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A Comparison of the Scientific Paradigm and Local Resource Users Perspective of Land Degradation in Bushbuckridge

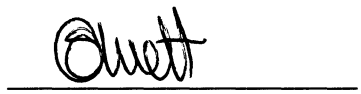
Colleen Saskia Cluett

9 October 2013

A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science

Declaration

I declare that this dissertation is my own, unaided work, unless otherwise noted within the text. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university.



Colleen Saskia Cluett

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Abstract

Many people living in the rural areas of South Africa rely on natural resources acquired from their surrounding communal lands as part of their livelihood strategy. This use is expected to continue into the foreseeable future. Individuals in a community do not necessarily have the same interest in, understanding of or value for the environment. People will value the environment and support environmental protection programmes differently depending on a variety of factors. Thus it is important to have an understanding of people's perceptions of their environment in order to develop CBNRM projects in these areas that will both provide benefits to the local people and ensure their sustainable use.

Land Degradation is expected to occur in these areas because of the combination of a large population with a high reliance on local natural resources, and high levels of utilisation of these resources. Degradation of these areas may jeopardise the livelihood strategies of the people living in these areas, while also compromising the ecological stability of land that may serve as a buffer zone for protected areas adjacent to communal areas, such as in the case of the greater Kruger National Park and communal lands of the central lowveld of South Africa. Therefore, it is important to understand the current state and perceived sustainability of the communal areas. This will aid in developing a greater understanding of the functioning of these areas and the use of them in order to ensure the continued, sustainable utilization of local resources and the development of CBNRM projects to manage these areas into the future.

This research was conducted in the Bushbuckridge Municipality in the Mpumalanga Province of South Africa. Land-cover change, resource use and coppice harvesting have been studied in this area using both scientific and indigenous knowledge, but little work has been done to identify perceptions of land degradation amongst the Bushbuckridge villagers. The aim of this study was thus to examine land degradation around three villages in Bushbuckridge, from two contrasting perspectives, the ecologist's (the scientific approach) compared with that of Local Resource Users (LRUs), specifically related to areas categorised as being in "good" and "poor" condition for the collection of important natural resources by the communities of each village

This was done by determining differences between LRUs perceptions of communal land degradation within defined areas of the communal lands of their (respective) villages. The communal lands were subdivided into smaller zones or sites according to the LRUs uses and perceived attributes of those sites; through developing an understanding of the views of LRUs regarding how their communal lands have changed over time and how they expect them to change in future. Following this, scientific ecological techniques were used to investigate patterns in the herbaceous and woody vegetation in two areas stratified by differing environmental conditions as perceived by LRUs. Finally, possible ways for the scientific approach and LRUs perceptions to be integrated are discussed in order to develop solutions to problems faced by the people living in these areas.

The extent and demarcation of different sites of use within the communal lands of the three study villages were defined by focus groups of local resources users, using participatory techniques. LRUs were selected for focus groups based on gender, which corresponded with primary resources used, either wood for fuel or grazing for livestock, and then stratified by age. The attributes of each of the areas defined by these groups were also discussed. LRUs who used the communal lands for grazing of livestock used a larger area, defined more sites within that area and had a more structured cycle of which sites were used when including rotational cycles of use, compared to fuel wood harvesters who used a smaller area and with individuals generally repeatedly returning to the same area for harvesting. The differences between different age groups of users of the resource were less distinct, especially among fuel wood harvesters. The two age groups (20-40 years and more than 40 years) of users of communal lands for grazing of livestock

depicted different borders between sites at two of the three villages, although the characteristics of each of the areas were very similar between these groups.

All participants perceived negative changes to their communal lands and a deterioration of the resources available there. However, male and female groups perceived these differently, with male groups identifying bush encroachment and a deterioration in the quality of graze for livestock and female participants perceiving a decrease in the availability of wood in general and of the tree species present. The majority of groups also stated that these problems would continue into the future. Participants largely attributed these negative changes to increased human population and livestock numbers and the effects of these changes on the demand for resources, and socioeconomic problems such as unemployment and unreliable availability of electricity.

Although all sites differed from each other in terms of vegetation characteristics, overall, the sites identified as "poor" by LRUs tended to show higher signs of use and characteristics associated with degradation compared with the "good" sites". More woody individuals showed signs of being harvested from the "poor" site compared with the "good" site, although the difference was not significant. Species richness and the diversity index scores were also lower at the "poor" site compared to the "good" site for each village. Patterns in vegetation height and basal area did not indicate any clear differences between "good" and "poor" sites. Herbaceous biomass and herbaceous vegetation cover were greater at two of the three "good" sites, while the "poor" site at the third village was dominated by dense patches of tall thatching grass species. While this tall thatching grass may be perceived negatively by people minding cattle, because of their low palatability later in the season, they may be viewed positively by other resource groups. The characteristics of the "good" sites largely corresponded with characteristics that are considered as "favourable" by ecologists while, many of the characteristics of the "poor" sites could be indicative of vegetation degradation. However, none of the sites had only good or bad characteristics; rather each site was made up of a unique assemblage of both "good" and "poor" characteristics.

Overall, the characteristics of these communal lands that were identified by LRUs were also identified through the use of ecological techniques. This will support the development of solutions for the problems that people living in these areas may experience. However, the value systems and motivations of all the groups involved in the development of these solutions must also be understood. This is to create changes that are meaningful, that the impetuses for and methods involved are understood by all participants and that the benefits that may be accrued and time lines over which this may happen are understood and accepted by all participants.

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List of Abbreviations

ANOVA	Analysis of Variance
CBC	Community-Based Conservation
CBNRM	Community-Based Natural Resource Management
CHANS	Coupled Human and Environmental Systems
DPM	Disk Pasture Meter
GIS	Geographic Information Systems
ILMS	Integrated Land Management Systems
LEK	Local Ecological Knowledge
LRU	Local Resource User
LSU	Large Stock Unit
NTFP	Non-Timber Forest Products
NDVI	Normalised Difference Vegetation Index
NMDS	Non-metric Multi-Dimensional Scaling
PGIS	Participatory Geographic Information Systems
PRA	Participatory Rural Appraisal
PRM	Participatory Resource Mapping
SES	Socio-Ecological Systems
TEK	Traditional Ecological Knowledge
UNEP	United Nations Environmental Program
WDI	Woody Disturbance Index

Chapter 1

1. A Comparison of the Scientific Paradigm and Local Resource Users Perspective of Land Degradation in Bushbuckridge

1. 1. Rationale

More than a third of South Africans live in rural communities - 38.3% in 2010 according to the United Nations Population Division (http://www.un.org/esa/population/). These people depend on natural resources acquired from their surrounding communal lands as part of their livelihood strategy. The combination of a large population, a high reliance on local natural resources, and high levels of utilisation of these resources has resulted in environmental degradation (as perceived from the scientific perspective) in the former Apartheid-era homelands (Hoffman and Ashwell, 2001; Blignaut and Moolman, 2006). The use of these natural resources by a large number of local people occurs currently and will continue to occur into the foreseeable future (Madubansi and Shackleton, 2007). For this reason, the current state and perceived sustainability of the communal areas should be studied in order to gain a greater understanding of their functioning and use that may assist in the continued, sustainable utilization of local resources (Chambers, 1995; Edwards and Steins, 1996; Shackleton *et al.*, 1998; Cousins, 1999; Mayher and Raab, 2009). The Bushbuckridge Municipality in the Mpumalanga Province of South Africa was chosen as the location for this project because this area has functioned as a hub for many types of research over many years, especially in the field of socio-ecological systems (for example Shackleton, 1996; Shackleton, 1998; Shackleton *et al.*, 1998; Cousins, 1999; Shackleton *et al.*, 2002; Shackleton and Shackleton, 2004; Dovie *et al.*, 2004; Kaschula *et al.*, 2005; Giannecchini *et al.*, 2007; Madubansi and Shackleton 2007; Shackleton *et al.*, 2008; Hunter *et al.*, 2010). Additionally, because these areas are in close proximity to a large number of nature reserves, including the Kruger National Park, they may be important buffer areas between concentrated human settlements and conservation areas (Neumann, 1997).

Individuals in a community do not necessarily have the same interest in, or understanding of the environment, nor do they value it in the same way. It has been shown that people will value the environment and support environmental protection programmes differently depending on cultural factors and material concerns. People in rural environments may value their environment because they rely on it first-hand in order to acquire important resources and services, thus, these people also tend to identify environmental problems if they are directly affected by them (Inglehart, 1995; Anderson *et al.*, 2007; Hunter *et al.*, 2010). These different interests, understandings and values will have consequences for general environmental degradation and the sustainability of use of natural resources and the environment, on the way they are used and on policies regarding their use, in comparison to people who value the environment less and consequently tend to overuse their resources (Murphree, 1991: Hunter *et al.*, 2010).

Land-cover change, resource use (Giannecchini *et al.*, 2007) and coppice harvesting (Kaschula *et al.*, 2005) have been studied in this area using both scientific and indigenous knowledge, but little work has been done to identify perceptions of land degradation amongst the Bushbuckridge villagers (although studies of this nature have been done in other rural areas of Africa: Dahlberg, 2000; Oba and Kotile, 2001; Roba and Oba, 2009). When developing projects that aim to address environmental problems in areas used by Local Resource Users (LRUs), it is important to have knowledge of their perceptions and understanding of these issues (Hunter *et al.*, 2010). However, one must also have an understanding of the perceptions from the paradigm of the researcher involved, in this case specifically ecologists. This will help to inform these programmes, may encourage the participation of villagers in these projects and may help to develop the

streams of communications between LRUs and researchers (Hunter, 2006; Anderson *et al.*, 2007; Hunter *et al.*, 2010). In this study the selection of LRUs was based on gender which corresponded with primary resources used, either wood for fuel or grazing for livestock. These two resources were selected because of the possible impacts of their utilisation on the vegetation of these communal areas (Parsons *et al.*, 1997; Dovie *et al.*, 2004; Britz and Ward, 2007; Ruger *et al.*, 2008) and the prevalence of their use in these areas (Madubansi and Shackleton 2007). They were also selected because of the conflicting views of resource change that may exist between these two groups.

This study, therefore, focuses on the perceptions of land degradation (both the current state and drivers of land degradation) for the communal areas of three villages in Bushbuckridge from both local and scientific perspectives. The additional knowledge gained from this study may be useful for future community-based natural resource management (CBNRM) projects as it assesses the similarities and differences between the perception of the LRUs and ecologists, especially in the context of the socio-ecological dynamics in the study area (Murphree, 1991).

1. 2. Aim, Objectives and Key Questions

1.2.1 Aim:

The aim of this study was to examine land degradation around three villages in Bushbuckridge, Mpumalanga, from the perspectives of ecologists and of LRUs, specifically related to areas categorised as being in "good" and "poor" condition for the collection of important natural resources by the communities of each village.

In order to achieve this aim, the following objectives were developed:

1.2.2 Objectives:

1. To determine differences between Local Resource Users (LRUs) perceptions of communal land degradation, as stratified by age groups and gender, within defined areas of the communal lands of their (respective) villages, subdivided into smaller zones or sites according to the LRUs uses and perceived attributes of those sites. This was done to understand the development of the patterns of land use and a means through which to contrast the positively and negatively perceived attributes within those communal lands.
2. To determine the views of LRUs regarding how their communal lands have changed over time and how they expect them to change in future.
3. Using scientific ecological techniques, to investigate patterns in the herbaceous and woody vegetation in two areas stratified by differing environmental conditions as perceived by LRUs.
4. To compare and contrast the information gathered from LRUs so as to identify possible ways for the perspectives of ecologists and LRUs to be integrated in order to develop solutions to problems faced by the people living in these areas.

1.2.3 Key questions

1. What are the boundaries of each village's communal lands, as defined by LRUs from different age and gender groups?
2. Can this land be divided into lands that are more or less useful for acquiring fuel wood and grazing for livestock and what criteria are used to determine this?
3. What resources do LRUs currently acquire from their communal lands?
4. What are the perceptions of LRUs regarding the (a) current, (b) past (from 1990), and (c) future (to 2030) value of the communal lands of their village for acquiring fuel wood and grazing for livestock?
5. If changes have occurred between these time periods, why have they occurred?

6. Using ecological methods what are the characteristics of the vegetation in the communal lands of these three villages, especially regarding density of woody individuals and woody stems?
7. What are the differences in woody vegetation structure, height and diameter, between areas identified as "good" and "poor" by LRUs for collecting fuel wood resources?
8. What are the differences in woody vegetation species richness and diveristy (including presence of alien invasive plants) in areas identified as "good" and "poor" by LRUs for collecting fuel wood?
9. What are the differences in herbaceous vegetation biomass in areas identified as "good" or "poor" by LRUs for grazing of livestock?
10. What are the differences between the functional types and cover and herbaceous biomass in areas identified as "good" or "poor" by LRUs for grazing of livestock?
11. What are the similarities between scientists and LRUs perceptions of these areas?
12. What are the differences between scientists and LRUs perceptions of these areas?
13. What are the implications of these similarities and differences for the way that LRUs and ecologists communicate and for projects that involve LRUs and ecologists?

1.3. Literature Review

1.3.1 Livelihood strategies of rural people

The livelihood strategies of poor, rural people in South Africa are diverse and dynamic, with communal rangelands being used for multiple purposes and activities varying between different family or community members and at different times of the year (Chambers, 1995; Cousins, 1999; Shackleton and Shackleton, 2004). The uses of communal rangelands include: to obtain resources such as food, medicine, fuel wood and building materials (thus direct uses); for exchange in markets; for ceremonial or aesthetic reasons; or, for the ecosystem services they provide (Cousins, 1999; Dovie *et al.*, 2004; Anonymous, 2004; Kirkland *et al.*, 2007). In South Africa, many rural households rely on multiple timber forest products and non-timber forest products (NTFPs) in their daily lives to supplement their income (Shackleton and Shackleton, 2004). Commonly used products include fuelwood, wooden utensils, edible fruits, wild spinach, grass-hand brushes and twig-hand brushes (Shackleton and Shackleton, 2004). The use of these products reduces costs for families and the state and function as a buffer during times of hardship (Shackleton and Shackleton, 2004).

The services provided by natural ecosystems include freshwater, maintenance of soil fertility and maintenance of biological diversity (Solbrig et al., 1996; DeFries *et al.*, 2004). Biological diversity has been associated with increased productivity, nutrient cycling and improved water economy/ water use efficiency, improved soil properties and ecosystem resilience while decreased biodiversity may have negative consequences for ecosystem processes and functioning (Solbrig et al., 1996; DeFries *et al.*, 2004; Blignaut and Moolman, 2006). The overall value of these uses and services is often underestimated if not translated into monetary terms, in cases where this has happened, a high per hectare economic value has been identified (Cousins, 1999, Shackleton *et al.*, 2002; Shackleton and Shackleton, 2003). Human well-being has also been shown to have a positive relationship with perceived species richness (Dallimer *et al.,* 2012).

The use of these resources may create diverse cultural landscapes with aesthetic, economic and ecological value (Anonymous, 2004). This has been shown for the Bushbuckridge region (Shackleton, 1996; Shackleton, 1998; Shackleton *et al.*, 1998; Cousins, 1999; Shackleton *et al.*, 2002; Shackleton and Shackleton, 2004; Shackleton *et al.*, 2008).

1.3.2 Anthropogenic effects on natural ecosystems

Ecosystems are affected by human activities such as changes in land-use, including the conversion of natural lands for food production, for resources such as timber and non-timber forest (woodland) products (NTFP) or for the creation of human settlements (Burgi and Russell, 2001; DeFries *et al.*, 2004). The use of natural resources can be very extensive with communities in the Limpopo Province of South Africa using up to 200-300 species of plants for NTFPs (Shackleton and Shackleton, 2004). In addition, the use of these resources can be intensive. For example, fuel wood use has been estimated at 692 kg/capita per year (Dovie *et al.*, 2004). Stocking rates of cattle for Bushbuckridge are estimated at 0·88±0·09 Large Stock Units (LSU) per ha. This is considered to be at or above the recommended carrying capacity (Parsons *et al.*, 1997) although it is unclear what the recommended carrying capacity is, or if it is even possible to define a single carrying capacity for an area (Leeuw and Tothill, 1990; Scarnecchia, 1990; Roe, 1997: Prato, 2009). Properly functioning ecosystems have natural recovery processes that maintain sustainable flows of soil, nutrients, water and organic materials through the system. However, when changes in the structure or function of an ecosystem occur the system may experience a decreased resistance to perturbations such as drought or be unable to maintain these processes (Hoffman and Ashwell, 2001). The ecosystem response to these changes varies with the type of land-use change and the ecological setting (DeFries *et al.*, 2004). As a consequence, the use of these communal areas will affect their structure and function and the type and quality of ecosystems services they provide, which may lead to unfavourable processes including land degradation and soil loss may also result (Higgins *et al.*, 1999; Hoffman and Ashwell, 2001; Anonymous, 2004; Blignaut and Moolman, 2006).

1.3.3 Land Degradation

1.3.3.1 Definition

Land degradation is defined as a decrease in an area's actual or potential biological or economic productivity or utility and the loss of complexity, features or organisms which cannot be replaced (Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001). Land degradation is a biophysical process that is driven by socio-economic and political causes (Eswaran *et al.*, 2001). Degradation may also enforce feedback mechanisms, which accelerate degradative processes. An example of this is land-use changes that are caused by high rainfall variability, which accelerate land degradation (Dube and Pickup, 2001; Geist and Lambin, 2004). This may lead to irreversible vegetation change once a site's capacity for self-repair is exceeded (Whisenant, 2002).

Lands exist on a continuum from highly resistant to degradation and stable to extremely sensitive to degradation and fragile (Eswaran *et al.*, 2001). Where an area falls on this continuum will depend on the natural characteristics and climate of the larger geographic area as well as to degradative processes or to specific properties of that area in particular (Eswaran *et al.*, 2001). Lands that are described as resistant to degradation are often not resistant to change but rather are resilient. In other words they are capable of responding to change while maintaining key characteristics and will change back to their previous state when the disturbance is removed (Holling, 1973; DeAngelis, 1980). Savannas are described as very resilient, in that they are unstable but are able to recover from disturbance (Harrison and Shackleton, 1999). While lands that are not resistant to degradation may undergo a change of state, the effectiveness of regulatory functions may decrease and conditions may become unfavourable for plant growth (Holling, 1973; Eswaran *et al.*, 2001). The densely populated areas of sub-Saharan Africa have been and are severely impacted by the economic impacts of land degradation and nutrient depletion with land degradations causing an estimated yield reduction of 8.2% for the African continent (Eswaran *et al.*, 2001). This is because they have

fragile soils, high population densities in localised areas and a low-input form of agriculture (Eswaran *et al.*, 2001).

1.3.3.2 Drivers of land degradation

Land degradation is driven by biophysical processes and occurs when a system's resilience thresholds are exceeded or its resilience is lost. It occurs, primarily, as a result of human activities, including land use and habitation patterns, and can occur over long periods of time (Blaikie and Brookfield, 1987; Barrow, 1991; Levia, 1999; Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001; Warren, 2002; Roba and Oba, 2009).

Land degradation is caused by various mechanisms by way of physical, chemical and/or biological processes (Blaikie and Brookfield, 1987; Lal, 1994; Eswaran *et al.*, 2001). Examples of physical processes that may lead to land degradation include a decline in soil structure resulting in crusting, compaction and erosion, desertification, increasing anaerobic conditions and unsustainable use of natural resources (Scherr and Yadav, 1996; Eswaran *et al.*, 2001). Chemical processes include acidification, leaching, salinisation, decreased cation retention capacity and depletion of fertility (Scherr and Yadav, 1996; Eswaran *et al.*, 2001). Examples of biological processes include a decrease in total and biomass carbon and a decline in the land biodiversity (Scherr and Yadav, 1996; Eswaran *et al.*, 2001). Land degradation as a result of anthropogenic effects occurs because of the interactions and incompatibility between natural ecosystems and human social systems (UNEP, 1993; Beinroth *et al.*, 1994; Eswaran *et al.*, 2001). Thus, the success of resource management systems is determined by the ability to manage both of these systems appropriately (Eswaran *et al.*, 2001).

Some types of degradation, such as deforestation, have also been linked to socio-economic problems such as rural poverty and government policies and political stability (especially past policies), land tenure, institutional support, income and human health. In these cases people are driven to over-utilise resources because of poverty, because areas are over-populated, because access to resources is not properly controlled or because people are forced to live in marginal lands with few options for economic upliftment, as is the case in the former homelands (Hoffman and Ashwell, 2001; Blignaut and Moolman, 2006). Increased livestock production and plant resource collection, especially for fuelwood, and field cultivation has led to degradation in communal areas (Hoffman and Ashwell, 2001). High population density will not automatically result in land degradation; instead land degradation occurs as a result of how the population uses the land. These include the practice of subsistence agriculture, directly, but may also occur as a result of indirect factors such as poverty and illiteracy and their effects on the use of this land (Eswaran *et al.*, 2001). Land users may allow their land to degrade for many reasons but two predominant ones are because of their perceptions of its value and because the processes of land degradation are often slow and imperceptible so that many people are not aware of it (Eswaran *et al.*, 2001; Johnson and Lewis, 2007).

Land degradation can also occur as a result of natural processes, with the inherent characteristics of an area, for example the climate, terrain, position in the landscape, vegetation and biodiversity, especially soil biodiversity, affecting processes of degradation (Barrow, 1991; Levia, 1999; Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001; Roba and Oba, 2009). An historic approach is needed in order to understand the impact of humans on landscapes and landscape ecology which identifies changes in human activities, needs, demands and interests over time (Burgi and Russell, 2001). Land use and management practices, such as deforestation or methods of tillage, and socio-economic factors will affect the rate of land degradation (Eswaran *et al.*, 2001).

1.3.3.3 Processes of Land Degradation

- *Soil Degradation*

Soil degradation is the major process of degradation in South Africa and is defined as a loss of actual or potential productivity or utility of soil as a result of natural or anthropogenic factors (Lal, 1997; Hoffman and Ashwell, 2001). This degradation is caused, primarily, by erosion by wind or water; occurring as a result of deterioration of the physical, chemical or biological processes of soil, or the long term loss of natural vegetation (Barrow, 1991; UNCCD, 1995; Hoffman and Ashwell, 2001). Soil degradation is also often attributed to the absence or poor maintenance of soil conservation works and lack of soil conservation regulations or law enforcement. Poor cultivation practices such as extensive and subsistence agriculture or poor vegetation management practices, lack of education and extension services, overstocking of livestock, poor planning of settlements, in particular paths and runoff control, deforestation and the removal of sand or soil for the building industry can all excaccerbate soil erosion (Lal, 1997; Hoffman and Ashwell, 2001).

Soil degradation negatively affects plant growth causing a decrease in the productivity of land. It may also have knock-on effects for rivers, dams and estuaries as a result of siltation (Hoffman and Ashwell, 2001). The soils in communal croplands are significantly more degraded than those in commercial areas with degradation occurring at an increased rate (Hoffman and Ashwell, 2001). This has been attributed to the steeper slopes and higher levels of precipitation that often occur in these areas (Hoffman and Ashwell, 2001). The highest levels of soil degradation occur in croplands, grazing lands and settlements as a result of increased erosion, and tends to be higher in communal lands than in commercial ones (Hoffman and Ashwell, 2001). Erosion tends to increase with increasing grazing pressure; however it may vary greatly in croplands depending on the type of crop and where and how it is cultivated (Hoffman and Ashwell, 2001).

- *Vegetation Degradation*

Vegetation degradation can be observed as a loss of cover, a change in the plant species composition and/or a loss of certain plant species, bush encroachment, invasions by alien plants, deforestation or veld clearing (Hoffman and Ashwell, 2001; Van Aardt *et al.*, 2011). Vegetation degradation may decrease the grazing capacity of veld, cause increased soil erosion, decrease the nutrient levels in soil and lower agricultural production (Hoffman and Ashwell, 2001). It may also lead to local extinctions of birds or animals dependent on specific plants (Hoffman and Ashwell, 2001). The main causes of vegetation degradation are grazing by livestock, which impacts on the composition and structure of vegetation, woodcutting and fire (Hoffman and Ashwell, 2001; Britz and Ward, 2007; Roba and Oba, 2009). Degraded areas may have decreased biomass and lower species richness compared to protected areas, commercial cattle farms or private property (Higgins *et al.*, 1999; Hoffman and Ashwell, 2001). Bush encroachment generally occurs in response to poor management practices and the replacement of indigenous browsing animals by grazing livestock as a result of reduced browsing pressures (Hoffman and Ashwell, 2001).

1.3.4 Use of natural resources

The use of natural resources in communal resource systems is regulated by institutions or by formal or informal sets of rules operating at multiple levels (Leach *et al.*, 1997; Cousins, 1999). However, changes in local power relations will impact the institutions that govern peoples' access to these resources and the ways these practices are interpreted and legitimized (Kepe, 1997).

Post-1994, many residents in Bushbuckridge assumed that resource regulation by traditional authorities was no longer valid and as a result, many people began to harvest resources or cultivate tracts of land without permission (Giannecchini *et al.*, 2007). With a reduced respect of traditional authorities such as chieftaincies, and/or local rules and regulations, as has occurred in the Bushbuckridge area, effective

regulation may be difficult to achieve (Cousins, 1997; Kepe, 1997; Cousins, 1999). Social differences within communities have also affected the use of environmental resources (Kepe, 1997). For example, differences in the method of harvesting wood or the amount of wood harvested. This has had a negative effect on the current availability and future production of these natural resources as a result of higher levels of wood, and other resources, harvesting from communal areas (Higgins *et al.*, 1999). In the case of Bushbuckridge disputes regarding its provincial location created divisions between traditional leaders and the politically active youth (Ramutsindela and Simon, 1999). Sustainable extraction of non-timber forest products (NTFPs) is a means to enhance rural incomes and conserve tropical forests and woodlands (Murali *et al.*, 1996).

1.3.5 Community involvement in resource management

It is being recognised increasingly that in order to encourage the sustainable use of resources, local people must be considered and involved in the development of their communities. They must also be healthy and motivated, both politically and economically, to care for the land and must have an understanding of why it is important to implement certain activities especially if implementing them requires additional effort on their part (Kepe, 1997, Eswaran *et al.*, 2001; Anonymous, 2004; de Beer and Marais, 2006). Community-based sustainable development and resource management programmes are viewed as important tools to achieve goals of reversing land degradation (Kepe 1997).

The ways that outsiders, particularly researchers, understand communities have changed fairly radically over time and, with this so has the way they are perceived and managed by external forces, such as local or national government. Communities were previously perceived to be environmentally destructive and a hindrance to conservation efforts (Agrawal and Gibson, 1999). However, communities are increasingly being acknowledged as having important local knowledge that could aid in the conservation of natural resources and the management of their use as a result of their intimate connection with their land (Mandondo, 1997; Agrawal and Gibson, 1999; Pretty, 2002). Both of these schools of thought are often based on generalisations and assumptions rather than the experiences of people working in or with rural communities. For example, communities are often assumed to have both a small population and a small geographic area, to be integrated units and to be homogeneous, with similar assets and incomes and similar household characteristics such as ethnicity, religion and/or language. This homogeneity and integration is assumed to foster good relations within the community which facilitates solution-making and reduces conflicts. Communities are, also, assumed to have a long-term dependence on the natural resources that occur near to where they live (Varughese and Ostrom, 2001). This dependence is assumed to foster a greater level of knowledge of these resources within the community than exists outside of the community. For this reason they are assumed to be the best managers of it (Agrawal and Gibson, 1999). It is assumed that they will develop locally-established practices to manage and share their natural resources as a result of their assumed social structure, shared norms and intimacy. However, all communities are stratified to some degree and in assuming homogeneity we may fail to recognise the differences that exist within and between communities (Agrawal and Gibson, 1999).

A community consists of individuals who have individual goals, ideals and value systems, with their perceptions being determined by their upbringing, the values of their parents and other family members, their teachers, community leaders and friends, as well as by their personal experiences, both in the past and currently (Mandondo, 1997). This is true for all groups of people including scientists, with empirical science existing within a set of values and beliefs that may not be significant universally (Mandondo, 1997).

People living in rural environments often value their environment and the natural resources it provides because they need these resources for their livelihoods. These people also tend to only identify

with environmental problems that directly affect them (Inglehart, 1995; Anderson *et al.*, 2007; Hunter *et al.*, 2010). Their reliance on these resources and their interest in, understanding of and valuing of their environment and natural resources depends on many different factors including their feelings, perceptions and thoughts (Mandondo, 1997). Age and education have been shown to be strong predictors of environmental values, while factors such as gender and race are less strong predictors (Dietz *et al.*, 1998). Studies that have investigated the social composition of a community often recognise differences that may exist within a subgroup of the community, such as women or pastoralists, who have different preferences for resource use (e.g., Agrawal, 1994). All of these differences may affect resource management and, thus, should be acknowledged to create sustainable and equitable outcomes (Agrawal and Gibson, 1999). More effort should be spent on accurately depicting communities and their relationships with their natural resources and focusing on the multiple actors with multiple interests and understanding the processes through which community members interrelate (Agrawal and Gibson, 1999). In this way, projects can be implemented that promote the involvement of various community members in the management of their resources. The projects may be referred to as Community-Based Conservation (CBC) and Community-Based Natural Resource Management (CBNRM) projects.

