from within and/or outside the village			Percentage of households selling fuelwood	
		Within	**Outside**	**Both**	**Ah hoc**	**Regularly**
Ntilini	43.3 (13/30 hh)	15.4 (2/13 hh)	61.5 (8/13 hh)	23.0 (3/13 hh)	N/A	0.0
Tidbury	8.3 (2/24 hh)	100.0 (2/2 hh)	0.0	0.0	12.5 (3/24 hh)	0.0
Fairburn	23.3 (7/30 hh)	71.4 (5/7 hh)	28.6 (2/7 hh)	0.0	6.7 (2/30 hh)	0.0
Mabins B	3.3 (1/30 hh)	100.0 (1/1 hh)	0.0	0.0	N/A	0.0
Finale A	6.7 (2/30 hh)	100.0 (2/2 hh)	0.0	0.0	3.3 (1/30 hh)	0.0
Willows	20.0 (6/30 hh)	100.0 (6/6 hh)	0.0	0.0	10.0 (3/30 hh)	16.7 (5/30 hh)
Thorndale	0.0	N/A	N/A	N/A	3.3 (1/30 hh)	3.3 (1/30 hh)
Mogano	20.0 (6/30 hh)	100.0 (6/6 hh) *	0.0	0.0	3.3 (1/30 hh)	0.0

* **Note**: In Mogano, households were buying from within the village, but they were all buying from fuelwood vans that came from surrounding villages into Mogano.

In terms of wild fruit, a very low percentage of sampled households indicated that they buy one or more of the three most preferred fruit species (Table 4.4). The three villages in the Eastern Cape appear to have similar trends in terms of the number of households buying wild fruit, and the majority of households buying fruit appear to come from the Eastern Cape villages. Fewer households were buying wild fruit in Limpopo Province, with Willows having the highest number of households buying wild fruit (ten households). Of the households buying fruit, the majority of the households in the Eastern Cape villages bought wild fruit outside the village, while the majority of households in the Limpopo Province villages bought their wild fruit within the village. In addition, very few households were involved in selling wild fruit in the Eastern Cape (only three households in the three Eastern Cape villages). However, a greater number of households were involved in selling fruit in Limpopo Province, with Willows having the highest number of households that indicated that they sell wild fruit on an ad hoc or regular basis (12 households). Finale and Thorndale were the exceptions, where there were no households selling wild fruit, and no households buying wild fruit.

Table 4.4 The percentage of households buying and selling wild fruit

Village	**Percentage of households buying one or more species**	**Of those households buying, percentage of households buying from within and outside the village**			**Percentage of households selling wild fruit**	
		Within	**Outside**	**Both**	**Ad hoc**	**Regularly**
Ntilini	16.7 (5/30 hh)	0.0	100.0 (5/5 hh)	0.0	N/A	N/A
Tidbury	16.7 (4/24 hh)	0.0	100.0 (4/4 hh)	0.0	4.2 (1/24 hh)	4.2 (1/24 hh)
Fairburn	20.0 (6/30 hh)	16.7 (1/6 hh)	83.3 (5/6 hh)	0.0	3.3 (1/30hh)	0.0
Mabins B	0.0	N/A	N/A	0.0	10.0 (3/30 hh)	0.0
Finale A	0.0	N/A	N/A	N/A	N/A	N/A
Willows	10.0 (3/30 hh)	100.0 (3/3 hh)	0.0	0.0	30.0 (9/30 hh)	10.0 (3/30hh)
Thorndale	0.0	N/A	N/A	N/A	N/A	N/A
Mogano	10.0 (3/30 hh)	100.0 (3/3 hh)	0.0	0.0	3.3 (1/30 hh)	6.7 (2/30 hh)

Table 4.5 indicates that for the majority of households in Limpopo Province are either not buying fuelwood or wild fruit, or are buying these NTFPs within their own villages. In contrast, all of the villages in the Eastern Cape (Ntilini, Tidbury and Fairburn) have some households buying wild fruit from external markets, and although households in Tidbury only buy fuelwood within the village, both Ntilini and Fairburn have households that access local markets to buy fuelwood. None of the households in the eight sample villages indicated that they buy from the regional centres. Although households in Mogano indicated that they buy fuelwood from within the village, they all indicated that they purchased them from vans that came into Mogano from the nearby surrounding villages. The vans collect fuelwood from their own villages' forests to sell (i.e. not from Mogano's forests). Thus, this market should reduce pressure on Mogano's communal dry forests, and exert greater pressure on the surrounding villages' dry forests. But the fact that significant volumes of fuelwood are brought into Mogano indicates that local stocks are insufficient to meet local demand. Thus, the impact score is expected to be high. This was indeed the case as Mogano is rated as the village with the highest impact ranking/score (Table 4.7).

Table 4.5 An indication of where the markets for fuelwood and wild fruit are

Of those households buying fuelwood or wild fruit, where are they buying these NTFPs?		
Village	**Fuelwood**	**Wild Fruit**
Ntilini	Ntilini Blinkwater	Fort Beaufort
Tidbury	Within Tidbury	Fort Beaufort
Fairburn	Katburg Hotel Stonehenge farm Phillopton farm Dambokiesvlei Balfour Seymour	Fort Beaufort Hertzog
Mabins B	Within Mabins B	Not buying wild fruit
Finale A	Within Finale A	Not buying wild fruit
Willows	Within Willows	Within Willows
Thorndale	Not buying fuelwood	Not buying wild fruit
Mogano	Within Mogano (vans)*	Within Mogano

***Note**: In Mogano, households were buying from within the village, but they were all buying from fuelwood vans that came from surrounding villages into Mogano.

