# THE INFLUENCE OF STRUCTURE, DENSITY AND DIRECT USE BENEFITS ON THE HARVESTING OF TREES IN THE RURAL VILLAGE OF PIKOI, EASTERN CAPE, SOUTH AFRICA.

**THESIS**

**Submitted in fulfillment of the requirements for the Degree of**

**MASTER OF SCIENCE**

**RHODES UNIVERSITY**

**by**

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**March 2002**

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**ACKNOWLEDGEMENTS**

I would like to thank my supervisor, Prof. Christo Fabricius, for his guidance and encouragement. I also would like to thank my co-supervisor, Prof. Roy Lubke, for his advice on the ecological survey and encouragement. I am grateful to Prof. Kate Rowntree and Mr. D. Mather whose advice during the initial and final stages of this project respectively is highly appreciated. A special thank you to a Cape Town-based Environmental Consulting firm, Common Ground Consulting for making funds available for my MSc programme and to Mr. J. Evans and Prof. C. Fabricius for the internship they arranged for me with the CSIR, which was an eye-opener. Thank you to heads of households in Pikoli for sharing their experiences with me, and also for accommodating me in their homes. Many thanks to the following people for their various help during this study: my brother Motinyane, Thabo, Ntuba, Mapesela, Hlalefang, Prof. Radloff, Dr. C. Shackleton, Tony Dold, Monde Duma, Nozipho Hoohlo, Thabo Sephaka, Maartje, Andrew Ainslie, Louisa Donaldson, Prof. Botha, Eric Tasmer and Sue Abrahams. Miss C. Blight deserves a thank you vote for editing this thesis. Thanks to all staff and post-grad students in the Botany Department and the Environmental Science Programme. A loving thank you goes to my parents for the financial support, encouragement and willing ear. Thank you to Kwame Nkrumah-Abebrese for the financial support and to Moletsane Mohapi, who loaned me his personal computer during the intensive write-up stage. Last but not least, my sincere appreciation goes to Lebo Lecoko, for her constant encouragement. I could not have done anything without your help -Thank you all.

**DISLAMER**

I, Teboho Raphael Motinyane, do hereby declare that the work presented in this thesis is my own. Where applicable, the work of others is acknowledged. I also declare that this thesis has not been submitted to any other university.

..........................................

Motinyane, R.T

5 March 2002

## DEDICATION

Only after the last tree has been cut down,
Only after the last river has been poisoned,
Only after the last fish has been caught,
Only then will you find that money cannot be eaten.

(Cree Indian Prophecy)

The prophecy takes a cynical view of human nature. Humans assume that their abuse of this planet's resources can go far without the whole system collapsing. This prophecy should give every human being and every government a pause. A pause to think and to act responsibly in caring for the environment, so that such a prediction does not come to pass (Showalter, 1999).

It is with this message therefore, that I specially dedicate this work to my late grandmother 'Mankhala Lesitha. I also dedicate this work to my dear mother, 'Mateboho.

## ABSTRACT

The people of Pikoli in the Peddie district of the Eastern Cape are mostly unemployed and earn most of their income from old-age allowances. The place is remote and 'modern' amenities such as paraffin and petroleum gas are expensive. Electricity and transport are unavailable. There is heavy reliance on woody plants for fuel and for materials for construction and fencing and to some extent medicinal and ritual uses.

Indigenous trees in this rural area are threatened by over-utilisation and the absence of clear government management policies. The over-utilisation of these resources is leading to deforestation. It was proposed at the beginning of this study that people who harvest trees cause similar results to the piosphere effect caused by the herbivores on the rangeland. Ecological-economic analysis was performed to find a common ground between the people's income and needs so that effective sustainable management strategies can be developed.

A combination of semi-structured interviews, direct observations and ecological surveys were used to gather information about:

ξ Tree species used, and for what purpose in Pikoli

ξ Individual tree species preference by inhabitants

ξ Change in tree density in response to changes in utilisation intensity at varying distances away from the village

ξ The local direct use benefits inhabitants derive from utilising indigenous tree resources

The study showed that the people of Pikoli use a variety of 23 indigenous trees and that they have marked preferences regarding the tree species they use for fuelwood and construction purposes. Although *Ptaeroxylon obliquum* is a highly preferred species for fuelwood and construction, its popularity can also be linked to its high relative abundance in this area. Other species such *Maytenus undata* and *Pappea capensis* are also highly preferred although they are harvested at much greater distances from the centre of the village.

Change in individual tree density in response to changes in utilisation intensity at varying distances away from the village showed clearly that a piosphere effect also applies to human harvesting. The average number of individual trees closer (1 200 m) to the village centre was 2 trees per 100 $m^2$, and their numbers increase to approximately 35 trees per 100 $m^2$ at a distance of about 3 000 m from the village centre.

The study reports on the direct use benefits derived by the people of Pikoli from harvesting tree resources. The average total net value of trees harvested for fuelwood was R4089.09 (US$ 359.01) per household per annum. The value of tree resources harvested represents a large percentage of average households' annual income. Therefore, the economic benefits households derive from utilising tree resources are high. Indigenous tree resource use in this rural village seems to be unsustainable and the inhabitants seem to be aware of it. However, they have few alternatives. Their economic conditions do not allow them to afford alternative resources available in the formal market.

# CHAPTER 1

# INTRODUCTION TO THE SUSTAINABLE USE OF TREE RESOURCES

## 1.1. INTRODUCTION

Most rural communities in developing countries of Africa and Asia rely on trees to meet their basic needs, and these tree resources make an important contribution to the economy of these developing countries (O'Keefe and Munslow, 1989; Tinker, 1984; Gandar and Udit, 1989; Low and Rebelo, 1998; Solomon, 2000; Adeoti *et al*, 2001; Kituyi *et al*, 2001; Parikesit *et al*, 2001). A lot of stress on the environment caused by over usage of indigenous trees by rural inhabitants has been observed (Steyn, 1990; Grundy *et al*, 2000; Mahiri and Howorth, 2001). In the case of South Africa, a rapid human population growth and poverty, caused by a long history of racial discrimination, land dispossession, the limitation of access to basic services and poor infrastructure, have resulted in an increase in the usage of traditional fuels such as fuelwood, to the extent that the natural regeneration of tree resources has become inadequate in some areas such as the Eastern Cape (Steyn, 1990). It is, therefore, imperative to address the need to encourage the wise use of natural resources and improve the lives of the rural communities (DWAF, 1997).

More than 10 years ago, nine member countries of the Southern African Development Coordination Conference (SADC)[1] reported that more than 60 million people rely upon biomass in the form of wood, charcoal and crop or animal residue for their basic household fuel (SADC, 1983). In 1998 woody biomass accounted for between 50% (Zimbabwe) and 90% (Tanzania) of national energy consumption in these southern African states (Munslow *et al*, 1988). Although fuelwood accounts for four-fifths of the total energy consumption in the SADC region (SADC, 1983), it is becoming temporally and spatially scarce (Liengme, 1983; Eberhard, 1990; Shackleton, 1993; Eberhard and Van Horen, 1995).

The appalling tree resource management and utilization conditions in the rural areas of South Africa is similar to conditions that exist in other parts of Africa (Shackleton and Scholes, 2000). South Africa has small indigenous forest patches that are home to millions of South Africans who depend on trees for fuel, medicine, construction timber, fruits and other resources (Shackleton and Mander, 2000; Shackleton and Scholes,

[1] 10 years ago, South Africa was not a member of the SADC, therefore the quoted numbers would be much higher if it were included.

2000). Fuelwood collection in communal areas and the increased felling of forests due to the commercialization of forest products has led to rapid deforestation, and a steep decline in forest cover (Steyn, 1990; Nhira *et al*, 1998; Lent *et al*, 2000).

This chapter will discuss the theory of sustainable management of natural resources. This will be achieved by firstly discussing the term sustainability as it applies to the management of indigenous tree resources. Then the sustainable indigenous tree use and preferences in rural areas of South Africa will be discussed. Thirdly, the amount of indigenous trees harvested per household per annum will be given together with the distances and times these rural communities require for their tree resources harvesting. An overview of relevant literature on the local direct use value of indigenous trees to the rural people will also be provided. Furthermore, this chapter will give the objectives of this study. Finally, the study area, its socio-economic characteristics and its vegetation will be discussed.

## 1.2. MANAGEMENT OF INDIGENOUS TREE RESOURCES

### 1.2.1. Sustainable management of indigenous tree resources

Sustainability or sustainable use of target stock, such as trees is meant also to include the impact of such use on non-target species and ecosystems (IUCN, 1993). In the context of direct extraction of natural tree resources, the term sustainable use means that the extraction of trees can be carried out with a certain degree of intensity into the foreseeable future. Sustainable use varies according to the biological features of the resource and its ecological surroundings, and it also varies in relation to levels of use and the effects of any socio-economic and other institutional controls on the use (WCMC, 1996; Geldenhuys, 1997; UNU, 1997). There are many other different meanings of sustainability or sustainable use of resources, but they all concur on one point: that resources should be used bearing in mind that they support the present needs and will be in a position to support the needs of the future generations as well (Bromley, 1989).

Sustainable utilisation of trees can be achieved in two separate, yet related ways (IUCN, 1993). The first is with reference to the sustainable use of a specific resource. The second use is a broader notion of sustainable development, on which this study will not elaborate. The key consideration for sustainable use of trees is that the rate at which they are harvested should either be equal to or less than the rate at which they regenerate (Shackleton and Scholes, 2000). Management strategies should also address the problems caused by invasive tree species as their dominance affects the abundance of indigenous species (SEI, 1998). However, as much as these exotic species are a threat to the local natural biodiversity, if well managed they can be of use in providing useful products such as fuelwood to the rural population.

Management strategies should also be carried out in such a way that they can efficiently deal with situations where indigenous trees are rare. In such situations, there will be a need to manage the balance between the consumption level and the ecosystem's ability to supply tree resource (Mukolwe, 1999). Failure to balance the rates of harvesting and production of a resource can take time to reveal itself (Shackleton and Mander, 2000), which can cause irreversible harm to the tree resource base. The determination of the sustainable use of a resource for a particular area is often not as simple as the definition implies. There are a number of factors such as: seasonality of resource supply and extraction; annual variations in resources supply; importation of resources from other areas; extraction and exporting of resources by non-residents; reasonable estimation of the area available for harvesting, and the quality of the resource, which needs to be taken into consideration when determining an area's sustainability (Shackleton and Mander, 2000). However, Shackleton and Mander (2000) argue that many of the values provided in current and unpublished literature for woodland resources have not been critically appraised within the context of sustainability of resources supply or use.

In South Africa, little work has been done to analyse the sustainability of use of most of the natural resources, which include indigenous trees by rural communities (Shackleton and Mander, 2000). However, a few isolated studies have been carried out to assess the use of some forest resources in different areas of this country (Mander and Quinn, 1995; Dzerefos and Shackleton, 1998; Mukolwe, 1999; Shackleton & Mander, 2000).

### 1.2.2. Indigenous tree use and preferences in the rural areas

Although modernisation has introduced some alternatives for wood such as wire, exotic timber in woodlands, building bricks and corrugated iron, the majority of rural inhabitants still prefer to use traditional materials for fuelwood [Plate 1.2] and fencing [Plate 1.3] (Bembridge and Tarlton, 1989; Palmer, 1996; Mukolwe, 1999). People use woodlands for the following purposes (DWAF, 1995; Munslow *et al*, 1988):

- Fuelwood, which is the major source of energy for cooking, lighting and heating;
- Timber for construction material and woodcarving;
- Fruit, which is an important dietary supplement, and sap for brewing of beer and wine;
- Bark for making ropes and weaving;
- Medicinal products from bark, bulbs, leaves and roots;
- Honey production;
- Harvesting of insects, mushrooms and other edible plants;
- Grass for thatching and weaving, and for grazing.

For poles, kraalwood and fuelwood, harvesting of tree resources is often opportunistic and depends on availability of preferred species. The opportunistic harvesting was observed by Poynton (1984) and suggests the scarcity of good quality trees in some areas of South Africa. In the Eastern Cape Province, the typical indigenous trees used by local inhabitants are *Acacia karroo* and forest species such as *Podocarpus* species, *Maytenus* species and *Ptaeroxylon obliquum* (Briers and Powell, 1996; Dyer, 1996). This can be attributed to the fact that these indigenous species are good fuelwood species, and also provide durable poles for construction purposes (Davis and Eberhard, 1991; Dyer, 1996; Dold and Cocks, 1997; Van Eck *et al*, 1997). In rural areas, regardless of whether they are well or poorly endowed with indigenous trees and woodlands, the majority of inhabitants prefer indigenous tree species rather to introduced woody species for fuelwood and other purposes (Hoffman *et al*, 1999). This can be attributed to the fact that exotic trees are generally less durable than indigenous trees, and that they are not appropriate for the traditional ways of construction and the making of fires (Mander and Quinn, 1995).