Proponents of CBC and CBNRM argue that if the authority governing these resources was decentralised from the governing authorities, who may be at a distance from the resource, i.e. in a provincial Capital, to those who are in the vicinity of, and, who use these resources, the system would function better (Agrawal and Gibson, 1999). Additionally, involving these people in the management and conservation of these resources will create incentives for community members to protect them (Sponsel, Headland and Bailey, 1996; Western and Wright, 1994, Agrawal and Gibson, 1999).

The empowerment of local actors to use and manage their natural resources requires the decentralisation of resources from the government to a community, but should include recognising the patterns of difference in use, the multiple actors within a community and their different and dynamic interests, as well as these interactions in the context of larger social forces, such as the political context, prices of resources, demographic changes or technological innovations. Within a community, actors will seek out their own opportunities within conservation programs and these may change as new opportunities emerge. These individuals participate in negotiations regarding the use, management and conservation of resources and disputes arising about these issues (Agrawal and Gibson, 1999).

People play an important role in the amelioration of land degradation with sustainable community development identified as a requirement for sustainable environmental development. However this depends on those people being healthy and motivated, both politically and economically, to care for the land (Eswaran *et al.*, 2001; de Beer and Marais, 2006). Thus, communities must be considered if development goals are to be achieved with community-based sustainable development and resource management programmes being viewed as important tools to achieve goals of reversing land degradation (Kepe, 1997).

Policies now acknowledge that rural communities be involved in their development and have a say in matters that affect their future, and that economic, social and environmental concerns should be solved within the context of one another in order to ensure sustainability (Kepe, 1997; Anonymous, 2004). Many grazing and rangeland development projects in arid zones of sub-Saharan Africa have not succeeded in spite of vast sums of money that have been invested in them over the past 30 years. This failure has been attributed to the projects attempting to change traditional patterns of land use and thus weakening indigenous pastoral systems and enforced management techniques not being understood by local communities; which have exacerbated land degradation and economic decline (Kepe, 1997; Anonymous, 2004).

Community-based projects are often based on the use of ecological models, such as the "Equilibrium Model", and on assumptions which have been shown to be inappropriate for sub-Saharan Africa (Ellis and Swift 1988; Oba *et al.*, 2000). Assumptions include that changing grazing systems and patterns of land use will improve range production, that degradation will be reversed by implementing grazing rotation and long-term exclusion of grazing and that sub-Saharan pastoralists have generally exceeded the livestock carrying capacity of land (Oba *et al.*, 2000). These findings are in line with many scientific theories and methods which are now viewed as oversimplifying ecological systems and analysing data according to scientist's own perceptions and with their own personal agendas (Gadgil *et al.*, 1993; Stocking, 1995; Levia, 1999). Additionally, these systems are increasingly being viewed as non-equilibrium systems (Kaschula *et al.*, 2005).

The current view is that elements of both equilibrium and non-equilibrium systems exist in semi-arid rangelands (Kaschula *et al.*, 2005; Vetter, 2005). It has been show that populations of animals are at equilibrium with resources available in the dry season in semi-arid grazing systems (Illius and O'Connor, 1999; Illius and O'Connor, 2000). These areas may therefore be disturbed but have the potential for high productivity, but this is highly variable and dependent on the system (Illius and O'Connor, 1999; Kaschula *et al.*, 2005). This has implications for rangeland managers who must manage these areas according to their goals for the system (Kaschula *et al.*, 2005). As a result, misleading, false or biased results and views of these systems may be obtained and reported and the solutions given may not be implementable, causing these systems to be overused, leading to resource exhaustion and environmental degradation (Gadgil *et al.*, 1993; Stocking, 1995; Levia, 1999). Traditional Ecological Knowledge (TEK) may be useful because of their long history of incentivised nurturement and sustainment of diversity within their environment (Gadgil *et al.*, 1993).

1.3.6 Traditional Ecological Knowledge (TEK)

1.3.6.1 Definitions of TEK

TEK is a cumulative and adaptive group of knowledge, practices and beliefs, specific to a particular place or people, focused on relationships between living beings and the environment, which have and are evolving from detailed observations and adaptive learning (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). TEK is tested by trial-and-error and handed down from previous generations and across present communities through cultural transmission, orally or by shared practical experiences (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). TEK is an attribute of societies with resource use practices and, in comparison with scientific methods, is more dependent on local social mechanisms, institutions and the prevailing world view (Berkes *et al.*, 2000). These societies are not necessarily tribal or indigenous but are generally less technologically advanced with their environmental theories merging with their theories on society (Bolig and Schulte, 1999; Berkes *et al.*, 2000). Whereas conventional resource management may be based on an equilibrium model or with an assumption of ecological stability which appears to cause a gradual loss of resilience and reduction in variability, TEK generally acknowledges the unpredictability of ecosystems and their nonlinear nature, and appears analogous to adaptive management as it acknowledges that the environment is in a constant state of flux and that therefore societies must be able to adjust their actions and practices in response to it (Ludwig *et al.*, 1993; Berkes *et al.*, 2000; Berkes *et al.*, 1998).

TEK has some commonalities with western science as they are both knowledge systems based on a series of observations and on practical experience and may potentially be complementary, although they are generated, accumulated and transmitted in very different ways (Berkes *et al.*, 2000). In some forms of TEK, the unit of nature may be defined using a geographical boundary, with all biotic components within this boundary, including humans, considered as interlinked with interactions and feedbacks occurring between

them (Berkes *et al.*, 1998; Bolig and Schulte, 1999; Berkes *et al.*, 2000). There is also often a perceived symbolic link between nature and people, and therefore TEK may perceive a link between environmental and social degradation (Kaschula *et al.*, 2005). As these indigenous people have depended on their local environments over long periods of time and interact with it daily they have an interest in conserving or enhancing it (Gadgil *et al.*, 1993; Oba and Kaitira, 2006). However, conservation of biodiversity in particular is not necessarily an objective of traditional management systems; instead it may be a consequence of it, such as from using a greater variety of species and landscape patches compared to modern food production techniques and monitoring, and responding to, changes in ecosystems (Berkes *et al.*, 2000). Having said this some indigenous people are aware of the importance of biological diversity for ecosystem services and resources they depend on and as a result may increase its heterogeneity or restore biodiversity if lands have been degraded (Gadgil *et al.*, 1993).

Ideal TEK systems use resource management practices that promote resilience in systems, for example a diversity of resources are used which promotes livelihood security, local rules are created and enforced and resource use is flexible (Berkes *et al.*, 2000). However, these systems have not always been and are not always ecologically wise, especially for nomadic people who are not dependent on a specific resource or resource base, but they are adaptable, as a result of monitoring, and evolve over time to become more environmentally friendly. Alternatively they may become maladaptive over time because of changing conditions (Gadgil *et al.*, 1993; Berkes *et al.*, 2000). This is important to be aware of so that TEK is not viewed with undue sentimentality with illogical or inappropriate concepts or practices over-looked or explained away (Kaschula *et al.*, 2005). Monitoring of resources and change in ecosystems is easier for local resource users because of their proximity to them which allows for the monitoring of day to day changes (Berkes *et al.*, 2000).

TEK regarding species' grazing values, plant succession and causes of environmental change of two African pastoral societies in Kenya and Namibia was found to be detailed and complex, socially constructed and rooted in ideology (Bolig and Schulte, 1999). Maasai herders classify their seasonally grazed landscapes using socio-cultural folk systems, soils, topography and vegetation, management knowledge and grazing seasons. Landscapes are characterized as degradable or non-degradable with references made to the soils and the vegetation type, in order to regulate seasonal grazing across heterogeneous landscapes (Oba and Kaitira, 2006). Past experiences are sometimes used by herders to measure changes in the plant species composition, with degradation indicated by disappearances of key forage species or increases in less desired species or a decline in productivity (Oba and Kaitira, 2006). It is more relevant to pastoralists to describe land degradation in terms of lost grazing value for livestock (Oba and Kaitira, 2006). In a study of the perceptions of environmental degradation in an agropastoral community in Botswana, multiple realities were perceived by villagers and various outsiders, with differences between local men and women, for example, and between scientists and community members. These contradictory explanations were partly resolved by grouping the respondents by age or wealth (among community members) and by identifying the main links between the local community and the environment and seeking a shared meaning of environmental change (between community members and outsiders) (Dahlberg, 2000). Differences in the language and terminologies used by local communities and scientists are a big obstacle when comparing TEK and ecological techniques. However, when these contradictory explanations are resolved an improved understanding of environmental and social dynamics will result (Berkes *et al.*, 1998; Dahlberg, 2000). A study was conducted on the harvesting technique and the impact of soil and species type on post-harvest coppice response of popular savanna fuelwood species in Bushbuckridge (Kaschula *et al.*, 2005). It was found that some TEK was in agreement with biological data. However, overall responses were inconsistent and were given at diverse scales making it difficult to parallel TEK and scientific knowledge (Kaschula *et al.*,

2005). The information collected from community members in this study showed an array of opinions that have been acquired from personal experience, through traditionally encoded knowledge, formal schooling and guesswork (Kaschula *et al.*, 2005).

Both farmers' perceptions and scientists' knowledge of degradation processes may be subjective and limited to the geographic area they have knowledge and experience with and the way they are used may also be subjective or directed (Stocking, 1995). However, they may still be valuable additions to the knowledge of degradation processes and should be investigated (Bielders *et al.*, 2001).

1.3.6.2 Roles of TEK

The knowledge systems of people play an important role in how they use their environment. For example the types, diversity and amount of natural resources they acquire from their environment, their uses for these natural resources and the methods they use to extract them (Mandondo, 1997). People play an important role in shaping their environment; people may change the way it looks, the species that live there and change the species that live there (Mandondo, 1997). This is true for all human communities from those that live in urban or peri-urban environments to those that live in rural or semi-rural areas. Our perceptions of peoples' effect on their environment depend very much on the lens through which we view that community as well as on our desires for that area and its uses (Pretty, 2002). For example, people will seldom criticise the development of a sprawling city if it provides employment or wealth for them. This may also vary with upbringing, personal preference and societal influences (Mandondo, 1997, Pretty, 2002).

In contrast to ecological assessments, the environmental knowledge of local communities has been developed over extended periods of time from the practical experiences and observations of people, living within ecosystems, who are often very involved with them and have responded to the changes in them (Berkes *et al.*, 1998; Berkes *et al.*, 2000; Roba and Oba, 2009). Therefore, local people can often give information about a variety of useful plant species, regarding their use and management, and about changes in the vegetation that has occurred over time (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Lykke, 2000). A variety of local and traditional practices for ecosystem management have been identified from case studies, including multiple species management, resource rotation, succession management, and management of landscape patchiness (Berkes *et al.*, 2000). Thus, TEK may be valuable for understanding the processes which lead to degradation and for developing methods to assess it where traditional ecological methods have not succeeded (Ellis and Swift 1988; Fraser et al., 2006; Oba and Kaitira 2006; Reed et al., 2007; Roba and Oba, 2009). The reanalysis of the validity and importance of TEK comes at a time when the role of communities for identifying indicators and monitoring sustainable behaviours and environmental management goals is becoming increasingly apparent (Fraser *et al.*, 2006).

1.3.7 Implementation of community-based natural resource management (CBNRM) projects

There will always be trade-offs involved between human requirements of natural resources, ecosystem services and land-use change and the need to ensure the sustainability of these ecosystems, their services and the natural resources they provide (DeFries *et al.*, 2004). These trade-offs are ultimately based on societal values. However, ecological knowledge can provide an important basis for assessment of trade-offs (DeFries *et al.*, 2004). In order for ecologists to participate effectively in land-use planning and for natural resource management programmes to succeed, an improved understanding of trade-offs between conservation of natural resources and peoples' use of them is required. Additionally, a large amount of local ecological and societal knowledge should be available so that informed decisions can be made regarding these trade-offs and resource and societal sustainability (Dahlberg, 2000; Theobald *et al.*, 2005). Additionally all interested and affected parties should be motivated to make these projects a success. These may include monetary incentives or benefits derived from harvesting in protected areas.

Studies of environmental change and degradation in semi-arid Africa have often yielded contradictory results in the measures of the magnitude, severity and causes and effects of changes. This has led to questions being raised regarding how these findings may be used, how perceptions of the environment should be recognized and analysed and how terms of value-judgement should be determined and used (Dahlberg, 2000). To combat degradation interdisciplinary technically-based measurements are required that can be used by planners and non-scientists (Stocking, 1995).

The willingness of people to protect land from degradation is usually dependent on their perception of the utility of that land (Barrow, 1991).This is an important concept that restricts the usefulness of interactions between conservationists and local community members when resource management projects are launched as different people have different priorities (Stocking, 1995; Kaschula *et al.*, 2005). In evaluations of change it is now seen as important to measure not only the actual changes or conditions in the environment but also to assess the different perceptions of the environment and of land-use change amongst resource users (Dahlberg, 2000). This is occurring as environmental management projects move from being governed by outsiders in a 'top-down' approach to a bottom-up, or more holistic, approach. Where top-down approaches tends to focus on single issues, view humans as separate from the environment and have not been effective for integrating various mechanisms involved because community participation is generally neglected (Kaschula *et al.*, 2005; Fraser *et al.*, 2006; Oba and Kaitira, 2006; Reed *et al.*, 2008). In order to implement CBNRM projects, a more politicized focus on the dynamics of entitlement to resources, and the institutions that regulate access to resources is required (Kaschula *et al.*, 2005). Where entitlements refer to "alternative sets of utilities derived from environmental goods and services over which social actors have legitimate effective command and which are instrumental in achieving wellbeing" (Leach *et al.*, 1999). Utilities can include direct use products such as food or fuel or environmental services (Leach *et al.*, 1999). Further, individuals will have endowments, "the rights and resources that social actors have" through which they can acquire entitlements and which regulates their use of those entitlements (Leach *et al.*, 1999). Institutions may mediate social actors' access to both endowments and entitlements and, therefore, the way in which they interact with their environment (Leach *et al.*, 1999).

There are multiple ways in which a person may perceive his or her environment and many ways that they may choose for their environment to function (Zube, 1987). Ultimately, outside of formally protected areas whose managers have their own impetus for how they should function and be managed, land is used and managed in a way that would provide the most benefits for the people who use that land. The same can be said for the people who live in Bushbuckridge. Communities are also often over-simplified by researchers, when seen as discrete, self-contained units whose members have common interests and beliefs (Kaschula *et al.*, 2005). Instead, communities are increasingly being acknowledged as less culturally homogenous and socially integrated, than they were in the past (Cousins and Claasens, 2006). Community-based conservation (CBC) is not a solution for every situation; in some instances communities may be unable to manage some resources because of their distribution in a landscape, the fixed nature of some resources such as trees, and the mobile nature of other resources, such as wildlife, may hinder the easy allocation of land between communities (Naughton-Treves and Sanderson, 1995, Agrawal and Gibson, 1999).

Institutions can facilitate some interaction while constraining others, and without them social interactions would not be possible (Bates, 1989; North, 1990). Institutions may promote the stability of expectations and consistency in action and are the primary medium to mediate, soften, structure and facilitate particular outcomes and actions (Ensminger, 1992; Alston, Eggertsson and North, 1996; Agrawal, 1995; Agrawal and Gibson, 1999). Institutions, once formed, are independent of the individual forces that created them, although constant challenges to their structure by members may cause them to change (Agrawal and Gibson, 1999). They are therefore a provisional agreement on how to achieve tasks by helping

the behaviour of actors to move along certain courses. It is important that authority is exercised to ensure that rules are created about the use, management and conservation of resources, these rules are implemented, and that disputes that arise as a result of the interpretation and application of these rules are resolved. The creation of institutions will not necessarily lead to better outcomes (increased biodiversity and biomass or sustainable stock levels etc.) but it may offer a tool for increased understanding of local-level processes and outcomes as well as more identifiable points of intervention and design (Agrawal and Gibson, 1999).

Local resource users may be more qualified for rule-making as they will, likely, be more familiar with local resource systems. National and regional government is still required for occasions that require defensive action, for some cases of intra-community conflict or for non-exploitative technical assistance. If the rules made by the communities are not in accordance with the desires of policy-makers they can do little to change them as that goes against the vision of CBC (Agrawal and Gibson, 1999).

1.3.8 Review of perceptions of African savanna ecosystems

African pastoral systems were historically viewed as potentially being equilibrium systems that may be destabilized by overstocking and overgrazing with this influencing the ways that they were studied and managed (Ellis and Swift, 1988; Hoffman and Ashwell, 2001). However, more recently, these systems have become understood as unpredictable and uncontrollable and their processes as non-linear and with multiple equilibriums. Additionally, through social science research in areas such as Botswana, Kenya, Namibia and elsewhere, the view of indigenous pastoralists and people as ignorant and environmentally damaging has changed and is increasingly being viewed as ecologically and economically appropriate and comparable with scientific views (Shackleton, 1993; Niamir 1995; Berkes *et al.*, 1998; Bolig and Schulte, 1999; Harrison and Shackleton, 1999; Dahlberg, 2000; Fernandez-Gimenez, 2000; Oba and Kotile 2001; Vetter, 2005; Roba and Oba, 2009). Although, that is not to say that it does not have any impacts, grazing impacts and abiotic factors must be viewed in the context of each other (Illius and O'Connor, 1999).

Additionally, because landscape degradation can occur as a result of processes that have occurred over long periods of time, short-term ecological assessments may not be appropriate for identifying these processes. The view of these systems as equilibrial has, in the past, guided development policies and projects to focus on altering the systems internal structure to restore equilibrium and increase productivity by enforcing grazing rotation or restricting it altogether (Ellis and Swift, 1988). However as these do not recognize the dynamics of these systems they often increase deprivation and ultimately fail (Ellis and Swift, 1988).

In comparison with scientific ecological assessments and knowledge, TEK, has developed over a longer period and often includes ecosystem-like concepts. Thus, TEK may be more appropriate and should be incorporated into development projects (Ellis and Swift, 1988; Berkes *et al.*, 1998; Roba and Oba, 2009). This is in accordance with Levia (1999) who recommends a "decentralized" approach to treat land degradation and its causes in which the role of government and scientists are as observers and for the distribution of advice to local land users, who then make the choice to minimise land degradation. Additionally the role of ecological information and analyses are considered in order for improved decision-making regarding the use of rural lands (Theobald *et al.*, 2005). However, this requires knowledge of an ecosystem's responses to different land-uses, in order to attempt to create a balance between human needs and the maintenance of ecosystem function (DeFries *et al.*, 2004). It is also important to develop a comprehensive land-use framework at a site for ecological studies to be incorporated into this broader land-use context (Theobald *et al.*, 2005). In this way environmental indicators may be developed to inform local

rural land-use planning efforts (Theobald *et al.,* 2005). One of the biggest challenges of CBNRM projects is comparing local and scientific knowledge categories (Kaschula *et al.*, 2005).

1.3.9 Dynamics of Socio-Ecological Systems

Societies and environmental systems are increasingly being viewed as inextricably linked, giving rise to a number of frameworks that focus on transdisciplinary studies of, amongst other things, the impacts of society on the environment (Berkes and Folke, 1998; Bodin and Tengö, 2012). These factors include "socio-ecological systems" (SES) and "coupled human and environmental systems" (CHANS). Where CHANS and SES are defined as: "integrated systems in which people interact with natural components" (Liu *et al.*, 2007), and "holistic conceptualisations and models" of both social and ecological systems (Young *et al.*, 2006). These frameworks are used to improve our understanding of the perceived environmental problems occurring as a result of the increasing effects of humans on biophysical processes (Anderies *et* al., 2004). When studying systems through these frameworks, one is able to identify trends that are not apparent when they are investigated by natural or social scientists independently (Liu *et al.*, 2007) especially for studies of resilience, vulnerability and adaptability (Young *et al.,* 2006). These studies measure ecological (e.g., biodiversity) and human variables (e.g., structures of governance) and also include variables that link them (e.g. collection of fuel wood) (Liu *et al.,*2007). This has presented problems as researchers have struggled with integrating quantitative and interdisciplinary methods (Prato, 2009; Bodin and Tengö, 2012). In addition, these systems are dynamic, both spatially and over time, and these and other processes of change that are involved makes understanding them far more complex (Dahlberg, 2000; Liu *et al.*, 2007). These changes may also occur simultaneously at different scales; and interact with each other, so that changes at one level may have different effects at another and may form complex feedback loops (Dahlberg, 2000; Liu *et al.*, 2007). For example, land use may have effects on a systems disturbance gradient at multiple scales because of the interactions between land use and other biophysical and social variables (Zurlini *et* al., 2006). There will always be some uncertainty in how these systems may react to changes, because of this it is important to focus on making SES more resilient (Anderies *et al.*, 2004). The feedback loops that occur may be similar between "developed" and "developing" communities, and urban and rural, e.g. in agriculture or tourism, or very different, such as socioeconomic problems (Liu *et al.*, 2007).

1.3.10 Importance of interdisciplinary studies

Interdisciplinary studies have shown that physical and social landscapes are complex and uncertain but may be fairly resilient, often in spite of very dramatic changes (Dahlberg, 2000). Many successful initiatives for combating land degradation have been conducted at a local level and supported by non-governmental organizations that consulted and worked with people at this level in order to address specific problems (Hoffman and Ashwell, 2001). These programs have drawn on indigenous knowledge systems and local technologies in order to combat land degradation (Hoffman and Ashwell, 2001). In this way both herder knowledge and scientific methods are used in order to identify rangeland management strategies and test their effectiveness; and to increase community participation in the monitoring of rangelands (Oba and Kaitira, 2006; Reed *et al.*, 2007). Therefore, participatory and ecological methods and TEK should be combined in order to create systems-level or landscape-level programmes for the conservation of the natural environment and for natural resource management that incorporates biological, cultural, economic and symbolic aspects of natural resource use nested within the eco-social system. These should be familiar and user-friendly for communities (Kaschula *et al.*, 2005; Theobald *et al.,* 2005; de Beer and Marais, 2006; Reed *et al.*, 2008).

Integrating TEK and scientific ecological methods may be difficult to achieve and may only be able to be reconciled after evaluating TEK using scientific yardsticks (Kaschula *et al.*, 2005). Especially in light of the

variety in community member's knowledge regarding natural resource use that has been obtained from studies (e.g. Kaschula *et al.*, 2005). However, this approach may reduce the range of concepts that may be used for management (Kaschula *et al.*, 2005).

As it is not feasible to analyse TEK in terms of the degree to which it is compatible with scientific knowledge, in interdisciplinary studies, its concepts should be analysed in a broader context (Kaschula *et al.*, 2005). Ecologists should engage with interdisciplinary research so that the appropriateness of including ecological information with rural land-use planning can be ascertained (Theobald *et al.,* 2005).

1.3.11 Overview of the study area: Bushbuckridge

1.3.11.1 History

This research was conducted in the rural municipality of Bushbuckridge, Mpumalanga Province, South Africa. Bushbuckridge was part of the Gazankula, Lebowa and KaNgwane homelands during the apartheid era of South Africa and was "independent" from South Africa from 1971 until 1994 when it was incorporated into the Mpumalanga Province under the "New South Africa" (Christopher, 2001; Mayher and Raab, 2009). Prior to the formation of the settlements that make up present day Bushbuckridge, there were relatively few people in the area and these people had open access to resources (Giannecchini *et al.*, 2007). In the Beaumont and Stubbs commissions of 1916 and 1917, Bushbuckridge was defined as a *release area*, which was an area designated for occupation by black people (Ritchken, 1994; Ramutsindela and Simon, 1999). From the 1960s onwards, soon after the creation of the "homelands", the population increased as many black South Africans were moved into the area as a result of Apartheid era policies, specifically the Group Areas Act (Act No 41 of 1950). People came from the surrounding areas, such as Sabie, Graskop and Klasserie that were now reserved for white South Africans (Blignaut and Moolman, 2006; Mayher and Raab, 2009, Share, focus group). These people were often from different 'tribes', many without a chief and were forced to integrate by the then apartheid government, a practice which often resulted in conflicts between the groups (Ramutsindela and Simon, 1999). During this time rules were introduced governing resource use. These rules were enforced by traditional authorities. For example, these rules dictated that the cutting of live trees was forbidden and that certain land be allocated for cultivation by village headsmen (Giannecchini *et al.*, 2007).

Between 1984 and 1992, about 320 000 Mozambicans left Mozambique and entered South Africa. Most of these people settled in the then-homelands of KwaZulu, KaNgwane and Gazankulu, and about 200 000 remained after 2005. About 30% of the residents of Bushbuckridge were first or second generation Mozambicans in 2005 (Polzer, 2005). These people settled in villages throughout Bushbuckridge, although some villages, including the village of Share, prevented any refugees settling on their land. Many of these former refugees are now naturalized citizens of South Africa or have permanent residency interacting with the rest of the community in the political, institutional, community and personal spheres (Polzer, 2005).

1.3.11.2 Demographics

In 2011 the population of Bushbuckridge was 541 248 people with an average annual population growth rate of 6.13% over the period of 2007 to 2011 (www.statssa.gov.za). The majority of inhabitants are of Shangaan ethnicity, with a small group being North Sotho and a smaller group of Siswati speakers (Mayher and Raab, 2009). The Shangaan ethnicity of the Mozambicans living in Bushbuckridge has assisted the integration of these groups (Polzer, 2005; Mayher and Raab, 2009), although some differences between Mozambicans and South Africans are still recognised by people, predominantly South Africans, living in these villages. This is in line with the idea that rural communities may be less culturally homogenous and have less

social integration than they did in the past as a result of the movement of people between areas and an increasing socio-economic differentiation between community members (Cousins and Claasens, 2006).

1.3.11.3 Location, geology and climate

The Bushbuckridge district of the Mpumalanga province borders on the Kruger National Park at its eastern edge, it is 234,761ha in area, with 184,301ha of that classified as communal land that undergoes no habitation or cultivation but is open for access by residents (CSIR, 1996; Shackleton, 2002; Blignaut and Moolman, 2006; Mayher and Raab, 2009). The climate here is sub-tropical, the mean annual temperature is 22°C, there is summer rainfall, mainly between October and April, and frost is rare (Shackleton, 2000; Shackleton, 2002; Giannecchini *et al.*, 2007). A gradient of decreasing rainfall exists from west to east with a mean annual rainfall of greater than 1200mm p.a. in the west against the Drakensberg and 550mm p.a. in the east (Shackleton, 2000). Rainfall is erratic and droughts occur fairly frequently (once every 3-4 years) especially in the lower rainfall areas (Shackleton, 2000; Shackleton, 2002; Giannecchini *et al.*, 2007).

The topography is also dominated by a west to east gradient (Shackleton, 2000). The principal soil type is relatively nutrient-poor, shallow, sandy lithosols (granitic) except where deeper, duplex soils are found towards the base of slopes and deep apedic soils occur closer to the escarpment (Shackleton, 2002). These soils are underlain by potassic granites and grandiorite with terrain varying between flat and undulating (Shackleton, 2000; Shackleton, 2002).

Bushbuckridge lies in the "Lowveld" with the natural vegetation being an open, deciduous woodland with two main vegetation types evident along the rainfall gradient, Legogote Sour Bushveld in the west, classified by Acocks (1988) as the Lowveld Sour Bushveld, and Granite Lowveld in the east, classified by Acocks (1988) as Lowveld (Acocks, 1988; Shackleton, 2000, Shackleton, 2002, Mucina and Rutherford, 2006). The Legogote Sour Bushveld is predominantly dense woodland containing medium to large shrubs (Mucina and Rutherford, 2006). Erosion in this vegetation type is very low to moderate (Mucina and Rutherford, 2006).

1.3.11.4 Natural resource use

The influx of people into Bushbuckridge and the high population growth rate there have resulted in a high population density (Hoffman and Ashwell, 2001; Weis *et al.*, 2002; Mayher and Raab, 2009). In 2000, it was estimated that the population density was 146 people per km^2 in the east and 30.3 people per km^2 in the west (Shackleton, 2000). Poverty levels are high in this area with an unemployment rate of 82% and 84% of the population classified as indigent with a total earning of less than R1300 per household per month (Mayher and Raab, 2009).

As a result of the high levels of poverty and unemployment in these areas many people rely heavily on the natural environment for a range of natural resources and ecosystem services as part of their livelihood strategy (Weis *et* al., 2002; Blignaut and Moolman, 2006; Mayher and Raab, 2009). As a result of this high demand for resources many people find it difficult to manage these resources effectively (Cousins, 1999; Hoffman and Ashwell, 2001; Blignaut and Moolman, 2006).