Table 4.6 summarises the key results from Chapters Two, Three and Four. It also contains the key variables for the application of the Shankaar *et al.* (2004b) model. The composite impact score is the measure of disturbance (the dependent variable), the level of dependency is given as a Rand value, and the distance to both local and regional markets is included. In addition, the percentage of households buying fuelwood is placed in Table 4.6 as an additional measure of access to markets (the hypothesis being that the greater the access to markets, the higher the percentage of people buying (and selling) NTFPs will be). Upon cursory inspection, there does appear to be some truth to this assumption, as the four villages that are closest to local centres (Ntilini, Fairburn, Tidbury and Mogano) have the highest percentage of households engaged in buying fuelwood.

Table 4.6 Summary of the key variables

Village	Composite impact score	Level of dependency (R)	Level of LEK (%)	Distance to local centre (km)	Distance to regional centre (km)	Percentage of households buying fuelwood
Ntilini	0.159	1 645	35.6	16	86	43.3
Tidbury	-0.182	1 607	39.6	26	96	8.3
Fairburn	0.522	2 526	48.9	11	96	23.3
Mabins B	0.456	5 019	35.8	58	58	3.3
Finale A	0.276	3 576	66.3	73	73	6.7
Willows	0.954	3 280	54.7	48	48	20
Thorndale	1.229	3 435	51.9	45	89	0.0
Mogano	2.126	7 238	43.1	32	32	20.0

To find out if there were any significant relationships between the dependent variable (the composite impact score) and the level of dependency, level of household LEK and access to markets, a Forward Stepwise Regression was run. According to the results of this regression, the only significant relationship is between the composite impact score and the level of dependency (p=0.014, r^2=0.654, $F_{1,6}$=11.33).

Impact score = 0.00039(dependency) – 1.239*...Eq. 2

This relationship is illustrated in Figure 4.2, which shows that as the level of dependency rises, so does the composite impact score, with the village that has the highest level of dependency (Mogano R7 238) also having the highest composite impact score (2.126). And the village with the lowest level of dependency (Tidbury R1 607) also has the lowest composite impact score (-0.182). When the results of the Forward Stepwise Regression were inserted into an equation for the impact score, it was found that although there is a clear relationship between the actual impact score, and the one created using the equation, they are not a perfect match.

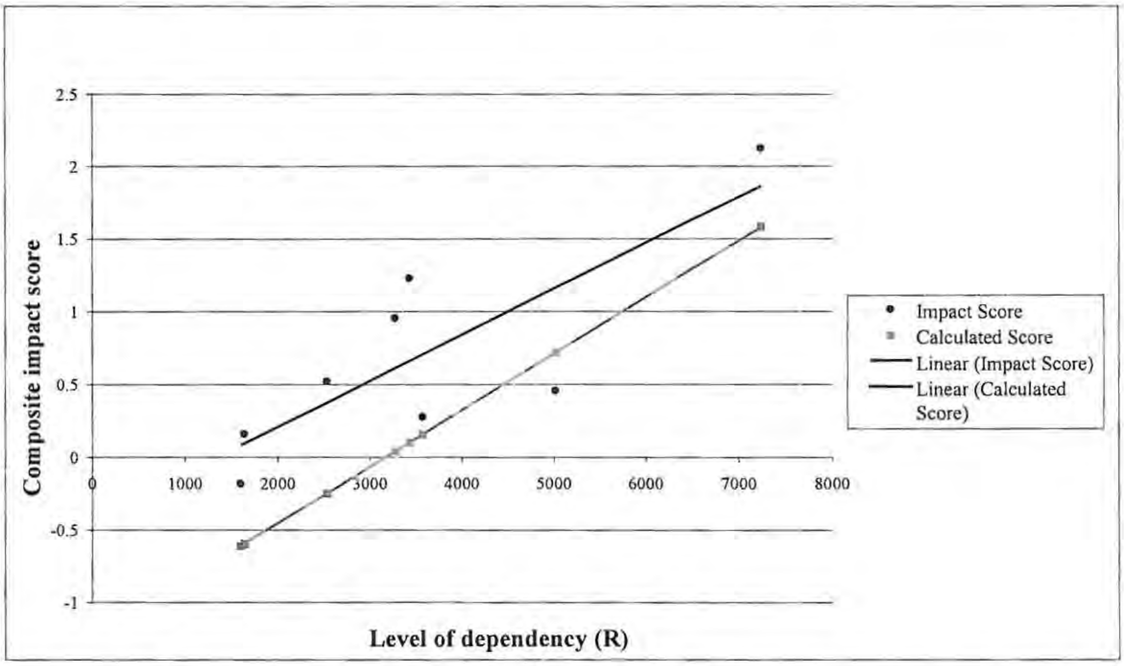


Figure 4.1 Regression relationship between the level of dependency and the composite impact score

4.5 Discussion

The results indicate that the Eastern Cape villages had lower levels of disturbance than the other villages in the north of South Africa. They also had the lowest levels of dependency, and relatively low levels of household LEK (although Fairburn scored relatively highly and was ranked fourth in terms of household LEK).

The results also indicate that there is a significant positive relationship between the level of dependency on NTFPs and the level of disturbance (Figure 4.1) (i.e. the composite impact score). This means that as the level of dependency increases, so too will the level of disturbance. This is illustrated by Mogano, which had the highest level of dependency, and also the highest composite impact score. Neither access to markets nor levels of household LEK were related to the composite impact score.

Of the three Eastern Cape villages, Ntilini was considered the most developed in terms of infrastructure (e.g. provision of water and electricity). However, in terms of key household wealth indicators, Fairburn has the greatest number of formal jobs and old-age pensions per household and also on average, more livestock per household in Fairburn than in either Tidbury or Ntilini, together with a greater proportion of households owning livestock (Shackleton and Shackleton, 2006). Fairburn was also associated with the highest annual gross direct-use value (Table 4.1). However, the use of the gross direct-use value of NTFPs as a measure of dependency is potentially not entirely accurate, and this limitation must be recognised. Shackleton *et al.* (2002a) found that a higher direct-use value in Fairburn does not automatically mean that they are more dependent upon the use of NTFPs (within the context of their overall livelihoods) than households at Tidbury or Ntilini. In fact, the lower livestock holdings and formal cash stream at Ntilini and Tidbury probably indicate that the dependency on NTFPs is higher than in Fairburn (Shackleton *et al.*, 2002a), i.e. the wealthiest and most developed village has the highest gross direct-use value attached to the use of wild resources. However, this distortion is probably a result of the fact that the local prices and consumption rates of NTFPs differ from village to village. Higher prices in Fairburn than in Ntilini and Tidbury would explain why Fairburn had a higher direct-use value of NTFPs. Indeed, Shackleton *et al.* (2002b) admitted that "the total value attached to the use of natural resources in a given area cannot be viewed simply as an indicator of high use and reliance on the natural resource base, but is rather influenced by local price, extraction costs, demand, market distortions and other externalities" (pg. 144).