It is widely thought that trees are the main supply of rural household energy and that the people in the rural areas of South Africa are dependent upon wood for fuel rather than for other purposes such as construction (Le Roux, 1979). If this is the case, it can be assumed that a large portion of trees harvested is consumed as fuelwood. However, fuelwood combustion characteristics vary a lot between species and different kinds of wood have distinct burning properties when used to make an open fire (Plate 1.1) or even when fed into a properly designed kitchen oven (Poynton, 1984). Some types of wood when burnt supply less energy than others, while some split with explosive violence, ejecting a shower of glowing splinters (Archer, 1994; Poynton, 1984). The factors which influence people's preference for tree species for fuelwood are their capacity for prolonged, steady burning without emitting sparks, excessive smoke or noxious vapours. The fuelwood most preferred should also make long-persistent glowing coals, which eventually disintegrate to leave nothing but fine ash (Steyn, 1990; Poynton, 1984).

Women, who do most of the fuelwood harvesting, do not prefer to collect large pieces of fuelwood even in cases where such wood is readily available. This is because large pieces require splitting before use, which is difficult for women (Steyn, 1990). Therefore, preference in collection is also governed by the gender of wood harvesters.

Harvesting trees and storing it as woodpiles is another form of fuelwood usage. This kind of fuelwood is usually packed adjacent to homes in rural homesteads for later use, or when there is no time available to harvest for daily fuelwood. Large pieces of wood are greatly preferred because they are sturdier and hence better to store for long periods (Steyn, 1990). Men are usually the ones who harvest large pieces for woodpiles, and in some cases woodpiles are bought from donkey cart wood vendors or collected by vehicle.

Plate 1. 1. **A traditional method of cooking. Open fires, often made outside houses are usually used for cooking meals.**

**Plate 1. 2. A woodpile adjacent to a home in Pikoli. Woodpiles usually comprise markedly heavier pieces of wood than those found in headload fuelwood.**

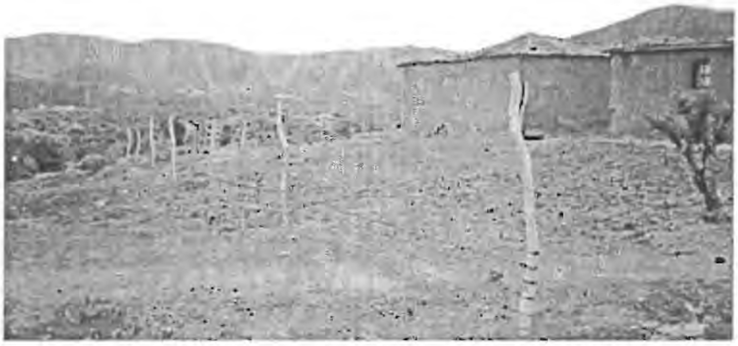

**Plate 1. 3. Fencing of homesteads in Pikoli using poles derived from *Ptaeroxylon obliquum* trees.**

### 1.2.3. Rates of tree harvesting for fuelwood (kg/household/annum) by rural communities in South Africa

The rate of use of indigenous trees in the rural areas of the developing countries show that there is likely to be a tree resource deficit in most rural areas, with the supplies predicted to be almost depleted by the year 2020 (Marker *et al*, 1978; Percival and Homer-Dixon, 1995; Grundy *et al*, 2000; Kituyi *et al*, 2001). For example, in Kwazulu-Natal, 200 to 250 natural forests have disappeared over the past 50 years (Wilson and Ramphele, 1989). The harvesting of trees occurs throughout the year, with harvesting for cooking fuel increasing rapidly in winter when additional wood is required to provide warmth (Munslow *et al*, 1988; Steyn, 1990; Martin, 1996). Earlier estimates show that on average, a South African rural household uses between 683 kg and 3 777 kg of tree resources as fuelwood annually (Best, 1979; Eberhard, 1986; Bembridge and Tarlton, 1990) [Table 1.1].

**Table 1. 1. Summary of fuelwood harvesting estimates from surveys in rural areas of the Eastern Cape Province and Kenya**

| AREA | ANNUAL FUELWOOD USED (kg/cap/year) | ANNUAL FUELWOOD USE (kg/household/year) | SOURCE |
|---|---|---|---|
| Jozanna's Nek | 270 | 1700 | Best, 1979 |
| Clarkebury | 484 | 2753 | Eberhard, 1986 |
| Nkanga | 498 | 3777 | Eberhard, 1986 |
| Manzimahle | 650 | 2845 | Eberhard, 1986 |
| Lujiko | 766 | 3402 | Eberhard, 1986 |
| Peddie | - | 683 | Bembridge and Tarlton, 1990 |
| New Bethesda | 648 | 3042 | Eberhard, 1986 |
| Turkana, Kenya | 402 | - | Ellis *et al*, 1984 |
| Machakos, Kenya | 707 | - | Mungala and Openshaw, 1984, |
| Amboseli Maasai, Kenya | 355 | - | Jensen, 1984 |
| Kenya | 291 - 1128 | - | Kituyi *et al*, 2001 |

From the estimates it would appear that the rural households in Kenya harvest more trees for fuelwood than households in the rural Eastern Cape of South Africa, but such a comparison cannot be made since for Kenya the figures quoted are in per capita per annum only. However, if a comparison is based on the per capita harvesting, it can be concluded that the rates are relatively the same.

### 1.2.4. Alternative sources of fuel

There are seven alternative energy sources identified for use by rural inhabitants in cases of wood scarcity. These alternatives are identified on the basis of their availability and feasibility of utilisation. The alternatives are biogas, solar thermal energy, coal, paraffin, liquified petroleum gas (LPG), diesel electricity and grid electricity (Table 1.2).

**Table 1. 2. The list of seven alternative energy sources identified for use by rural inhabitants in cases of fuelwood scarcity.**

| Energy sources | Convenience and comfort (0 – 1) | Degree of safety (0-1) | Continuity and predictability (0-1) |
|---|---|---|---|
| LPG | 1.00 | 0.5 | 1.00 |
| Grid electricity | 1.00 | 0.5 | 1.00 |
| Diesel electricity | 0.5 | 0.5 | 0.75 |
| Solar thermal | 0.5 | 1.00 | 0.5 |
| Biogas | 0.5 | 0.75 | 0.5 |
| Coal | 0.25 | 0.75 | 0.75 |
| Paraffin | 0.25 | 0.25 | 0.75 |

Note: Diesel electricity refers to electricity generated at the local level (village or municipality) using diesel in a diesel engine coupled to an alternator (Agrawal and Singh, 2001).

Source: Ramanathan and Ganesh, 1994

From the table above, it is clear that LPG and grid electricity have a high ranking in: convenience and comfort, safety, and continuity and predictability. Based on the same scale, coal and paraffin have the worst ranking in convenience and comfort and safety. A recent study on energy allocations for cooking in India demonstrated that LPG and biogas are the most suitable alternative energy sources which should be promoted for the supply of rural households' energy due to their low costs (Agrawal and Singh, 2001). Attempts to promote fuelwood alternatives to rural population are, however, usually hampered by the poor rural economic conditions (Furness, 1979; Martin, 1996; Agrawal and Singh, 2001).

It is logical therefore to assume that an improvement of rural populations' economic conditions is one of the many ways that can help reduce dependence on indigenous timber for fuel. In South Africa, the installation of electricity is considered to be the most economical step forward in meeting rural people's fuel needs (Furness, 1979; Gandar, 1994), although some studies reveal that even electrification of rural households does not necessarily guarantee that there will be less fuelwood usage, as most electrified rural households in this country still use fuelwood as their main energy source (Trollop and Coetzee, 1978). Therefore, from current demographic patterns and the reluctance of the majority of rural people to change to other commercially available household fuels, it is clear that fuelwood usage will continue to rise in absolute terms (Munslow *et al*, 1988). Another unknown customary factor is the impact of AIDS-related deaths on fuelwood consumption, due to an increase in funerals and their associated customary feasts.

### 1.2.5. Relationship between land degradation and patterns of tree harvesting

People's need for fuelwood and construction materials is so desperate that any tree near the home is cut to obtain materials for building houses, cattle kraals, fencing posts and any structure. This use of poor quality building materials may prove expensive as structures erected need frequent repairs and hence, more trees harvesting (Steyn, 1990). This has resulted in trees continually being cut developing clear patterns of use that leave the land near villages, either denuded, or with isolated patches of indigenous bush exposed to erosion (Van Rensburg *et al*, 1997). This pattern results in trees being unavailable near the village center, while more trees are available in areas further away from the village (Figure 1.4 – 1.5).

The Ciskei[2] government realized the unsustainability of tree resources use patterns and instituted fines for the illegal cutting of green (live) trees. These fines provided some measure of protection for trees and indigenous forests, especially those found along the Fish River Valley (Steyn, 1990). However, these laws have not succeeded in curbing exploitive utilisation patterns, as some households acknowledge that they cut live trees while harvesting for wood (pers.obs; Steyn, 1990). It is thought that the collapse of traditional institutions and the lack of capacity for law enforcement play a major role in the exploitative and illegal use of tree resources (Cocks, 2000).

It is argued that intensive selective chopping of trees does not have a major impact on the structure of the trees and the Valley Bushveld in the Eastern Cape, and that, if the root system remains intact, this will allow coppicing and regrowth (Martin, 1996). The involvement of commercialisation in fuelwood has made selective harvesting of trees impossible, as fuelwood vendors to cut of access paths for donkey carts that are used to ferry wood (Martin, 1996).

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[2] A former South African Homeland/Bantustan that ceased to exist on 27 April 1994. The capital was Bisho (see page 16).

**Plate 1. 4. A photo taken about 800 m from the centre of Pikoli village. The land near the village has no vegetation cover and hence vulnerable to erosion.**

**Plate 1. 5. A photo showing good vegetation cover at distance of 3000 m (3 km) from the centre of Pikoli village.**

Although tree harvesting patterns vary between provinces in South Africa, due to a decrease in the number of trees suitable for fuelwood closer to the villages, the time spent by harvesters in gathering this resource is increasing (Gandar, 1983). In rural villages of the Eastern Cape, inhabitants on average collect wood for about 3 to 5.2 times per week (Bembridge and Tarlton, 1989; Mander and Quinn, 1995). The time spent per each fuelwood harvesting expedition is between 9.5 to 12.95 hours per week, and the distance traveled is between 7.2 and 19 km (Mander and Quinn, 1995) [Table 1.3].

**Table 1. 3. The number of adult working hours and distances required to harvest fuelwood in KwaZulu-Natal and the Eastern Cape.**

| Area | Hours spent per week | Distance traveled round trip (km) | Source |
|---|---|---|---|
| Msinga (valley Bushveld) KwaZulu-Natal | 11.0 | - | Gandar, 1983 |
| Amatola basin | 10.7 | 7.2 | Bembridge and Tarlton, 1990 |
| Ciskei | 10.2 | 4.0 | Bembridge and Tarlton, 1990 |
| Eastern Cape | 10.95 | - | Mander and Quinn, 1995 |
| Eastern Cape | 12.95 | - | Ward, 1994 |
| KwaZulu-Natal | 9.5 | 19[3] | Gandar, 1983 |

## 1.3. DIRECT USE VALUES OF INDIGENOUS TREES HARVESTED FROM COMMUNAL TREE RESOUCE BASES IN THE RURAL AREAS OF SOUTH AFRICA

The natural capital stocks such as trees contribute both directly and indirectly to human welfare and therefore represent tangible and intangible benefits to rural inhabitants (McNeely, 1993; Costanza *et al,* 1997; Hassan, 1998; Shackleton and Shackleton, 2000; Guo *et al*, 2001). These benefits are also derived by urban dwellers that import these resources (Stiles, 1994; Taylor, 1997; Hassan, 1998; Qureshi and Kumar, 1998). A number of case studies in South Africa have given a descriptive analysis of the types of products harvested from natural woodlands and forests (Everard and Van Wyk, 1995; Davis and Wynberg, 1996). Several attempts have been made to quantify and value the products rural communities derive from natural woodlands and forests (Liengme, 1983; Borchers *et al,* 1990; Griffin *et al,* 1992; Gandar, 1994; Mander and Quinn, 1995; Von Maltitz and Scholes, 1995; Costanza *et al,* 1997; Hassan *et al,* 1997; Beukman *et al,*

[3] This is an extreme case Gandar (1983) observed in KwaZulu-natal, where a group of women spent 9.5 hours gathering a single headload each and walking a round trip of 19 km (Table 2)

1998; High and Shackleton, 2000; Shackleton *et al*, 2000a; Shackleton and Mander, 2000; Shackleton and Shackleton, 2000). However, these tangible and intangible benefits derived from trees are not recognized fully by human societies (Guo *et al*, 2001).