About 78.5% of the land in Bushbuckridge is under communal tenure with signs of live wood harvesting (Shackleton and Shackleton, 2000; Kaschula *et al.*, 2005, Blignaut and Moolman, 2006). Most households harvest several types of resources from these communal areas including fruit, thatch grass, fuelwood, mushrooms, reeds and wood for construction (Shackleton and Shackleton, 2000). Fuelwood is the primary energy source for residents of Bushbuckridge, being used by more than 85% of households (Shackleton, 2000). Almost all households in Bushbuckridge cultivate small tracts of land around their homestead in the rainy season and between 30 and 40% of households also cultivate in demarcated arable fields around villages, this number is restricted by the availability of land (Shackleton, 2000). One third of

households own cattle (Shackleton, 2000). The stocking rate is said to be close to or greater than the carrying capacity of these areas at 0·88±0·09 Large Stock Units (LSU) per ha (Parsons *et al.*, 1997).

Giannecchini *et al.* (2007) identified a trend of decreasing woodland cover accompanied by growth of human settlements. However, this trend was not found to be linear (Giannecchini *et al.*, 2007). Instead it was often site-specific and dependent on interacting forces including population growth, drought, shortages of land, grazing and wood, the weakening of institutional governance of natural resources and diversification of livelihood strategies (Giannecchini *et al.*, 2007). Indeed, Fisher *et al.*, (2012) found that while disturbance gradients may exist spanning outwards from a settlement in sparsely populated or utilised areas, in heavily utilised areas these gradients ceased to exist.

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Dissertation Structure

This dissertation consists of a series of chapters written as papers that focus on each of the four objectives. As a result overlap may occur between chapters in the dissertation in order for them to be largely stand-alone.

Chapter 1 provides the context of the study and includes the aim and objectives, as well as a review of the relevant literature. Chapter 2 investigates participatory resource mapping of the communal lands of the study villages, answering objective 1. Chapter 3 investigates LRUs perceptions of their communal lands and how they have changed over time and how they are predicted to change into the future, related to objective 2. Chapter 4 provides an ecological comparison of sites described as "good" or "poor" for the collection of certain natural resources by LRUs, answering objective 3. Chapter 5 identifies ways in whichthe perspectives of ecologists and LRUs can be integrated within the context of Community-Based Natural Resource Management to fulfill chapter 4.

These chapters are being edited to be submitted to journals.

Chapter 2

2. Comparison of perceptions of the extent, division and use of communal lands between different age and gender groups in Bushbuckridge, South Africa

2.1. Abstract

The extent and demarcation of different sites of use within the communal lands of three villages in Bushbuckridge were defined by groups of local resources users, using participatory techniques. These groups were stratified by age; 20-40 years old and >40 years; and gender. The attributes of each of the areas defined by these groups were also discussed, such as the quantity and quality of the graze or wood available there. Participatory mapping and Geographic Information Systems (GIS) techniques were used. This was done in order to identify differences in the perceptions of extent, division and use of communal lands between these resource users for each village. It also enabled researchers to develop a broader understanding of these communal areas and their distribution between and use within villages. Local Resource Users (LRU) who used the communal lands for grazing of livestock (men) used a larger area, defined more sites within that area and had a more structured rotational grazing system, compared to fuel wood harvesters (women) who used a smaller area and with individuals generally repeatedly returning to the same area for harvesting. The differences between different age groups of users of the resource were less distinct, especially among fuel wood harvesters. The two age groups of users of communal lands for grazing of livestock depicted different borders between sites at two of the three villages, although the characteristics of each of the areas were very similar between these groups. This has broadened the understanding of the role and function of these areas for these residents and of their role in peoples' livelihoods. In this way, these results have implications for the way that resource use in this and other areas with similar characteristics is studied and understood.

Keywords: Fuel wood, grazing, local resource users, participatory mapping, preference

2.2. Introduction

2.2.1 Cultural landscapes

Communities in rural areas rely on the natural resources obtained from the communal lands around their village (Shackleton *et al*, 2001; Varughese and Ostrom, 2001), such as firewood or grazing of livestock. This interconnectedness between communities and their environment, in space and time, can be reflected in a cultural landscape (Burgi and Russell 2001; Birks *et al.*, 1988; Russell, 1997). Cultural landscape is defined by Farina (2000) as 'geographic areas in which the relationships between human activities and the environment have created ecological, socio-economic and cultural patterns and feedback mechanisms'. Head (2000) defines them as those landscapes 'transformed by human action'. Sauer (1965) describes cultural landscapes as the works of man on the natural landscape, which may include the succession of landscapes linked with a succession of cultures. This dependence on the natural resources in these communal lands is also assumed to foster a greater level of knowledge of these resources within the community than exists outside of the community (Agrawal and Gibson, 1999). The transformation of these landscapes may occur to a greater or lesser extent. It is thought that this may result in certain landscapes being favoured by LRUs to a greater or lesser extent depending on the degree to which their characteristics are useful to the LRUs.

2.2.2 Local Resource Users Perspectives and Local Ecological Knowledge

Different members of a community do not necessarily have the same interest in, or understanding of their environment, nor do they value it in the same way. Rather, people value their environment and

support environmental protection programmes differently depending on cultural factors and material concerns. People in rural environments may value their environment because they rely on it first-hand in order to acquire important resources and services, thus, these people also tend to identify environmental problems if they are directly affected by them (Inglehart, 1995; Anderson *et al.*, 2007; Hunter *et al.*, 2010). Their perceptions of their environment's value may also vary based on their own feelings, influences and thoughts (Mandondo, 1997) as well as age and education (Dietz *et al.*, 1998). These different interests, understandings and values will have consequences for general environmental degradation, on the yields and sustainability of use of natural resources and the environment, on the way they are used and policies regarding their use; for example, people who value the environment less tend to overuse their resources (Murphree, 1991; Agrawal and Gibson, 1999; Hunter *et al.*, 2010). The views of all of these people must be acknowledged for the creation of sustainable and equitable outcomes (Agrawal and Gibson, 1999). The empowerment of community members to use and manage their natural resources and communal lands sustainably requires the decentralisation of resources from the government to a community. It should also include recognising the patterns of difference in use, the multiple actors within a community and their different and dynamic interests. As well as these interactions in the context of larger social forces, such as the political context, prices of resources, demographic changes or technological innovations (Agrawal and Gibson, 1999).

Policies now recommend that rural communities be involved in their development and have a say in matters that affect their future, and that economic, social and environmental concerns should be solved within the context of one another in order to ensure sustainability. This is expected to improve the success rates of local upliftment projects (Kepe, 1997; Anonymous, 2004). This has occurred as the behaviour and practices of these groups of people are increasingly being viewed as ecologically and economically appropriate and comparable with scientific views (Shackleton, 1993; Niamir 1995; Berkes *et al.*, 1998; Bolig and Schulte, 1999; Harrison and Shackleton, 1999; Dahlberg, 2000; Fernandez-Gimenez, 2000; Oba and Kotile 2001; Vetter, 2005; Roba and Oba, 2009).

As mentioned in the previous section, the dependence of members of rural communities on the natural resources in their communal lands is assumed to foster a greater level of knowledge of these resources within the community than exists outside of the community (Agrawal and Gibson, 1999; Berkes *et al.*, 2000). This is will be referred to as Local Ecological Knowledge (LEK) because it was deemed as more appropriate for this area given the social upheavals of people living in the Bushbuckridge area in the past century. However it may also be referred to as Traditional Ecological Knowledge (TEK) which is discussed in Chapters 1 and 5. This group of knowledge is cumulative and adaptive and includes knowledge, practices and beliefs that are specific to a particular place or people and focus on relationships between living beings and the environment (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). This knowledge has and is evolving from detailed observations and adaptive learning (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). The societies that are associated with this form of knowledge are not necessarily tribal or indigenous but are generally less technologically advanced with their environmental theories merging with their theories on society (Bolig and Schulte, 1999; Berkes *et al.*, 2000).

LEK and scientific knowledge types are now being incorporated and considered in order to improve decision-making on the use of rural lands (Theobald *et al.*, 2005). This also requires the development of a comprehensive land-use framework and environmental indictors at a site for both knowledge types to be incorporated within a given context (Theobald *et al.*, 2005). One of the biggest challenges of CBNRM projects is comparing local and scientific knowledge categories (Kaschula *et al.*, 2005).

2.2.3 Communal land tenure

Communal rangelands are state-owned tribal lands that a group or groups of people have the right to live on and use (Abel, 1997; Scogings *et* al., 1999; Vetter *et al.*, 2006; Nyamukanza *et al.*, 2008). The activities these lands are used for include the harvesting of natural resources, such as fuel wood, for the grazing of livestock or for, predominantly, subsistence farming (Everson and Hatch, 1999, Shackleton *et al.*, 2001, Kirkland *et al.*, 2007). These rights are often historical as in South Africa the communal areas were established under the Native Land Act (Act 27 of 1913 and 1936) as part of the former homelands (Hoffman and Ashwell, 2001; Nyamukanza *et al.*, 2008).

The residents of villages in Bushbuckridge use the communal lands to obtain various resources, including fuel wood, wild fruit and vegetables, for livestock production and for agriculture (Dovie *et al.*, 2002; Dovie *et* al., 2006; Kirkland *et* al., 2007). However, the extent of the land available for use by residents, the boundaries, distribution and divisions within the land used by each village is unclear. The boundaries of the commons for a village tend to be determined by the boundaries of the old surveyed farm boundaries for that land or by features in the landscape such as streams or railway lines (Kirkland *et* al., 2007). It is also assumed that disturbance levels in these areas decrease radially with increased distance from human settlements, similar to a piosphere (Parker and Witkowski 1999), however this pattern is not found in villages with highly utilised rangelands where disturbance gradient cease to exist (Fisher *et al.*, 2012).

2.2.4 Participatory resource mapping

Focus groups discussions or interviews, are commonly implemented to attempt to understand LRUs perceptions and use of the landscapes available to them (Chambers, 1992). Participatory Resource Mapping (PRM) has proved to be a useful place to start when collecting this information. PRM involves collecting information from several people, often during a focus group, while these participants create a graphic representation of their landscape or annotate an already constructed map, such as an aerial photograph, this process is facilitated by an external facilitator (Mbile *et al.*, 2003). This process may help to stimulate enthusiasm within the group as well as providing practitioners with an overview of the community (Mbile *et al.*, 2003). PRM can be used to develop a systematic, graphic understanding of the layout and set-up of a community's landscape, indicating its makeup, the location of different features and the ways that community members relate to their landscape (Mbile *et al.*, 2003). Generating these databases that incorporate spatial data with data obtained through household surveys or econometric analyses can improve our ability to work with, analyse and draw lessons or to extrapolate results (Kristjanson *et al.*, 2002). Through PRM, LRUs sense of their environment may also be strengthened, they may feel empowered and their development needs may be located (Mbile *et al.*, 2003) and better understood. It can also assist with integrating local and external expertise (Abbot *et al.*, 1998).

2.2.5 Participatory GIS

When maps generated through PRM are integrated with GIS the process is commonly referred to as Participatory GIS (PGIS). GIS is computer-based mapping software that translates real-world geographic information into a computer-readable form, incorporating both map-making and spatial analysis to create a relational database that has access to spatial data and attribute information (Abbot *et al.*, 1998, Mbile *et al.*, 2003, Tripathi and Bhattarya, 2004). Through this database, data can be manipulated and multiple layers of information brought together (Abbot *et al.*, 1998). The product of this can be disseminated in many forms, most frequently as maps (Abbot *et al.*, 1998). The applications for GIS include the planning of resource management, optimal sitting studies, marketing and others these applications are through the use of spatial information and the production of maps (Abbot *et al.*, 1998). One of the key objectives of PGIS is

the integration of local knowledge and spatial information (Abbot *et al.*, 1998). This is expected to enhance the involvement of communities in development projects (Abbot *et al.*, 1998). Through PGIS the communities involved can expound their perceived strengths of and needs from their environment, while utilizing GIS technology which can add an air of credibility and succinctness to the information that is supplied to policy- or decision-makers. Geographic Information Systems (GIS) may provide insights into a variety of issues by producing relevant, readable maps and making it possible to monitor changes in the quantities of and relationships between attributes across locations and over time. GIS can also be used to store different types of data and knowledge (Mbile *et al.*, 2003, Tripathi and Bhattarya, 2004). The information collected through PGIS can also be scaled up to different levels to reflect local or national trends or concerns (Abbot *et al.*, 1998, Mbile *et al.*, 2003). These characteristics can increase empowerment in communities through the promotion of increased responsibility and power for decision-making (Tripathi and Bhattarya, 2004, McCall and Minang, 2005). The information generated through PGIS is primarily visual and thus can be simple to understand for the people who generate it, as they are able to express themselves within contexts they are familiar with, and for those that use it (Abbot *et al.*, 1998, Mbile *et al.*, 2003, Tripathi and Bhattarya, 2004). Thus, a very important feature of PGIS for systems research is integrating qualitative and quantitative information sources that were previously isolated to consolidate and share ideas (Abbot *et al.*, 1998).

There are concerns over the use of PRM and PGIS techniques. Concerns include that PRM could be used to exploit local knowledge or increase control from the outside (Abbot *et al.*, 1998, Jordan and Shrestha, 1999, Tripathi and Bhattarya, 2004). GIS technology is often expensive and requires trained personnel and associated technology to operate it, such as data capturing, storage, processing and output systems (Abbot *et al.*, 1998, Mbile *et al.*, 2003, Tripathi and Bhattarya, 2004). Additionally, it is perceived as susceptible to manipulation by 'outsiders' such as experts, district officers or transnational companies and to top-down development planning (Abbot *et al.*, 1998). The integration of qualitative data, obtained from LRUs, with GIS data, which is largely quantitative, is also of concern for PGIS. During PGIS, large volumes of generally qualitative, descriptive data are generated through participatory methods and there may be problems associated with the processing of this data (Mbile *et al.*, 2003). There may be problems with capturing data regarding community dynamics such as power relations or politics, integrating data obtained at differing scales or finding a balance between these differing forms of data and information (Abbot *et al.*, 1998). Especially as this qualitative data must be integrated with GIS data, which is often quantitative and precise. It can be a challenge to integrate these two forms of data in a way that all users can understand and use to develop information (Abbot *et al.*, 1998). This can also be a positive because the common structure imposed by GIS can make analysis more systematic (Mbile *et al.*, 2003). PRM and PGIS techniques have been used in projects throughout Africa (Mbile *et al.*, 2003; Mapedza *et al.*, 2003; Kyem , 2004; McCall and Minang, 2005; Duvail *et* al., 2006; Dongus *et al.*, 2007; Fagerholm and Käykö, 2009) and the world (Smith, 2003; Hasse and Milne,2005, Shrestha, 2006; Beverly *et al.*, 2008).

It has been shown in previous studies that although LRUs are knowledgeable about their environment, its characteristics and changes within it, this knowledge is not uniformly shared (Knapp and Fernandez-Gimenez, 2008; Kassam, 2009 and Kgosikoma *et al.*, 2012). In order to assess areas perceived as being better or worse than each other ecologically, it was necessary to capture the knowledge and perceptions of these areas from a range of Local Resource Users (LRUs), stratified by key socio-demographic determinants of knowledge. To investigate these patterns, the aim of this study was to determine differences between local resource users, stratified by age, 20 to 40 years old and older than 40 years, and gender, in their definition of the boundaries of the communal lands of their village, the divisions of those

areas into smaller zones or sites and the uses and attributes of those sites. This was done by focussing on two key questions:

2.1 What are the boundaries of each village's communal lands, as defined by LRUs from different age and gender groups?

2.2 Can these areas be divided into lands that are more or less useful for acquiring fuel wood and grazing livestock and what criteria are used to determine this?

2.3. Methods

2.3.1 Village Selection

Sampling was conducted in three villages in the Bushbuckridge Municipality of Mpumalanga, South Africa. These were the villages of Allandale, Clare A and Share (Figure 2.1). Bushbuckridge is an area of 234,761ha in size. Of this, 78.5% is classified as communal land that is available for utilisation by residents with no habitation or formal cultivation (CSIR, 1996; Shackleton, 2002; Blignaut and Moolman, 2006, Raab and Mayher, 2008). Bushbuckridge is also undergoing significant change; over a thirteen year period, between 1993 and 2006, 36% of the land cover in the Kruger to Canyon region, which includes Bushbuckridge, underwent transition from one form to another (Coetzer *et al.*, 2010). This transition was dominated by a 39.7% increase in settlement areas, predominantly in Bushbuckridge and other rural areas and there was also a 6.8% increase in the expanse of human-impacted vegetation, this occurs as communal areas are transformed from areas of no habitation (Coetzer *et al.*, 2010). The climate, geology and floral characteristics are described in greater detail in Chapter 1 and Chapter 4.

The study villages were selected for sampling because of their location and the high levels of heterogeneity that existed in the Normalised Difference Vegetation Index (NDVI) in the lands surrounding these villages, which would likely provide for a range of specific resource areas. The NDVI describes the presence of vegetation inside a pixel and the condition of the vegetation in that pixel (Wan *et al.*, 2004). This was selected for because of the effects it was presumed to have on the way that areas within these lands would be used or valued (Figure 2.1). Additionally, these three villages are located along a north-south axis; thus, they have similar annual rainfall, as the rainfall gradient in this area exists from east to west. They also occur on the same substrate, principally nutrient-poor, shallow, sandy granitic soils (Shackleton, 2002).

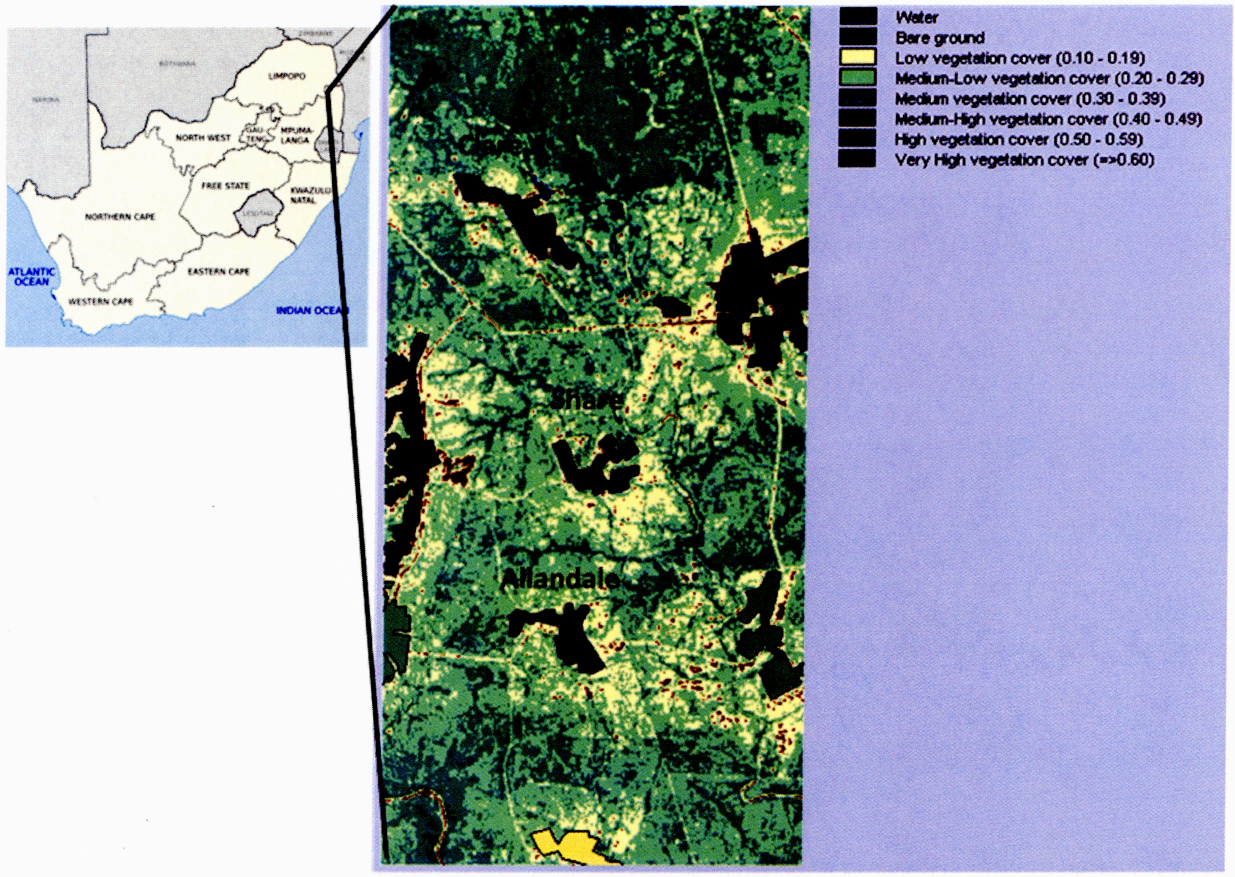


Figure 2.1. Location of the three villages, Allandale, Clare A and Share, in relation to each other and within the Mpumalanga province of South Africa. NDVI scores for the land surrounding each village. Data sourced from Wayne Twine (*pers. comm)*

2.3.2 Data Collection Methods

Focus group discussions were conducted with members of from each village, these participants were self-selected to join the discussions after they were announced to members of the communities by the appropriate *induna*. A total of ten focus group discussions were conducted, each was independent and involved a semi-structured discussion (the results of which are included in Chapter 3) and participatory mapping. The participants for each of the three villages were stratified into four groups: two male groups that used the lands predominantly for grazing livestock, especially cattle, and two female groups that used the land to harvest fuel wood predominantly. These male and female groups were further stratified by age into groups between 20 - 40 years of age and people older than 40 years of age. Focus group discussions were conducted in November 2010. Three focus group discussions were conducted for the villages of Clare and Allandale, with 20 - 40 year old and older than 40 year old females from each village respectively failing to attend and four focus group discussions were conducted at Share. The composition of the ten focus groups is shown in Table 2.1.

Table 2.1. Numbers of participants that were involved in each focus group

	Male Focus Groups		Female Focus Groups	
Village	**20-40 years old**	**>40 years old**	**20-40 years old**	**>40 years old**
Allandale	5	4	5	0
Clare A	5	6	0	6
Share	7	9	7	6

Aerial photographs of each village and its surrounding land; size A1 and laminated, were used for participatory mapping during these focus group discussions (Figure 2.2). The mapping generally started with the boundaries of each village's communal lands being identified and the establishment of the boundaries of different areas of use (Figure 2.2). Figure 2.2 was created by the older male focus group at Allandale village. The boundaries of the different sites used were drawn in and labelled. The villages that use those communal lands were also written below each number, as well as annotations of this use. For example site 2 was grazed by cattle owned by people from the village of *Lepong* during droughts. Lands that were not used by the village in question but were known to be used by other villages were also annotated (e.g. The area to the left of the map was used by residents of *Dumphries A* and *B*). Major features in the landscape were also annotated for orientation purposes, such as a river or railway line.

The boundaries of the sites were often determined by the presence of a fence, road or river. The characteristics of each of these sites were defined, as was their value for collection of certain key resources, especially grazing for cattle and fuel wood. These sites were further categorised in terms of the LRUs preference for these sites. Male and female focus group participants were asked to rank the sites in their order of preference for the specific use being discussed, grazing or fuelwood collection, this ranking happened within the group. They were then asked about the criteria they used to make these judgements and why certain sites were preferred. "Good" (labelled 1 in Figure 2.3a-c) and "poor" (labelled 2 Figure 2.3a-c) sites as rated by the focus group participants were selected for further data collection. Other sites that were used but were not the best or worst or used by all groups at the applicable village were labelled three or four. From these discussions a map was created for each village that included the data obtained from each focus group (Figure 2.2) and digital images were created using ArcMap version 9.2 using on-screen digitizing by approximating from the maps created during discussions (Figure 2.3a-c). Following the selection of these villages, human ethics clearance was sought from the Human Research Ethics Committee (Non-Medical) of the University of the Witwatersrand, and was approved, with protocol number H100810. Permission was also sought from the chief presiding over these three villages and from the *induna* for each village.

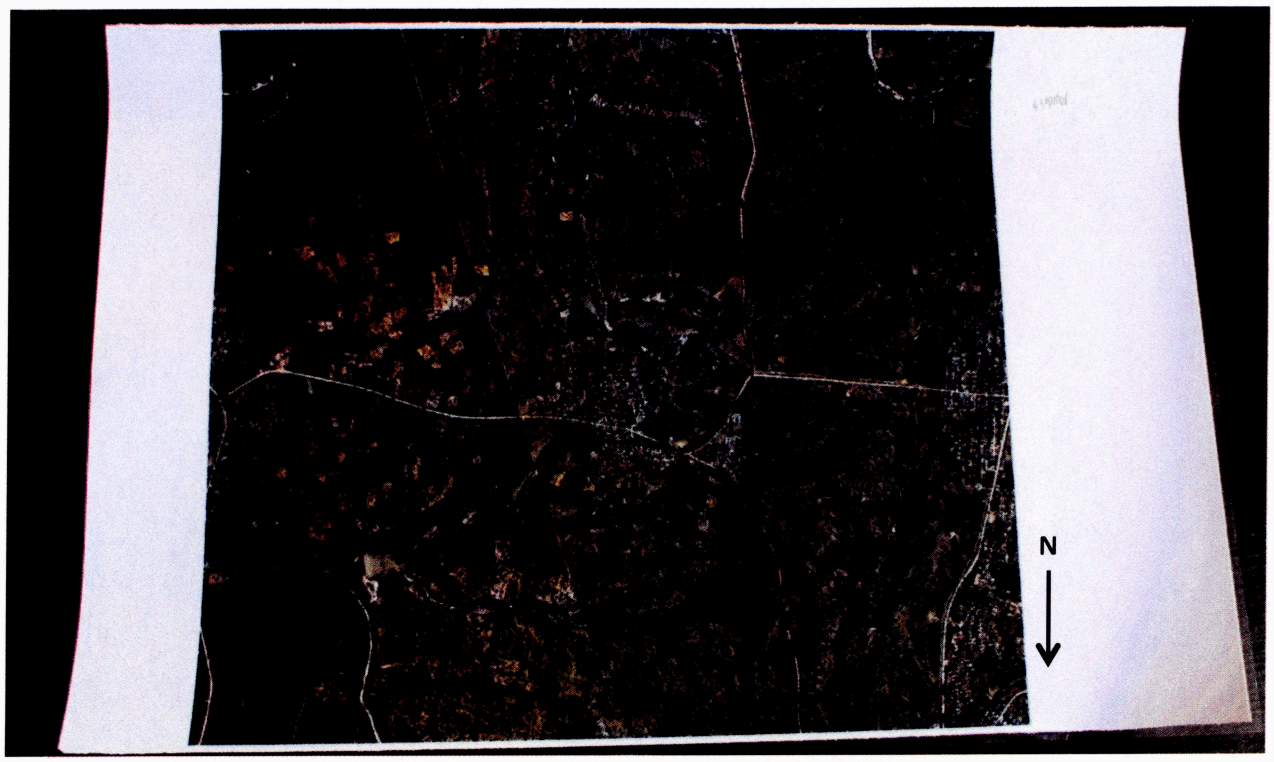


Figure 2.2. Aerial photograph of the location and use of communal areas surrounding Allandale village, as an example of participatory mapping. This map is orientated as it was orientated by focus group participants. The boundaries of the different sites used were drawn in and labelled (1 and 2). Major features in the landscape were also annotated for orientation purposes, such as a river or railway line.

2.4. Results

The boundaries of the communal lands and the sites within them were identified differently by different groups for some villages (Figure 2.3). For example, in Allandale the younger male group identified a site to the west of the village that neither of the other two groups at this village did. At Clare A, the extent of the communal lands that were defined by the two male focus group discussions was similar. However, the female focus group only identified a single site of use and members were unfamiliar with the boundaries for the rest of their village's communal lands. A prominent boundary for all groups was the "foot and mouth fence" or "redline", indicated by the black and white line in Figures 2.3a-c. This is despite the fence being poorly maintained at the time of this research, but it has been in existence since the 1960s.

Each village identified between two and four sites surrounding their village. Two sites were defined at Allandale by all focus groups, with a third site described by the younger male focus groups only (Figure 2.3a). This site was also said to be used infrequently. The extent of each of the two main sites was defined in a similar way between the three focus groups. This is especially true for site 1. At site 2 the same area was defined but the extent of the site was unclear between groups with some indicating that the site overlapped with the village. The boundaries of this site were unfenced while those of the site 1 were fenced. These sites occurred to the north (site 1) and south (site 2) of the village. Site 1 was identified as the best land by all three focus group discussions. It is said to have good quality grass and good soil, this was attributed to the large amount of water available especially in a river that cattle could drink from. This site was said to be used predominantly in summer, according to both male groups. There were also large amounts of wood available at this site and so harvesting was said to be time-effective. Thus, many resources

could be obtained from this site. Site 2 was identified as the worst land. The main reason given for this was that people were beginning to build new stands on this land. For this reason there were low amounts of grazing and wood available, according to all groups. The soils were also said to be of a lower quality here according to the older male group. The lack of agreement between the three focus group discussions regarding the boundaries of this site may be a result of this site experiencing high amounts of change as it is increasingly being converted to new stands.