Shackleton *et al.* (2002b) found that the rural communities of the three Eastern Cape villages make extensive use of the biological resources around them, and the financial value of this direct provisioning is significant. However, the proportion of households selling NTFPs in the Kat River valley is low relative to villages in the northern parts of South Africa, so too, is the income derived from selling. This finding was again replicated in this study (Tables 4.2 and 4.3). The reasons for this remain unclear, but it may be related to low net values as Shackleton *et al.* (2002b) intimated. However, Salick *et al.* (1999) and Dovie (2006) showed that the number of plant species used is a fixed proportion of the total number of species available, i.e. the more species in the surrounding environment, the greater the number of species used. Thus, the lower proportion of households selling NTFPs may be related to differences in vegetation type (i.e. the types of species that are available). Further research is required to elucidate upon the reasons for this.

One of the key issues related to the impacts of NTFP harvesting are levels of local governance/institutions that regulate natural resource management. However, "changes in the institutional arrangements for local level governance following the democratic transition in 1994 have resulted in ambiguity and confusion as to who is responsible for natural resource management" (Shackleton and Shackleton, 2004a: 221). Thus, as a result of this vacuum, many communal dry forests are now operating as *de facto* open access systems. Given the considerable value of savanna resources for the vast majority of rural households, it is crucial that the state develops strategies and policies to address the management of these resources in order to contribute to enhanced livelihoods, sustainable development and poverty alleviation in the rural areas of South Africa (Shackleton and Shackleton, 2004a).

Higgins *et al.* (1999) found that the vegetation structure of savanna ecosystems can be strongly influenced by the type of landuse. And although this study has no control (i.e. only impacted sites were assessed, there are no non-impacted sites) it seems fair to say that this research seems to back up the findings of Higgins *et al.* (1999), with varying levels of extraction from communal dry forests resulting in varying composite impact scores in the eight study sites. Accounting for the level of disturbance in a more specific way than just relating it back to 'landuse' is more complex. Although conceptually the three variables identified by Shankaar *et al.* (2004a) and Shankaar *et al.* (2004b) make sense, this study has only found a significant relationship between the level of disturbance, and the level of dependency (i.e. as the level of dependency increases, so too does the level of disturbance). The distance to markets had no significant influence on the level of disturbance, this may be because the markets are actually within the villages themselves (as indicated by the low proportion of households buying either fuelwood or wild fruit outside the villages, and the low proportion of households involved in selling these resources). If the external markets have a negligible influence, then it seems likely that the internal markets do not create any extra external demand on the resource base, thus there is a low/statistically insignificant relationship between access to markets and the level of disturbance. It is possible to hypothesise that if there was greater urban demand for fuelwood and wild fruit, combined with easy access to markets, then this would create the type of external pressure that would result in more households deciding to supply these external markets, which would result in a higher level of disturbance. However, this does not seem to be the case in any of the sample villages, so it is beyond the scope of this thesis to test this hypothesis.

It makes intuitive sense that the level of LEK would influence the level of disturbance created through NTFP harvesting. However, this study finds no statistically significant relationship between these two variables. There are a number of possible reasons for this:

1. The measure of household LEK that was used in this study does not adequately assess household LEK levels (i.e. it is too specific and focused on too few questions).
2. The institutions governing natural resource management in these villages have malfunctioned, and because of this vacuum, the level of household LEK is less relevant than the fact that the dry forests have become *de facto* open access systems.
3. LEK is not held equally by members of a single community, and thus even if there is an overall high household LEK score, there may be a number of households with low household LEK levels who may be harvesting in unsustainable ways.

The potential inadequacies and limitations of the LEK measure used in this paper must be recognised, but it is difficult to know what the real reasons behind the statistically insignificant relationship between LEK and the level of disturbance are. Clearly, further research into this under-researched area is required.

4.6 Conclusion

Communal dry forests are economically important, multiple-use systems that are integral to rural people's welfare, livelihoods and culture. However, this value is potentially being lost on a daily basis due to land transformation and resource degradation. Diversity of livelihoods is a reality, and any attempt to develop rural areas should enhance this, rather than focus on single livelihood sources (Shackleton and Shackleton, 2004a). Despite the significant contribution of dry forests in South Africa to meeting rural households' livelihood requirements, and indeed the national requirement for biomass energy, their management has been neglected and there is limited empirical knowledge to guide their sustainable utilisation (Neke *et al.*, 2006). Poverty is a major challenge on an international scale (Sunderlin *et al.*, 2005) and communal areas are generally underdeveloped in terms of infrastructure, markets, government infrastructure and jobs (Shackleton *et al.*, 2007). This has a major impact on the level of dependency on the natural resource base (poorer households are generally more dependent on natural resources), and this is an issue that must be addressed if livelihoods are to be safeguarded in the long-term. The analysis of poverty and rural livelihoods requires a holistic approach, and must take cognisance of the importance of NTFPs as a component of everyday livelihoods and as a safety net in times of need, misfortune and stress. Since women and the most marginalised members of rural communities tend to be more heavily reliant on the natural resource base, interventions and policies need to be effectively targeted at these groupings (Shackleton and Shackleton, 2004a). Although research over the past decade has questioned the simplistic links that have been made in the past between poverty and forest degradation, poverty remains part of the mix of acknowledged causal factors (Sunderlin *et al*., 2005). This means that tackling rural poverty is a very important part of maintaining rural livelihoods in the long term.