Earlier estimates of the contribution of the natural capital stocks to the South African economy show that these resources account for about one billion Rand per year (DWAF, 1997). A further addition to the national economy of about 7 million Rand is thought to derive from tree resources in the form of formal and informal curio and woodcarving in some rural regions of this country (DWAF, 1997).

In 1998 it was estimated that a rural person in the Eastern Cape derived approximately R157.17 per annum directly from using the tree resources (Shackleton *et al*, 1998a). In KwaZulu-Natal and the Bushbuckridge area, it is estimated that a rural inhabitant derives about R301.00 and R117.52 per annum respectively (Shackleton *et al*, 1998a). The figures are given below (Table 1.4).

**Table 1. 4. Direct annual use values derived from woodlands and forests by a rural inhabitant in Eastern Cape, KwaZulu-Natal and Bushbuckridge (1998 prices).**

| | Eastern Cape | KwaZulu-Natal | Bushbuckridge |
|---|---|---|---|
| Fuelwood | R132.99 | R229.27 | R89.54 |
| Buildings | R12.96 | R32.04 | R16.68 |
| Fences and kraals | R11.22 | R39.69 | R11.30 |
| Total | R157.17 | R301.00 | R117.52 |

Source: Shackleton *et al* (1998a).

Although lack of data makes it difficult to estimate the real contribution of natural woodlands and forests to the country's economy, Shackleton *et al* (1998a) estimates that direct use values of natural woodlands and forest resources by rural inhabitants is approximately R3.6 billion per annum, a much higher figure than earlier estimates by DWAF (1997). The Eastern Cape, with about 4.94 million hectares of wooded area and about 20% (3.66 million people) of South Africa's rural population contributes approximately 11% of this income (Table 1.5).

**Table 1. 5. Provisional and national direct use value of tree resources' estimates (1998 estimates)**

| | Easter Cape | KwaZulu-Natal | Northern Province | Rest of RSA | Total RSA |
|---|---|---|---|---|---|
| Wooded area (million Ha) | 4.94 (10.6%) | 6.09 (13.1%) | 11.851 (25.4%) | 23.794 (50.9%) | 46.675 (100%) |
| Rural population (millions) | 3.66 (20.2%) | 4.603 (25.4%) | 2.473 (13.6%) | 7.393 (40.8%) | 18.135 (100%) |
| Estimated value | R396,180 | R1,528,914 | R842,573 | 865,956 | R3,633,623 |
| Estimated percentage contribution | 10.9% | 42.1% | 23.2% | 23.8% | 100% |

Source: Shackleton *et al* (1998a)

From the table above, it is clear that KwaZulu-Natal contributes disproportionately to the economy. The explanation for this high contribution is that tree resources have been highly commercialized in KwaZulu-Natal. This clearly exhibits the fact that natural capital stocks such as trees have an important role in uplifting the rural economy in this country.

## 1.4. OBJECTIVES

This study was conducted on communal land at Pikoli in the Eastern Cape Province of South Africa. The objectives of the research were to:

- Determine which tree species are used in Pikoli,
- Determine the purposes the tree species are used for,
- Determine the level of preference for certain trees by the inhabitants,
- Quantify change in tree density and levels of tree damage/utilisation at varying distances away from the village centre,
- Quantify and determine the local direct use value the Pikoli community gains from collecting for fuelwood.

These objectives were achieved by answering the following key questions:

- Do the people of Pikoli prefer certain trees over others for fuelwood, fencing and construction materials?

- Does their preference of certain trees have an impact on the availability of preferred species closer to the village?
- Is the abundance of preferred trees and their levels of utilisation the same at varying distances from the centre of the village?
- Does the harvesting of indigenous trees have a direct use value to households?
- Are there any other sources of energy people can use instead of fuelwood? If so, can they afford them?
- Do social conditions such as education and earnings affect the way indigenous trees are being harvested?

## 1.5. STUDY AREA

Pikoli is situated along the Great Fish River in the magisterial district of Peddie in the Eastern Cape Province of South Africa (Figure 1.1). the area is approximately 50 km from Grahamstown and 30 km from Peddie. Most inhabitants of this area are unemployed and obtain most of their cash in the form of old-age allowances or government pensions (Ainslie, 1995; Ainslie *et al*, 1996). The Eastern Cape Province's rate of unemployment and poverty is among the highest in this country that is estimated to be between 45% (Deshingkar and Cinderby, 1997) and 56.3% (DWAF, 1995). The UN Human Development Index (UN, 1998) indicates that approximately 64% of the population lives in poverty. In the rural areas of Peddie these poverty levels are predicted to be much higher than those for the province as a whole, and the average wage earner supports about eight other people on his/her little income (Deshingkar and Cinderby, 1997). Pikoli is a remote place, and 'modern' amenities such as paraffin and liquefied petroleum gas are expensive and difficult to acquire. Electricity and mechanized transport are almost unavailable.

The human concentration is estimated to be between 70 and 98 persons per km$^2$ (Ainslie *et al*, 1994; Gandar, 1994). This, coupled with the high unemployment rate, has led to the people of this rural area living in very poor, overcrowded conditions and exerting great pressure on their limited natural resources (Percival and Homer-Dixon, 1995). This poverty has been highlighted and reported by many other researchers in the past (Percival and Homer-Dixon, 1995; Fabricius *et al*, 1996).

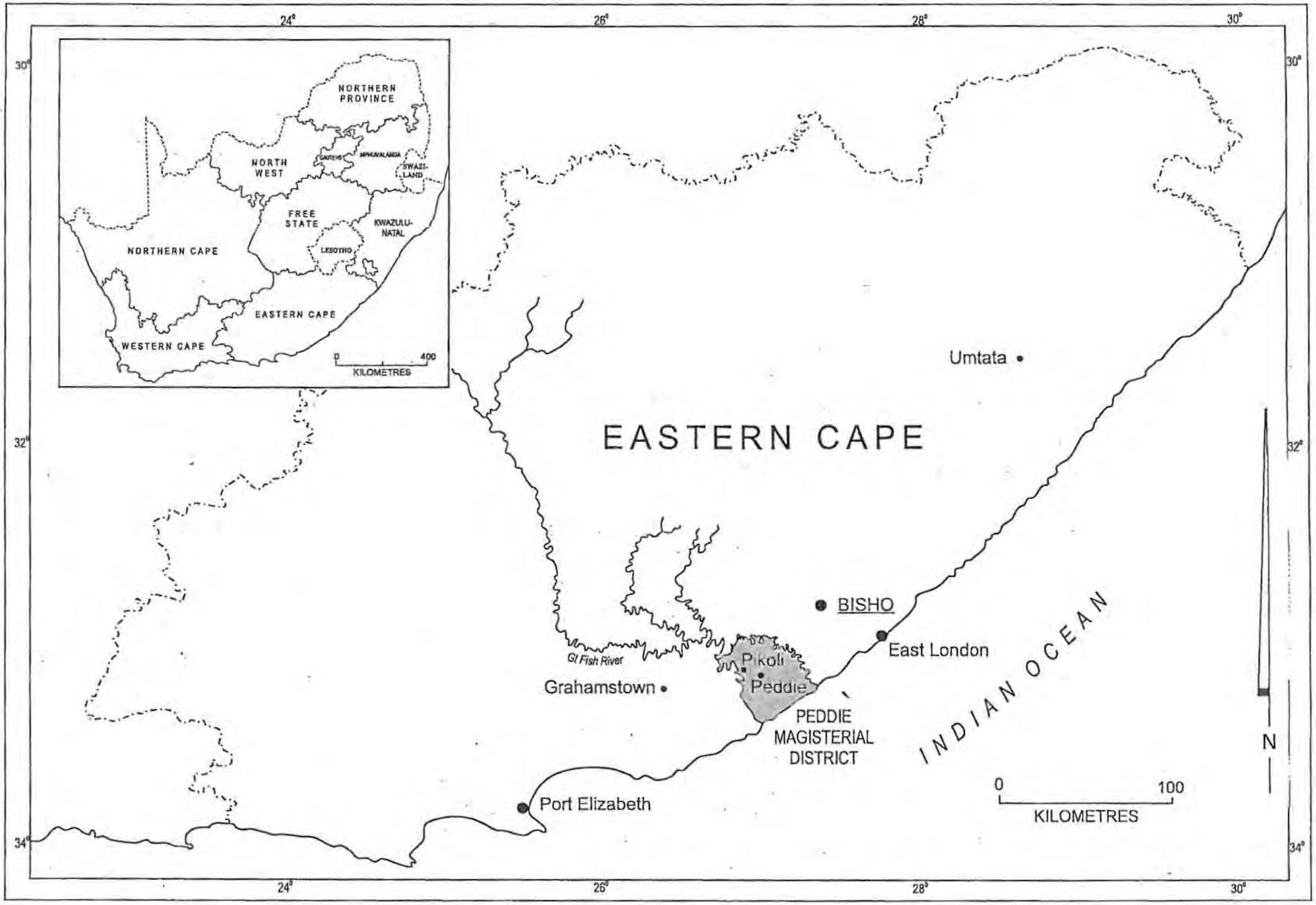


Figure 1. 5. A map showing the study area of Pikoli

### 1.5.1. Vegetation

The vegetation along the Great Fish River is known as Xeric Succulent Thicket, a suborder of Subtropical Transitional Thicket that consists of a mixture of succulents and evergreen trees and shrubs on shallow clay soils (Everard, 1987; Fabricius *et al*, 1996). This is an unusual type of arid savanna (Rutherford and Westfall, 1986) with higher species diversity than other savannas and an extremely low ability to recover its natural state after disturbance (Palmer *et al*, 1990; Stuart-Hill and Aucamp, 1993). The Xeric Succulent Thicket, also known as Fish River Scrub, occupies the wide, flat valley of the Great Fish River at elevations ranging from 100 to 450 m above sea level, and woody shrubs with slow physical growth rates dominate this natural vegetation (Acocks, 1988).

According to 1961 – 1990 climatology records (South African Weather Bureau, 2000), the mean minimum annual temperature for this area is 14.0 °C, with mean minimum winter (May to October) temperature being 11.6 °C. The mean maximum annual temperature is 22.8 °C, with the mean maximum temperature of 24.4 °C recorded in summer months (November to February). Given the natural conditions of sparse ground cover, high geological erosion rates, hot summer conditions (Deshingkar and Cinderby, 1997) and low mean rainfall of between 300 and 400 mm per annum, this vegetation is degraded recovers slowly after degradation (Kerley *et al* , 1994).

Allsopp *et al* (1996) argue that in its undamaged state, this vegetation is extremely dense, semi-succulent and a thorny scrub, which grows to about 2 meters in height. However, human activities threaten the health of the ecosystem and vegetation (Kerley *et al*, 1994). Acocks (1988) mentions that this once dense thicket has been opened up by overgrazing which lead to the invasion of *Euphorbia bothae*. He further argues that in the lower parts of the valley, the scrub is also being invaded, and in parts being replaced by *Acacia karroo*, while on the slopes of this area, patches of *Pteronia incana* are developing (SEI, 1998). The invasion by *A. karroo* occurs mainly in the river valley and along the foot of the mountains. Once it becomes dense enough, it shades out the grass and causes soil erosion, by bringing about a concentration of grazing pressure on the sweeter and more palatable vegetation that develops under it (Acocks, 1988). Many researchers have expressed concern about this encroachment of *A. karroo* in the rural areas of the Eastern Cape, and think that its negative effects are derived from the betterment planning policies of the former homeland governments which led to a reduction in fires and goat numbers of communal lands (Forbes and Trollope, 1991; Gonqwana, 1998; Trollope and Coetzee, 1978). Most of the trees in Pikoli, with the exception of *A. karroo,* which is mostly found in the alluvial areas, are slow growing.