In Allandale the same boundaries to the "good" site were identified by each focus group (Table 2.2), however at the bad site the boundaries varied with the largest demarcation being more than 60 hectares larger than the smallest demarcation, although the smallest demarcation fitted within the boundaries of the largest demarcation. This was true for every site that was mapped for all of the villages. Though the extent of the sites varied between groups the location was the same. At Allandale the "good" site was smaller than the "poor" site. At Clare A, the "good" site was more than twice the size of the "poor" site and this was one of the reasons for people's preference of the one site over the other despite them being so close together. In Share, the demarcated size of the sites varied widely between the groups. The "good" site was shown to be larger, by between 58 to 99 hectares, by three of the groups. However, the older male group indicated that the "poor" site was about the same size as the "good" site.

In Clare A, a total of four sites were identified, although these sites were not identified by all members (Figure 2.3b). The same boundaries were identified for site 2 by both male groups, For sites 1, 3 and 4 the boundaries overlapped for much of their distance but there were smaller areas where there were some discrepancies between the sites. For example, the eastern boundary of site 3 which the older male group depicted as extending all the way to the boundary of site 4 while the younger male group did not. Site 1 was identified by all groups and was said to be the best site (Table 2.3) . This site was identified as the best because it was large, had good grass and rich soil. It was used in summer and to a lesser extent in winter, when it is rested and alternate sites are used. The land had been ploughed in the past and some of it was ploughed occasionally now. Both male groups said that *Acacia nilotica* and *Dichrostachys cinerea* have spread in this site; however these species are now being cleared and burnt on site. These species were not used for fuel wood, as focus group members described their fear of thorns. Burning these invasive species was a strategy that was described by members of both male focus group discussions for improving the grazing lands. This strategy was also said to be sanctioned by the local authority of *Induna* and Chief. Individual trees were cut down to their bases and the removed vegetation was placed in big piles. These were left to dry and then burnt. It was unclear how frequently burning occurred however during data collection in these sites many of these piles were found that appeared to have been left for at least a season judging by the presence of seedlings within. Site 1 was the only site that the female participants identified as being used and was said to contain most of the important species for fuel wood. Site 1 was also said to have better grass than site 2, soil was not identified as different between sites. Site 2 was chosen to be sampled as the worst land as site 3 was said to be used very rarely as it is far away from the village and was formerly a quarantine site for cattle. Site 4 was used for ploughing and was inaccessible at the time of vegetation sampling, this site was used for grazing cattle in winter. The characteristics of site 2, that made it appropriate as the "bad" site, in that it was too small and had too many thorn trees present, more than site 1, that made both harvesting of fuel wood and grazing cattle difficult. The quality of graze was also said to be lower than in site 1. The boundaries of the communal lands in this village were similar between all focus group discussions as were the boundaries of sites. Access to sites within this village was also restricted with both sampling sites being fenced with locked gates, during sampling the assistance of an LRU from the village was required in order to enter the sites. Sites 1 and 2 are adjacent to each other, but are separated by a river

and a fence. From this research it is unclear why these sites had different characteristics despite being adjacent to one another.

Four sites were identified by the male groups in Share, while three were recognised by the female groups (Figure 2.3c). The boundaries identified between these sites by the groups were the most varied for any of the villages, as indicated by the boundaries depicted for each group. The boundary defined by the groups for site 2 was the most consistent for all the sites. The largest variation within this site came from the two female groups regarding the northern boundary (the one closest to the river). The greatest variation occurred with the sites to the east of the village. These sites were across a large river, the Khokhovela. The two male groups also defined the boundaries within sites differently. The younger male group identified two grazing sites at site 1, while the older male group identified two sites at site 3. It is unclear if this discrepancy was caused by a difference in understanding between the groups, a misunderstanding promulgated between the groups or a change in the boundaries of these sites. Sites 1 and 2 were used for the vegetation sampling (Chapter 4). The female groups felt that there was no difference in the amount or quality of wood that could be harvested in either site; rather they said that people would go to the same area to harvest wood each time they went. However, differences between sites were identified by both male groups. Site 1 was identified by the older male group as having good soil (although that at site 3 was better), it had some rivers present and limited *Acacia nilotica* is present there (Table 2.3) . The younger male group also said the soil was of a high quality, identifying it as loam and clay-loam soil. This group said that no *Acacia nilotica* was present in this site. Site 2 was identified by both male groups as the worst site. The older male group said that it had poor soil, the presence of many aloes, which was viewed as a negative characteristic by these resource users, and only a non-perennial river. It was also said to have many *Acacia nilotica* trees. While the younger male group also said that it had the worst soil, identifying it as sandy soil, with a large amount of *Acacia nilotica* and therefore bad grazing. Site 3, west of the village, on the other side of the Khokhovela River (this served as the boundary between 2 and 3), was described as having good soil, identified as loam by the younger cattle group, and many small rivers. This area has been partially "invaded" by *Acacia nilotica.* The younger male group in this village was the only one to categorise the soil type as sand, loam or clay while all other groups who mentioned the characteristics of soil described it as either good or poor. The female groups in this village were also the only ones to talk about the presence of soil erosion and the value of trees for their indirect service as a wind break. This indicates a greater appreciation for the value of their communal lands than the focus group discussions of other villages who mentioned entirely utilitarian uses.

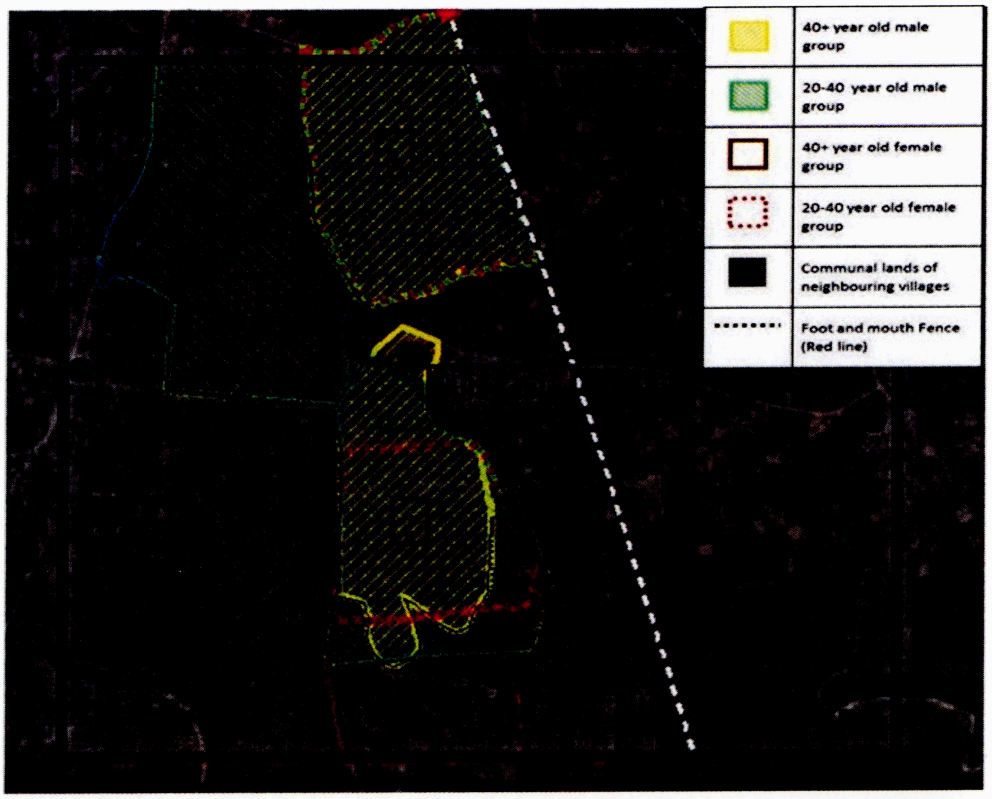
Table 2.2 Area (in hectares) for each of the sites described by each focus group. Site 1 and 2 for each village were described "good" and "poor" by focus group discussions for the collection of natural resources. The areas were determined from the boundaries drawn during participatory mapping).

	Village	Allandale			Clare A				Share		
	Site	1 (Good)	2 (Poor)	3	1 (Good)	2 (Poor)	3	4	1 (Good)	2 (Poor)	3
Male 20-40	**Area (ha)**	381	383	508	672	200	155	580	388	330	436
Male 40+	**Area (ha)**	381	406	-	692	138	155	652	324	330	295
Female 20-40	**Area (ha)**	381	339	-	-	-	-	-	466	367	449
Female 40+	**Area (ha)**	-	-	-	672	-	-	-	459	439	-
Overlap	**Area (ha)**	381	339	-	672	138	155		324	330	295

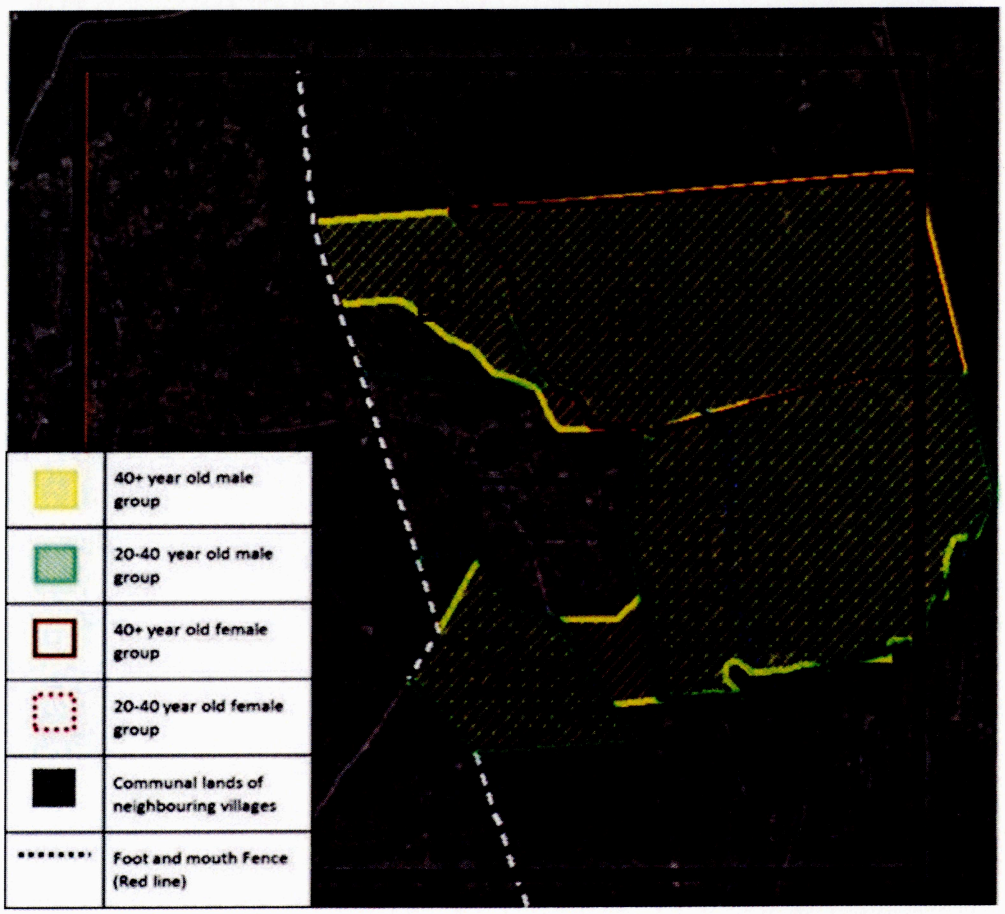
Only one group, the younger female focus group from Share described using a site on the opposite side of the fence to their village for harvesting of wood (Figure 2.3c). Participants from this group had no preference for certain sites over others, saying that people harvesting fuel wood instead went to the same area repeatedly. Additionally, this site bordered on a tarred road with a gate connecting both sides of the fence and, thus, is fairly easy to access for people collecting fuel wood.

Most male focus groups indicated their use of the entire area around their villages, divided into different grazing sites. One of the only barriers to this distribution was the foot and mouth fence. The exception is Allandale where some of the land was only used by neighbouring villages (Figure 2.3a). Male groups also indicated some forms of rotational grazing, although it is unclear how strictly this was followed (Table 2.3).The younger female focus group at Share showed that all of the land around the village was allocated for use. Their counterparts at Allandale used the same area as the male focus groups. However, the female focus group at Clare A only indicated that they used a small part of the area that was potentially available. The village whose focus group participants described using the most land was Clare A with 1706 hectares of land, Share had 1 232 hectares available and Allandale 787 hectares available, or 1 332 hectares if site 3 (Figure 2.3a) was included as one group suggested it should be.

a)


40+ year old male group
20-40 year old male group
40+ year old female group
20-40 year old female group
Communal lands of neighbouring villages
Foot and mouth Fence (Red line)

b)


40+ year old male group
20-40 year old male group
40+ year old female group
20-40 year old female group
Communal lands of neighbouring villages
Foot and mouth Fence (Red line)

c)

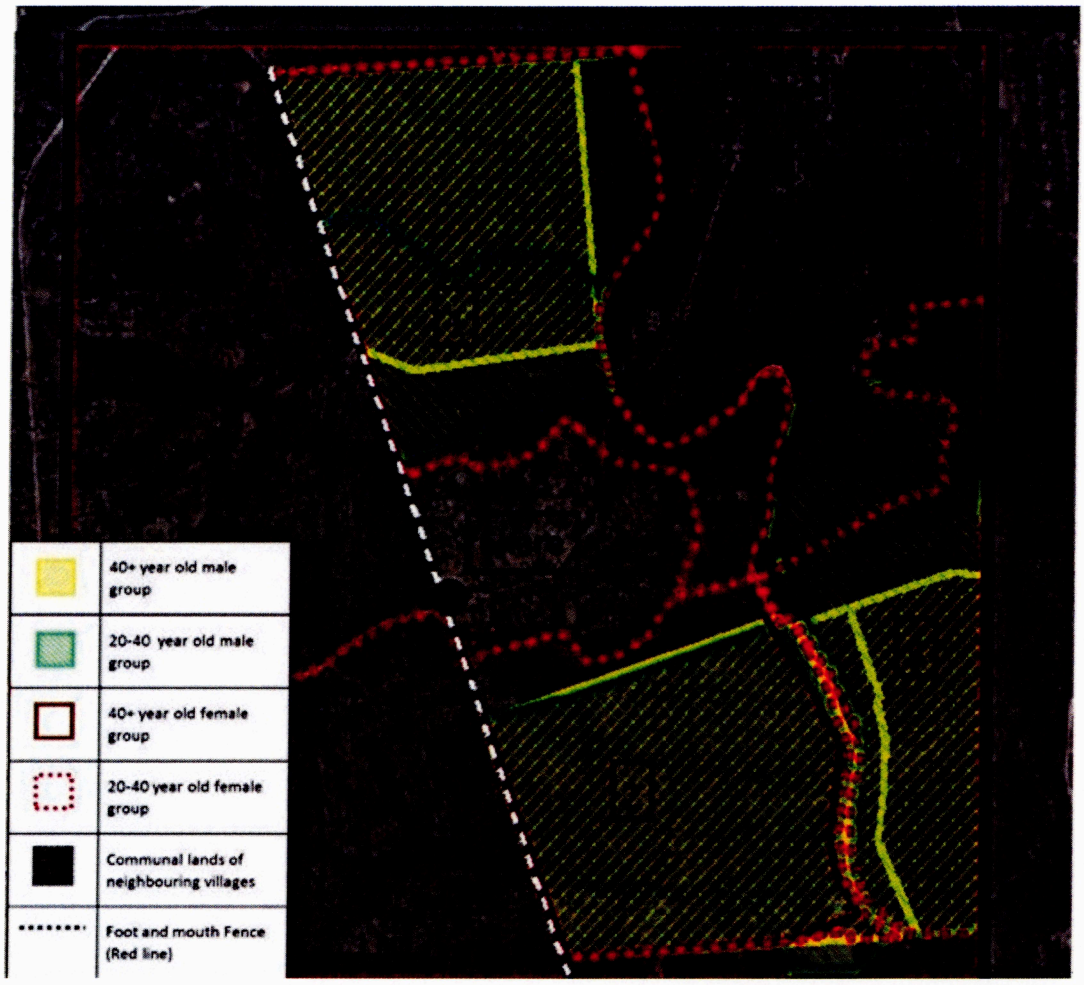


Figure 2.3. Maps of each village as created by all focus groups. Large square border indicates the boundary of what was displayed in the printed map, the numbers represent the different sites as identified by focus group participants a) Allandale; b) Clare A; c) Share

Many of these sites were also shared by two or more of the neighbouring villages. This appeared to be based on the position of the site in relation to other villages as opposed to the perceived quality of the site. For example, the site identified as the "good" site (site 1) at Share was also used by four other villages, while the site that was identified as "poor" (site 2) was used by Share only. While in Allandale the site that was recognised as the "poor" site (site 2) was used by one other village and the site that was perceived as "good" (site 1) was used only by Allandale. All sites at Clare A were shared with Clare B, except for the, infrequently used, old quarantine site that was only used by Clare A.

Table 2.3. The characteristics of the "good" (site 1) and "poor" (site 2) sites in the communal lands of each village as described by male and female focus group participant.

			"Good"	"Poor"
Allan dale	**Male**	**20-40 year olds**	Good grazing Good soil Lots of wood available Rivers are present Used in summer	Worst land New stands being built here Some ploughing takes place Poor grazing Poor soil Used in winter
		>40 year olds	Best grazing Best soil	Worst land New stands are being built here Worst grazing
	Female	**20-40 year olds**	High availability of wood Harvesting is time-effective	New stands being built here Low availability of wood
Clare A	**Male**	**20-40 year olds**	Good grazing Rich soil Lots of thorn trees	Poor grazing Small area Many thorn trees
		>40 year olds	Good grazing Large area Good soil Thorn trees present but are harvested and burnt Used in summer, sometimes in winter	Poor grazing Small area Many thorn trees Used in winter but infrequently
	Female	**>40 year olds**	Only site used All important woody species are present.	Many thorn trees
Share	**Male**	**20-40 year olds**	Good grazing Good soil (loam and clay-loam) No *Acacia nilotica* Used in winter (for 3 months)	Poor grazing Poor soil (sandy) Non-perennial river Much *Acacia nilotica* Used in summer (for 3 months)
		>40 year olds	Good grazing Good soil (loam and clay-loam) Some rivers Small amount of *Acacia nilotica* Used in winter (for 3 months)	Poor grazing Poor soil (sandy) Non-perennial river Much *Acacia nilotica* Many aloes (unpalatable) Used in summer (for 3 months)
	Female	**20-40 year olds**	Same quality and amount of fuel wood as "Worst"	Same quality and amount of fuel wood as "Best" Soil erosion
		>40 year olds	Same quality and amount of fuel wood as "Worst"	Same quality and amount of fuel wood as "Best"

2.5. Discussion

Focus group discussions were able to plot the boundaries of their communal lands and of different sites without difficulty once the map had been explained and certain land marks had been indicated. Overall, the areas were the same between all groups, but the boundaries were defined slightly differently between groups, especially for sites where the boundaries were not defined by a fence or by features in the landscapes such as rivers or roads or those implemented by external role-players such as the "red line".

Similar "natural boundaries" have been found to be used to delineate boundaries in other studies such as Fagerholm and Käyhkö (2009) where multifunctional cultural landscapes were mapped in Tanzania. The use of the boundaries to demarcate sites indicates that the exact boundaries may not be of great significance to LRUs (McCall, 2006; Fagerholm and Käyhkö, 2009). The foot and mouth fence was the most prominent boundary for sites and for villages. It is unclear how these boundaries were allocated to different villages and when this had occurred. This lack of understanding is in line with literature where there is a lack of discussion of the boundaries of land under communal tenure and of how the methods through which lands are allocated aside from their being allocated by the appropriate chief or traditional leader or council (Ntsebeza, 1999, Cousins, 2007). It is also unclear, from these discussions and the available literature, how these boundaries are communicated with many members of these focus groups stating that they "just knew".

Different groups within a village did not necessarily identify the same boundaries for sites within their communal lands. This was especially apparent between the male and female groups, a factor that may be attributed to the differences in the ways that the two groups utilise these sites. The male groups, who either owned or minded cattle, generally showed a preference for different sites at different times of the year, with both groups from Share indicating that they implement rotational grazing across the sites and the two groups from Clare A indicating that they use some sites in winter and others in the summer months. However, the female groups, whose predominant use of the communal lands was for collecting fuel wood, appeared to use fewer sites and also tended to stick to certain areas within those sites, although they did not discuss distance to the village as being a factor in their choice of site. Differences in boundaries were the greatest at sites that were unfenced or were being converted for other land uses such as new stands, whereas, the described boundaries for sites that had been fenced were more similar between groups. Male groups from each village were in agreement over the "good" and "poor" sites for grazing, i.e. the different male age groups were largely in agreement. The criteria used by male focus groups for ranking sites were: the quality and availability of graze and the presence and amount of "unfavourable" tree species such as *Dichrostachys cinerea* and *Acacia nilotica,* as well as the distance from the village and the presence of rivers or streams which are important in maintaining livestock, particularly cattle. In spite of thorn trees being spoken of during discussions as reducing the quality of grazing lands, this was not a criteria used for ranking of sites. The reasons for this are not clear from this reference. The female groups on the other hand showed a limited preference for one site over another, instead they returned to a certain area from where they harvested fuel wood. Common criteria used by the female focus groups were the quality and availability of fuel wood or of species used for fruit. In spite of the male groups indicating that there had been an increase in the amount of *Dichrostachys cinerea,* a good fuel wood species, present in these areas, the female participants did not mention this change and did not appear to perceive it favourably. Different people will value land and natural resources differently depending on a number of factors, from demographic to experiential and the resource that they use (Barrow, 1991, Stocking, 1995; Inglehart, 1995; Anderson *et al.*, 2007; Hunter *et al.*, 2010).

The issue of the conversion of communal lands to be used for homesteads is also an interesting occurrence. There is an annual population growth rate of 6.13% (from 2007 to 2011, www.statssa.gov.za) in the Bushbuckridge municipality and only 18.02% of the population between the ages of 15 and 60 are employed, with 23.89% classified as unemployed and 58.07% classified as not economically active (Bushbuckridge IDP 2011-2016), with many people relying on natural resources in order to supplement their livelihoods (Shackleton and Shackleton, 2004). However, with the decreasing size of communal areas and evident trends of degradation this may become a serious problem in the future. Coetzer *et al.* (2010) found

a decrease in the amount of intact vegetation (7.3%) and an increase in human impacted vegetation (6.8%) over a thirteen year period in the communal areas of Bushbuckridge

Participatory mapping proved to be an effective strategy for creating enthusiasm and facilitating the involvement of all group members. It enabled the boundaries of each village's communal lands to be mapped and for the sites within the communal lands to be mapped and their attributes described. This made it possible to identify possible differences between "good" and "poor" sites without assuming a decrease in anthropogenic effects with distance from a human settlement, a characteristic that would be difficult to identify in Bushbuckridge given the high population density and the scattered nature of villages throughout the landscape. Previous studies have shown that the knowledge of LRUs about their environment, it's characteristics and changes within it, is not uniformly shared (Knapp and Fernandez-Gimenez, 2008; Kassam, 2009 and Kgosikoma *et al.*, 2012) as was the case in this study. For example, certain groups, particularly younger groups, described changes in a way that is more closely aligned with ideas taught in schools such as describing soil types as clay and loam or identifying patterns of soil erosion whereas older groups described patterns of change more than the processes behind them. Major differences between the male and female groups were centred on the ways the two groups used the communal lands, where females returned to the same site frequently while male groups used larger areas of land to graze their livestock. It is important to take the spatial complexity of resource use in these areas into account and to be wary of limiting differences in use to two-dimensional space (Rocheleau, 2005; Roth, 2009). However, the differences in perceptions that were observed in this study are not regarded as distinct enough to limit the potential of the participatory mapping process or the information that was generated through it at this point.

The participatory mapping and discussion of the boundaries and use of the communal lands available to the residents of these three villages in Bushbuckridge has developed the understanding of how the members of these communities use the communal areas available to them. This knowledge can be used to understand features in the communal areas (Chapter 4) and also to understand peoples' preference of certain characteristics of vegetation or land type, such as soil characteristics the role and function of these areas for these residents and can contribute to developing an understanding of their role in peoples' livelihoods (Chapter 3).

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Chapter 3

3. Local resource users' perceptions of their communal lands: Past, Present and Future

3.1. Abstract

The role of communities in the protection of biodiversity and the mitigation of processes leading to degradation is increasingly being recognized. However, in order to involve communities in this process, and associated initiatives or projects, it is important to develop an understanding of communities' perceptions of their environment, the drivers of their actions towards their environment and the threats to that environment that they perceive. Data to develop an understanding of the perceptions of Local Resource Users (LRUs) of their communal lands in three villages in Bushbuckridge, Mpumalanga Province, were collected during focus group discussions, stratified by gender and age. It was found that all participants perceived negative changes to their communal lands and a deterioration of the resources available there in the past. However, male and female groups perceived these differently, with male groups identifying bush encroachment and a deterioration in the quality of graze for livestock, while female participants perceived a decrease in the availability of wood and of the tree species present. The majority of groups also perceived that these problems would continue into the future. These changes were largely attributed to the impacts of society, such as increased human population and livestock numbers and the effects of these changes on the demand for resources, as well as socioeconomic problems such as unemployment and unreliable availability of electricity. Recommendations for how to mitigate these effects depended largely on a greater regulation of people's access to resources, such as fencing in communal areas and increasing the presence of authorities to reduce the illegal harvesting of fuel wood. The recommendation of these steps was dependent on the perceived problem and the severity of the threat faced. In groups where problems were not perceived participants did not identify any changes in behavior that were required. Thus in order for community-based projects to be successful they must involve the mitigation of threats as identified by community members.

Key words: Perceptions; Degradation; Bushbuckridge, Communal Land Tenure, Fuel wood, Livestock

3.2. Introduction

3.2.1 People and conservation

Individuals within a community may not have the same interest in, understanding of their environment and they may value it differently (Hunter, 2006; Hunter *et al.*, 2010). It has been shown that people will value the environment and support environmental protection programmes differently depending on a variety of cultural factors and material concerns (Inglehart, 1995; Hunter *et al.*, 2010). People in rural environments may value their environment because they rely on it first-hand in order to acquire important resources and services, and thus, also tend to identify environmental problems if they are directly affected by them, as well as having important cultural and spiritual values attached to them (Inglehart, 1995; Anderson *et al.*, 2007; Hunter *et al.*, 2010). These different interests, understandings and values will have consequences for environmental degradation and on local natural resources but will also have consequences for peoples' willingness to protect their environment and to be involved in different CBNRM projects (Murphree, 1991: Hunter *et al.*, 2010). In the past, biodiversity conservation only considered protected areas, but efforts are increasingly being focused on the areas outside of protected areas (Colchester, 1994). In order to promote conservation efforts outside of protected areas, active community participation is

required (Sponsel, Headland and Bailey, 1996; Western and Wright, 1994; Agrawal and Gibson, 1999). This strategy, commonly known as Community-Based Conservation (CBC), aims to realise both biodiversity conservation as well as socio-economic development of the local people simultaneously (Berkes, 2004). Here, emphasis is placed on the local knowledge of community members and incorporating this knowledge and their locally-established practices in managing their own environment (Agrawal and Gibson, 1999).

3.2.2 Local Ecological Knowledge

In order to enhance the preservation of biodiversity in areas outside of protected areas while enhancing or maintaining the livelihoods of the people living in those areas, it is important to take those people's perceptions and their local knowledge into account. As local people tend to have a more in-depth knowledge of these systems as compared to outsiders (Agrawal and Gibson, 1999). Many terms have been proposed to describe the knowledge that a community possesses of their environment, such as indigenous knowledge (IK) and local knowledge (LK) as well as knowledge of the natural components and processes within their environment, such as traditional ecological knowledge (TEK) and local ecological knowledge (LEK). In this chapter I will refer to LEK. LEK is increasingly being investigated and legitimised for its value in biodiversity conservation and resource management, as local people may have a more in depth understanding of their environment (Agrawal and Gibson, 1999).