The ecology of NTFPs is inextricably linked to a multitude of political, socio-economic and cultural factors, and the development of sustainable resource-use systems for NTFPs in South Africa (and internationally) will require that all of these factors are given due consideration in terms of management systems (Ticktin, 2004). Indeed, if sustainability in terms of NTFP extraction is to be achieved, then the economic, social and political structures at national, regional and local levels need to be managed in such a way that NTFP extraction is lucrative over time, does not compromise agronomic and ecological variables, and yields social improvement for NTFP harvesters (Shahabuddin and Prasad, 2004). Certainly, it seems clear that NTFPs require some form of management if they are to withstand harvesting pressures of varying intensity (Ticktin, 2004). Regulation of landuse is clearly a key issue, with weak local institutions in communal areas making effective resource management difficult at the moment. However, the socio-economic and political conditions necessary for the sustainable extraction of NTFPs remain unclear, and the greatest barriers to sustainable harvesting may fall within these domains (Ticktin, 2004).

The people who tend to be most economically dependent on NTFPs are often the most marginalised and the poorest members of rural communities, and it is because of this that sustainable harvesting is essential for the maintenance of ecosystem functioning, and a huge proportion of rural livelihoods (Ticktin, 2004). The means of attaining sustainable harvest limits is conceptually easy, but in reality win-win situations are few and far between, and very difficult to attain. Perhaps the reality is that win-win situations will never truly be achieved, but every effort should be made to ameliorate the 'lose' part of the equation so that there is more of a balance between livelihood benefits and ecosystem benefits. Sadly, if the natural resource base becomes degraded because of extractive practices, it is the poorest and most marginalised people whose livelihoods depend on those resources that ultimately stand to lose the most.

This study has contributed to the general body of knowledge related to NTFPs, and has indicated that the level of dependency on the natural resource base does in fact have a significant statistical relationship with the level of disturbance, which is an important finding in itself. However, the issues of how important the level of household LEK and access to markets are, is not as clear-cut. It was found that there was no statistically significant relationship between household LEK and the level of disturbance, and it was also found that there was no statistically significant relationship between access to markets and the level of disturbance. However, intuitively it makes sense that the level of household LEK must influence harvesting patterns in some way. Thus, it seems clear that effectively assessing levels of household LEK remains a challenge, and further research into this area is clearly an imperative. Again, intuitively it makes sense that access to markets should influence natural resource harvesting patterns, but this is not the case in the eight sample villages. This research has indicated that the issue of 'access to markets' is a complicated one and clearly (as was also found by Shackleton and Shackleton, 2004b) urban-rural linkages, and how these linkages impact on NTFP harvesting and sale need to be more thoroughly understood.

The aim of this study was to determine how the level of disturbance in the communal forests of the fore-mentioned eight villages is related to the three key factors (LEK, the level of dependency, access to markets), within the South African context. This research indicates that the level of dependency is clearly (and statistically significantly) related to the level of disturbance, but the same cannot be said for either the level of LEK, or access to markets. Thus, it is indeed possible to apply the Shankaar *et al.* (2004b) model in South Africa, but it is not necessarily as applicable to the situation in South Africa as it is to the situation in India.

Indeed, although models predicting the impacts of NTFP harvesting, such as the Shankaar *et al.* (2004b) model may be conceptually very useful, there needs to be greater recognition of the level of socio-economic complexity surrounding NTFP harvesting. The socio-economic differentiation in NTFP use and access is a relatively under-researched area, and requires further work (Shackleton and Shackleton, 2006). A much better understanding of the relationship between NTFP use and household socio-economic indicators such as wealth, gender, income and vulnerability is needed to begin to address the pressing issues of poverty alleviation, environmental change and sustainability (Shackleton and Shackleton, 2004a). Within the South African context, dry forest management policies must take the political, social and economic contexts of dry forest use into account more than they have done in the past. Thus, it seems clear that in pursuit of the ultimate 'win-win' situation, further research is required before it can be clearly understood to what extent and in which ways livelihoods based on NTFPs can be compatible with benefits for the resource base (Shahabuddin and Prasad, 2004).

REFERENCES

Abu-Lughod, J. 1987. The Shape of the World System in the Thirteenth Century. *Studies in Comparative International Development*, 22: 3-25.

Acocks, J.P.H. 1988. Veldtypes of South Africa 3rd Ed. *Memoirs of the Botanical Survey of Southern Africa*, 57 (1)-146.

Agrawal, A. 1995. Dismantling the divide between indigenous and scientific knowledge. *Development and Change*, 26: 413-439.

Allison, E. H. and Badjeck M-C. 2004. Livelihoods, local knowledge and the integration of economic development and conservation concerns in the Lower Tana River Basin. *Hydrobiologia*, 527: 19-23.

Belcher, B.M. 2003. What isn't an NTFP? *International Forestry Review*, 5(2): 161-168.

Berkes, F., Colding, J. and Folke, C. Rediscovery of Traditional Ecological Knowledge as Adaptive Management. *Ecological Applications*, 10: 1251-1262.

Bowers, K. 2005. Learning from Traditional Ecological Knowledge. *Ecological Restoration*, 23 (3): 149.

Briggs, J. 2005. The use of indigenous knowledge in development: problems and challenges. *Progress in Development Studies*, 5: 99-114.

Campbell, J. 1991. Land or peasant? The dilemma confronting Ethiopian resource conservation. *African Affairs*, 90: 5-21.

Campbell, B.M., Luckert, M. and Scoones, I. 1997. Local-level valuation of savannah resources: a case study from Zimbabwe. *Economic Botany*, 51 (1): 59-77.

Campbell, B., Frost, P., Goebel, A., Standa-Gunda, W., Mukamuri, B. and Veeman, M. 2000. A conceptual model of woodland use and change in Zimbabwe. *International Tree Crops Journal*, 10: 347-366.