# CHAPTER 2

# CHANGES IN THE STRUCTURE AND DENSITY OF PREFERRED TREES IN RESPONSE TO CONSUMPTIVE USE BY HUMANS

## 2.1. INTRODUCTION

An uneven use of trees by rural communities around their settlement areas has been, and continues to be, a major problem in the management of tree resources. In an ideal situation, humans harvesting fuelwood should be harvesting trees in such a manner that the harvest is evenly spread. However, a uniform harvest distribution seems to be problematic due to uneven terrains, and distances traveled to collect fuelwood. Just as in the utilisation of forage by grazing animals around water points, factors that cause uneven use of trees include: mountainous topography, diverse variety of tree species and marked preference to certain types of trees.

The argument built in this chapter is that the harvesting of trees by rural communities is similar to the effect grazing animals have on the rangeland which surrounds a permanent watering point, known as the pioshere effect (Lange, 1969). Herbivores impact negatively on vegetation and soils close to waterpoints, due to increased grazing and hence trampling pressure (Crawley, 1983; Thrash, 1998; Brits *et al*, 2000; Yates *et al*, 2000; Mphinyane, 2001). Rural inhabitants who harvest natural trees intensively for their daily survival are likely to have the same effect as the observed piosphere effect caused by herbivores. In this context, a water point is equated to a village and tree resource harvesters are substituted for herbivores.

Most of the tree resource bases, especially those found in rural communal areas, are harvested continuously. In most cases, areas closer to the village are overutilized while areas further away from the village centres are often harvested lightly, or not at all, due to the fact that an increase in distance from the village centre means an exponential increase in the size of harvesting area.

The differing percentage harvesting of particular tree species is considered to be a measure of preference of a species. In this regard, differences in percentage use of harvested species will express the preference that people have for one species over the other. Therefore, changes in the structure and density of preferred species as a whole will also determine the preference. This chapter was mainly designed to evaluate the impact of tree harvesters on the individual tree species, in relation to distance from the village centre. The conceptual framework for this study is based on a definition of a piosphere as given by Graetz and Ludwig (1978) and explained above. Their definition, when adapted to human tree harvesters, would mean that a piosphere develops due to interaction of the maintenance and social behavior patterns of tree harvesters with the tree resource base (vegetated landscape) in which a village (equivalent of a watering point) has been established.

With the above background and concepts the aims of this chapter are:

- To determine which tree species are used for what purposes at Pikoli;
- To determine the preference ranking of individual trees by the inhabitants;
- To quantify changes in tree density in response to changes in utilization intensity at varying distances away from the village.

## 2.2. METHODS

### 2.2.1. General approach

The research approach combined a household survey in the form of an administered questionnaire, direct observations, and ecological surveys. The data were collected over a 16-month period. The first survey, the pilot study, was undertaken for one week in July 1999. A semi-formal questionnaire in English, administered with the help of a Xhosa translator was used. The objective of the pilot study was to, in an exploratory manner, assess the feasibility of the research, the practicalities of carrying it out and the suitability of the methods and instruments of measurement (Bless and Higson-Smith, 1995).

The main study, which incorporated household surveys, direct observations and ecological surveys, was undertaken from August 1999 to November 2000 after some adjustments were made to questionnaire and research methods following the pilot study.

### 2.2.2. People's use of and preference for indigenous trees

Direct observations coupled with semi-structured interviews were the main tools used to gather information about the use of and preference for trees at Pikoli. For this section of the survey, semi-structured interviews were conducted with the following general properties (Bless and Higson-Smith, 1995):

- They were structured such that they make a contribution to answering a survey's objectives or subobjectives;
- They were clearly and unambiguously worded; and
- They were able to evoke the most accurate answer within time constraints.

A representative sample of 70 households, which is 40% of the total 174 households[1], was surveyed. This included 5% (10 households) of the total households sampled during the pilot study. The interviews were contacted in each every second house along the pre-determined transect line. This ensured that the households surveyed were randomly selected and representative of the community. The interviews took approximately 60 minutes each (Appendix I). They were aimed at obtaining information on:

- The species harvested;
- The uses of various species (e.g. cooking, heating, and erecting structures such as dwellings and kraals);
- Their 8 most preferred trees, from most to least preferred (see Appendix I).

The interview sessions were undertaken by sitting down, asking questions and listening. This is the best way to learn from the local people (Chambers, 1983). With these core principles of social surveys in mind, an easy, informal and friendly attitude on part of the interviewer made interviewees feel comfortable and hence information was openly and generously shared (see Swanepoel, 1992).

Direct observation methods were used to determine which trees people use. Households were visited and the observer sat with the people and observed how they use their woody resources, and what they use them for. As part of the direct observation exercise, some household members were also accompanied on their tree harvesting expeditions. The tree species harvested and their uses, according to the harvesters, were noted. Harvesting methods were also observed and recorded. Specimens were collected for identification and crosschecking in the Selmar Schönland Herbarium, Grahamstown. The direct observation method was successfully used in a comparable study on indigenous tree uses and preferences in the Eastern Cape Province to establish the

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[1] Source, StatsSA (1996)

indigenous tree use patterns and species preferences in the former Transkei forests (Van Eck *et al*, 1997).

### 2.2.3. Changes in individual tree density and utilisation level at varying distances from the centre of the village

The patterns of tree availability in relation to distance from the village, and patterns of damage to trees caused by tree harvesters were assessed by determining the relationships between distance from the centre of the village and:

i. Tree density (number of trees per 100 $m^2$);
ii. Damage to trees.

The point-centered quarter (PCQ) method of plotless sampling was used to determine tree density and damage (Greg-Smith, 1957; Muller-Dombois *et al*, 1974; Smith, 1990; Reid and Thompson, 1996). Four directional lines from the centre of the village, and transects running at right angles to the directional lines were established at various points and distances from the centre of the village. In positioning directional lines, the area around the village was assessed using 1: 10 000 orthophoto maps. Local informants were consulted about the village boundaries. The length and direction of directional lines were determined using this information.

Firstly, continuous directional lines (1 – 4) [Fig. 2.1], starting at the centre of the village (Themba Secondary School) and transects radiating outward from the centre of the village were established. The bulk of the study was focused on the three major directional lines 1 – 3 of 3 000 m each. Each of these directional lines had interval transects placed at distances 1 200 m, 1 800 m, 2 400 m and 3 000 m perpendicular to the directional lines (Fig. 2.1).

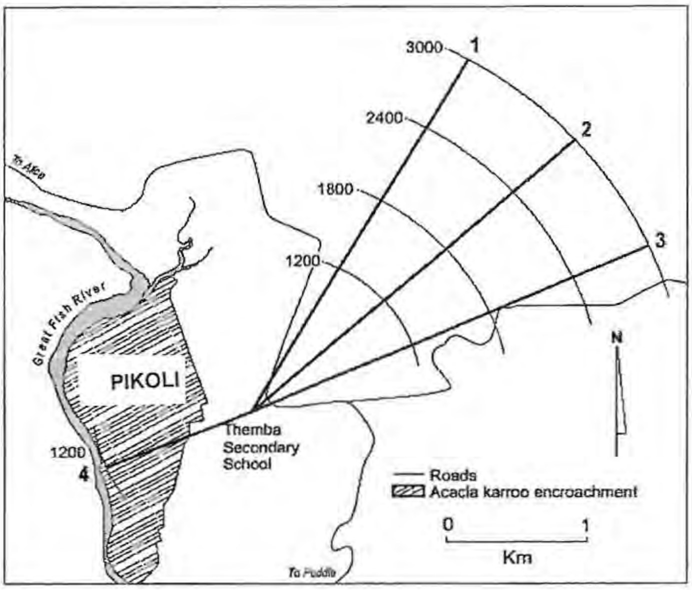


**Figure 2. 1. A map of Pikoli showing the layout of directional lines 1 – 4 used in ecological survey.**

A series of 30 PCQ points were located at random distances along each interval transect. The area around each point was divided into four quadrants. This was done by drawing lines perpendicular and parallel to the interval transect at the sampling point. The tree nearest to the point in each quarter was located and noted, as were the distances from the centre point to the nearest tree in each quadrant. The point-to-tree distances (d1; d2; d3; d4) were measured from the point to the centre of the rooted base of a tree (Fig. 2.2). Tree species were recorded, and samples taken for identification at the Selmar Schönland Herbarium in Grahamstown.

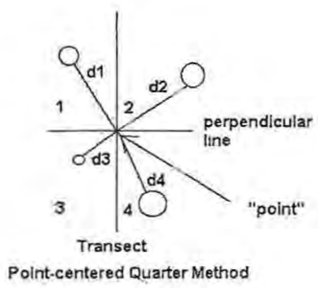


**Figure 2. 2. Point-centred quarter method. Points are located along the interval transect. A line perpendicular to the transect is drawn at each point, which divides the local area into 4 quarters. (source: Cipollini, 2001).**

The same procedure was also performed along the fourth direction line, which was 1200 m long and could accommodate only 1 interval transect, because of the barrier effect of the Great Fish River 1200 m from the village.

### 2.2.4. Tree utilisation level

The extent to which individual trees were utilised was also quantified during density assessments. A five-point classification system was used (Table 2.1) based on visual determination. Examples of each utilisation class are illustrated in Plates 2.1.1 – 2.1.5.

**Table 2. 1. Classification categories used in quantifying individual tree utilisation levels (see Plates 2.1.1 – 2.1.5).**

| Utilisation level | Classification |
|---|---|
| 1 | A tree that has less than 10% of its branches broken or cut. A tree in this category will have no form of damage to its main stem. |
| 2 | A tree that has between 10 and 30% of its branches broken or cut. |
| 3 | A tree with between 30 and 50% of its branches broken or cut. |
| 4 | A tree that has more than 50% of its branches broken or cut. A tree that has its main stem partially broken or cut also falls into this category. |
| 5 | A tree that has 80 – 100% of the branches broken or cut. This would include a tree that has its main stem broken or cut and trees that are totally dead. |

Plate2.1.1. *Ptaeroxylon obliquum* (sneezewood) with it main stem and branches intact. It is classified as having damage level of 1.

Plate 2.1.2. Sneezewood, with its main stem only partially broken. This tree was categorized as having a damage level of 2.

Plate 2.1.3. *Olea europaea* subsp. *Africana* (wild olive) with between 30 and 50% of its branches cut. This tree is classified as having a damage level of 3.

Plate 2.1.4. . Sneezewood with between 50 and 80% of its branches and its main stem broken or cut. The main stem has also been severely broken. This tree is classified as having a damage level of 4.

Plate 2.1.5. This wild olive has 100% of its branches cut. Classified as having a damage level of 5.

**Plate 2.1. Photographs illustration the five-point visual tree-utilisation damage classification.**

### 2.3. DATA ANALYSIS

The ranking of tree species preference was determined from the total survey results. The percentage preference was calculated:

- $$\text{Percentage preference} = \frac{\text{Total number a particular species was mentioned}}{\text{Total number of times all species were mentioned}} \times 100$$

This analysis was used previously and proved to be a success in the determination of the indigenous tree uses and preferences in the Eastern Cape Province by Van Eck *et al* (1997).

In analysing the tree density data collected, point-to-plant distances were first totaled for all species of trees and all points and this was averaged to give the mean point-to-tree distance:

- $$\text{Mean point-to-tree distance (D)} = \frac{\text{Sum of all distances measured}}{\text{Total number of quadrants}} \text{ (m)}$$
- $$\text{Total tree density (per 100 m}^2\text{)} = \frac{100}{D^2}$$

Calculations were also performed to establish whether preference ranking of a tree species by residents is determined by its abundance closer to the village centre. This objective was met by determining the absolute abundance of tree species. Muller-Dombois (1974) noted that this parameter is often considered as a measure of species availability, and that it should be related to density calculations. The abundance of species was determined using the equation outlined by Greig-Smith (1957) that:

- $$\text{Absolute abundance of tree species (\%)} = \frac{\text{Number of species} \times 100}{\text{Total number of points sampled.}}$$

It is worth noting here that in determining the tree density, which Lyon (1968) defines as the number of individual trees per area, the assumption was made that individuals of all tree species were randomly dispersed.

A relationship between individual tree density (the dependent variable) and distance from the village along the directional lines (1 – 3) [the independent variable) was determined. An ANOVA was conducted to determine whether the linear regression model was appropriate. Three density measures at each distance point (e.g. 1200 m) were averaged to obtain a single average density. Therefore, one dependent variable (density) and one independent variable (distance) with 4 levels were analyzed per directional line.

In analyzing the tree utilisation data, three totals of damage levels at each distance interval were obtained from each of the three distances and the average determined to represent the utilisation level at that particular point.

Three replicate data sets were measured for individual density and utilisation at each sampling point along the transect, combined and mean values calculated. ANOVA relationships between individual tree damage at different distances from the village along directional lines (1 – 3) were also determined using simple linear regressions. A confidence level of 95% was used to determine the statistical significance of both density and utilisation regression analyses. The computer program used to perform statistical functions was Statistica 5.5 (StatSoft. Inc. 1984 – 1999).