LEK is a cumulative collection of knowledge, practices and beliefs, specific to a particular place or people, focused on relationships between living beings and the environment, which have and are evolving from detailed observations and adaptive learning (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). LEK is adaptive and is tested by trial-and-error and handed down from previous generations over long periods of time through and across present communities by means of cultural or oral transmission, or shared practical experiences (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). This is through the practical experiences and observations of the people, living within ecosystems, that are often very involved with them and have responded to the changes in them (Berkes *et al.*, 1998; Berkes *et al.*, 2000; Roba and Oba, 2009). Thus, local people often have knowledge of the uses of different plant species and how to manage them and of how vegetation or the landscape may have changed over time (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Lykke, 2000). Different local, traditional practices for ecosystem management have been identified, including management of multiple species, resource rotation and management of succession and of landscape patchiness (Berkes *et al.*, 2000). In this way LEK may be useful in understanding local degradation processes and in developing additional methods to assess it (Ellis and Swift 1988; Fraser *et al.* 2006; Oba and Kaitira 2006; Reed *et al.* 2007; Roba and Oba, 2009). LEK often takes the unpredictability of ecosystems into account, functioning in a similar way to an adaptive management strategy, acknowledging the constant state of flux of an environment and the necessity that societies adjust their actions and practices in response to it (Ludwig *et al.*, 1993; Berkes *et al.*, 2000; Berkes *et al.*, 1998). Similarities between LEK and western scientific method centre on both knowledge systems being based on observations and practical experience and thus, although they are accumulated and transmitted in different ways, they may be complimentary (Berkes *et al.*, 2000). Conservation of biodiversity is not necessarily an objective of LEK management systems but rather a potential consequence of it, through activities such as the use of a greater number of species and landscape types (Berkes *et al.*, 2000). Both LEK and scientific ecological knowledge may be subjective, limited by the geographic area that there is knowledge and experience of (Stocking, 1995). However, they may still provide valuable knowledge of environmental processes such as degradation (Bielders *et al.*, 2001).

3.2.3 Combating Land Degradation

Land degradation is defined as a decrease in an area's actual or potential biological or economic productivity or utility and the loss of complexity, features or organisms which cannot be replaced (Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001). It is a biophysical process that is largely driven by socio-economic and political factors (Eswaran *et al.*, 2001).

Successful initiatives for combating land degradation involve implementation at a local level. As well as being supported by non-governmental organizations to consult and assist local people to deal with specific problems (Hoffman and Ashwell, 2001), thus drawing on both LEK systems and outside knowledge to identify rangeland management strategies, test their effectiveness and increase community participation (Oba and Kaitira, 2006; Reed *et al.*, 2007). The integration of participatory and ecological methods and LEK may help to create systems- or landscape-level programmes for the conservation of the natural environment and for natural resource management (Kaschula *et al.*, 2005; Theobald *et al.,* 2005; de Beer and Marais, 2006; Reed *et al.*, 2008). The integration of these two knowledge systems may be difficult to achieve, requiring that LEK be evaluated against scientific yard sticks (Kaschula *et al.*, 2005). This is especially so because of the variety of perceptions that may be obtained when community members' knowledge in regards to various aspects of natural resource use is studied (Kaschula *et al.*, 2005). It may not be feasible to analyse LEK in terms of its compatibility with scientific knowledge, thus its concepts should be analysed in a broader context (Kaschula *et al.*, 2005). Ecologists should engage with interdisciplinary research so that the appropriateness of including ecological information with rural land-use planning can be ascertained (Theobald *et al.,* 2005).

Land-cover change, resource use (Giannecchini *et al.*, 2007) and coppice harvesting (Kaschula *et al.,* 2005) have been studied in this area using both scientific and indigenous knowledge but little work has been done to identify perceptions of land degradation amongst the Bushbuckridge villagers (although studies of this nature have been done in other rural areas: Dahlberg, 2000; Oba and Kotile, 2001; Roba and Oba, 2009). When developing projects that aim to address environmental problems in areas used by Local Resource Users, it is important to have knowledge of their perceptions and understanding of these issues (Hunter *et al.*, 2010). Local Resource Users were selected whose primary resources used were either wood for fuel or grazing for livestock. These two resources were selected because of the possible impacts of their utilisation on the vegetation of these communal areas (Parsons *et al.*, 1997; Dovie *et al.,* 2004; Britz and Ward, 2007; Ruger *et al.,* 2008) and the prevalence of their use in these areas (Madubansi and Shackleton 2007). This study, therefore, focused on the perceptions of land degradation (both the current state and drivers of land degradation) for the communal areas of three villages in Bushbuckridge. The aim was to attempt to understand the views of local resource users (LRUs) in three villages in Bushbuckridge regarding their communal lands: their current state, how they have changed and how they are expected to change in the future (Objective 2). This was done with the following key questions in mind.

1.1. What resources do LRUs currently acquire from their communal lands?
1.2. What are the perceptions of LRUs regarding the (a) current, (b) past (from 1990 until 2010), and (c) future (to 2030) state of their village's communal lands in terms of acquiring fuel wood and grazing for livestock?
1.3. If changes have occurred between these time periods, what has caused these changes and how could their effects be mitigated?

3.3. Methods

Three villages in Bushbuckridge were sampled during this research, namely Allandale, Clare A and Share (Figure 3.1). These villages were chosen because of the variability in NDVI that was associated with the communal lands around each village (further information in Chapter 2)

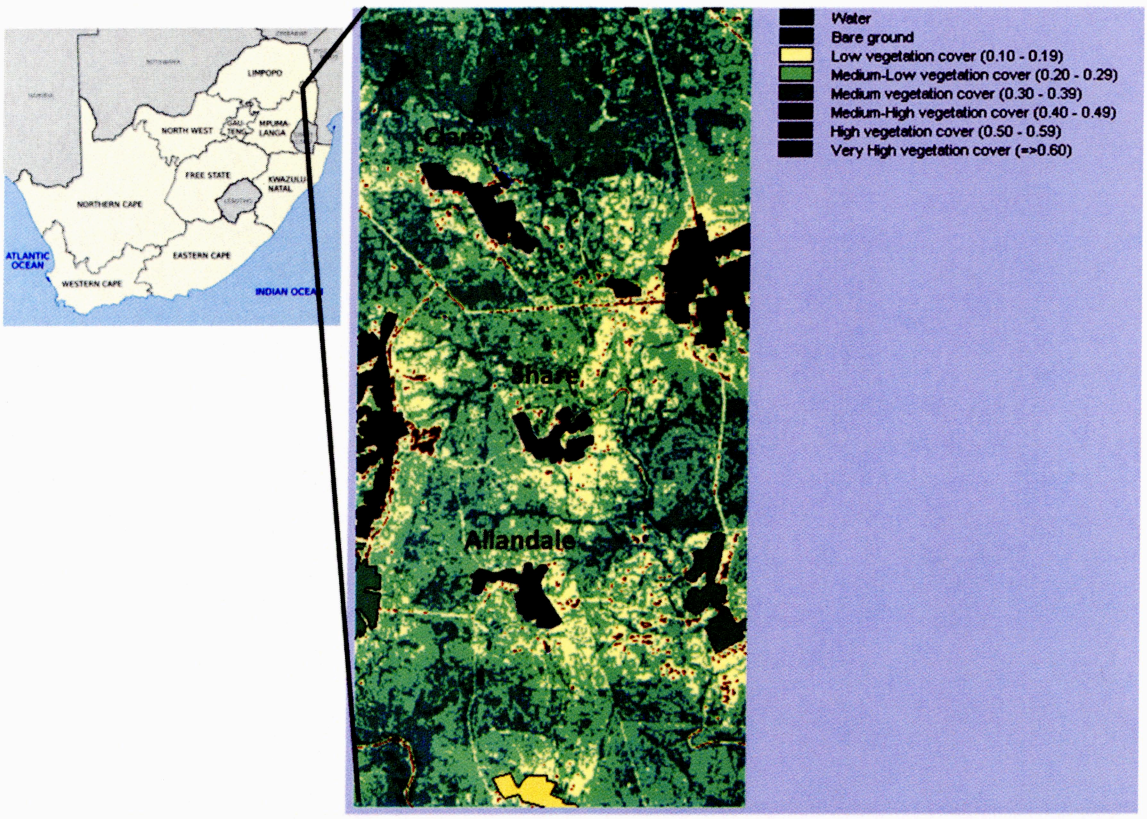


Figure 3.1. Location of the three villages, Allandale, Clare A and Share, in relation to each other and within the Mpumalanga province of South Africa. NDVI scores for the land surrounding each village were used to select the villages studied.

3.3.1 Research setting: Bushbuckridge

This research was conducted in the Bushbuckridge Municipality in the Mpumalanga province of South Africa. This area provides an interesting setting when studying LEK because of its history. Present day Bushbuckridge was part of the Gazankulu, Lebowa and KaNgwane homelands during the apartheid era and these were "independent" from South Africa between 1971 and 1994 (Christopher, 2001; Mayher and Raab, 2009). From about the 1960s onwards the population in this area increased significantly/substantially as many black South Africans were forcibly moved into the area as a result of Apartheid era policies, specifically the Group Areas Act (Act 41 of 1950). In terms of the Act people were forcibly relocated to this area from the surrounding areas, such as Sabie, Graskop and Klasserie that were now reserved for white South Africans (Blignaut and Moolman, 2006; Mayher and Raab, 2009). In addition, between 1984 and 1992 about 320 000 Mozambicans left Mozambique and its ongoing civil war and entered South Africa. Many of these refugees settled in the then-homelands of KwaZulu, KaNgwane and Gazankulu (Polzer, 2005). As of 2005, about 200 000 Mozambicans were found to have remained in South Africa (Polzer, 2005). About 30% of the residents of Bushbuckridge municipality are first or second generation Mozambicans and many of these people are now naturalized citizens of South Africa or have permanent residency and interact with the rest of the community in political, institutional, community and personal spheres (Polzer, 2005). The shared

Shangaan ethnicity between the majority of South Africans living in Bushbuckridge and the Mozambicans living there has assisted the integration of these groups (Polzer, 2005; Mayher and Raab, 2009). As a result of these movements of people, many of the residents of Bushbuckridge do not have a long period of association with the environment and fauna and flora of this specific region, unlike many other communities of more traditional tribal areas that have been utilised as the subject of more detailed research on LEK.

The population of Bushbuckridge was 541 248 people in 2011 with an average annual population growth rate of 6.13% over the period of 2007 to 2011 (www.statssa.gov.za). Poverty levels are high in this area with 18.02% of the population between the ages of 15 and 60 classified as unemployed and 58.07% of that same group classified as not economically active in 2007 (Bushbuckridge IDP 2011-2016). In 2000, it was estimated that the population density was 146 people per km^2 in the east and 30.3 people per km^2 in the west (Shackleton, 2000). Almost all households in Bushbuckridge cultivate small tracts of land around their homestead in the rainy season and between 30 and 40% of households also cultivate in demarcated arable fields around villages. This number is restricted by the availability of land (Shackleton, 2000).

About 78.5% of the land in Bushbuckridge was under communal tenure in 2006 (Blignaut and Moolman, 2006). Most households harvest several types of resources from these communal areas including fruit, thatch grass, fuelwood, mushrooms, reeds and wood for construction (Shackleton and Shackleton, 2000). Fuelwood is the primary energy source for residents of Bushbuckridge, being used by more than 85% of households (Shackleton, 2000). One third of households own cattle (Shackleton, 2000). The use of these natural resources by a large number of local people occurs currently and will continue to occur into the foreseeable future (Madubansi and Shackleton, 2007). The combination of a large population with a high reliance on and utilisation of local natural resources has resulted in environmental degradation (as perceived from the scientific perspective) in the former Apartheid-era homelands (Hoffman and Ashwell, 2001; Blignaut and Moolman, 2006). For this reason, the current state and perceived sustainability of the communal areas should be studied in order to gain a greater understanding of their functioning and use that may assist in the continued, sustainable utilization of local resources (Chambers, 1995; Edwards and Steins, 1996; Shackleton *et al.*, 1998; Cousins, 1999; Mayher and Raab, 2009).

3.3.2 Data collection

Data for this study were collected in two stages. Firstly, focus group discussions were held with all members of the community. Following this discussions were held with elder members of the communities in order to gather historical information of each of the villages.

3.3.2.1. Focus groups

Data were collected through focus group discussions with LRUs. These focus group participants also participated in the participatory mapping process (Chapter 2). Focus groups were stratified by gender, and these groups were focussed on the collection of fuel wood, for groups of women, and grazing of livestock, for groups of men. Groups were further stratified by age. The organization of the focus groups was aided by the local *Induna* from each village; the *Induna* announced the project to members of the village and invited them to join the focus groups. Each of these focus group discussions were held in central meeting areas for each village in November 2010 and included between six and twelve members of the community. All participants were Shangaan South Africans. The focus group discussions usually lasted for 2 hours. Topics that the focus groups concentrated on were:

- Which natural resources LRUs acquired from the land.
- How the use of communal lands had changed over time.
- How the communal lands had changed since 1990 and why these changes had occurred.
- How the communal lands were expected to change in the next 20 years.

- If negative changes were expected, how these changes could be mitigated.

These topics were discussed using a semi-structured questionnaire, this is attached as appendix 2.

3.3.2.2 Collection of oral histories

Further discussions were conducted when the information gathered during this research process was presented back to the members of each community at village meetings, in July 2011. At this stage, discussions with a group of between four and seven elder males and females were conducted at each village. Thus, three discussions took place. These discussions centred on the histories of each village. Having a combination of questionnaire and participatory mapping allowed for discussions to follow the topics that were most applicable for focus group participants (Chambers, 1994; Roba and Oba, 2009). The participatory mapping process is discussed in Chapter 2 of this dissertation. In this way, the local knowledge of local resource users (LRUs), the way they value their communal lands and the strategies they identify or implement to reduce or adapt to negative changes in communal lands were identified (Reed *et al.*, 2007; Reed *et al.*, 2008).

3.3.2.3 Data analysis

Data acquired from local resource users was largely analysed qualitatively and with some quantitative analysis. Major trends and common terminologies within and between groups were identified. Proportions of respondents who used specific key resources as well as common responses to questions of change were calculated. Additionally, participants from different focus groups' descriptions of their landscape were integrated to create broad descriptions of the sites that were further investigated in Chapter 4 (as in Kaschula *et al.*, 2005; Roba and Oba, 2009).

3.4. Results

Results are discussed in relation to the key questions addressed in this study. The results discussed represent the pooled data obtained from the 10 focus groups – six male and four female.

3.4.1 What resources do LRUs currently acquire from their communal lands?

All six of the male focus groups mentioned using the communal lands for grazing their cattle. Only one group, the young male group from Allandale, also mentioned harvesting wood from the communal lands. Likewise, all of the four female groups mentioned using the communal lands for harvesting wood. The female groups also all mentioned harvesting wild fruit from the communal lands. Some of the female groups mentioned using wild vegetables, grass for thatching, wood for building and mud for housing, each mentioned by a female group from Share (Figure 3.2).

Female participants mentioned using a greater number of resources compared with male groups. Only older female groups mentioned using resources other than fuel wood and fruit. The species that female participants listed using are included in Appendix 1. One of these older female groups, from Share village, also mentioned non-consumptive resources obtained from the communal lands such as trees providing a wind-break or trees as a barrier to illness through the protection from wind.

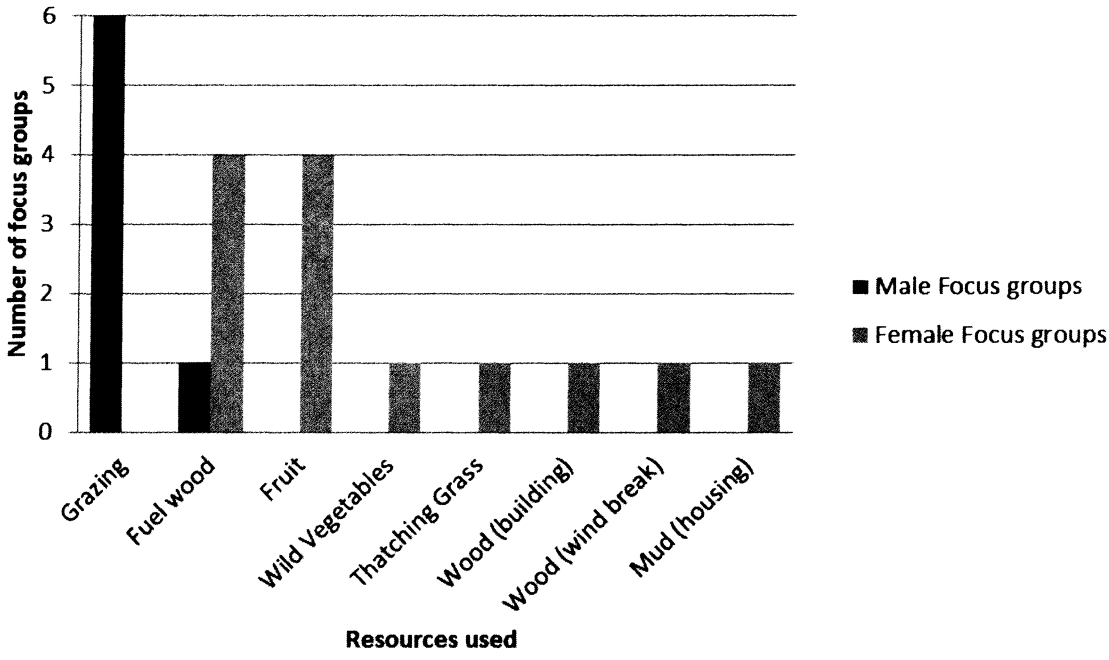


Figure 3.2: Natural resources obtained from the communal lands used by focus groups from all villages. Male groups: n=6, Female groups: n=4.

3.4.2 Can more and less useful sites within communal lands be distinguished?

Focus groups described using different sites within their communal lands. However, with the exception of the female focus group at Allandale, only male groups displayed a preference for certain sites over others. The female group at Clare A only identified using resources from one site, while the female groups at Share described using a number of sites but having no preference for any of them. The female group in Allandale preferred a particular site over another that was increasingly being cleared for new households. The male groups from Allandale also preferred the former site describing the same reasons of the second site being increasingly utilised. For male groups from Clare A and Share, sites were preferred if they had grass that was palatable for cattle and few or no trees from species that were identified as encroacher species (especially *Acacia nilotica* and *Dichrostachys cinerea*). Other favourable characteristics were the presence of water sources, especially streams, and of "good" soil, described as either "loam" or "loam-clay" soil by the younger male group from Share. These results are discussed further in Chapter 2.

3.4.3 What are the perceptions of land state change?

Only one of the focus groups felt that the communal lands had not changed for the worse compared to 20 years ago. This was the younger male group from Clare A who felt that the quality of the grazing was the same, except during the dry season when there was less graze available. Each of the other groups, however, indicated that the state of land had changed over the past twenty years, but how it had changed varied sharply between male and female groups (Figure 3.3). For example, all male participants, who felt that the communal lands had deteriorated in the past 20 years, said that the amount and quality of graze had decreased. This was largely attributed to an increase in the number of trees, in particular *Dichrostachys cinerea* and *Acacia nilotica* (Figure 3.3). The edible seeds pods of these trees were said to be eaten by cattle and spread through the cattle dung. Male focus groups also felt that the way grazing sites were used had changed. Where cattle had been able to use a site for up to 6 months in the past now, because of drier grass

and less water available, cattle can only use sites for 3 months. Also, the increase in the amount of *Acacia nilotica* was said to hamper grazing as plants grow too close together and too low to the ground for cattle to graze beneath or near them. All female groups on the other hand felt that there was less harvestable material available now (Figure 3.3), identified as either fewer trees being present or less wood available. There were fewer species of trees, especially of fruit trees, with some species identified as missing completely from communal lands. Species that were said to have disappeared from the communal lands of Share village, according to both female focus groups, were *Pterocarpus angolensis* and *Combretum imberbe.* Both of these species are slow growing hard-wood species. One group felt that there was a decrease in tree size, as observed by the greater proportion of small trees. The negative consequences of these changes, as elucidated by the female focus groups, are that it takes more time to collect wood, that people will struggle more as trees protect them from wind and disease and that their children won't learn about the trees. Other changes in the local environment identified by female groups were an increase in soil erosion, with river beds being wider and deeper now, as identified by the younger group at Share, as well as reduced numbers of various animals because of the ease of capture and loss of habitat in the thinning bush, according to the older female group at Share. Thus, male and female focus groups view changes in tree density differently, where men see increased tree abundance hampering grazing while women see decreased abundance and less fuel wood.

Predictions for future change of the communal lands were also almost exclusively negative, with the only exceptions being the two male focus groups from Allandale who thought the lands would remain unchanged. The reasons given for this were that wood is a renewable resource and will, therefore, always recover from harvesting and that these communal lands can't change because the people here have no other option (Allandale 20-40 years old).The majority of the remaining male focus groups (66%) felt that, in the future, the amount and quality of graze would decrease further as a result of an increase in the number of trees in the communal lands and a decrease in the availability of water. All the female focus groups felt that in the future there would be a further decrease in the number of trees and the number of species of trees. This was attributed to the same drivers that had been responsible for the changes from past to present, including an increase in the human population and the land occupied by the villages, and because of poor electricity supply, high cost of electricity and a lack of employment.

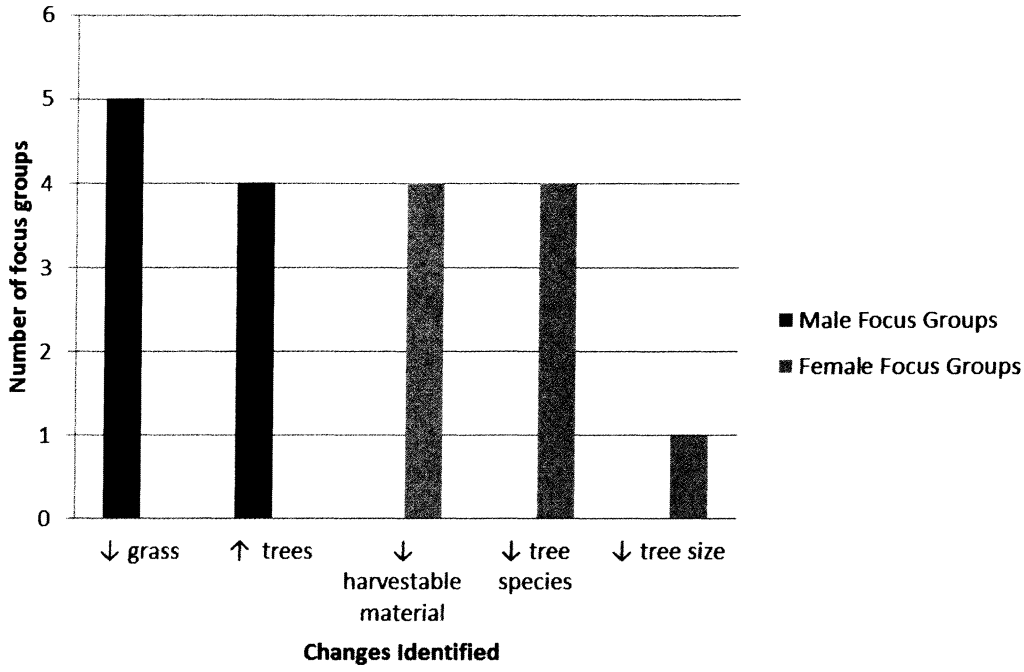


Figure 3.3. The changes in resources between 1990 and 2010 identified by focus groups, stratified according to gender as a percentage. All responses are graphed as the percentage of respondents who identified this change.

3.4.4 Why did these changes occur?

Male focus groups attributed these observed changes to the behaviour of cattle in spreading of the seeds of certain plants through the cattle dung, especially *Dichrostachys cinerea* (four groups or 66%), as well as a perceived increase in the frequency of droughts (two groups or 33% both younger). On the other hand, female focus groups attributed these changes to an increase in the population of these villages (two groups or 50%, an older and a younger group) and an increase in harvesting and, subsequently, less dead wood being available and live wood being cut (both age groups in Share or 50%).

Female focus groups perceived that they now harvested both dead and live wood. The harvesting of live wood is either done under a permit obtained from the chief or the wood is stolen. Group members said that live wood was only harvested from certain species of trees; predominantly thorn trees especially *Acacia nilotica* and *Dichrostachys cinerea*. However, one female group admitted to cutting marula trees (*Sclerocarya birrea* subsp. *caffra*) and the only male group who harvested fire wood, Allandale 20-40 years old, admitted to cutting many species of fruit tree including marula, jackalberry (*Diospyros mespiliformis*) and Black Monkey Orange l.c. (*Strychnos madagascarensis*). The harvesting of live wood was recognised, by female groups, as having negative consequences, with one group saying that it was bad because "it kills nature", but was seen as unavoidable because of the need for fuel wood, especially because the increased population exceeds the amount of dead wood available (75%). Unemployment, inadequate electricity supply and high costs of electricity, were also seen as contributing factors for the high harvesting levels by female groups (100%). The perception here was that unemployed people do not have the money to pay for electricity or to buy wood and that the supply of power is erratic and unreliable (both female groups from Share). These issues around electricity therefore pushed people to continue to use firewood, and cut live trees where deadwood was unavailable.

Other changes that focus groups participants observed were that the human population had increased (all male and all female groups agreed). Four of the six male focus groups felt that the number of cattle had increased. While all three of the younger focus groups felt that this cattle increase was detrimental, with two groups explicitly stating that there were too many cattle, the only older focus group to recognise the increased cattle population thought that the increase was not a problem.

3.4.5 How can these changes be mitigated?

In order to mitigate the changes they identified, four of the six male focus groups, with the exception of male participants from Allandale, who did not identify a problem, recommended that *Acacia nilotica* and *Dichrostachys cinerea* be cut in order to improve the grazing lands. These groups also suggested that the grazing land be fenced to prevent the movement of cattle between sites (Allandale over 40 year olds), that the amount of grazing land made available to them be increased (Share over 40 years) and that the number of cattle owned by each person in each village be reduced (Share 20-40 year olds). Female focus groups recommended that the amount of wood that is harvested be reduced and that fruit trees not be cut. They recommended that this be done by increasing law enforcement in communal lands by increasing the presence of rangers (Allandale 20-40 year olds), increasing employment (Allandale 20-40 year olds, Share both groups) and improving the delivery of electricity (Allandale 20-40 year olds, Share over 40 year olds). The process of soil erosion was said to be reduced if tree and grass cover was to be increased (Share over 40 year olds).

3.4.6 Oral history discussions

Discussions held with elders in each of the three villages provided interesting insights into the history of these villages. According to these participants prior to the formation of these settlements there were relatively few people living in the area and these people had open access to resources. White settlers were said to have moved into the area in the late 19th century and created demarcated farms with ploughed sites. The people living in this area were made to work on the farms for free or were forced to leave (Clare A, oral history focus group). The people began to protest at which time the government stepped in and moved the white farmers out (Clare A, oral history focus group; Share, oral history focus group). The people who had now made homes on these farms as labourers stayed at these sites while some other people from the surrounding area moved into those settlements (Allandale A, Clare A and Share, oral history focus groups). More people were forced into these areas from the 1960s onwards because of apartheid-era policies with many of these people coming from surrounding areas, such as Sabie, Graskop and Klaserie (Share, focus group). Additionally, many Mozambican refugees fleeing the civil war in that country began to arrive in the 1980s. These people settled in villages throughout Bushbuckridge, although some villages including Share prevented any refugees settling on their land (Share, oral history focus group). Although the Mozambicans who still live in Bushbuckridge have now been in the area for about 30 years, differences between the groups are still recognised by people living in these villages.

Participants in the focus group discussions stated that many Mozambicans are skilled at welding and repairs of vehicles and electricity (Allandale, oral history focus group). They are also said to be good at ploughing and physically strong and to have knowledge of the plants in the area and their uses, for example making marula beer (Allandale, focus group with women, 20-40 years old). They are also seen as being destructive of the communal lands, as they were said to steal wires from the Redline (a government-installed fence that restricts the transfer of possible foot and mouth infected cattle) to fence their own fields and to cut fruit trees (Allandale and Clare A, focus groups).

3.5. Discussion

From these focus group discussions it was shown that the majority of focus LRUs had negative perceptions of the current and future states of their communal lands and concern over the future availability of important resources. These sentiments have been echoed in other studies in South Africa and Africa, for example, Kaschula *et al.* (2005) found that almost half of the respondents, in Bushbuckridge, felt that if current utilisation practices of fuel wood were maintained, the fuel wood supply would run out. Similarly Kirkland *et al.* (2007) also found that 90% of fuel wood users identified scarcity of fuel wood around their village in Bushbuckridge as a problem. Ward *et al.* (2000) found that pastoralists in Namibia perceived their environment had become degraded and Solomon *et al.* (2007) found that pastoralists in Ethiopia perceived rangeland condition in their area as having decreased dramatically over time, as well as perceiving bush encroachment as a threat.

The negative changes perceived by the different groups were strongly related to how they used that area and these views were often in direct contradiction of each other. Males observed and expected a decrease in the quality of graze available to cattle, largely because of an increase in the amount of trees at sites (mainly bush encroacher species). By contrast, females perceived a loss of woody biomass and woody species as a problem that has and is continuing to occur in these areas. This is in accordance with the idea that people tend to perceive the problems that directly affect them (Inglehart, 1995; Anderson *et al.*, 2007; Hunter *et al.*, 2010).