Campbell, B.M., Jeffery, S., Kozanayi, W., Luckert, M., Mutamba, M., Zindi, C. 2002. *Household Livelihoods in Semi-arid Regions: Options and Constraints*. CIFOR, Bogor. 153 pp.

Campbell, M.O. 2005. The impact of small-scale wood harvesting on neem *Azadirachta indica* A. Juss stands in the coastal savanna of Ghana. *Area*, 37: 8-16.

Cavendish, W. 2000. Empirical irregularities in the poverty-environment relationship of rural households: evidence from Zimbabwe. *World Development*, 28: 1979-2003.

Chidumayo, E.N. 2002. Changes in *miombo* woodland structure under different land tenure and use systems in central Zambia. *Journal of Biogeography*, 29: 1619-1626.

Cottam, G. and Curtis, J.T. 1956. The use of distance measures in phytosociological sampling. *Ecology*, 37: 451-460.

Cunningham, A.B. 2001. *Applied Ethnobotany: People, Wild Plant Use and Conservation.* Earthscan, London. 300 pp.

Dahdouh-Guebas, F., Van Pottelbergh, I., Kairo, J.G., Cannici, S. and Koedam, N. 2004. Human-impacted mangroves in Gazi (Kenya): predicting future vegetation based on retrospective remote sensing, social surveys and tree distribution. *Marine Ecology Progress Series*, 272: 77-92.

Dahdouh-Guebas, F. and Koedam, N. 2006. Empirical estimate of the reliability of the use of the Point-Centred Quarter Method (PCQM): Solutions to ambiguous field situations and description of the PCQM+ protocol. *Forest Ecology and Management*, 228: 1-18.

Davis, A. and Wagner, J.R. 2003. Who knows? On the importance of identifying experts when researching local ecological knowledge. *Human Ecology*, 31: 463-489.

Dovie, D. B. K, Shackleton, C. M. and Witowski, E. T. F. 2002. Direct-use values of woodland resources consumed and traded in a South African village. *International Journal of Sustainable Develoment and World Ecology*, 9: 269-283.

Dovie, D.B.K. 2001. *Woodland resource utilisation, valuation and rural livelihoods in the lowveld*, South Africa. MSc thesis, University of the Witwatersrand, Johannesburg.

Dovie, D. B. K. 2003. Rural economy and livelihoods from the non-timber forest products trade. Compromising sustainability in southern Africa? *International Journal of Sustainable Development and World Ecology*, 10: 247-262.

Dovie, D.B.K. 2004. Economic valuation of secondary resources in the context of total livelihoods. In Shackleton, C.M. and Shackleton, S.E. Use of woodland resources for direct household provisioning. In: Lawes, M., Eeley, H., Shackleton, C.M. and Geach, B.S. (Eds.). *Indigenous Forests and Woodlands in South Africa: Policy, People and Practice*. University of KwaZulu-Natal Press, Pietermartizberg. 863 pp.

Dovie, D.B.K. 2006. *The relationship between woody biodiversity and use of NTFPs in the savanna biome, South Africa*. PhD thesis, University of the Wiwatersrand, Johannesburg.

Drew, J. A. 2005. Use of Traditional Ecological Knowledge in Marine Conservation. *Conservation Biology*, 19: 1286-1293.

Eckholm, E. 1980. The value of small farms. *Focus*, 30 (3): 11-16.

Emanuel, P.L., Shackleton, C.M. and Baxter, J.S. 2005. Modelling the sustainable harvest of *Sclerocarya birrea* subsp. *caffra* fruits in the South African lowveld. *Forest Ecology and Management*, 214: 91-103.

Food and Agriculture Organization of the United Nations (FAO). 2000. *FRA 2000 On definitions of forest and forest change*. [Accessed 27 May 2006]. Available online: http://www.fao.org/docrep/006/ad665e/ad665e02.htm#TopOfPage.

Ford, J. and Martinez, D. 2000. Traditional Ecological Knowledge, Ecosystems Science and Environmental Management. *Ecological Applications,* 10: 1249-1250.

Furley, P.A. 2007. Tropical savannas and associated forests: vegetation and plant ecology. *Progress in Physical Geography*, 31 (2): 203-211.

Godoy, R., Reyes-Garcia, V., Byron, E., Leonard, W.R. and Vadez, V. 2005. The Effect of Market Economies on the Well-Being of indigenous peoples and on their use of renewable natural resources. *The Annual Review of Anthropology*, 34: 121-138.

Grundy, I.M., Campbell, B.M., Balebereho, S., Cunliffe, R., Tafangenyasha, C., Fergusson, R. and Parry, D. 1993. Availability and use of trees in Mutanda Resettlement Area, Zimbabwe. *Forest Ecology and Management*, 56: 243-266.

Hardin, G. 1968. The Tragedy of the Commons. *Science*, 162: 1243-1248.

Higgins, S.I., Shackleton, C.M. and Robinson, R. 1999. Changes in woody community structure and composition under contrasting landuse systems in a semi-arid savanna, South Africa. *Journal of Biogeography*, 26 (3): 619-627.

Hiremath, A.J. 2004. The ecological consequences of managing forests for non-timber products. *Conservation and Society*, 2 (2): 211-216.

Hoffman, M.T. 1997. Human impacts on vegetation. In: Cowling, R.M., Richardson, D.M. and Pierce, S.M. (Eds.). *Vegetation of Southern Africa.* Cambridge University Press, Cambridge. 649 pp.

Huntington, H. P. 2000. Using Traditional Ecological Knowledge in Science: Methods and Applications. *Ecological Applications*, 10: 1270-1274.

Kant, S., Nautiyal, J.C. and Berry, R.A. 1996. Forests and economic welfare. *Journal of Economic Studies*, 23 (2): 31-43.

Leach, M. and Fairhead, J. 2002. Manners of contestation: "citizen science" and "indigenous knowledge" in West Africa and the Caribbean. *International Social Science Journal*, 299-312.