## 2.4. RESULTS

### 2.4.1. People's use of and preference for indigenous trees

From the 70 interviews, 23 indigenous trees were identified that the people of Pikoli preferred and used for either fuelwood or construction purposes. A list of these tree species, which are used by the community, their preferred uses and the percentage times that they were mentioned during the interviews, is presented in tabular form (table 2.2).

Five indigenous tree species are most popular as fuelwood in Pikoli. These species are preferred by more than 50% of the people interviewed. They are: *Ptaeroxylon obliquum* (sneezewood), *Pappea capensis* (Jacket plum), *Schotia afra* (karroo boer-bean), *Maytenus undata* and *Acacia karroo* (Sweet thorn).

**Table 2. 2. Indigenous tree species preferred in Pikoli. The table gives a ranking of the preference and preferential use of tree species. Use of some tree species is not relevant to this research, but is included in the table (e.g. use as fruit).**

| Rank | Percentage | Botanical name | Xhosa name | Common name | Preferred use |
|---|---|---|---|---|---|
| 1 | 63 | *Ptaeroxylon obliquum* | Umthathi | Sneezewood | Fuelwood, poles, building, ritual ceremonies. |
| 2 | 59 | *Pappea capensis* | Ilitye | Jacket plum | Fuelwood, fruit |
| 3 | 58 | *Schotia afra* | Umgxam | Small-leaved karroo boer-bean | Fuelwood |
| 4 | 58 | *Maytenus undata* | Umqaqoba | | Fuelwood, poles |
| 5 | 53 | *Acacia karroo* | Umnga | Sweet Thorn | Fuelwood, poles |
| 6 | 35 | *Maytenus mossambicensis* | | Black Forest Spike-thorn | Fuelwood |
| 7 | 27 | *Coddia rudis* | Intsinde | Small Bone-apple | Fuelwood |
| 8 | 27 | *Schotia brachypetala* | Umfofo | Weeping Boer-bean | Fuelwood, poles |
| 9 | 25 | *Boscia oleoides* | Umgqamagqama | Karroo Shepherd's Tree | Fuelwood |
| 10 | 25 | *Pleurostylia capensis* | Umngqangqa | Coffee Pear | Fuelwood, poles |
| 11 | 18 | *Olea europaea.* subsp. *africana* | Umnquma | Wild olive | Fuelwood, poles, fruit, ritual ceremonies |
| 12 | 13 | *Scutia myrtina* | Isiphingo | Cat-thorn | Fuelwood |
| 13 | 10 | *Sideroxylon inerme* | Umqwashu | Milkwood | Fuelwood, poles |
| 14 | 10 | *Dovyalis caffra* | Umqokolo | Kei Apple | Fuelwood, fruit |
| 15 | 8 | *Ehretia rigida* | Umhleli | Puzzle Bush | Fuelwood, |
| 16 | 8 | *Euclea undulata* | Umgwari | Guarri | Fuelwood, fruit |
| 17 | 7 | *Trimeria grandifolia* | Ilitye | Wild Mulberry | Fuelwood |
| 18 | 7 | *Olea woodiana* | Umgqukunqa | Forest olive | Fuelwood |
| 19 | 5 | *Azima tetracantha* | Igcegceleya | Needle bush | Fuelwood |
| 20 | <5 | *Cussonia thyrsiflora* | Umsenge | Cape Coast Cabbage Tree | Fuelwood |
| 21 | <5 | *Dovyalis rhamnoides* | Umqokolo | Common Sourberry | Fuelwood |
| 22 | <5 | *Clerodendrum glabrum* | Uluvethe | Cat's Whiskers | Fuelwood |
| 23 | <5 | *Acalypha glabrata* | Umthombothi | Forest False-nettle | Fuelwood |

### 2.4.2. Changes in individual tree density at varying distances from the centre of the village

In Pikoli, the community complained about the scarcity of tree resources close to the village. The initial observations (pilot study) showed that the centre of village, or centre of the piosphere, has people radiating from it in a non-circular pattern that is determined by terrain and other physical barriers. Trees closer to the village centre are used unselectively. However, as the distance people travel to harvest trees increases, utilization seems to become more selective. Livestock also has an influence on the availability of trees, but mainly on foliage and seedling recruitment (Yates, 2000). A distinct change in the individual density of trees at varying distances from the centre of the village was observed. Figure 2.3 shows that tree density exponentially increases with increasing distance from the village.

One-way Analysis of variance (ANOVA) indicated that the relationship between tree density with distance away from the centre of the village along directional line 1 is significant. The same analysis also indicated a significant relationship between tree density and distance away from village along directional line 3. However, ANOVA test along directional line 2 indicated a non-significant relationship between tree density and distance away from the village. This might have been as a result of the relatively small sampling numbers and also as a result of a small plot size. It likely that the point centred quarter method is only valid in woodland with more evenly spaced trees, and that another method would have been better in this clumped Valley Bushveld (Table 2.3).

**Table 2. 3. Analysis of variance in directional lines 1 – 3.**

| Directional line | Number of samples at each distance interval (n) | R | $r^2$ | Significant relationship ($P < 0.05$) |
|---|---|---|---|---|
| Directional line 1 | 12 | 0.95 | 0.91 | Yes |
| Directional line 2 | 12 | 0.82 | 0.68 | No |
| Directional line 3 | 12 | 0.96 | 0.91 | Yes |

The average numbers of trees per directional line 1 – 3 was found to be 23.5, 27.0 and 13.75 respectively. ANOVA indicated high standard deviations of 22.2, 22.5 and 15.3 for these directional lines, which means that the sample is a slightly biased estimate of the population, in that on the average it is slightly a low estimate, especially in this relatively small sample. Directional line 4 was not included in the analysis due to lack of sufficient sampling points.

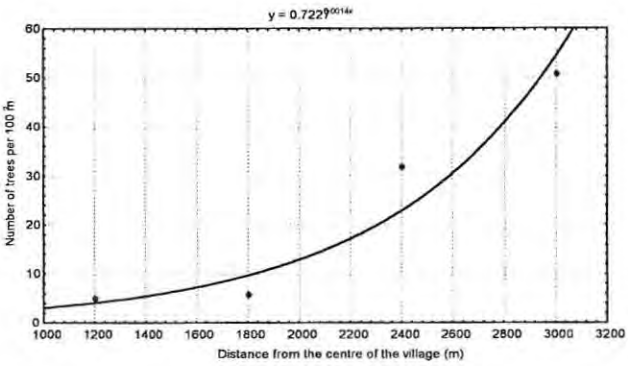


**Figure 2.3. 1. Changes in the number of trees per 100 m² in relation to distance from the centre of the village along directional line 1.**

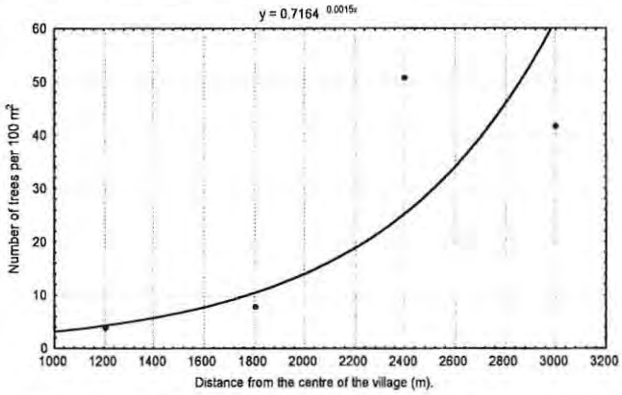


**Figure 2.3. 2. Changes in the number of trees per 100 m² in relation to distance from the centre of the village along directional line 2.**

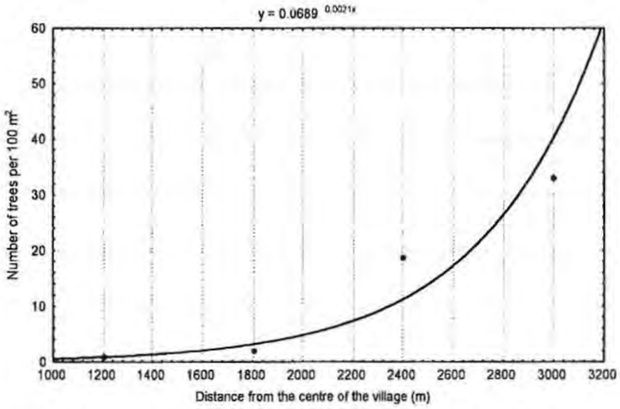


**Figure 2.3. 3.Changes in the number of trees per 100 m² in relation to distance from the centre of the village along directional line 3.**

**Figure 2. 3. Changes in individual tree density per 100 m² in relation to distance from the centre of the village along directional lines 1 - 3.**

The average of all numbers of individual trees per 100 m² per directional line were plotted (Figure 2.4), and this showed that there is an exponential increase in tree density with increasing distance from the centre of the village.

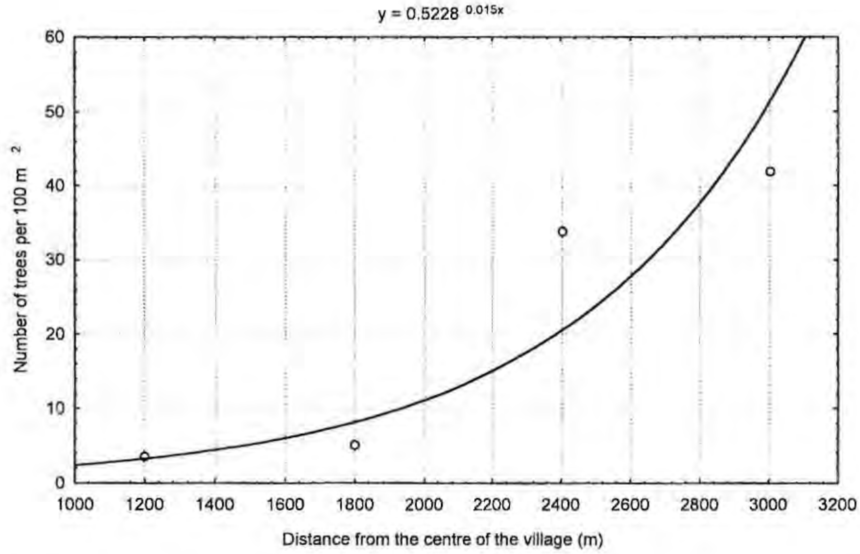


**Figure 2. 4. Change in the number of trees per 100 m² in relation to distance from the centre of Pikoli.**

One-way Analysis of Variance (ANOVA) indicated a significant relationship between tree density and distance away from the centre of the village along all three directional lines (Table 2.4).

**Table 2. 4. Analysis of variance for means of directional lines 1 – 3.**

| | N | R | $r^2$ | Significant relationship ($P < 0.05$) |
|---|---|---|---|---|
| Mean of directional lines 1-3 | 3 | 0.94 | 0.89 | Yes |

### 2.4.3. Abundance of individual tree species in relation to distance from the center of Pikoli

The relative abundance of trees in directional lines (1 – 3) along the 3 000 m length from the centre of Pikoli is graphically presented below (Fig. 2.5).

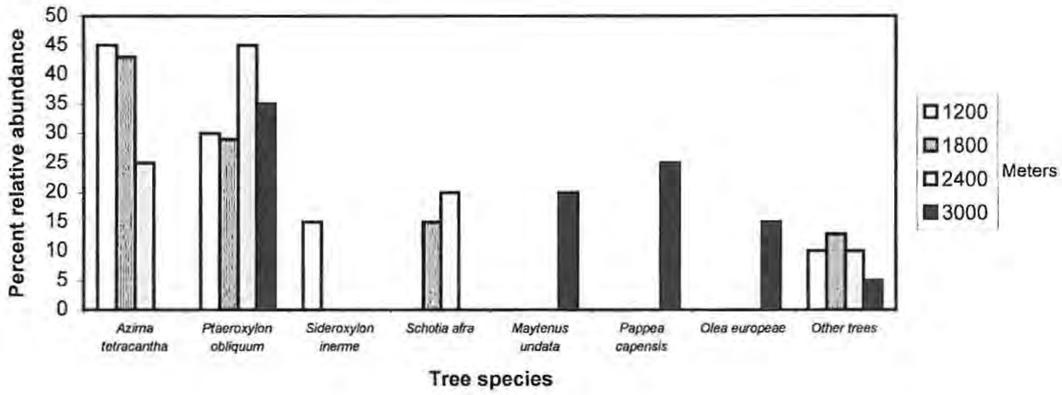


**Figure 2. 5. Percentage relative abundance of trees at varying distances from the centre of the village.**

*Azima tetracantha* (Igcegceleya/needle bush) is highly abundant at a distance of 1200 m from the village in directional lines 1 – 3. Its abundance slightly decreases at 1800 m and 2400m distances from the centre of the village. The reason for it not being available at 3000 m distance from the village centre is due to the fact that needle bush is an increaser species that thrives under disturbed conditions (Ralphs, 2000).