These issues were attributed to an increase in the human population and, thus, an increased demand for fuel wood, an increase in the amount of livestock (although this was only identified by the younger and one older male groups) the actions of cattle, and the effects of these for spreading seeds of bush encroachers. The human population was found to have increased at a rate of 1.5% per annum (between 2007 and 2011 as calculated from population figures on statssa.org.za) which is higher than the South African average of 0.96% per annum, and the world average of 1.16% per annum (over the period of 2005-2010, source: UN Data http://data.un.org). Another perceived contributing factor identified was an increase in the frequencies of droughts which had negative effects on the quality of graze available. Unreliable and relatively expensive electricity supply, so that people chose to rely on fuel wood for cooking and heating, and unemployment were also identified as contributing factors. This was also reported in other studies where fuel wood was used rather than electricity to save money (Twine, 2013), or where people attributed the scarcity of fuel wood to unemployment and the cost of electricity (Kirkland *et al.*, 2007, Dovie *et al.*, 2008).

Their recommendations for ameliorating these negative changes were to remove *Acacia nilotica* and *Dichrostachys cinerea* in order to improve the grazing lands and to fence the sites to prevent the movement of cattle between sites. This is happening in areas of the Clare A sites, however it is as yet unclear whether this strategy will be effective in reducing bush encroachment. Alternatives are to reduce the number of cattle owned by each person and to increase the amount of land available for grazing of livestock. Given that only people who did not own cattle, or owned very few (i.e. the younger males), perceived overstocking of cattle as a problem, this is unlikely to develop support from cattle owners. In the case of increasing the land available for grazing, during the mapping process of this study (Chapter 2) and in other studies (Coetzer *et al.*, 2010 and Fisher *et al.*, 2012) the majority of the land is already allocated to different villages, and often to multiple villages as was found in this study. Female focus groups recommended that they reduce the amount of wood that is harvested and prohibit the cutting of fruit trees. This should be done by increasing law enforcement in communal lands, especially by increasing the presence of rangers. However, Kirkland *et al.* (2007) showed that even with a high presence of rangers and the threat of being arrested was not enough to deter people from harvesting live wood. Another recommendation was that

employment levels be increased, the delivery of electricity should be improved and the cost be reduced. This is also a sentiment that was shared by respondents in Kirkland *et al.*'s (2007) and Hunter *et al.'s* (2010) studies. From this we can see that there are no easy solutions to the issues that are perceived by individuals from these communities. This may promote the idea of integrated strategic planning between these individuals and outsiders, such as government employees or researchers, for CBNRM programs to be beneficial.

Of the ten focus groups interviewed, the members of one of the groups felt that there were no threats to the communal lands in their village, with one of them stating that it is impossible to overuse the resources there; "If you cut wood now, in the next rainy season it will be back. You can't get rid of it. Today it is rainy and so as we sit here we don't have a chance to cut the wood and it is growing". They felt the same about grass which would also regrow during the rains. This feeling translated to a lack of concern about committing societal taboos, such as the harvesting of fruit trees. Where the other groups that mentioned the harvesting of wood from fruit trees appeared to be embarrassed and regretful of this practice, the participants in this group were unapologetic for it and were very apathetic about the use of those species by other villagers.

A topic that is also very important in this study is the conflicting view of different resource users; directly conflicting perceptions of change were identified between the male and female focus groups. Issues like these need to be identified and addressed before a CBNRM project can be established and common goals between the groups must be identified, for example using the *Dichrostachys cinerea* that is being removed from these areas as a strategy for reducing bush encroachment and dependence on slow-growing or rare fuel wood species.

Women in Bushbuckridge, as in many other areas of South Africa have traditionally fulfilled the role of gathering water, food (except for meat) and other household supplies such as fuelwood, while the men are expected to be the breadwinners (Niehaus, 2002). The finding that female participants mentioned using a greater number of natural resources from the communal areas compared with male participants fits with this trend. Female participants also mentioned the indirect values of these natural resources such as trees providing a windbreak, indicating a greater familiarity with these resources. Additionally, as men are expected to be the breadwinners for a family, a large number of them are migrant labourers, as a result of this they may have a reduced knowledge of natural resources in the communal lands. This was identified by Dovie *et al.* (2008) where males between the ages of 31 and 50 were the least knowledgeable about resources.

While the information garnered from the oral history focus groups in this study is subjective and should not be used as stand-alone, it is effective for providing context to the area. Additionally, in rural areas, especially when exacerbated by the limited record-keeping by the apartheid government in the former Bantustans as is the case in these areas, these discussions may provide the most conclusive observations of changes in the landscape over long time periods (Riley, 2004). When used in conjunction with written histories and other forms of fieldwork, it is a highly effective strategy for getting a comprehensive understanding of a community and the way that it functions. Elder members in the community had observed marked increases in the population of their villages, especially in the 1960s, as a result of apartheid-era policies, and the 1980s, with Mozambican refugees. These Mozambicans were also still seen largely as outsiders and were perceived to differ, in a number of ways, to South Africans living in this area. In this way this knowledge may contribute to our greater understanding of the process.

The willingness of people to protect their environment from perceived threats is dependent on their perception of the utility of that land (Barrow, 1991, Anderson *et al.*, 2007), as well as their ability to conceptualise ways to solve or mitigate the effects of the problem. In this study, where people perceived

problems they were more inclined to discuss ways that they could change the way they used their resources. However, where problems weren't perceived people tended to be apathetic to any change. Thus, in order to create meaningful change it is important to tackle issues that societies feel strongly about. The engagement of local resource users with their environment and their history can aid in their empowerment and promote them to engage with their environment and promote the discussion of their understanding and their values regarding their environment. Often this willingness to become involved is dependent on the socioeconomic benefits that these changes would bring (Songorwa, 1999). It is also important to discuss fully the expectations of all parties involved in bringing about change and what these changes would mean for these parties, if expectations aren't met it is often difficult to maintain changes (Songorwa, 1999; Masozera *et al.*, 2006). This may be compounded by societal issues, the effects of poverty and the dependence of society upon these habits to support their livelihood, as people may have high hopes for the benefits they can receive from these projects (Songorwa, 1999; Alcorn *et al.*, 2002). When choosing to implement or assisting in the implementation of changes in a community it is important to investigate thoroughly peoples' perceptions of their environment prior to making any decisions about the changes that should be implemented (Songorwa, 1999; Alcorn *et al.*, 2002; Masozera *et al.*, 2006). With this it is also important to identify the willingness of people to support and enforce changes. As well as to understand their motivations for doing so. Projects often fail if local people have expectations that cannot be met by the project. These people may also become disillusioned and unwilling to support any future projects (Murphree, 1995; Shackleton *et al.*, 2002).

The participants involved in these focus groups had a largely negative view of the state and future changes of their communal lands. However, their willingness to implement changes would largely depend on an improvement in their socioeconomic status, for example by having increased employment and increased access to resources such as electricity. Additionally, the effects of members of the community who do not perceive any problems and who show disregard for the needs of others or of the rules enforced by society and traditional authorities, as is the case with the male group that did not perceive any problems in this study, may undermine the entire process and thus the buy in of the entire community is required (Agrawal and Gibson, 1999; IFAD, 2006).

The ten focus group meetings identified differing perceptions of both the existing and possible future state of the communal lands. Awareness of degradation influenced the respective group opinions with differences exisiting between groups. One group showed a lack of concern for the future status of the land, an unawareness of degradation and apathy towards implementing interventions. Whereas other groups who had perceived degradation, could foresee a worsening supply of resources. They perceived this as being brought about by increased human related activities including population growth, settlement expansion, increased resource consumption and lack of discipline with regard to protection of the environment. The results indicate that there is a distinct need for improved environmental education and awareness in any sustainability initiative or community based conservation programme. Future research should conduct focus groups with a greater number of participants, stratified to include a larger number of age groups and a different range of resource users in order to identify further difference in preference or perception, for example between livestock grazers and people harvesting thatching grasses.

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3.7. Appendix

Appendix 1: Trees mentioned by focus groups as being used by local resource users.

Shangaan name	Scientific name	Number of groups who used this species (n=5)
Marotso	*Pterocarpus angolensis*	3
Mbhandzu	*Philonoptera violacea*	3
Mbhota	*Acacia gerrardii*	2
Mondzo	*Combretum imberbe*	3
Ndzenga	*Dichrostachys cinerea*	5
Nhlanhleni	*Peltophorum africanum*	2
Nkhanye	*Sclerocarya birrea*	3
Nkonola/Nkonolwa	*Terminalia sericea*	4
Nkwakwa	*Strychnos madagasariensis*	1
Nsavane	*Acacia exuvialis*	3
Ntoma	*Diospyros mespiliformis*	2
Ntsala	*Strychnos spinosa*	1
Nxangwa	*Acacia nilotica*	5
Xibalatse/Xipalatsi	*Dalbergia melanoxylon*	1
Xihlangwe	*Gymnosporia* sp.	3
Xikhavi	*Combretum hereroense*	3
Xikukutsu	*Combretum collinum/ Combretum apiculatum*	1
Xirhomberhombe	*Ficus stuhlmannii*	1

Appendix 2: Semi-structured questionnaire as presented to focus groups.

1. What resources do you currently acquire from your communal lands?
2. Please indicate, on this map of your village, where you collect resources from your communal lands.
   a. Are certain areas more important than others for obtaining grazing for livestock?
   b. Are certain areas more important than others for obtaining fuelwood?
3. How has the vegetation changed in these areas since 1990?
   a. How has the population changed?
   b. How has the number of livestock changed?
   c. Has the amount of graze changed since 1990?
4. Has the way you use communal lands changed since 1990?
5. How do you think these lands will change in the next 20 years (i.e. up to 2030)?
6. Additional comments.

Chapter 4

4. A comparison of the characteristics of vegetation in sites rated as "good" and "poor" for the collection of natural resources by local resource users in three villages in Bushbuckridge, South Africa.

4.1. Abstract

Natural resources are used and valued differently by different people, such as Local Resource Users and ecologists, as are the areas from which they are collected. This may result in different perceptions of vegetation degradation. This study aimed to quantify the vegetation characteristics in three villages, with two sites per village in the Bushbuckridge municipality of Mpumalanga, South Africa. These sites were chosen based on their being perceived as either "good" or "poor" by Local Resource Users (LRUs) for obtaining natural resources; in this case fuel wood and grazing for livestock. This fitted into a larger aim of identifying similarities and differences in the ways that LRUs and ecologists perceived vegetation characteristics. The characteristics of woody vegetation structure, woody species richness and herbaceous vegetation biomass and proportion of different herbaceous cover types was ascertained for each of these sites. Although all sites differed from each other in terms of vegetation characteristics, overall, the "poor" sites tended to show higher signs of use and characteristics associated with degradation compared with the "good" sites". More woody individuals showed signs of being harvested from the "poor" site compared with the "good" site, although the difference was not significant ($p = 0.16$). Species richness and the Shannon Index of Diversity were both significantly lower at the "poor" site ($p < 0.01$ and $p < 0.05$ respectively) while the Simpson's Index of Diversity score tended to be lower at the "poor" site ($p = 0.30$). Patterns in vegetation height and basal area did not indicate any clear differences between "good" and "poor" sites. Herbaceous biomass and herbaceous vegetation cover were greater at two of the three "good" sites, while the "poor" site at the third village was dominated by dense patches of tall thatching grass species. Herbaceous biomass was significantly greater at the "good" site in both Allandale and Share ($p < 0.0001$ and $p < 0.001$, respectively). While, herbaceous biomass was significantly greater at the "poor" site in Clare A ($p < 0.001$). The characteristics of the "good" sites largely corresponded with characteristics that are considered as "favourable" by ecologists, while many of the characteristics of the "poor" sites could be indicative of vegetation degradation. However, none of the sites had only good or bad characteristics; rather each site was made up of a unique assemblage of both "good" and "poor" characteristics.

Key words: communal lands, fuel wood harvesting, grazing by livestock, vegetation degradation

4.2. Introduction

4.2.1 Ecosystem functioning

All ecosystems are characterised by flows of energy and matter, such as of soil, nutrients, water and organic materials. The rates and pathways of these processes may vary between and within systems, depending on their structure, composition and the disturbances that exist in that system (Schulze and Mooney, 1993).The variations of these rates and pathways may make the system more or less desirable for use by local resource users than when the system is in alternate states. In more desirable states, systems may provide important natural services and resources (Hoffman and Ashwell, 2001) and biodiversity within the system may be maintained (Walker, 1995). Systems will change as a result of a number of factors, both

natural and anthropogenic, and will also vary depending on the variety, intensity and duration of each perturbation and are, thus, not necessarily linear (DeFries *et al.*, 2004). Anthropogenic disturbances can include the use of land and resources and changes within these (Barrow, 1991; Levia, 1999; Hoffman and Ashwell, 2001; Warren 2002; Roba and Oba, 2009).

The combined effects of these natural and anthropogenic changes can alter the functionality of the systems and this may in turn increase or decrease their favourability for human utilisation or harvesting. Additionally these changes may affect the way that a system responds to other perturbations, thus causing an increase or decrease in the resilience of the system (Hoffman and Ashwell, 2001). Resilience is defined as the capacity of a system to absorb disturbances and/or changes in its state or driving variables, while retaining the same or similar function, structure, identity and feedback (Holling, 1973; Walker *et al.* 2004).

4.2.2 Land degradation

Land degradation is defined as a decrease in an area's actual or potential biological or economic productivity or utility and the loss of complexity, features or organisms which cannot be replaced. It may present as a persistent reduction in the capacity of the ecosystem to deliver ecosystem services to the broader community (Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001; Van Aardt *et al.*, 2011). Degradation may also reinforce positive feedback mechanisms, thereby accelerating damaging processes. This may lead to irreversible vegetation change once a site's capacity for self-repair is exceeded (Whisenant, 2002) and the system is not able to absorb perturbations and maintain the same or similar function, structure, identity and feedbacks (Walker *et al.*, 2004).

Land degradation can occur through natural and anthropogenic processes. Natural processes that cause land degradation may be physical, e.g. a decline in soil structure, chemical, such as acidification or salinization, and/or biological, e.g. a decrease in total and/or biomass carbon (Eswaran *et al.*, 2001). However, these processes may also occur because of the inherent characteristics of an area including climate, terrain and biodiversity, especially soil biodiversity (Barrow, 1991; Levia, 1999; Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001; Roba and Oba, 2009). In this case they may affect degradative processes although they did not occur as a result of degradation (Barrow, 1991; Levia, 1999; Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001; Roba and Oba, 2009). Land degradation may also be caused by anthropogenic effects on the natural systems people use and may be driven by socio-economic and political causes (Eswaran *et al.*, 2001). The human activities that can lead to land degradation include land uses, such as for habitation or agriculture (Barrow, 1991; Levia, 1999; Hoffman and Ashwell, 2001; Warren 2002; Roba and Oba, 2009).

Land degradation may occur over long periods of time (Barrow, 1991; Levia, 1999; Hoffman and Ashwell, 2001; Warren 2002; Roba and Oba, 2009). Thus, the primary cause may be difficult to ascertain, or it may be the result of a range of occurrences or disturbances (Hoffman and Ashwell, 2001).The exact definition of land degradation or the factors through which it is identified are contextual and dependent on the intended application or use of that land and of the person, or group of people, it is being assessed by (Barrow, 1991; Stocking, 1995; Oba and Kotile, 2001).

Densely populated areas in sub-Saharan Africa have been shown to be degraded (Eswaran *et al.*, 2001, Van Aardt *et al.*, 2011). This degradation is attributed to fragile soils, high population densities in localised areas and the low-input form of agriculture prominent on the continent (Eswaran *et al.*, 2001). When the actions of humans, such as increasing population, conflicts in land management and miscommunication over land tenure, and increasing agricultural production are compounded with land degradation, degradation may be further exacerbated and the period of time over which it occurs may be diminished (Mwavu and Witkowski, 2008).

4.2.3 Vegetation Degradation

Land degradation primarily occurs as a consequence of degradation of either the vegetation or the soil (Hoffman ad Ashwell, 2001) or a combination of both. Vegetation degradation is said to decrease the grazing capacity of veld, cause increased soil erosion, decrease in nutrient levels in soil, and lower agricultural production. It may also lead to local extinctions of birds or mammals that are dependent on specific plants or vegetation forms and may decrease the capacity of the ecosystem to deliver ecosystem services to the broader community (Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001; Van Aardt *et al.*, 2011). Anthropogenic effects on vegetation through processes of deforestation (Eswaran *et al.*, 2001), increased grazing pressure, overharvesting of vegetation, especially wood, field cultivation and fire (Hoffman and Ashwell, 2001; Britz and Ward, 2007; Roba and Oba, 2009) can further promote land degradation. Bush encroachment may occur in response to poor management practices and the replacement of indigenous browsing animals by grazing livestock (Hoffman and Ashwell, 2001). Land users may allow their land to degrade because of perceptions of its value and/or because the processes of land degradation may be slow so that many people are not aware of them or of which processes are ultimately causing the degradation (Eswaran *et al.*, 2001). For this reason, an historical approach is often needed to understand the process of land degradation as caused by humans (Burgi and Russell, 2001).

Vegetation degradation is the focus of this study as identified from an assessment of the loss of vegetative complexity, features or organisms (Eswaran *et al.*, 2001; Hoffman and Ashwell, 2001; Van Aardt *et al.*, 2011). Vegetation degradation can be observed as a change in the plant species composition and/or a loss of certain plant species and an increase in the presence of alien plants (especially alien invasives), bush encroachment and, conversely, a loss of woody vegetation, a loss of herbaceous vegetation cover or biomass, or an increase in vegetation cover in the case of bush encroachment (Hoffman and Ashwell, 2001; Van Aardt *et al.*, 2011).

4.2.4 South African Context

In South Africa, 12% of the land is under communal tenure (Everson and Hatch, 1999). This is land that is owned by the government and is available for use by the communities in that area. The use of natural resources is regulated by institutions, such as chieftaincies and village-level *Indunas*, (Findlay, 2013). These lands often experience continuous grazing, usually at higher stocking densities than private lands (Harrison and Shackleton, 1999; Rutherford and Powrie, 2011). This is also compounded by the historical legacies of these areas. Present-day areas under communal tenure were homelands under the apartheid regime. These areas made up 13% of the land of South Africa (Native Trust Land Act of 1936) but were home to 75% of its population (Simon and Ramutsindela, 2000). In addition, these areas were not developed by the apartheid regime in order to necessitate inhabitants to seek employment as migrant workers, especially for the mines. Furthermore, the traditional authorities, who were responsible for local resource management, were incorporated into the homeland administration. This diminished the credibility of these authorities with the local communities and, thus, the efficacy of their administration was also diminished. Their role in the current democracy is still often unclear and contested (van Kessel and Oomen, 1997, Ntsebeza, 1999). As a long term consequence of this historic legacy, lands that are designated as "communal" are often assumed to be degraded (Hardin, 1968, Hoffman and Ashwell, 2001) and subject to the presumed effects of the "tragedy of the commons" (Hardin, 1968). The "tragedy of the commons" occurs when there is a disincentive for the individual in a community to reduce their amount of livestock or limit their harvesting because their sacrifice may allow others to have more livestock or to harvest more, thereby putting that individual at a disadvantage. The system may then be overgrazed or overharvested and degradation can occur (Hardin, 1968, Scholes, 2009, Rutherford and Powrie, 2011). This degradation is, therefore, assumed

to occur as a result of increased livestock production, plant resource collection, especially for fuel wood, and field cultivation, as well as increased human densities and a legacy of poverty and reliance on natural resources to supplement livelihoods following apartheid-era policies (Hoffman and Ashwell, 2001).

4.2.5 Aim

The aim of this study was to use scientific ecological techniques to investigate the characteristics of the herbaceous and woody vegetation of sites in communal lands identified as either "good" or "poor" by LRUs. This was done in order to compare these 'scientific results' with the LRUs 'perceptive assessment' of "good" and "poor" lands for collecting resources so as to identify whether these LRUs 'perceived patterns' correlated with those scientifically 'measured patterns' (LRU, MSc objective 3, chapter 1).

This was achieved by asking the following key questions:

1. What are the differences in woody vegetation structure between sites identified as "good" and "poor" by LRUs for collecting fuel wood resources?
2. What are the differences in woody vegetation species richness and composition (including presence of alien invasive plants) in sites identified as "good" and "poor" by LRUs for collecting fuelwood?
3. What are the differences in herbaceous vegetation biomass in sites identified as "good" or "poor" by LRUs for grazing of livestock?
4. What are the differences between the functional types and basal cover of herbaceous vegetation in sites identified as "good" or "poor" for grazing of livestock?

It was hypothesised that the "good" sites would be characterised by a greater number of taller trees with a greater basal area and fewer small shrubby, bush encroaching species as well as a higher number of woody species than that of "poor" sites. Herbaceous biomass was expected to be greater at the "good" sites and a greater percentage of perennial grass types were expected at the "good" sites compared with annuals, sedges and creeping plant forms at the "poor" sites. In addition, it was expected that there would be a greater proportion of standing (bunch) grass types at the "good" sites and a greater proportion of creeping (rhizomatous/stoloniferous) grass types at the "poor" sites as a result of heavy grazing at the "poor" sites.

In this study, degradation was measured comparatively between sites in each village, as opposed to measurement over a longer period of time. Lower herbaceous ground cover or biomass, reduced woody biomass, presence of unfavourable species such as alien or invader species (bush-encroaching trees/shrubs) or a loss of woody species richness were used as indicators of degradation. The consequences of degradation, such as wind or water erosion, and drivers of degradation such as overharvesting or trampling by livestock, for example, (Hoffman and Ashwell, 2001) were not dealt with explicitly. However, although the effects of land degradation on productivity were not measured explicitly, these would provide valuable insights for the sustainability of these lands in the future.

4.3. Methods

4.3.1 Study Site

This study was conducted in three villages of the Bushbuckridge Municipality in the Ehlanzeni district of Mpumalanga, South Africa. Bushbuckridge is an area of 234,761ha, of which 184,301ha or 78.5% in a paper from 2006 (Blignaut and Moolman, 2006), is classified as communal land with no habitation or formal cultivation and that is open for access and utilisation by residents (CSIR, 1996; Shackleton, 2002; Blignaut and Moolman, 2006, Raab and Mayher, 2008). This area is also undergoing significant change: over a thirteen year period, from 1993 to 2006, 36% of the land cover in the Kruger to Canyon region, which includes Bushbuckridge, underwent transition from one form to another (Coetzer *et al.*, 2010). This

transition was dominated by a 39.7% increase in settlement areas, predominantly in Bushbuckridge and other rural areas (Coetzer *et al.*, 2010). There was also a 6.8% increase in the expanse of human-impacted vegetation (Coetzer *et al.*, 2010).

The climate in this area is 'sub-tropical' with a mean annual temperature of 22°C and summer rainfall, frost is rare (Shackleton, 2000; Shackleton, 2002; Giannecchini *et al.*, 2007). There is a gradient of decreasing rainfall across Bushbuckridge with an average of 1200mm per annum in the west to 550mm per annum in the east (Shackleton, 2000). Rainfall generally occurs between October and April, but it may be erratic and droughts occur fairly frequently (once every 3-4 years) especially in the lower rainfall areas (Shackleton, 2000; Shackleton, 2002; Giannecchini *et al.*, 2007). The principal soil type is a relatively nutrient-poor, shallow, sandy lithosol derived from granite. These soils are typically sandy and characterised as shallow, coarse-textured and nutrient-poor on the uplands and as deeper, finer-textured and more nutrient-rich on the bottomlands and these are the soils which dominate the study site (Shackleton, 2002). The natural vegetation in Bushbuckridge is open, deciduous woodland with two main vegetation types evident along the rainfall gradient, Legogote Sour Bushveld in the west, classified by Acocks (1988) as the Lowveld Sour Bushveld, and Granite Lowveld in the east, classified by Acocks (1988) as Lowveld (Acocks, 1988; Shackleton, 2000, Shackleton, 2002, Mucina and Rutherford, 2006). The Legogote Sour Bushveld is predominantly dense woodland containing medium to large shrubs (Mucina and Rutherford, 2006).

The study sites all occur on Granite Lowveld (Mucina and Rutherford, 2006). This vegetation type is characterised by tall shrublands, with uplands ranging between sparse trees and moderately dense woodlands and the bottomlands ranging between dense thicket and open savanna (Mucina and Rutherford, 2006). Common species on the uplands are *Terminalia sericea, Combretum zeyheri* and *Combretum apiculatum* while the bottomlands are dominated by *Acacia nigrescens, Dichrostachys cinerea* and *Grewia bicolor.* Erosion in this vegetation type is very low to moderate (Mucina and Rutherford, 2006).

4.3.2 Data Collection

The villages involved in this study were Allandale, Clare A and Share. Following discussions with LRUs two sites were chosen for the study at each of the three villages. The term "site" was used to identify the areas demarcated as units within communal lands by these LRUs. Focus group discussions were held with LRUs so as to classify the vegetation conditions in these "sites" as either "good" or "poor" for obtaining natural resources, by users of fuel wood or for grazing livestock (Chapter 2 and Chapter 3). Users of fuel wood displayed less of a preference for different sites, indicating that they harvest repeatedly from the same area, while users of grazing land for livestock had clear preferences for certain sites over others. As far as possible, the selection of the study sites was based on two criteria, namely, sites that were favoured or disfavoured by both groups, or alternatively sites that were favoured by the grazing focus groups but used by both groups were selected. The former occurred at Allandale, the latter occurred at Share. While at Clare A, users of fuel wood indicated that they only harvested from one site. At this village sites were selected based on preference of the grazing focus groups and proximity to the site used by fuel wood focus groups.

The three villages that were sampled occur along a roughly north to south axis in the eastern part of Bushbuckridge. The two sites sampled at each village were referred to as the "good" site and the "poor" site. Three 50 x 4 m (200m^2) belt transects were set up for vegetative assessment at each site. Belt transects were used because they have been shown to reduce bias when sampling woody vegetation as they reduce bias when sampling heterogeneous communities (Muller-Dombois and Ellenburg, 1974; Higgins *et al.*, 1999). These transects were placed up the catenal slope against the edge of the riparian zone of any water course, this was in order to sample a similar section of the catena. Effort was made to ensure that as

far as possible transects were parallel, orientated along the contours and placed on slopes of similar aspect for each village, these slopes were generally west-facing. These transects were spaced roughly 75 metres apart.

Within transects, all woody plants, taller than one metre in height, were measured, with stems shorter than one meter in height being sampled within quadrats. The species, height of the main stem, the number and basal diameter of each lesser stem was measured for each individual plant. If cut branches or stems were identified on these living plants this was identified as presence or absence data per individual. Using a Woody Disturbance Index, evidence of harvesting on individual plants was also recorded.

Fifty 1m x 1m quadrats were assessed per transect, thus 150 in total for each site. These were measured once in late summer. The quadrats were located on either side of the central transect line at intervals of 2 meters along the transect, i.e. 25 sample points per side. Sampling started and finished 50cm from the beginning and end of the transect, respectively. In these quadrats the different functional types of cover, i.e. creeping grass form, standing grass form, and woody vegetation smaller than 1m; were identified and each of these were visually estimated for their percentage of basal cover in the quadrat. A Disk Pasture Meter (DPM) was used to measure herbaceous biomass in each quadrat. DPM readings were taken and associated with every quadrat along each transect. This was done using a DPM according to the method established by Trollope and Potgieter (1986).

4.3.3 Data Analysis

4.3.3.1 Woody Disturbance Index

Using a Woody Disturbance Index (WDI) the number of cut plants over the total number of standing plants, the differences in the disturbance level of woody plants between sites at each village was determined. This was calculated in order to understand the proportion of plants that have been disturbed by LRUs. This index was similar to the percentage of stems cut as in Shackleton *et al.* (1994). A two-way Analysis of Variance (ANOVA) was performed to compare the mean WDI between the respective sites in each of the three villages. From these results, the number of woody individuals and woody stems per hectare was calculated, graphed and compared between villages and across sites. The use of the two-way ANOVAs further allowed for the testing for significant differences across all villages and both the "good"and "poor"sites for both the number of individuals and the number of stems, after the Kolmogorov-Smirnov Test found both measures to be normally distributed ($p > 0.10$ for both).

4.3.3.2 Vegetation Structure

Non-parametric tests were used in cases where data were non-normal and could not be transformed satisfactorily. Woody vegetation height was compared between sites for each village using a Mann-Whitney U test. The average height of woody individuals was calculated and the heights of all woody individuals were compared between villages using a Kruskal-Wallis test, with Dunn's Multiple Comparison test used for post-hoc analysis. The basal diameter of each individual stem was compared between sites at each village using a Mann-Whitney U test and between villages using a Kruskal-Wallis test, with Dunn's Multiple Comparison test as a post-hoc analysis.

4.3.3.3 Woody Vegetation Height

Woody vegetation height for individuals was categorised into size classes using 50cm divisions from 1m through to 5.5m. Anything greater than 5.5m was grouped into the final size class, resulting in ten size classes in total. The count and proportion of individuals in both sites for each village was graphed, in order to visualise difference between sites in height distribution. A Kolmogorov-Smirnov two sample test was

performed to test if the frequency of individuals in different height classes differed significantly between good and poor sites.