Lesetla, T., Witowski, E.T.F. and Balkwill, K. 2002. Direct-use values of communal resources in Bokong and Tsehlanyane in Lesotho: whither the commons? *International Journal of Sustainable Development and Wilderness Ecology*, 9: 351-368.

Lovett, J.C. and Poudyal, M. 2006. Policy piece: Terraforming Africa. *African Journal of Ecology*, 44: 302-304.

Low, A.B. and Rebelo, A.G. (Eds.). 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria. 85 pp.

Luoga, E. J., Witowski, E.T.F. and Balkwill, K. 2002. Harvested and standing wood stocks in protected and communal miombo woodlands of eastern Tanzania. *Forest Ecology and Management*, 164 (1-3): 15-30.

Madubansi, M. and Shackleton, C.M. 2006. Changing energy profiles and consumption patterns following electrification in five rural villages, South Africa. *Energy Policy*, 34 (18): 4081-4092.

Madubansi, M. and Shackleton, C.M. 2007. Changes in fuelwood use and selection following electrification in the Bushbuckridge lowveld, South Africa. *Journal of Environmental Management*, 83 (4): 416-426.

Mueller-Dombois, D.R. and Ellenberg, H. 1974. *Aims and methods of vegetation ecology*. John Wiley and Sons Inc., New York. 547 pp.

Neke, K.S., Owen-Smith, N. and Witkowski, E.T.F. 2006. Comparative resprouting response of Savanna woody plant species following harvesting: the value of persistence. *Forest Ecology and Management*, 232: 114-123.

Paumgarten, F. 2007. *The significance of the safety-net role of NTFPs in rural livelihoods, South Africa.* Masters thesis, Rhodes University, Grahamstown.

Pierotti, R. and Wildcat, D. 2000. Traditional Ecological Knowledge: The Third Alternative (Commentary). *Ecological Applications,* 10: 1333-1340.

Ramirez-Marcial, N., Gonzalez-Espinosa, M. and Williams-Linera, G. 2001. Anthropogenic disturbance and tree diversity in montane rain forests in Chiapas, Mexico. *Forest Ecology and Management*, 154: 311-326.

Rao, P., Barik, S.K., Pandey, H.N. and Tripathi, R.S. 1990. Community composition and tree population structure in a sub-tropical broad-leaved forest along a disturbance gradient. *Vegetatio*, 88: 151-162.

Reyes-Garcia, V., Vadez, V., Huanca, T., Leonard, W. R. and McDade, T. 2007. Economic Development and Local Ecological Knowledge: A Deadlock? Quantitative Research from a Native Amazonian Society. *Human Ecology,* 35: 371 – 377.

Sagar, R., Raghubanshi, A.S. and Singh, J.S. 2003. Tree species composition, dispersion and diversity along a disturbance gradient in a dry tropical forest region of India. *Forest Ecology and Management*, 186 (1): 61-71.

Salick, J., Buin, A., Martin, G., Apin, L. and Beaman, R. 1999. Whence useful plants? A direct relationship between biodiversity and useful plants among the Dusan of Mt. Kinabalu. *Biodiversity and Conservation*, 8: 797-818.

Sankaran, M., Hanan, N.P., Scholes, R.J., Ratnam, J., Augustine, D.J., Cade, B.S., Gignoux, J., Higgins, S.I., Le Roux, X., Ludwig, F., Ardo, J., Banyikwa, F., Bronn, A., Bucini, G., Caylor, K.K., Coughenour, M.B., Diouf, A., Ekaya, W., Feral, C.J., February, E.C., Frost, P.G.H., Hiernaux, P., Hrabar, H., Metzger, K.L., Prins, H.H.T., Ringrose, S., Sea, W., Tews, J., Worden, J. and Zambatis, N. 2005. Determinants of woody cover in African savannas. *Nature*, 438 (7069): 846-49.

Schulte-Bisping, H., Bredermeier, M. and Beese, F. 1999. Global availability of wood and energy supply from fuelwood and charcoal. *Ambio*, 28: 592-594.

Shankaar, R. U., Ganeshaiah, K.N., Krishnan, S., Ramya, R., Meera, C., Aravind, N. A., Kumar, A., Rao, D., Vanaraj, G., Ramachandra, J., Gauthier, R., Ghazoul, J., Poole, N. and Chinnappa Reddy, B. V. 2004b. Livelihood gains and ecological costs of non-timber forest product dependence: assessing the roles of dependence, ecological knowledge and market structure in three contrasting human and ecological settings in south India. *Environmental Conservation*, 31 (3): 242-253.

Shackleton, C.M. 1993a. Fuelwood harvesting and sustainable utilisation in a communal grazing land and protected area of the eastern Transvaal lowveld. *Biological Conservation*, 63: 247-254.

Shackleton, C.M. 1993. Demography and dynamics of the dominant woody species in a communal and protected area of the eastern Transvaal lowveld. *South African Journal of Botany*, 59: 569-574.

Shackleton, C.M. 2000. Stump size and the number of coppice shoots for selected savanna tree species. *South African Journal of Botany*, 66 (2): 124-127.

Shackleton, C.M. 2001. Re-examining local and market-orientated use of wild species for the conservation of biodiversity. *Environmental Conservation*, 28:3: 270-278.

Shackleton, S.E. 2004. Livelihood benefits from the local level commercialization of savanna resources: a case study of the new and expanding trade in marula (*Sclerocarya birrea*) beer in Bushbuckridge, South Africa. *South African Journal of Science*, 100: 651-657.

Shackleton, S.E. 2005. *The Significance of the Local Trade in Natural Resource Products for Livelihoods and Poverty Alleviation in South Africa*. PhD thesis, Rhodes University, Grahamstown.

Shackleton, C.M., Griffen, N.J., Banks, D.I., Mavrandonis, J.M. and Shackleton, S.E. 1994. Community structure and species composition along a disturbance gradient in a communally managed South African savanna. *Vegetatio*, 115: 157-167.