*Ptaeroxylon obliquum* (Umthathi/sneezewood) is abundant at all distances (i.e. 1200m, 1800m, 2400m and 3000m) from the village. The relative abundance of this most preferred species reaches its maximum at a distance of 2400 m from the centre of the village. Although it is abundant closer to the village, most sneezewood occurring at 1200m from the village center is heavily utilised and hence useless as fuel or construction material.

*Sideroxylon inerme* (Umqwashu/Milkwood) is only abundant at 1200m from the centre of the village. The reason for it not being available at the distances of 1800m to 3000m from the centre of the village is unknown.

*Schotia afra* (Umgxam/small-leaved karroo boer-bean) is only abundant at 1200m and 1800m away from the centre of the village. This species is not abundant at 2400m and 3000m distances from the village centre. *S. afra* might be an area specific species that grows well at low altitudes, since up to the distance of approximately 2000 m from the village the area is low lying and high lying above that.

*Maytenus undata* (Umqaqoba), *Pappea capensis* (Ilitye/jacket plum) and *Olea europaea* subsp. *Africana* (Umnquma/wild olive) are only found at 3000m distances from the centre of the village. These trees require a long period to reach their maturity stages (CRFG, 2000), and this might be the reason why they are not abundant near the village centre where utilisation rates are high.

*Acacia karroo* (Umnga) has absolute abundance along directional line 4. There were no other species found along this directional line.

### 2.4.4. Changes in individual tree utilisation at varying distances from the centre of the village

A distinct change in utilisation of trees at varying distances from the centre of the village was observed. Damage/utilisation to trees decreases significantly with increasing distance away from the village (Fig.2.6).

Damage to individual trees is very high close to the village centre, with low damage levels being observed at distances further than 1200m away from the village centre. ANOVA indicated that along directional lines 1 – 3, there exist significant relationships between tree damage levels and the distance away from the center of the village (Table 2.4).

**Table 2. 5. Analysis of Variance of tree damage along directional lines 1 – 3.**

| Directional line | n | R | $r^2$ | Significant relationship ($P < 0.05$) |
|---|---|---|---|---|
| Directional line 1 | 12 | -0.87 | 0.07 | Yes |
| Directional line 2 | 12 | -0.67 | 0.04 | Yes |
| Directional line 3 | 12 | -0.54 | 0.03 | Yes |

Low standard deviations of 1.10, 0.95 and 0.64 along these directional lines indicate that the sample is not a biased estimate of the population. Directional line 4 was not included in the analysis due to lack of sufficient sampling points.

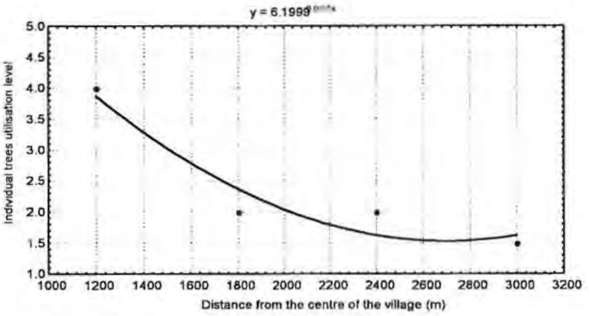


**Figure 2.6. 1. Changes in individual tree utilisation levels with distance from the centre of the village in directional line 1.**

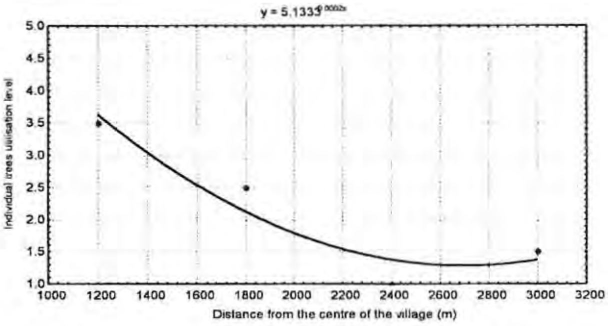


**Figure 2.6. 2 Changes in individual tree utilisation levels with distance from the centre of the village in directional line 2.**

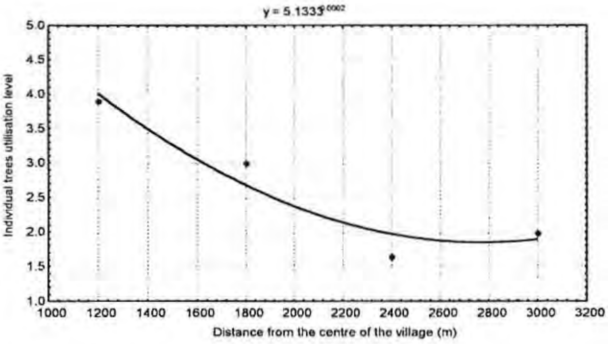


**Figure 2.6. 3. Changes in individual tree utilisation levels with distance from the centre of the village in directional line 3.**

**Figure 2. 6. Changes in individual tree damage levels.**

An average of utilisation levels for individual trees per directional line was plotted (Figure 2.7) and this graph shows that there is a significant decrease (Table 2.6) in tree utilisation with increasing distance from the centre of the village.

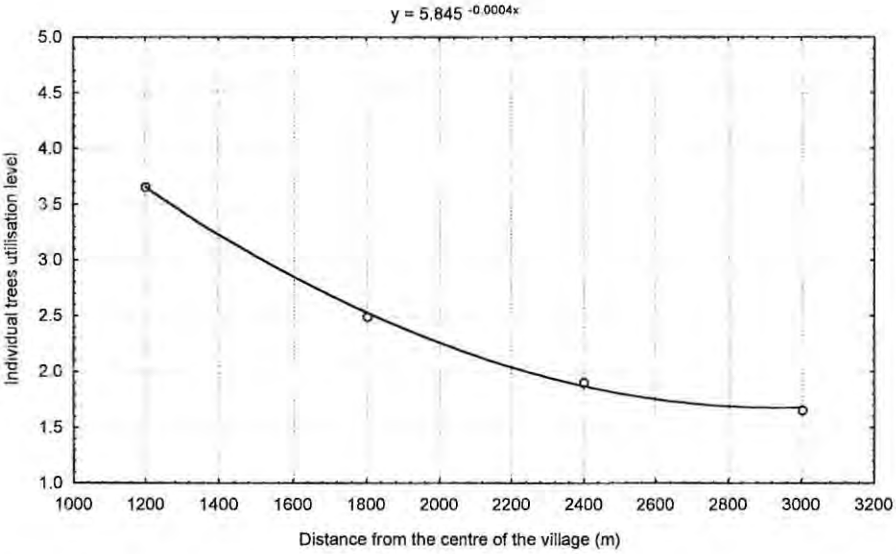


**Figure 2. 7. Changes in individual tree utilisation level on distance from the centre of the village in Pikoli.**

**Table 2. 6. Analysis of variance for means of directional lines 1 – 3.**

| | n | R | $R^2$ | $P < 0.05$ |
|---|---|---|---|---|
| Mean of directional lines 1-3 | 3 | -0.75 | 0.56 | YES |

## 2.5. DISCUSSION

All the people interviewed during this study had a good knowledge of the tree species they harvest for fuelwood and construction. Most respondents had definite answers about the species of trees they prefer to harvest and why they are using them (e.g. a species *P.obliquum* lasts a long time as fencing poles). This also supports the findings of Bembridge and Tarlton (1990) that most tree harvesters in the Eastern Cape have a good knowledge on the trees they harvest. The fact that they knew a lot about their tree species highlights their reliance or dependence on indigenous trees.

Many villagers interviewed preferred to harvest and use *Ptaeroxylon obliquum*. This observation is in concurrence with the findings of Dyer (1996). An interesting observation in this study was that, although *A. karroo* is thought to be a highly preferred and used species in most rural areas of the former Ciskei (Dyer, 1996), in Pikoli this tree is preferred by about 50% of the interviewed people, lower than the preference given for *P. obliquum, Pappea capensis, Schotia afra* and *Maytenus undata*. Although *A. karroo* is relatively abundant at only 1 200 km distance from the centre of the village, where it is encroaching on the unused agricultural land, the people seem reluctant to harvest it. This limited enthusiasm for harvesting A. *karroo* and its relatively low preferential status seems to be because its thorns make it almost impossible to harvest with the poor harvesting tools (axes, hand saws and home-made machetes) the people use.

Although it is widely believed that rural communities prefer indigenous trees mainly for the supply of fuelwood (Le Roux, 1979), it was established in this study that the rural people use indigenous trees for both fuelwood and construction materials. The rural people's construction and fuelwood requirements are dealt with in more detail in chapter 3. All 23 tree species mentioned by people (Table 2.2) are preferred as fuelwood, although their preferential levels differed greatly. Only 7 tree species; *Ptaeroxylon obliquum* (Sneezewood), *Maytenus undata, Acacia karroo* (sweet thorn), *Schotia brachypetala* (weeping boer-bean), *Pleurostylia capensis* (coffee pear), *Olea europaea.* subsp. *africana* (wild olive) and *Sideroxylon inerme* (milkwood) were found to be preferred for both kraal building and fencing. There seems to be a limited selection of trees suitable for construction, due to the extreme requirements of good quality species for construction material. This result agrees with the finding by Dold and Cocks (2000) that some species such as *P. obliquum* are highly preferred for construction purposes because of their termite resistance.

Most of the indigenous trees that the people of Pikoli use, such as; *Ptaeroxylon obliquum, Pappea capensis, Schotia afra* and *Maytenus undata* take a long time to reach maturity. The exception is *Acacia karroo*, and this, has implications for the sustainable use of trees. Also, the people seem to be concentrating their efforts on harvesting mostly these 5 species. A wide gap is realised between the fifth most used tree (*A. karroo*) and the sixth most used tree, *Maytenus mossambicensis*.

The impact of harvesting on tree resources is indicated by the direct relationship between distance and density. The harvesting of trees near human settlements has a piosphere effect. The symptoms of piosphere are (Lange, 1969):

- The watering point becomes a focus of grazing activity that results in a zone of a piosphere around the water point.
- Areas that lie far away from the watering points show an improved biodiversity as compared to areas close to watering points, and that it should be expected that this status will decline once there is a grazing.

A zone of attenuated impact that is characterized by highly utilised individual trees has been shown in this study. The overharvesting of trees has thus reduced the density of indigenous trees and biodiversity nearer to the village centre. This has increased the susceptibility of land to degradation such as soil erosion. Only tree species that have high regeneration ability and are resilient to cutting seem to be abundant in this zone, whereas non-sprouting species such as *Olea europaea* subsp. *africana* have a lower resilience to cutting and are hence less abundant. It was proved that at areas that lie far away from the village centre, there is an improved density of individual trees. It was also proved that at these areas there is less damage or utilisation to individual tree species. This shows that more harvesting, can impoverish tree resource bases. This high damage level coupled with low individual tree density closer to the centre of the village corroborates the hypothesis that there is intensive harvesting of trees closer to the village that causes patterns similar to a piosphere effect.

It has been observed that people require access to tree resources, as much as herbivores would require access to drinking water. The proliferation of villages across much of South Africa's rural areas, which are generally characterized by poor infrastructure and low household incomes, means that land degradation associated with human tree harvesting have become widespread. As observed with the demographics of Pikoli (Table 3.1), this village has many old people, who optimise their time and labour by harvesting as much as they can when the have a chance to. Also, there is a high level of unemployment within the young generation, which leaves them with no option, but to survive through intensive use of the natural stock capital such as indigenous trees. With both scenarios, it does not seem that the sustainable harvesting of indigenous trees in this village will be possible without outside intervention.