4.3.3.4 Basal Diameter

Using increments of 15 mm in stem diameter, the basal diameters of stems were categorised into size classes. Classification in terms of diameter, in preference to area, was deemed to be more meaningful for real-world applications and to be more meaningful to local resource users. The frequencies of both number of stems and proportion of stems belonging to each size class were graphed for all villages. The frequencies of the numbers of stems belonging to different size classes were compared between sites using a Kolmogorov-Smirnov two sample test.

4.3.3.5 Species richness

After a Kolmogorov-Smirnov test showed all data to be normally distributed, a two-way ANOVA was used to compare the species richness for each of the two sites at the three villages. Using log transformed species abundance data for all the transects at each site, non-metric multidimensional scaling (NMDS) was then employed to identify similarities and dissimilarities in species composition within and between the two sites at each village. Each NMDS was performed using 25 runs.

Both the Simpson's Index of Diversity (1-D) and the Shannon Index were calculated as described in Magurran (2004). Both indices were run as the Simpson's Index emphasises dominance while the Shannon Index emphasises rarity in species (Krebs, 1999, Magurran, 2004). Results obtained from these indices were tested for normality using a Kolmogorov-Smirnoff test and were compared using two-way ANOVAs to test for differences in species diversity between sites and across villages. The Jaccard Similarity Index was also calculated for each site, according to Magurran (2004). The five most common species, the total number of species and the number of families present were also calculated for each site. Woody vegetation of less than one metre in height was measured using quadrats during the sampling of herbaceous biomass.

4.3.3.6 Herbaceous biomass

Herbaceous biomass was determined for each transect at each site from the DPM readings according to calibrations by Zambatis *et al.* (2006) following Trollope and Potgieter (1986). This reference was used as it was calibrated for a similar vegetation type in the adjacent Kruger National Park. A total of 150 readings were taken per site. These readings were taken inside the quadrats. Herbaceous biomass as kilograms per hectare was calculated for each DPM reading and then averaged for each site. Two different equations were used for this depending on the DPM reading, this was as a result of patterns observed by Zambatis *et al.* (2006) where DPMs of greater than 26cm were strongly influenced by the structure of the grass and were poorly correlated with readings of less than 26cm. For readings of less than 26cm the following equation was used:

$$kg.ha^{-1} = [31.7176\ (0.3218^{1/x})\ x^{0.2834}]^2$$

and for readings of more than 26cm the following equation was used:

$$kg.ha^{-1} = [17.3543\ (0.9893^{x})\ x^{0.5413}]^2$$

Where x refers to the dpm reading obtained. Mann-Whitney U tests were then performed to identify differences between sites at each village after they could not be normalised through transformation. Herbaceous biomass was not compared across villages as biomass was measured at different times in the growing season for each village.

The functional types of herbaceous cover were investigated by plotting the percentage of basal cover for the four most common functional types. Annuals, sedges and creepers (ASC) which were all non-grass forms were together because of the low proportion of each of them. After data were shown to be normally distributed using a Kolmogorov-Smirnov test, the average percentage cover was calculated for each of these functional types and compared between sites at each village using unpaired two-tail t-tests.

Excel 2010, Statistica 8.0 and Primer 5.0 were used to analyse these results.

4.4. Results

4.4.1 Disturbance

Overall, 21.44% of all sampled woody individuals showed signs of harvesting. More individuals showed signs of disturbance at the "poor" site in each village compared with the "good" site, but these differences were not significant (Figure 4.1). The Disturbance Index was not significantly different between villages ($F_{1,2}$ = 0.304, p = 0.744), between site ($F_{1,2}$ = 2.036, p = 0.179) and neither was the village by site interaction significant ($F_{1,2}$ = 1.215, p= 0.331). Allandale had both the highest (33.12%) and lowest (11.77%) disturbance levels across all villages for its "poor" and "good" sites respectively.

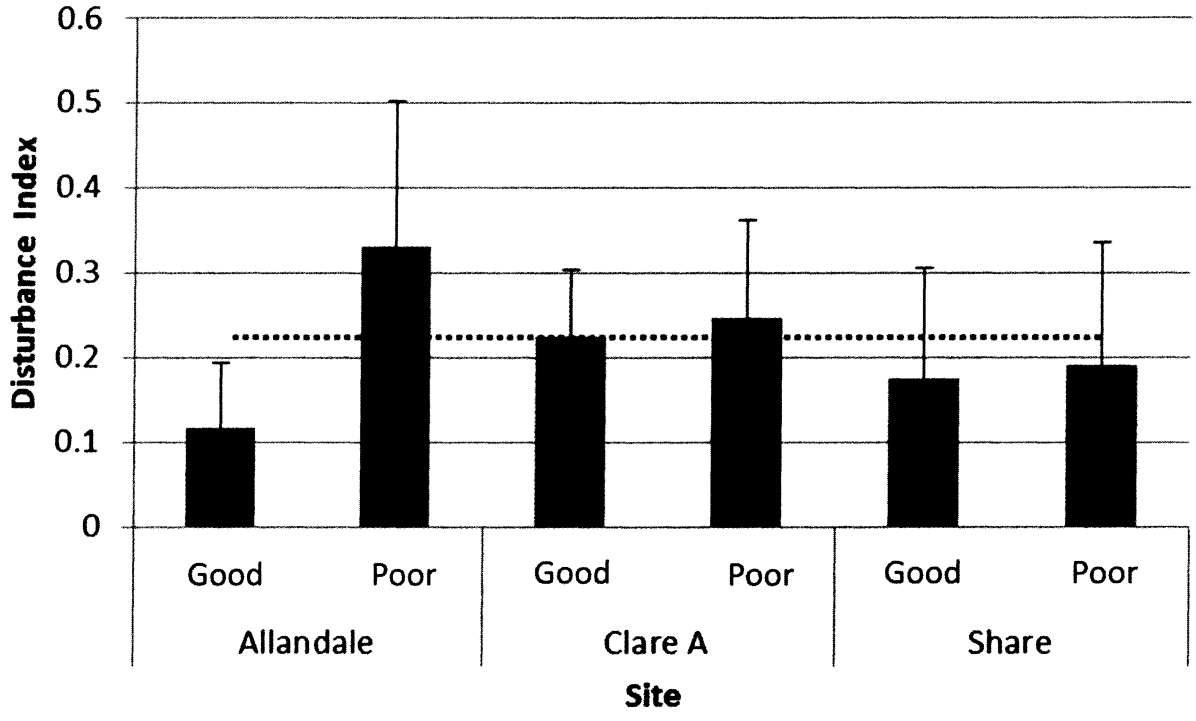


Figure 4.1. The mean Disturbance Index of woody individuals at each site for each village (mean ± SD). The dotted line represents the mean disturbance level for all sites (0.2144).

4.4.2 Woody Vegetation

4.4.2.1 Density

There was a higher density of trees at the "good" site for both Clare A and Share, while Allandale had more individuals at the "poor" site (Table 4.1). The number of individuals did not differ significantly between villages ($F_{1,2}$ = 1.553, p = 0.251), between sites ($F_{1,2}$ = 2.531, p = 0.155) and there was no significant

village by site interaction (village*site interaction; $F_{1,2}$ = 1.231, p = 0.326) (Table 4.1). The number of stems did not differ significantly between villages ($F_{1,2}$ = 1.510, p = 0.260) or between village by site interactions site (village*site interaction; $F_{1,2}$ = 2.183, p = 0.155) but did differ significantly with site ($F_{1,2}$ = 8.526, p = 0.013) (Table 4.1). The "good" site at all villages had significantly more woody stems than the "poor" site (Table 4.1).

There was a slightly higher percentage of small woody vegetation cover at the "good" site for all villages than the "poor" site, although this difference was not significant. (Table 4.1) There was a significantly greater basal cover of small woody vegetation at the "good" site at Share than at the "poor" site ($p < 0.05$). At Allandale, the "poor" site and the "good" site at Clare A had more small woody vegetation cover than the other sites for each village. However, this difference was not significant (Table 4.1).

Table 4.1. Descriptive statistics and p values for woody vegetation measures between sites in all villages. *p* values in bold type are significant.

		"Good"	"Poor"	*p*
Number of Individuals per hectare (Mean±SD)	Allandale	2600 ± 1153	2700 ± 867	0.9120
	Clare A	1967 ± 1338	1433 ± 321	0.5389
	Share	2883 ± 679	1300 ± 912	0.0734
	All villages	2483 ± 1030	1811 ±935	0.1664
Number of Stems per hectare (Mean±SD)	Allandale	6867 ± 2533	6617 ± 1636	0.8928
	Clare A	5033 ± 3265	4400 ± 1300	0.7706
	Share	7267 ± 1336	3083 ± 1247	**<0.05**
	All villages	6944 ± 1604	4700 ± 1968	**<0.05**
Tree Height (m) (Mean±SD)	Allandale	2.03 ± 0.76	2.39 ± 0.96	**<0.01**
	Clare A	1.85 ± 0.54	1.60 ± 0.37	**<0.001**
	Share	2.05 ± 0.88	2.14 ± 1.07	0.6732
	All villages	1.99 ± 0.76	2.12 ± 0.93	0.2320
Basal Diameter (mm) (Mean±SD)	Allandale	25.78 ± 10.48	29.32 ± 17.02	0.1036
	Clare A	25.65 ± 13.72	20.16 ± 14.78	**<0.0001**
	Share	27.49 ± 24.00	29.49 ± 30.05	0.5853
	All villages	26.39 ± 17.53	26.50 ± 20.46	0.07
Small woody vegetation cover (%)	Allandale	0.71 ± 0.17	1.75 ± 1.61	0.3333
	Clare A	0.61 ± 0.46	0.59 ± 0.14	0.9300
	Share	1.89 ± 0.52	0.76 ± 0.43	**<0.05**
	All villages	1.07 ± 2.87	1.03 ± 4.28	0.4554

4.4.2.2 Structure

Mean woody vegetation height was greater in the "poor" sites in Allandale and Share, and in the "good" site in Clare A. These results were significant at both Allandale and Clare A ($p<0.01$). Sites at Clare A had the lowest average tree heights and the smallest standard deviations (Table 4.1). There was no significant difference in the height of woody individuals between sites for all villages (Mann-Whitney U-statistic = 69196, p = 0.2320). Tree heights were significantly different between villages, when sites within villages were combined (KW = 28.853, $p < 0.0001$) with Clare A having significantly different heights to both Allandale ($p < 0.001$) and Share ($p < 0.01$) (Table 4.2).

In Allandale the "good" site had a greater number and proportion of small individuals, between 1 and 3m, than the "poor" site, while the "poor" site had a greater number of trees 3m and taller (Figure 4.2). In Clare A, there was a difference between the number and the proportion of individuals between 1.5 and 2m. Although there were a greater proportion of individuals from the "poor" site in this size class, there were a greater number of individuals in this class from the "good" site. There were more bigger individuals at the "good" site but more smaller individuals, 1-1.5m, at the "poor" site. In Share, there were greater numbers of individuals in the "good" site than the "poor" site for all size classes. However, patterns in the proportions of individuals were more similar between sites, except for individuals between 1.5 and 2m, where there was a greater proportion of individuals in the "good" site and between 1 and 1.5m, 2 and 2.5m and 4 and 4.5m, where there were greater proportions of individuals in the "poor" site. However, no significant differences were identified between sites ($p > 0.10$ for all villages).

Table 4.2. Descriptive statistics for vegetation height and basal area for combined sites across all villages.

	Allandale	Clare A	Share
Average Tree Height (m) (Mean±SD)	2.21 ± 0.89	1.74±0.49	2.08±0.95
Average Basal Area (mm^2) per hectare (Mean±SD)	37 619.77 ± 49 981.23	29 152.60 ± 86 585.36	57 351.30 ± 159 776.70

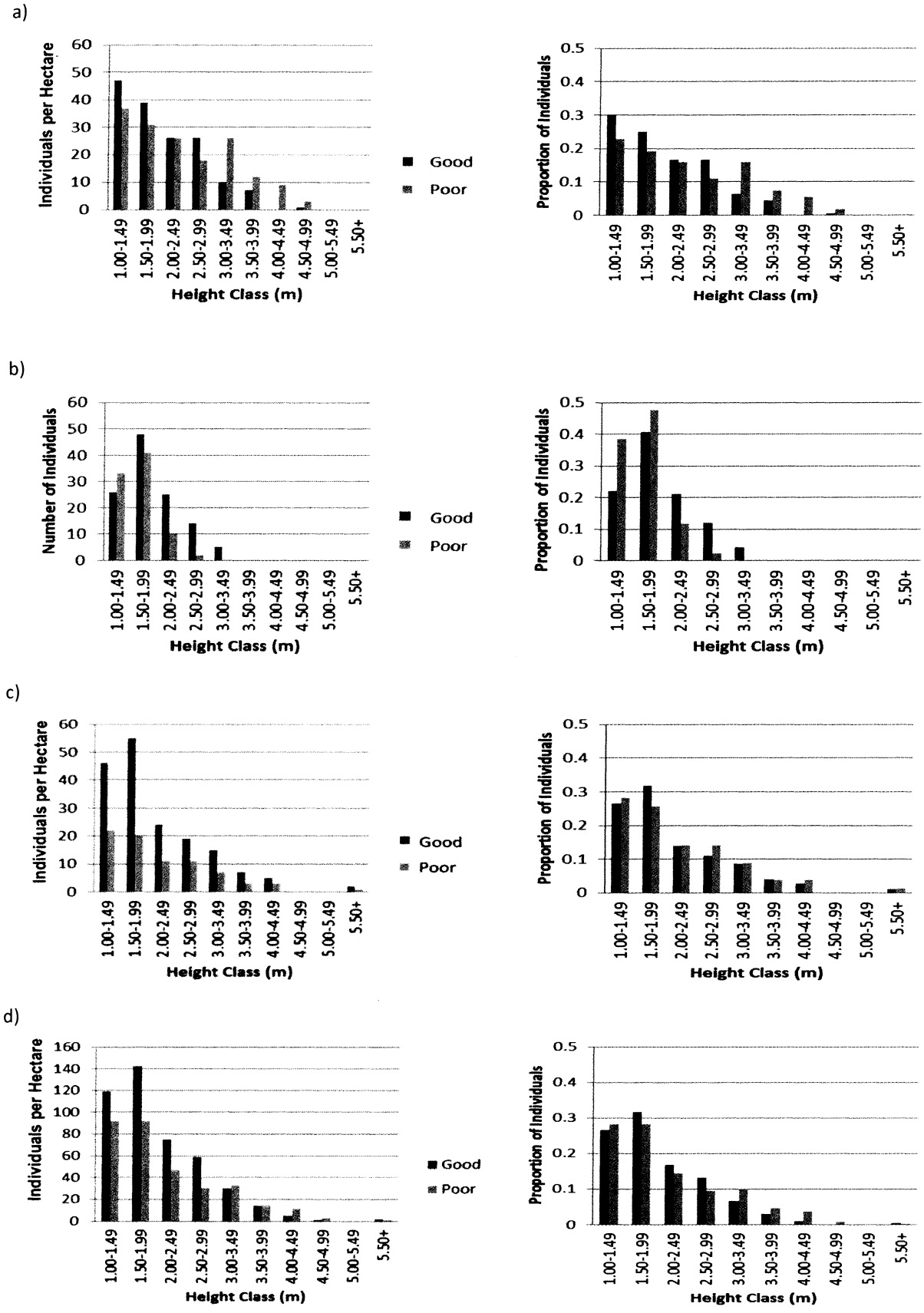


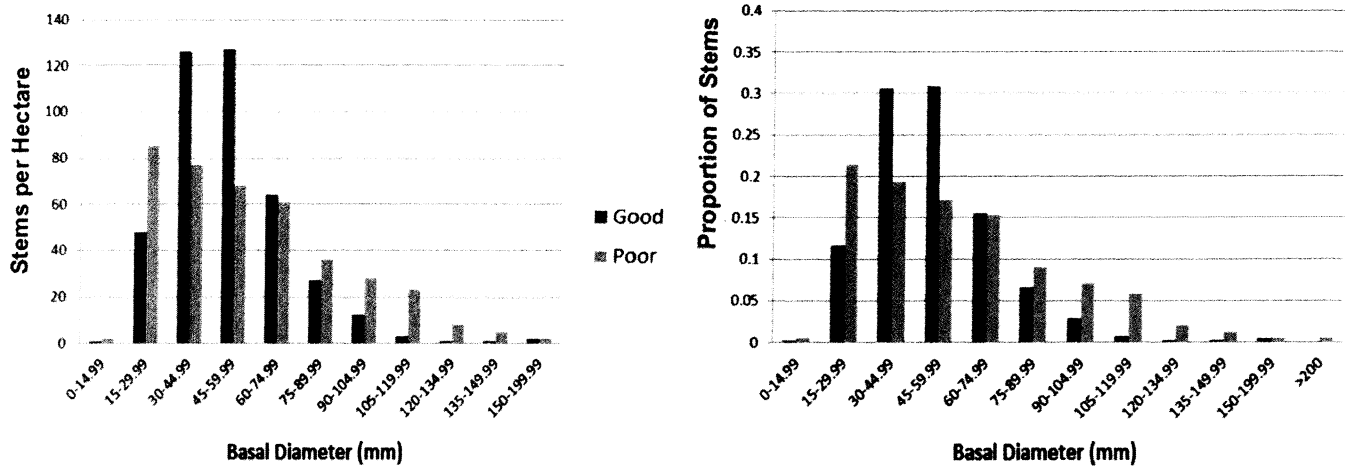
Figure 4.2. Numbers of woody individuals and proportions of woody individuals within classes at good and poor sites in each village per hectare; a- Allandale, b- Clare A, c- Share and d- All villages. Both number and proportion were graphed to fully illustrate the patterns at each site.

4.4.2.3 Basal Diameter

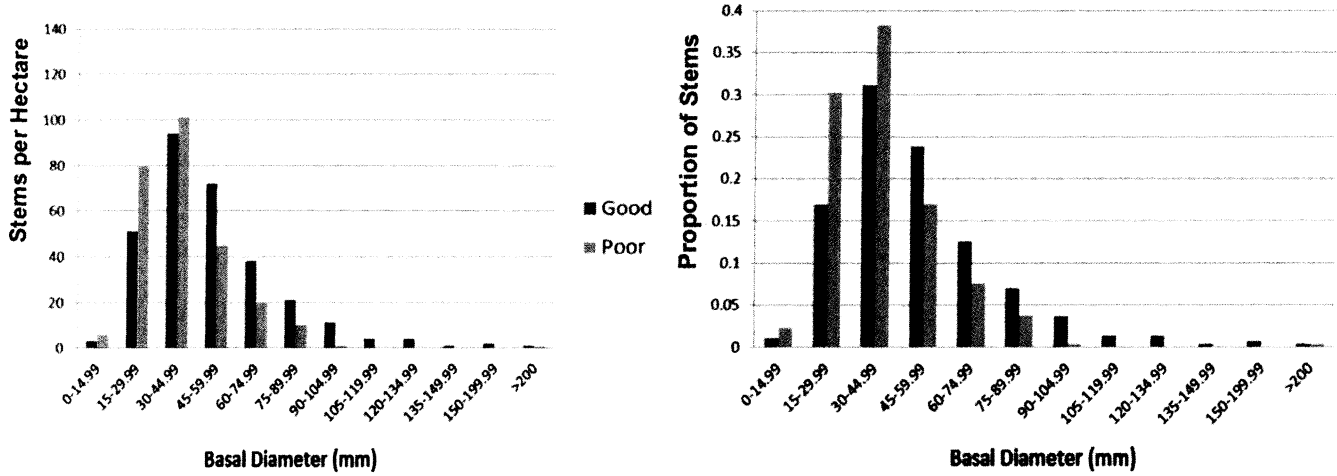
Basal diameter was significantly higher in the "good" site compared with the "poor" site in Clare A ($p < 0.0001$). Basal diameter did not differ significantly between sites in Allandale or Share, although the "poor" site at both of these villages had a greater average basal area. Basal area did not differ significantly at the 5% level between sites for all villages combined although it was significant at the 10% level (Mann-Whitney U-statistic = 463476.5, $p = 0.07$) but basal area was significantly different between villages for both sites combined (KW = 53.62, $p < 0.0001$), where Allandale was significantly different to both Clare A ($p < 0.001$) and Share ($p < 0.001$) (Table 4.1). The average basal diameter of stems for all sites was between 26 and 27mm. Standard deviations tended to be smaller in the "good" than the "poor" sites (Table 4.1). In Clare A, there were more stems at the "good" site and the average basal area was greater compared with the "poor" site (Table 4.1).

Both the number and proportion of stems in different size classes between sites at each village were graphed (Figure 4.3). In all but one site, Share's "poor" site, there were more stems in the second size class (15-29.99 mm) than the first (1 – 14.99 mm). However, size classes were not significantly different between sites ($p > 0.10$ for all villages). This may be due to the sampling strategy as only individuals that were at least 1m in height were measured in the transects. Stems with a basal diameter of larger than 150mm were found in only three sites, both sites in Share and the "poor" site in Clare A. A total of nine stems of this size were found in these three sites. Thus, out of the 1996 stems measured across all sites, they represented only 0.75%. Furthermore, only 2.74% of stems were greater than 60mm diameter (Figure 4.3).

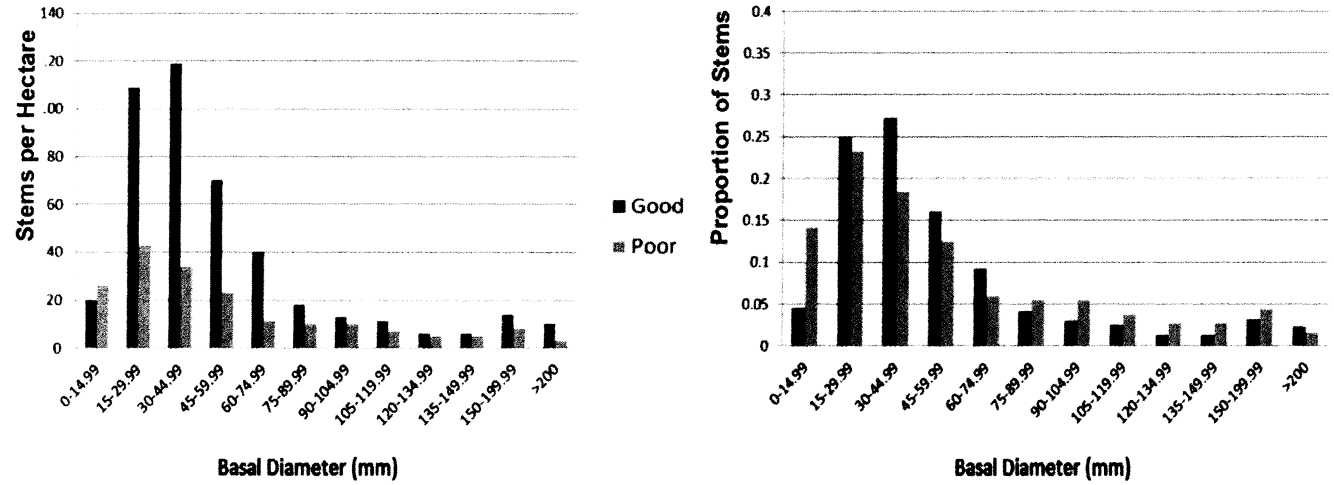
a)


Stems per Hectare
140
120
100
80
60
40
20
0
0-14.99
15-29.99
30-44.99
45-59.99
60-74.99
75-89.99
90-104.99
105-119.99
120-134.99
135-149.99
150-199.99
Basal Diameter (mm)
Good
Poor
Proportion of Stems
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
>200
Basal Diameter (mm)

b)


Stems per Hectare
140
120
100
80
60
40
20
0
0-14.99
15-29.99
30-44.99
45-59.99
60-74.99
75-89.99
90-104.99
105-119.99
120-134.99
135-149.99
150-199.99
>200
Basal Diameter (mm)
Good
Poor
Proportion of Stems
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Basal Diameter (mm)

c)


Stems per Hectare
140
20
00
80
60
40
20
0
0-14.99
15-29.99
30-44.99
45-59.99
60-74.99
75-89.99
90-104.99
105-119.99
120-134.99
135-149.99
150-199.99
>200
Basal Diameter (mm)
Good
Poor
Proportion of Stems
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Basal Diameter (mm)

d)

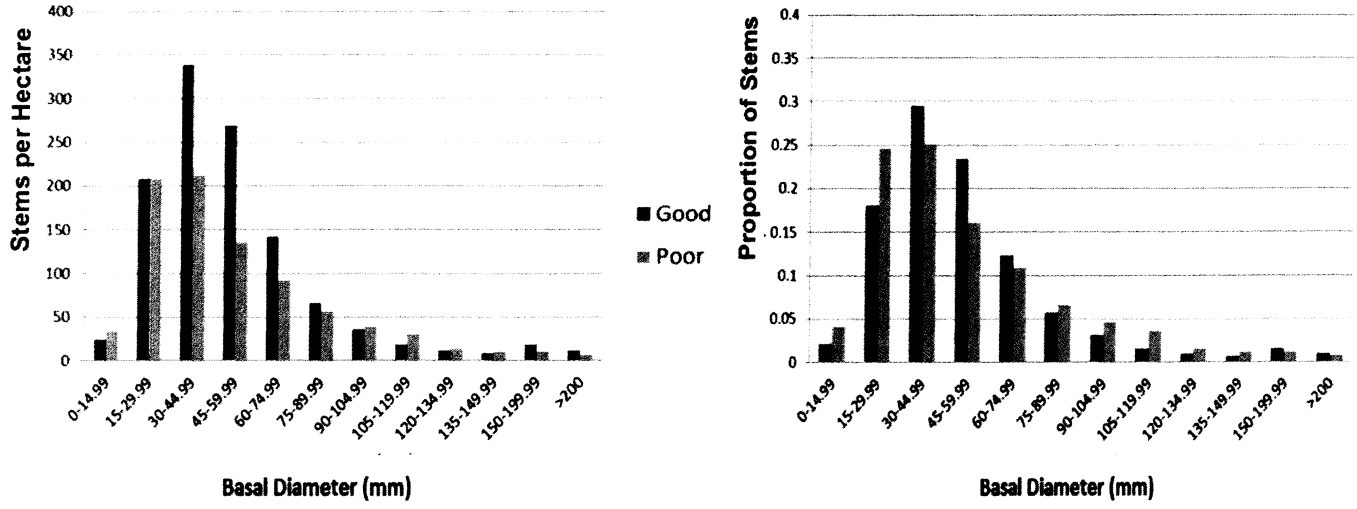


Figure 4.3. Proportions and numbers of woody stems of different basal diameter (mm) size classes for each site and each village per hectare. a- Allandale, b- Clare A, c- Share, d- All villages. Basal diameter was used instead of Basal areas as was used for the rest of the study because the size classes are more intuitive and relate to size classes that may be used by fuel wood harvesters.

4.4.2.4 Species Richness

In total, 44 species were encountered during sampling. All of these species were indigenous except for a single individual Guava tree (*Psidium guajava*) which was sampled in the "poor" site at Share. Similar species numbers were measured at each site for Clare A and Share. Eleven species were identified at both sites in Clare A. In Share, 25 species were identified in the "good" site and 21 species were identified in the "poor" site. In Allandale, 25 species were sampled at the "good" site and 12 species at the "poor" site (Table 4.3). Fewer species were encountered on average on transects at the "poor" sites compared with the "good sites" for each village, this difference was significant at Allandale ($p<0.05$).

Non-metric multidimensional scaling (NMDS) revealed groupings between the transects at both the "good sites" and "poor" site at Clare A and the "poor" site at Allandale (Figure 4.4). Transects at the "good" and "poor" sites at Share and the "good" site at Allandale did not group. These sites may not have grouped because they have greater numbers of rare species.

For the Simpson's Index of Diversity and the Shannon Index, the "good" sites at all villages had higher index scores than the "poor" sites for both indices. A significant difference was found in Simpson's Index data between sites ($F_{1,2} = 5.329$, $p < 0.05$) but not villages ($F_{1,2} = 2.853$, $p = 0.0969$) or in the interaction between villages and sites ($F_{1,2} = 1.123$, $p = 0.357$). The same result was obtained for the Shannon Index, there was a significant difference between sites ($F_{1,2} = 8.110$, $p < 0.05$) but not between villages ($F_{1,2} = 3.047$, $p = 0.085$) or the interaction between villages and sites ($F_{1,2} = 1.7712$, $p = 0.212$). The "good" site in Share had the highest and the "poor" site at Allandale, the lowest scores for both indices. The Jaccard Index for similarity between sites showed that the most similar village was Clare A (0.6923). Sites in Clare A shared nine species and had two each that were only represented on one site. Allandale had a Jaccard Index of 0.3846, sharing ten species and with 14 and 2 species occurring on only the "good" or "poor" site, respectively. Sites at Share were the most dissimilar with a Jaccard Index of 0.3143. These sites had 11 species in common and 14 and 10 species respectively on the "good" and "poor" sites. The woody species and family list for all sites is listed as appendix 3.