Shackleton, S.E., Shackleton, C.M. and Cousins, B. 1999. The economic value of land and natural resources to rural livelihoods: case studies from South Africa. *Proceedings of the Land and Agrarian reform conference*, 26-28 July 1999. PLAAS, Cape Town.

Shackleton, C.M. and Shackleton, S.E. 2000. Direct use values of secondary resources harvested from communal savannas in the Bushbuckridge lowveld, South Africa. *Journal of Tropical Forest Products*, 6 (1): 28-47.

Shackleton, C. M., Shackleton, S. E., Ntshudu, M. and Ntzebenza, J. 2002a. The role and value of savanna non-timber forest products to rural households in the Kat River valley, South Africa. *Journal of Tropical Forest Products,* 8 (1): 45-65.

Shackleton, S. E., Shackleton, C. M., Netshiluvhi, T. R., Greach, B. S., Balance, A. and Fairbanks, D. H. K. 2002b. Use patterns and value of savanna resources in three rural villages in South Africa. *Economic Botany*, 56 (2): 130-146.

Shackleton, C.M., Guthrie, G., Keirungi, J. and Stewart, J. 2003. Fuelwood availability and use in the Richtersveld National Park, South Africa. *Koedoe*, 46 (2): 1-8.

Shackleton, C.M. and Shackleton, S.E. 2004a. Use of woodland resources for direct household provisioning. In Lawes, M., Eeley, H., Shackleton, C.M. and Geach, B.S. (Eds.). *Indigenous Forests and Woodlands in South Africa: Policy, People and Practice*. University of KwaZulu-Natal Press, Pietermartizberg. 863 pp.

Shackleton, C.M. and Shackleton, S.E. 2004b. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African Journal of Science*, 100: 658-664.

Shackleton, C.M., Guthrie, G. and Main, R. 2005. Estimating the potential role of commercial over-harvesting in resource viability: a case study of five useful tree species in South Africa. *Land Degradation and Development*, 16: 273-286.

Shackleton, C.M. and Shackleton, S.E. 2006. Household wealth status and natural resource use in the Kat River valley, South Africa. *Ecological Economics*, 57: 306-317.

Shackleton, C.M., Shackleton, S.E., Buiten, E. and Bird, N. 2007. The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *Forest Policy and Economics*, 9: 558-577.

Shahabuddin, G. and Prasad, S. 2004. Assessing Ecological Sustainability of Non-Timber Forest Produce Extraction: The Indian Scenario. *Conservation and Society*, 2 (2): 235-250.

Shankaar, U., Hedge, R. and Bawa, K.S. 1998. Extraction of non-timber forest products in the forest of Bilingiri Rangan Hills, India. VI. Fuelwood pressure and management options. *Economic Botany*, 52: 320-336.

Sinha, A. and Bawa, K.S. 2001. Impacts of Anthropogenic Pressures on Population Dynamics, Demography, and Sustainable Use of Forest Species in the Western Ghats, India. In: K.N.Ganeshaiah, R.U. Shankaar and K.S. Bawa (Eds.), *Tropical Ecosystems: Structure, Diversity and Human Welfare*. New Delhi: Oxford and IBH. 791 pp.

Stewart, G. 2005. Plant trade sustains and threatens traditions. *Daily Dispatch*, June 16: 5.

Sunderlin, W.D., Angelsen, A., Belcher, B., Burgers, P., Nasi, R., Santoso, L. and Wunder, S. 2005. Livelihoods, Forests, and Conservation in Developing Countries: An Overview. *World Development*, 33 (9): 1383-1402.

Ticktin, T. 2004. The Ecological Consequences of NTFP Harvest: A Review. *Journal of Applied Ecology*, 41: 11-21.

Tietema, T., Tolsma, D.J., Veenendaal, E.M. and Schroten, J. 1991. *Plant responses to human activities in the tropical savanna ecosystem of Botwsana. Ecological Responses to*

Environmental Stresses. pp. 262-276. (In: J. Rozema and J.A.E. Verkley (Eds.)), Kluwer Academic Publishers, The Netherlands.

Twine, W., Moshe, D., Netshiluvhi, T. and Siphugu, V. 2003. Consumption and direct-use values of savanna bio-resources used by rural households in Mametja, a semi-arid area of Limpopo province, South Africa. *South African Journal of Science*, 99: 467-473.

Twine, W., Siphugu, V. and Moshe, D. 2003. Harvesting of communal resources by 'outsiders' in rural South Africa: a case of xenophobia or a real threat to sustainability? *International Journal of Sustainable Development and World Ecology*, 10: 263-274.

Shankaar, R. U., Ganeshaiah, K.N., Nageswara Rao, M. and Aravind, N.A. 2004a. Ecological Consequences of Forest Use: From Genes to Ecosystem – A Case Study in the Biligiri Rangaswamy Temple Wildlife Sanctuary, South India. *Conservation and Society*, 2 (2): 347-363.

Shankaar, R. U., Ganeshaiah, K.N., Krishnan, N., Ramya, R., Meera, C., Aravind, N.A., Kumar, A., Rao, D., Vanraj, G., Ramachandra, J., Gauthier, R., Ghazoul, J., Poole, N., and Chinnappa Reddy, B.V. 2004b. Livelihood Gains and Ecological Costs of NTFP Dependence: Assessing the Roles of Dependence, Ecological Knowledge and Market Structure in Three Contrasting Human and Ecological Settings in South India. *Environmental Conservation*, 31: 242-253.

Velásquez Runk, J., Mepaquito, P. and Peña, F. 2004. Artisanal Non-Timber Forest Products in Darién Province, Panamá: The Importance of Context. *Conservation and Society*, 2 (2): 217-234.

Vermeulen, S.J. 1996. Cutting of trees by local residents in a communal area and an adjacent state forest in Zimbabwe. *Forest Ecology and Management*, 81: 101-111.

Walker, B.H. 1976. An approach to the monitoring of changes in the composition and utilisation of woodland and savanna vegetation. *South African Journal of Wildlife Research*, 6: 1-32.