# CHAPTER 3

# THE TANGIBLE LOCAL DIRECT USE VALUE OF FUELWOOD HARVESTING

## 3.1. INTRODUCTION

The recent efforts by the South African government to improve the economic situation of rural communities have achieved relatively little (Nel and Binns, 2000). This is despite the drafting of key economic improvement documents such as the Rural Development Strategy (Republic of South Africa, 1995), and the Reconstruction and Development Programme of the African National Congress (ANC, 1995 cited in Nel and Binns, 2000) that was adopted as a national development strategy. Among the reasons put forward for the government's delay in improving the economic conditions of rural households has been the high population densities in rural areas. Nel and Binns (2000) argue that there has been a gradual degeneration of the rural economy and the capacity of most of South African rural areas to be self-sustainable. In most rural parts of the Eastern Cape, the population reached saturation point as early as 1900, which led to communities being unable to provide even their subsistence needs (Switzer, 1993; Nel and Binns, 2000). Another reason for the delay in implementation has been the government's financial and capacity constraints (Nel and Binns, 2000).

South Africa boasts a healthier economy than that of most countries of Africa. However, decades of spatial, social and economic segregation on the basis of race have created a wide gap between different societies in this country (Nel and Binns, 2000). The black rural communities have been the hardest hit to the extent that an average black household's income in rural areas is half that of black households in urban areas of South Africa (Deng and Tjenneland, 1996). Therefore, poverty in rural areas is considerably worse than in urban areas. The situation is made more worse by the outmigration of the young and able who are leaving such areas with only the old and unemployed (Christopher, 1984; Lemon, 1987).

In order to address the issue of rural poverty in relation to South Africa's rural socio-economic conditions and the sustainable use of indigenous trees, key documents dealing with sustainable development, Agenda 21 (DEAT, 1998) and Forest Principles (Sitarz, 1993) were reviewed and an economic valuation of tree resources was preformed on the basis of their interpretation. These documents are the products of the 1992 Rio de Janeiro United Nations Conference on the Environment and Development, which agreed to the global Convention on Biological Diversity. The main aim of the convention was to protect the world's biological resources from further erosion or, at least, to reduce the rate at which natural resources are being utilized. But can these objectives be met in rural areas, which are characterized by high poverty levels? The term biological resources is used here to include biota such as forests, wetlands and marine habitats, and hence biological resources can be defined as those components of the biodiversity which maintain current or potential human use (e.g. trees used for fuelwood). However, the rate at which natural resources are being used is increasing despite the convention. Therefore, there is a growing need to demonstrate the importance of the conservation of resources which can be done by demonstrating to policy-makers (e.g. government) and the general public that sustainable use of natural resources has a positive economic value, and that in most cases this economic value will be higher than the value of alternative resources (Common, 1996; Pearce and Moran, 1994).

The valuation of natural resources is an important exercise since it can be used by decision-makers to assess alternatives, to allocate scarce resources and reconcile conflicting demands. Decision-makers can use the information to understand the importance of natural resources to rural communities, and to determine compensation levels for loss of use of resources (Balance *et al*, 1998). It may on the other hand also be used by researchers as a powerful tool to influence policy changes in matters such as communal woodlands resources, which have received little formal recognition and have been thought of as having limited economic value (Shackleton *et al*, 2000b).

The economic value of forest resources in developing countries has been the subject of much international debate and is important in developing policies for resources use (Martinot, 2000). In demonstrating that sustainable use of natural tree resources has a positive value, an economic valuation of environmental goods is essential. An economic valuation is a means of allocating a monetary value to the goods and services provided by the environmental resources in order to demonstrate their worth (Shackleton, 1996; Shackleton, 1998b; Shackleton and Shackleton, 2000b). This economic valuation of ecological resources has been found to be effective in addressing the needs of the rural poor and in facilitating in conflict resolution (Higgins *et al*, 1997). Such an exercise is particularly important in the context of developing countries because of the high incidence of the use of natural resources by poor rural communities (Stauth, 1983; Pearce and Turner, 1990; Solomon, 2000).

Techniques for assigning values to resources that are traded commercially and informally, as well as resources that are not marketed, are available (Balance *et al*. 2000). Although these values are rarely revealed by other socio-economic analyses, many of the analytical methods used in the valuation of natural resources have been useful in assisting in the understanding and valuation of the economic benefits of natural resources by rural communities (Arntzen, 1998). There is a concern in designing means to evaluate the benefits rural communities derive from their natural stock capital. This concern is whether the total economic value is required, or a specific value, such as use value, option value, anticipatory value, existence value and bequest or altruistic value (Garrod and Willis, 1999). Different types of resources are associated with different values (Callan, 1996; Field, 1997). For example, open access non-priced harvesting of indigenous trees in the Eastern Cape's rural village has a direct 'use value'.

This study concentrates on the local direct-use value of tree resources for the supply of fuelwood as described by Pearce and Turner (1990), Pearce and Moran (1994), Pearce (1998), Balance *et al* (2000), Shackleton and Mander (2000), Shackleton and Shackleton (2000) and Solomon (2000). Indigenous tree values used for erecting and repairing structures such as kraals has been excluded in the valuation since they have a once-off building cost, and has a small repairing cost per year. The direct use values are estimated based on the quantity of wood people harvest.

The economic valuation described here takes into account the benefits of domestic consumption and domestic sales. The economic benefits communities derive from indigenous woody resources for fuelwood have already been evaluated in places such as Namaqualand and Paulshoek (Solomon, 2000), and, to a limited extent, on the eastern seaboard of the Eastern Cape (Timmermans, 2000). The failure to calculate an economic value for woody resources is however true for most parts of southern Africa, with the possible exception of Zimbabwe (Shackleton and Mander, 2000).

The aims of this chapter are to:

1. Determine the monetary value of fuelwood to the inhabitants of Pikoli;
2. Determine whether there is any economic gain realized by the community from harvesting and using indigenous trees for fuelwood instead of using instead of using commercially available alternatives.

## 3.2. METHODS

### 3.2.1. Net value of fuelwood harvested

The net annual value for fuelwood harvested by an average household in Pikoli was determined:

**Net value of harvested wood = gross value – cost of harvesting**

**= (Ha x AP) – (Ha x AHC)** [Equation 1]

Where:

i. Ha is the average household mass (kg) of fuelwood harvested
ii. AP is the average price (Rands/kg) of fuelwood in Pikoli as determined from the field data collected by studying local fuelwood vendors' prices.
iii. AHC is the harvesting cost (Rands/kg) of fuelwood in Pikoli.

First, the average mass of fuel wood harvested (Ha) by a household in Pikoli per annum was calculated by determining the mean of headload fuelwood masses collected. During the household survey, women from 20 randomly selected households were asked to select the amount of wood that they use per day for cooking. The random selection criterion of household surveyed in this study was the same as the one mentioned in section 2.2.2 earlier. This amount was then weighed using a hanging weighing balance and the mass recorded. This exercise was then repeated for each of these 20 previously randomly selected households for all four seasons. The mean total amount of headload fuelwood used in Pikoli was calculated as follows:

**Mean total mass of headload fuelwood consumed per annum (Ha) = mean amount of wood used in spring + mean amount of wood used in summer + mean amount of wood used in winter + mean amount of wood used in autumn** [Equation 2].

Then, the average price of fuelwood (AP) was determined using the field data collected on the cost and mass of donkey loads of fuelwood. This is the only form of commercially available fuelwood in this area. Donkey carts loads (n = 20) were weighed, and vendors asked for a price for each load. Then this local price for woody resources was determined in Rands per kilogramme (R/kg).

The harvesting cost (AHC) was also determined using the fuelwood harvesting cost of R0.33[1]/ kg as determined by Higgins *et al* (1997), with a 10% increase per annum in the harvesting cost taken into consideration on this secondary data to allow for inflation.

Then an assumption was made that the people of Pikoli have the alternative of using paraffin instead of fuelwood. With the assumption that paraffin is used as an alternative source of energy in mind, the energy equivalent of fuelwood used in Pikoli by a household per annum was calculated using the average calorific value of fuelwood species of 17.4 MJ/kg (Eberhard, 1990). The total energy derived from fuelwood per household was calculated as:

**Total energy per household per annum (MJ) =**
**17.4 MJ/kg x total amount of fuelwood consumed by a household (kg)** [Equation 3]

The amount of paraffin in litres, capable of producing the same amount of energy, as would the amount of fuelwood used, was determined based on the characteristics of paraffin. The calorific value of paraffin is 10.34 kilocalories per gram (Lange *et al*, 1967) and the density of paraffin (kerosene) is 0.82 kg/litre (M.Brown, pers.comm[2].). Therefore 1 kg of paraffin was calculated to produce 43.29 MJ = 38 MJ/l and the number of litres of paraffin needed per household to substitute for the equivalent energy of woodfuel is

[1] Secondary data was used in this case because of the complicated economic analysis methods employed in determining this parameter.
[2] M.Brown. Professor of Chemistry, Rhodes University. E-mail communication, November 2000.

$$\textbf{Amount of paraffin needed (per annum)} = \frac{\textbf{Amount of energy produced by fuelwood (MJ)}}{\textbf{39 MJ/litre}}$$

[Equation 4]

The cost of paraffin needed per household per annum was calculated as

- **Cost/value of paraffin = Equation 4 x R3.50** [equation 5]

Therefore, the direct use value was calculated as

- **Direct use value = annual cost of alternative market resources – net value of indigenous trees harvested.**

  **= Equation 5 – Equation 1** [Equation. 6]

  Where:

  A positive value means that the households are gaining economically from using indigenous tree resources in their area and a negative value means that the harvesting of trees is not an economically viable exercise for the community of Pikoli.

### 3.2.2. Demographics of Pikoli

The socio-economic characteristics of the community of Pikoli were presented in five categories. These following information about heads of households in Pikoli was presented in a tabular form; sex; age, highest educational level achieved, occupation, and income. Information from the main questionnaire survey (n = 60) was used for this purpose (Appendix I).

## 3.3. DATA ANALYSIS

Descriptive statistics were performed on the masses of headloads to calculate standard deviations in loads surveyed in Pikoli. The same statistics were used to assess the data on the time people of Pikoli spent harvesting for tree resources. Statistica 5.5 (StatSoft. Inc. 1984 – 1999) and Statgraphics version 7.0 (1993) computer programmes were used in this exercise. Socio-economic characteristics such as, sex, age, educational level, occupation and pensioners were presented in numbers and percentages. Individual household's earnings per household per month were computed to represent the annual income and classified into five categories (see Table 3.1). A grand total of 60 households' income was computed. A total amount of income received by households as government pensions was also computed and presented.

## 3.4. RESULTS

The results of the survey of the socio-economic characteristics of Pikoli show that the people have a low income, and that there is a high level of unemployment (88%). The majority of the surveyed households' heads were between the age of 21 and 65 years. There is an even spread of household heads - 53% of households are headed by males as opposed to 47% by females. About 70% of the respondents have only a primary education or no formal education at all.

**Table 3. 1. Demographic characteristics of heads of households in Pikoli (n = 60)**

| Characteristic | Number (%) |
|---|---|
| Sex: Male (average age = 50) | 32 (53) |
| Female (average age = 55) | 28 (47) |
| Age (years): < 21 | 0 (0) |
| 21 – 40 | 17 (28) |
| 40 – 65 | 24 (40) |
| >65 | 19 (32) |
| Educational level: | |
| No formal education | 15 (25) |
| Primary education | 28 (47) |
| Did not complete secondary school education | 7 (12) |
| Secondary education | 9 (15) |
| Tertiary education | 1 (2) |
| Occupation: Labourer | 3 (5) |
| Self-employed | 2 (3) |
| Unemployed | 53 (88) |
| Other | 2 (3) |
| Household income (Rands per annum) | |
| 0 – 1 500 | 17 (28) |
| 1 500 – 5 500 | 11 (18) |
| 5 500 – 10 250 | 25 (42) |
| 10 250 – 29 250 | 5 (8) |
| > 29 250 | 2 (3) |
| Number of pensioners | 31 (52) |

Pensioners head 52% (31) of the 60 households surveyed. This means that 52% of households derive their earnings primarily from the government social grants. A sizeable proportion of household surveyed (41%) earn between R5 500 and R10 250 per annum. Only 7% of the households earn more than R10 250 per annum. Approximately 30% of the households earn less than R1 500 per annum, and this includes those households who no means of generating any income.

The total average household mass of fuelwood harvested per annum (Ha) was computed to be **2760 kg** (Table 3.2) [Equation 2]. More headload fuelwood is used during winter months, when an average household consumes approximately 984.4 kg of fuelwood, than in other seasons.