Zarger, R. 2002. Acquisition and transmission of subsistence knowledge by O'eqchi' Maya in Belize. In: Stepp, J.R., Wyndham, F.S. and Zarger, R. (Eds.). *Ethnobiology and Biocultural Diversity*. International Society of Ethnobiology, Athens: 592-603.

APPENDICES

APPENDIX ONE: PCQ datasheet for one transect

	1/4	Species	Distance from PCQ point	No. of stems	Status of largest stem (alive, dead, broken)	Largest circumference (below branching)	No. of cut stems	If cut, % removed	No. of broken stems	If broken, % removed	No. of dead stems	% dead [more or less than half, etc]
PCQ No. 1	1											
	2											
	3											
	4											
PCQ No. 2	1											
	2											
	3											
	4											
PCQ No. 3	1											
	2											
	3											
	4											
PCQ No. 4	1											
	2											
	3											
	4											
PCQ No. 5	1											
	2											
	3											
	4											

Datasheet for NTFP Fieldwork. PCQ

Date:____________ Village:__________________ Proximity: Near / Mid / Far

	1/4	Species	Distance from PCQ point	No. of stems	Status of largest stem (alive, dead, broken)	Largest circumference (below branching)	No. of cut stems	If cut, % removed	No. of broken stems	If broken, % removed	No. of dead stems	% dead [more or less than half, etc]
PCQ	1											
No.	2											
6	3											
	4											
PCQ	1											
No.	2											
7	3											
	4											
PCQ	1											
No.	2											
8	3											
	4											
PCQ	1											
No.	2											
9	3											
	4											
PCQ	1											
No.	2											
10	3											
	4											

Datasheet for NTFP Fieldwork. PCQ

Date:____________ Village:__________________ Proximity: Near / Mid / Far

	1/4	Species	Distance from PCQ point	No. of stems	Status of largest stem (alive, dead, broken)	Largest circumference (below branching)	No. of cut stems	If cut, % removed	No. of broken stems	If broken, % removed	No. of dead stems	% dead [more or less than half, etc]
PCQ	1											
No.	2											
11	3											
	4											
PCQ	1											
No.	2											
12	3											
	4											
PCQ	1											
No.	2											
13	3											
	4											
PCQ	1											
No.	2											
14	3											
	4											
PCQ	1											
No.	2											
15	3											
	4											

Datasheet for NTFP Fieldwork. PCQ

Date:_____________ Village:____________________ Proximity: Near / Mid / Far

	1/4	Species	Distance from PCQ point	No. of stems	Status of largest stem (alive, dead, broken)	Largest circumference (below branching)	No. of cut stems	If cut, % removed	No. of broken stems	If broken, % removed	No. of dead stems	% dead [more or less than half, etc]
PCQ No. 16	1											
	2											
	3											
	4											
PCQ No. 17	1											
	2											
	3											
	4											
PCQ No. 18	1											
	2											
	3											
	4											
PCQ No. 19	1											
	2											
	3											
	4											
PCQ No. 20	1											
	2											
	3											
	4											

Datasheet for NTFP Fieldwork. PCQ

Date:____________ Village:__________________ Proximity: Near / Mid / Far

	1/4	Species	Distance from PCQ point	No. of stems	Status of largest stem (alive, dead, broken)	Largest circumference (below branching)	No. of cut stems	If cut, % removed	No. of broken stems	If broken, % removed	No. of dead stems	% dead [more or less than half, etc]
PCQ No. 21	1											
	2											
	3											
	4											
PCQ No. 22	1											
	2											
	3											
	4											
PCQ No. 23	1											
	2											
	3											
	4											
PCQ No. 24	1											
	2											
	3											
	4											
PCQ No. 25	1											
	2											
	3											
	4											

Datasheet for NTFP Fieldwork. PCQ

Date:____________ Village:__________________ Proximity: Near / Mid / Far

APPENDIX TWO: Questionnaire

My name is Melita Steele and this survey is part of independent research that I am conducting as a student at Rhodes University in Grahamstown, funded by the University and the National Research Foundation. I am looking at how the harvesting of non-timber forest products (i.e. this questionnaire is related specifically to fuelwood and wild fruit) from communal forests changes the ecology of the forests. There will be no direct/monetary benefits for the people who are interviewed, or for the village, but a report will be given to the local authorities explaining the results of the study when it has been completed.
Are you willing to be interviewed?

Village________________________ Date ________________________ House No. ______________

Top three PREFERRED species fuelwood	1. Why are these the preferred species?	2. How do you get the wood?			2.1 If you buy, how often do you buy?		2.2 If you buy, where do you buy from? Within village/outside village	2.3 If you collect this species, how do you collect?			3. Do you sell this species?			4. How often do you use this species?		
		Buy	Collect	Both	Sometimes	Always		Cut	Collect deadwood	Both	Sometimes	Always	Never	Sometimes	Always	Never
a.																
b.																
c.																

Top three PREFERRED species of fruit	**5. Why are these the preferred species?**	**6. How do you get the fruit?**			**6.1 If you buy, how often do you buy?**		**6.2 If you buy, where do you buy from? Within village/outside village**	**7. Do you sell this species?**			**8. How often do you use this species?**		
		Buy	Collect	Both	Sometimes	Always		Sometimes	Always	Never	Sometimes	Always	Never
d.													
e.													
f.													

Specialists versus randomly selected household:

1. When do the fruits for spp.__________________________ ripen?

____

2. When does spp. __________________________ flower?

____

3. What colour are the flowers?

____

4. Does cutting the stem kill spp. ___________________________________? Yes [ ] No [ ] Don't know [ ]

5. What are the other uses of spp. ______________?

____

6. Of the 3 key fuelwood spp., which grows the fastest?

____

7. How is spp. __________________ pollinated?

____

8. Does spp. ____________________have specific requirements to grow? (i.e. near a river, shade, sun) ________________________________

9. How long does it take for spp. ________________ to be big enough to harvest?

____