**Table 3. 2. Measured mean mass of headload fuelwood consumed per household in relation to the time of the year**

| Season | Measured masses of headloads used (n = 20) | |
|---|---|---|
| | Mean mass (kg) ± S.D | Consumption per annum (kg) |
| Spring (September – November) | 8.1 ± 3.6 | 737.1 |
| Summer (December – February) | 5.1 ± 1.8 | 459.0 |
| Autumn (March – May) | 6.3 ± 1.9 | 579.6 |
| Winter (June – August) | 10.7 ± 2.8 | 984.4 |
| Estimated headload fuelwood per household per annum (Ha) | | 2760.1 |

The donkey cart fuelwood load is R40.00 and has a mass of 71.4 ± 29.02 kg. Therefore, the average value (AP) of fuelwood is **R0.56 per kg**.

The harvesting cost (AHC) was found to be **R0.48/kg**.

The fuelwood total energy derived by a household was calculated by substituting Ha in equation 3.

Total energy = 17.4 MJ/kg x 2760.1 = **48 025.74 MJ** [Equation 3].

This means that an average household in Pikoli would need **1231.4 litres** of paraffin per annum to produce the 48 025.74MJ of energy produced by 2760.1 kg of fuelwood per annum. The cost or value of 1231.4 litres of paraffin was calculated to be **R4 309.90** using equation 5 [Equation 5]. Then the community was found to be realizing a saving of about **R4089.09** per annum by using fuelwood instead of paraffin (Table 3.3).

**Table 3. 3. A comparison of the costs of paraffin and fuelwood as sources of energy for the people of Pikoli, and the gains realised by households for using fuelwood instead of paraffin.**

| **Source of energy** | **Amount needed to produce 48 025.74 MJ of energy needed per household per annum** | **Cost of fuel source per household per annum** |
|---|---|---|
| Paraffin | 1231.4 litres | (Equation 4 x R3.50)<br>R4 309.90 **(1)** |
| Fuelwood | 2760 kg | (Ha x AP) – (Ha x AHC)<br>R 220.81 **(2)** |
| Economic saving realized by the community by harvesting and using fuelwood instead of paraffin **(1) – (2)** | | R4089.09 |

## 3.5. DISCUSSION

The results presented above represent only the fuelwood portion of indigenous trees utilised by the people of Pikoli. The results do not take into account indigenous trees harvested for construction of structures such as kraals, and for fencing. Lack of previous research on the quantities of wood, and time frames needed to maintain kraals and replace fencing poles made it impossible to analyse such data.

Indigenous forest degradation in rural areas of South Africa is caused mainly by extreme poverty and low education levels. Low education leads to people with low skills that cannot escape the poverty web through employment. The study has revealed endemic poverty in the rural area of Pikoli. It was also shown that the bulk of income generated in Pikoli originates from government social grants. The unemployment rate is much higher than the initial estimates of 56.3% by DWAF (1997). This has led to a situation where indigenous trees play an important role in the economy of this rural area by providing vital monetary benefits to households.

In addressing the poverty of rural areas such as Pikoli in terms of sustainable utilisation of indigenous trees, it becomes apparent that there is no clear way to move towards the sustainable consumption, especially when local communities are poor and derive direct tangible local use-value from harvesting trees. This makes the task of establishing institutional and legal frameworks that can support the sustainable utilisation of these resources difficult since indigenous trees have become an important part of the community's economy. It has been noted earlier that extreme poverty levels compel rural people to utilise their resources heavily since this is essential to maintaining their local economical infrastructure (Timmermans, 2000). According to the results presented, approximately half (47%) of the Pikoli community earn R5 500 or below per annum. For this people, the R4089.09 saving, or, direct use benefit, they realise through using fuelwood instead of paraffin represents about 74% of their total annual income. The main reason why people are more reliant on inexpensive natural products is that they can hardly afford the commercially available alternatives.

The harvesting rate of trees for fuelwood in Pikoli seems to be almost the same as in other rural villages of the Eastern Cape, where research on fuelwood utilisation was performed. The 2760 kg of fuelwood consumed in Pikoli is comparable to 2753 kg and 2845 kg estimated at Clarkebury and Manzimahle respectively (Eberhard, 1986). This figure is, however, much lower than other figures quoted in other surveys, such as, 3042 kg for New Bethesda, 3402 kg for Lujiko and 3777 kg for Nkanga (Eberhard, 1986). The Pikoli community consumes more fuelwood per household per annum than the 683 kg consumed per household per annum estimated for the Peddie district (Bembridge and Tarlton, 1983). Although Peddie is situated 30 km away from Pikoli, this marked discrepancy in fuelwood consumption rates is not surprising. Peddie is a 'semi-urban' area where there is a much easier access to alternative sources of energy such as paraffin, grid electricity and liquified petroleum gas (LPG). This result also highlights the fact that lack of infrastructure such as roads and motorized transportation such as in Pikoli, contributes to rural communities lack of access to most resources available in the formal markets. Another reason for the discrepancy between Bembridge and Tarlton's estimates and the results reported here is that people currently rely on fuelwood than in 1983, because of growing poverty in the rural areas.

The scarcity of tree resources together with economic hardships has also created a conducive environment for the emergence of small-scale wood vendors (Solomon, 2000). This shows that fuelwood and other woody resources, which were once harvested for free, are becoming more economically valuable as the need for them increases due to high alternative energy costs and growing poverty (SADC, 1983). Therefore, the poor rural communities will continue to harvest tree resources for some time to come, unless the price of alternative resource becomes more affordable, or it becomes easier to access.

The results presented challenge the findings of other researchers, who argue that the rate of fuelwood consumption is closely related to its availability (Best, 1979; Gandar, 1983). In this study it was established that availability is not a root cause of fuelwood harvesting, but inaccessibility of alternative resources is.

# CHAPTER 4

# CONCLUSION
# AND
# MANAGEMENT RECOMMENDATIONS

It is concluded that the harvesting of indigenous trees by the people of Pikoli is unsustainable. The conclusion is based on the fact that uneven harvesting patterns cause a piosphere effect, and that there are sufficient direct use value realised by the community from harvesting trees for fuel instead of acquiring alternatives available in the formal market. These factors lead to the situation whereby tree resource bases in Pikoli and other rural settlements sharing the same conditions are nearly or totally degraded in certain zones. This will lead to the collapse of the indigenous tree resources bases if no intervention takes place.

The density of preferred trees closer to the village is directly proportional to the distance from the village centre, while damage to tree structure is inversely proportional to distance from the village. The degraded land zone has a radius of about 1800m, and is followed by a good vegetation cover zone that extends to the radius of approximately 3000 m from the centre of the village.

The implications that the results hold for natural resource management agencies in the Eastern Cape and South Africa deserve serious consideration by policy-makers. The distribution of people who are fully or partially dependent on indigenous trees for fuelwood in most rural areas of South Africa has led to the development of piospheres on an escalated scale. This results in some distant areas being under-harvested at the expense of those closer to the village. This piosphere effect, which is often associated with the ecological impact of livestock grazing, is often overlooked when it comes to human fuelwood harvesting behavior. The degree of the indigenous tree resources harvesting in relation to zonal areas around rural villages has not been extensively studied, and in view of the results presented, this needs immediate attention. Where the level of harvesting is excessive, the establishment of woodlots closer to rural settlements should be considered to relieve the harvesting stress on indigenous trees. Such woodlots can possibly be established with indigenous trees; research into the potential of indigenous woodlots that can be used as a benchmark study has been performed by Van Rensburg *et al* (1997), who concluded that it might prove successful if well implemented. Another measure to counter the uneven harvesting might be to leave pockets of re-forested areas where preferred trees can survive because of distance. This implies sacrificing the areas close to the village, and planting woodlots to reduce harvesting pressure. Therefore, the main focus should be on the better management of harvested trees and should be geared towards controlling the factors that causes uneven harvest to ensure a much more sustainable harvesting.

There are several practical approaches that are available to minimize the impact of indigenous tree harvesting closer to the village centre and its associated degradation of land in close proximity of the rural settlements. However, data on the influence of travel distance on the harvesting of trees in South Africa are scarce. Therefore, there is an immediate need for comprehensive research on the rural communities' harvesting behaviour. Such a research proposal, which was initiated by among others, Daes (1999), should evaluate the relationship/s between travel distance and tree density, with respect to other factors such as rural economy and indigenous tree availability.

Also, it was found that households in Pikoli derive substantial annual economic gains from harvesting indigenous trees for fuelwood. Such high returns realised by households from harvesting trees coupled with low annual 'formal' earnings play a major role in the continued degradation of the indigenous trees base and land around most rural villages in South Africa. Furthermore, it was found that most of the household heads in Pikoli have little formal education, with the majority having primary education only. Education is perceived to be directly proportional to the tangible local direct use value realised by most of the rural households through harvesting resources; uneducated people are unemployed and more dependent on the natural capital than educated people.

One of the options to counter people from gaining too much direct use value, and hence overharvesting of trees is that departments responsible for the good management of natural resources have to increase the cost of fuelwood harvesting. This according to Foley *et al* (1987) can be achieved by introducing tax on the cutting of trees. The implications of the tax levy is that, if the value of harvesting trees becomes more costly than the amount people would usually pay for other fuel sources such as paraffin, they are likely to shift to buying alternative sources. The tax levy policy on harvesting trees should be accompanied by a massive infrastructure development, because without proper infrastructure such as roads linking rural areas to places where alternative resources are supplied such as towns, the mission is meaningless; since the prices for such alternative sources would still be too high for the local communities due to inadequate infrastructure.

The degree of people's preference for certain indigenous trees for fuelwood is, however, high in rural areas, and will be hard to change. The Provincial government should develop strategies to encourage the use of alternative resources by for example, introducing subsidies on resources such as paraffin for certain communities.

At this juncture it is clear that research input is needed to evaluate all the possible ways in which the direct use values rural people derive from using indigenous trees for fuel can be interchanged with economic gains through using sources available in formal markets. This calls for professionals in various fields such as economics and environmental science to engage in integrated research on the use of indigenous trees that are inclusive of all stakeholders. Without comprehensive research and well-planned government intervention, the degradation of indigenous tree bases will proceed unhindered.

A five-pronged strategy is thus advocated to improve the sustainability of tree resource use:

1) Establishment of woodlots to reduce the pressure on distant forest pockets, by increasing the availability of fuelwood closer to the village;
2) The introduction of a levy on indigenous trees;
3) Education and job creation in rural areas;
4) Improvement of transport infrastructure and subsidies to make alternative resources more accessible and affordable;
5) Interdisciplinary research into economic incentives for reducing the harvesting pressure on indigenous trees.

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# Appendix I: Semi-structured questionnaire

## QUESTIONNAIRE

This questionnaire is being done for Teboho Motinyane, a Master of Science Student at Rhodes University, Grahamstown. It will be very much helpful of you, if you take some few minutes of your time to answer some few questions for us.

### GENERAL

1. Name: ____________________
2. Age: ________ years
3.

| | |
|---|---|
| MALE | FEMALE |

3. Were you born here at Pikoli?

| | |
|---|---|
| YES | NO |

IF NO: Where were you born: ______________

Why did you come to live here at Pikoli?

________________________________________

4. How many people live in this household?

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

5. Who is the head of this family:
6. Where is the head of family (if not respondent):
7. Is the head of family working?

| | |
|---|---|
| YES | NO |

### SOCIAL INFORMATIOIN

1. Health Status:

| | | |
|---|---|---|
| Healthy | Sick | Other |

2. Employment status:

| | | | | |
|---|---|---|---|---|
| Employed (where?) | Unemployed | Self-employed | Pensioner | Other |

3. Education:

| | | | | | |
|---|---|---|---|---|---|
| Never attended | Standard 1-5 | Finished primary | High school - did not finish | Complete d high school | Tertiary education |

4. Monthly earnings:

| | | | | | |
|---|---|---|---|---|---|
| Non | <R100 | R100-R499 | R500-R999 | R1000 - R1999 | >R2000 |

5. Do you receive any money from some family members (e.g. son, daughter, wife, etc)? YES/NO

IF YES: how much: ________ per wk/month/year

### TREE RESOPURSES

1. Which tree types (species) do you harvest (e.g. Umthathi) in order of preference:

| | |
|---|---|
| i | v |
| ii | vi |
| iii | vii |
| iv | Viii |

2. What do you use them for (e.g. fuelwood, etc.)

.....................................................................

3. Which tree type/species do you like (prefer) most: ______________

Why: ______________________________

4. How long does it take to harvest your normal load of wood per day?

| | | | | | | |
|---|---|---|---|---|---|---|
| 30 mins | 1 hr | 2hrs | 3 hrs | 4 hrs | 5 hrs | |

4. Which other fuel sources do you use?[1]

| | | | | | |
|---|---|---|---|---|---|
| Coal | Petro. Gas | Electricity | Paraffin | Candles | Other: |

[1] Insert approximate cost/s of each resource per month.