Table 4.3. Species richness and diversity (mean ± SD) of woody plants at "good" and "poor" sites for each village per sampled area. Significant differences are shown in bold.

	Village	"Good"	"Poor"	*p*
Cumulative Species Richness	Allandale	25	12	
	Clare A	11	11	
	Share	25	21	
	All villages	36	31	
Average Species Richness	Allandale	13.33±3.21	6.33±2.52	**<0.05**
	Clare A	7.67±1.53	6.33±0.58	0.2290
	Share	12.67±5.13	9.67±2.08	0.4010
	All villages	11.23±3.09	7.44±1.93	**<0.01**
Average Simpson's Index of Diversity (1-D)	Allandale	0.768±0.156	0.528±0.127	0.1077
	Clare A	0.822±0.039	0.681±0.184	0.2639
	Share	0.832±0.060	0.815±0.078	0.7797
	All villages	0.8073±0.091	0.6747±0.172	0.3033
Average Shannon Index (H')	Allandale	1.918±0.422	1.059±0.326	**<0.05**
	Clare A	1.755±0.101	1.399±0.365	0.1788
	Share	2.015±0.442	1.87±0.248	0.6462
	All villages	1.896±0.333	1.443±0.447	**<0.05**

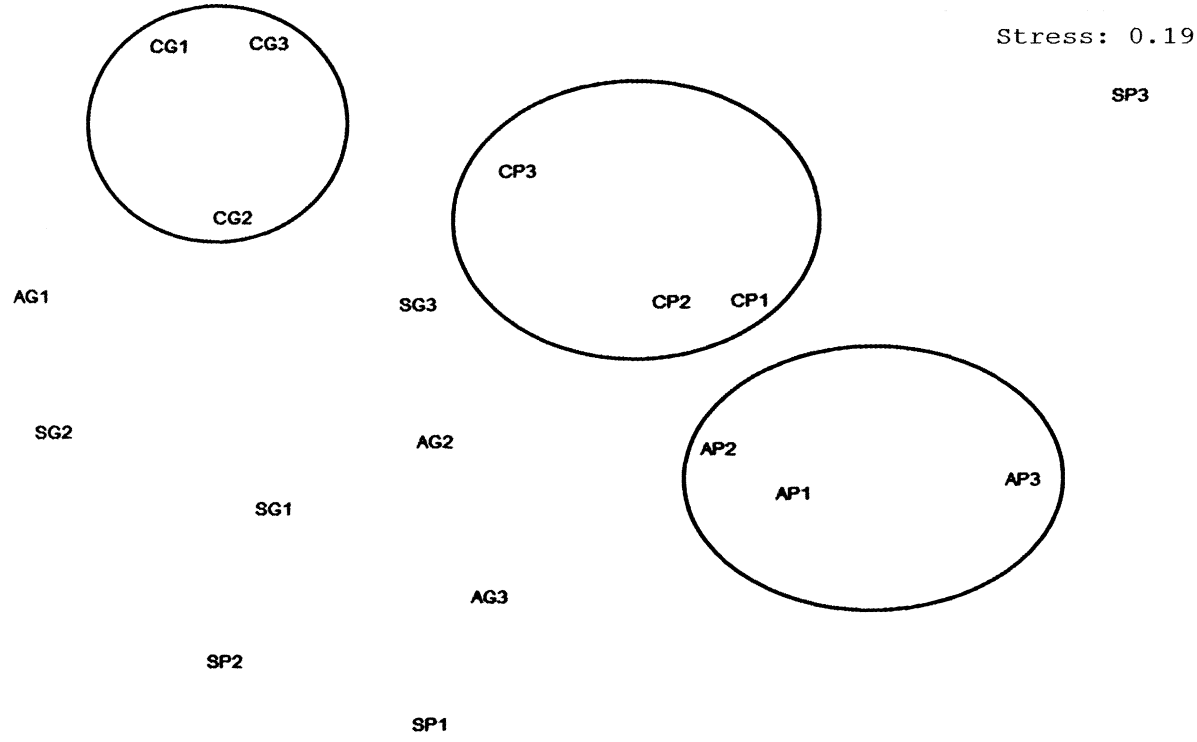
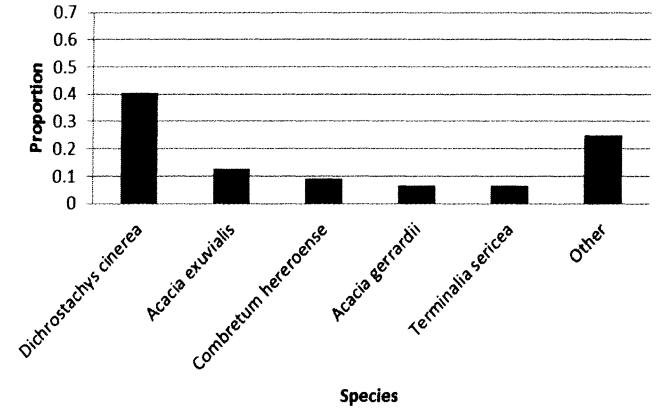


Figure 4.4. NMDS plot showing similarities and dissimilaritites in the number of species encountered within and between sites. This was done on the log transformed species abundance data for all transects at each site. The first letter indicates the village (A- Allandale, C- Clare A and S- Share) the second letter indicated the site (G- Good, P- Poor) and the number indicates the transect number, 1-3. The red circles indicates where transects within a given site appear to have grouped.

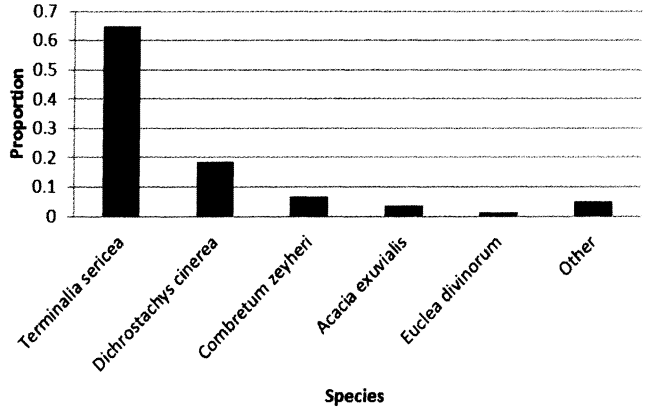
The five most common species across all sites and villages were *Dichrostachys cinerea, Terminalia sericea, Acacia exuvialis, Acacia gerrardii* and *Combretum hereroense.* These 5 species represented 72.44% of the total number of individuals sampled. The 5 most common species at each site are shown in Figure 4.5. The five most common species represented 75% and 95% of the woody individuals encountered for the "good" and "poor" sites in Allandale respectively, 84.8% and 87.2% for the "good" and "poor" sites in Clare A, respectively and 75.1% and 65.4% of the woody individuals encountered for the "good" and "poor" sites at Share.

The "poor" sites at all three villages tended to have a greater presence of *Terminalia sericea* than the "good sites", with *Terminalia sericea* being the most common species to be sampled at the "poor" sites (Figure 4.5). *Dichrostachys cinerea* was the most dominant species at the "good" site. *D. cinerea* dominated the "good sites" at both Allandale and Clare, but not Share which was dominated by *Acacia gerrardii.* The most dominant species at the "poor" sites also accounted for a greater proportion of the total than the most dominant species at the "good" sites, although the cumulative proportion of the top 5 species was not always greater on the "poor" site. *Dichrostachys cinerea* was the only species that was encountered at all sites and which was one of the five most common species at all sites. Of the 44 species encountered, 16 species were sampled at only one site and for 12 of these only a single individual was sampled. None of these were sampled in either site at Clare A. More species were represented by a single individual in the "good" compared with the "poor" site at Allandale, with ten and six respectively, and Share, with 11 and nine respectively. While one species at the "good" site and two species at the "poor" site of Clare A were represented by a single individual. Species were sampled from a total of 17 families. The family with the most species encountered was Mimosaceae with nine species belonging to this family, the family with the second most species encountered was Combretaceae with six representatives. Nine of the families sampled were represented by one species.

a)



b)



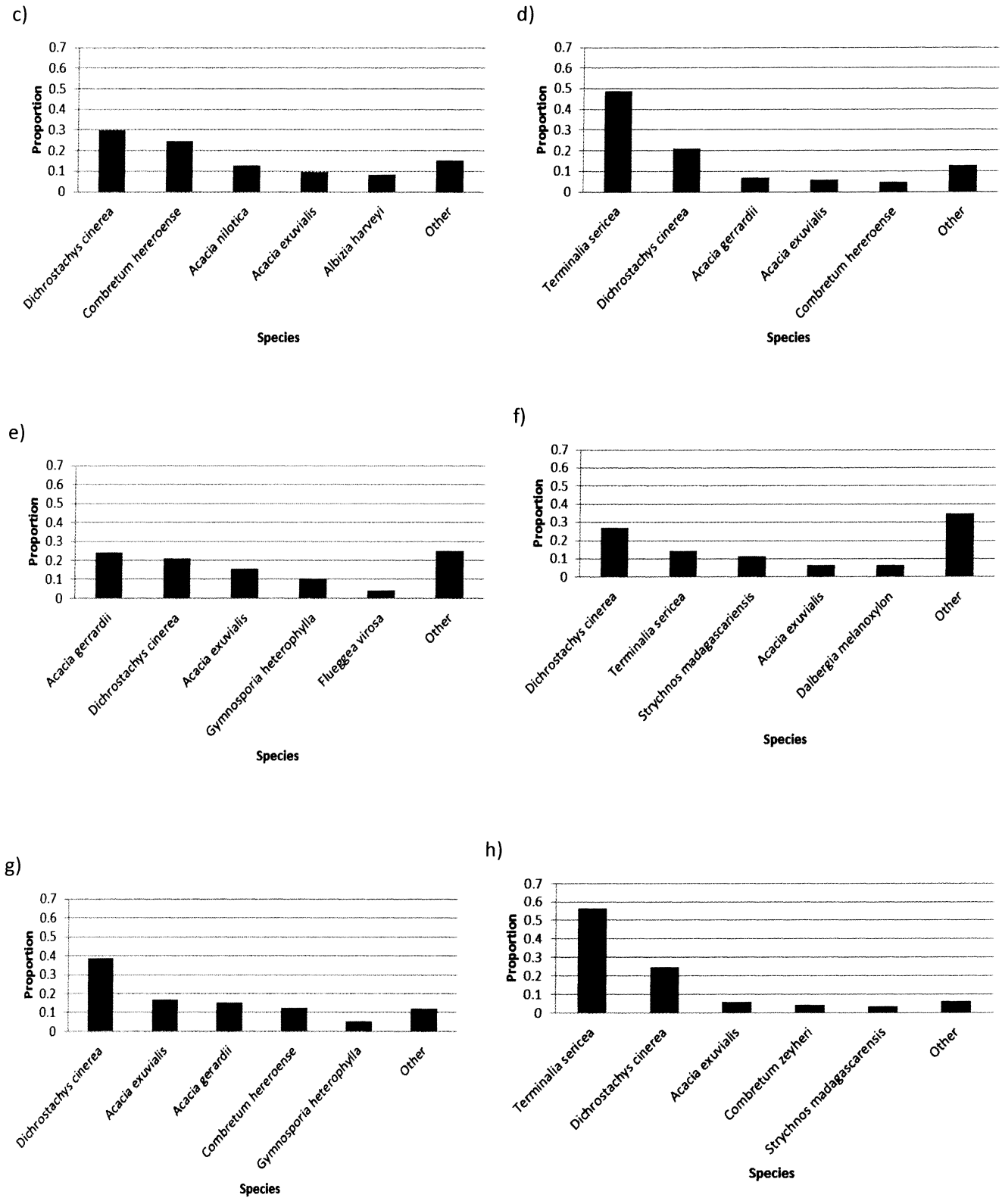


Figure 4.5. The frequency of encounters for the five most common species of woody vegetation for each site. a) Allandale "good", b) Allandale "poor", c) Clare A "good", d) Clare A "poor", Share "good", f) Share "poor", g) All villages "good", h) All villages "poor"

4.4.3 Herbaceous Vegetation

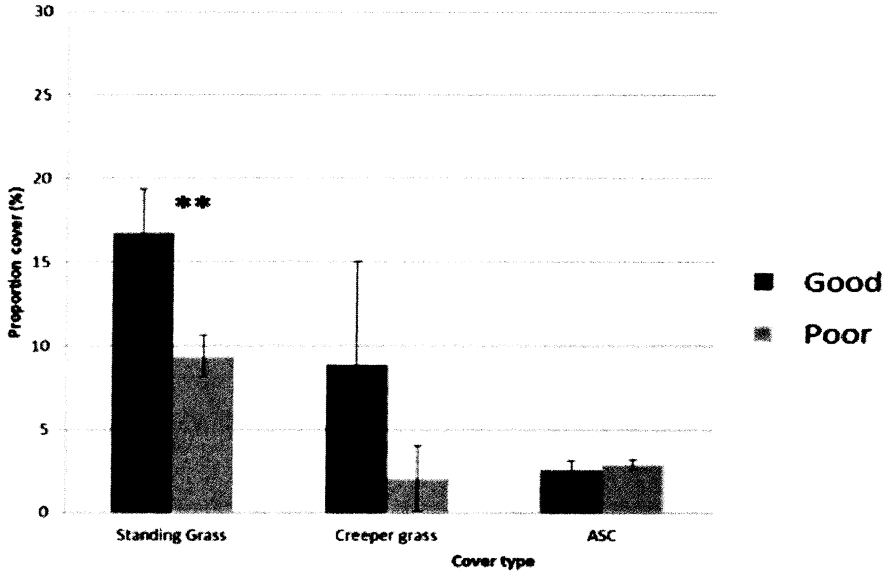
Herbaceous biomass between sites at each village was significantly different (Table 4.4). The "good" sites at Allandale and Share had more herbaceous biomass and more herbaceous cover than their respective "poor" sites. At Clare A, the "poor" site had more herbaceous biomass and more herbaceous cover than the "good" site. Biomass was not compared between villages as measures were taken at different times of the year.

All sites were dominated by grasses, both "standing" and "creeping". However, proportions of "standing" and "creeping" grass varied across sites as did the amounts of "Annuals, Sedges and Creepers"(ASC) (Figure 4.6). Both sites in Allandale were dominated by "standing grass", but the "good" site had significantly more than the "poor" site ($p<0.05$, $df=4$). No other functional types were significantly different between sites at Allandale. "Creeping grass" was the second most dominant cover at the "good" site, while at the "poor" site the second most dominant cover was "ASC". In Clare A, the "poor" site was dominated by "standing grass", predominantly *Hyperthelia dissoluta*. There was significantly more "standing grass" at the "poor" site ($p<0.05$, $df=4$) The "good" site was dominated by creeping grass, of which there was none at the "poor" site. Other functional types were not significantly different. At Share, the "good" site was dominated by "standing grass", while the "poor" site was dominated by "creeping grass". There was a greater proportion of bare ground on the "poor" site than the "good" site. Significant differences were found between sites at Share for all functional types, with the "good" site having more "standing grass" and "ASC" and the "poor" site having more "creeping grass" (Figure 4.6). A summary of these results is given in Table 4.5.

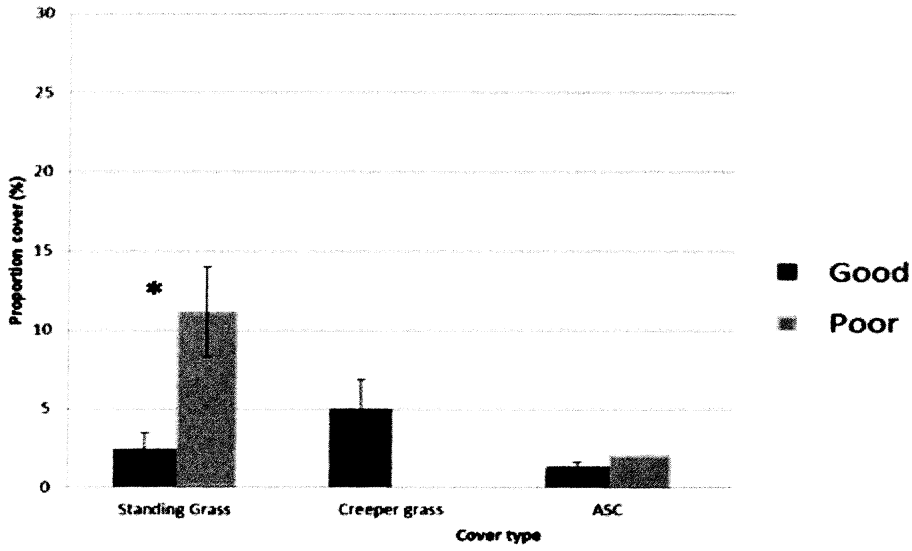
Table 4.4. Herbaceous biomass between sites for each village and t-test results for differences in herbaceous biomass between sites. MWU-values indicate the Mann-Whitney U test values obtained

		"Good"	"Poor"	MWU-values	df	p
Herbaceous	Allandale	2021 ± 801	609 ± 473	1322.0	4	**<0.0001**
Biomass	Clare A	348 ± 349	2894 ± 1398	165.0	4	**<0.0001**
(kg/ha)	Share	978 ± 1086	212 ± 299	3497.5	4	**<0.001**

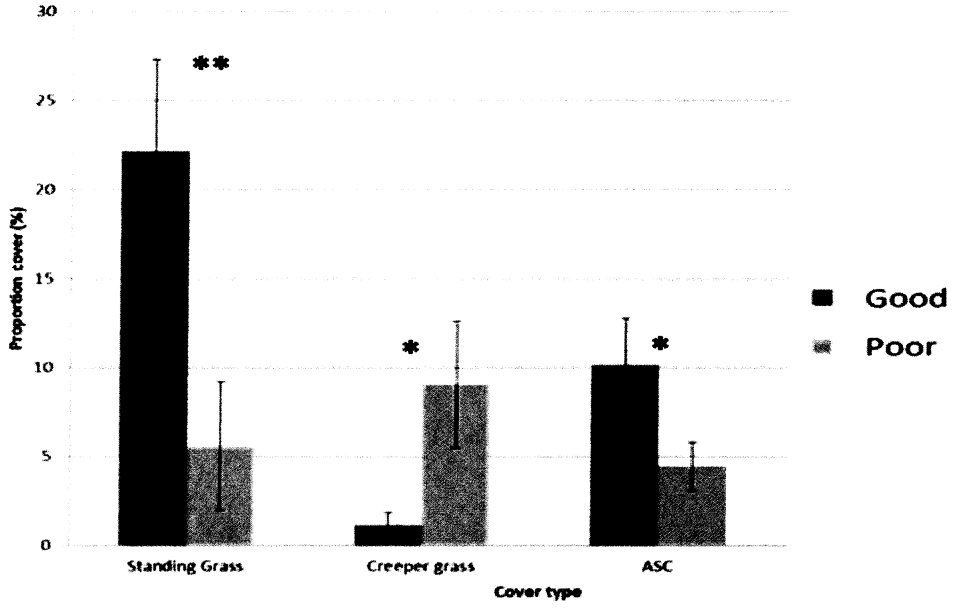
a)


30
25
20
15
10
5
0
Proportion cover (%)
**
Standing Grass
Creeper grass
ASC
Cover type
Good
Poor

b)


30
25
20
15
10
5
0
Proportion cover (%)
*
Standing Grass
Creeper grass
ASC
Cover type
Good
Poor

c)



d)

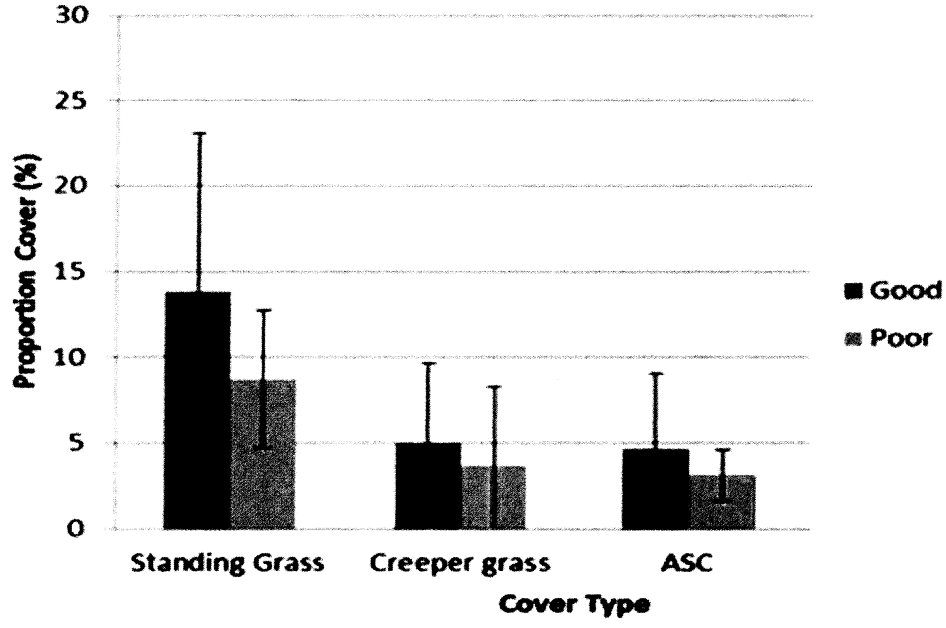


Figure 4.6. Percent cover (mean ± SD) of the 3 main cover types for each site and each village. a- Allandale b- Clare A, c- Share, d- All villages. Asterisks represent significant difference between sites (* $p<0.05$, ** $p<0.01$). Standing grass describes standing grass forms, creeper grass describes creeping grass forms and ASC refers to annuals, sedges and creepers.

Table 4.5: Summary of differences in vegetation indices between sites for all villages. An asterisk indicates whether these patterns were significantly different across those sites. C+P indicates that this was correct for the cumulative and average values while either a C or P indicates it being true for either the cumulative or proportional value only.

	Allandale		Clare A		Share	
	"Good"	"Poor"	"Good"	"Poor"	"Good"	"Poor"
Disturbance Index	Less	More	Less	More	Less	More
Number of Woody Individuals	Less	More	More	Less	More	Less
Number of Woody Stems	More	Less	More	Less	More*	Less*
Average Height (m)	Shorter*	Taller*	Taller*	Shorter*	Shorter	Taller
Height Class	More short (C+P)	More tall (C+P)	More tall (C+P)	More Short (C+P)	More of all (C)	More tall (P)
Average Basal Diameter (mm)	Larger (C+P)	Smaller (C+P)	Larger (C+P)	Smaller (C+P)	Larger (C)	Larger (P)
Number of Species	More	Less	Equal	Equal	More	Less
Diversity Index	More (Shannon*)	Less	More	Less	More	Less
Jaccard Index	2nd most similar		Most similar		Least similar	
Five Most Common Species	75.00%	95.00%	84.75%	87.21%	75.14%	65.38%
Most Common Species	*Dichrostachys cinerea*	*Terminalia sericea*	*Dichrostachys cinerea*	*Terminalia sericea*	*Acacia gerrardii*	*Dichrostachys cinerea*
Non-Indigenous Species	None	None	None	None	None	*Psidium guajava* (Guava)
Herbaceous Biomass	More*	Less*	Less*	More*	More*	Less*
Herbaceous Cover	More*	Less*	Less*	More*	More*	Less*
Functional Types	More Standing Grass* and Creeping Grass	More ASC	More Creeping Grass	More standing grass*	More Standing, ASC *	More creeping grass*

4.5. Discussion

Fuel wood is a very important natural resource for people living in rural areas of South Africa, with usage estimates of between 91 and 97% of households (Shackleton *et al.,* 2002; Shackleton and Shackleton, 2003; Twine *et al.*, 2003). Studies have shown that the demand for fuel wood outweighs the availability of dead wood and as such many LRUs have taken to harvesting live wood (Shackleton, 1994; Shackleton, 1998). The proportion of mature stems that have been cut and the level of cutting per stem were found to have increased for five species in a nearby village in Bushbuckridge over a period of eleven years (Shackleton *et al.*, 2005). In this study, 21.44% of the woody individuals that were sampled showed signs of harvesting, in other studies in this area harvesting rates as high as 34.9% were found, although this was close to the village and decreased sharply with distance from it and most proportions were between 10 and 15% (Shackleton *et al.*, 1994). Higher levels of harvesting were observed at "poor" rather than "good" sites (Figure 4.1). "Good" sites also had more woody individuals and more woody stems per hectare than the "poor" sites for all villages (Table 4.1). However, two of the most common species at both the "good" and "poor" sites, *Dichrostachys cinerea* and *Terminalia sericea*, are bush encroaching species and high densities of these plants have also been found in other studies indicating that bush encroachment may be occurring in these areas (Roques *et al.,* 2001, Moleele *et al.*, 2002 Coates-Palgrave, 2002). Hence, both signs of removal of woody biomass and signs of bush encroachment were observed on both "good" and "poor" sites in all villages.

The majority of stems sampled occurred in smaller size classes, with fewer than 0.05% of all stems measuring greater than 60mm in diameter, and most measuring between 20 and 30mm in diameter. This lack of individuals in larger and intermediate size classes may indicate over utilisation of that resource (Shankar *et al.,* 1998; Neke *et al.*, 2006; Gaugris and Van Rooyen, 2010). The high proportion of small stem sizes could also be indicative of a coppice growth-form response to harvesting, a property of many savanna tree species (Shackleton, 2000b; Luoga *et al.*, 2004; Mlambo and Huizing, 2004; Shackleton *et al.*, 2005). The trend of a greater number and proportion of stems in the second size class compared with the first was also found by Shackleton *et al.* (2005) in five species of trees that were sampled in a nearby village in Bushbuckridge. They attributed this to constricted or episodic recruitment with similar patterns found in a number of other studies (Walker *et al.*, 1986; Shackleton, 1993b; Wiegand *et al.*, 2000). However, these broad trends in basal area and height did not translate into clear difference at the site or village scale. The "good" sites at both Allandale and Share had a shorter average vegetation height and smaller basal area compared with the "poor" site, while the "poor" site at Clare A had significantly shorter individuals and a smaller basal area compared with the "good" site. A change in woody vegetation density, either an increase (e.g. because of bush encroachment) or a decrease (e.g. from deforestation or die-off) may be indicative of vegetation degradation (Hoffman and Ashwell, 2001). These results indicate that processes leading to bush encroachment may be occurring in these sites. However no sites are noticeably more or less affected by this apparent bush encroachment.

A loss of species richness and diversity is also associated with vegetation degradation (Hoffman and Ashwell, 2001) and lower woody species richness and lower diversity index values were found at the "poor" site compared with the "good" site. Vegetation degradation is also associated with lower evenness between species and a higher dominance from a few species (Hoffman and Ashwell, 2001). Higher levels of dominance were found at the "poor" sites for both Allandale and Clare A. The five most commonly encountered species at the "good" site in Share accounted for a greater proportion of species than at the "poor" site. This indicates that woody degradation may be more prevalent at the "poor" sites than the "good" sites. However, two of the most dominant species, *Dichrostachys cinerea* and *Terminalia sericea*, are

also important species for fuel wood (Neke *et al.*, 2006; Madubansi and Shackleton, 2007) thus, although bush encroachment may be occurring this may benefit local fuel wood users. There have been mixed results from studies comparing species richness between communal areas and areas with other land-use types. Some studies have shown that utilisation by communities may lead to a significant increase in plant species richness at the landscape level in Bushbuckridge (Higgins *et al.*, 1999, Shackleton, 2000) while, other studies have shown that plant species richness decreases sharply with heavy grazing (Rutherford and Powrie, 2011) and increases when grazing pressure is removed (Harrison and Shackleton, 1999).

Additionally, the patterns in Clare A of shorter vegetation heights and high levels of similarity and low diversity in woody vegetation species between sites may be as a result of the historical legacy of this area. This is because the area was previously used for growing crops, how long ago was unclear from discussions. It has, thus, only been available for wood harvesting and grazing of livestock in recent years (Clare A oral history). Therefore, there may be a lag to changes in species diversity after disturbance (Fang and Peng, 1997). A high proportion of indigenous species was found in this study, as only a single non-indigenous individual was sampled across all sites. This has been found in other studies in these areas (Shackleton, 2000). The two most commonly sampled families, Mimosaceae and Combretaceae, are both highly dominant within these vegetation types (Mucina and Rutherford, 2006).

There was less herbaceous biomass and a lower percentage of herbaceous cover at the "poor" sites for both Allandale and Share. This may be indicative of vegetation degradation and can also lead to increased rates of processes such as soil erosion and degradation (Hoffman and Ashwell, 2001). The exception to this trend was the "poor" site at Clare A which was dominated by thatching grass, *Hyperthelia dissoluta*, and had both high biomass and a greater percentage herbaceous cover compared with the "good" site. This species is only palatable in the early part of the growing season and can be dense enough to obstruct movement of livestock and, therefore, its presence may be viewed negatively by cattle owners or minders (van Oudtshoorn, 2009). However, it is also a valuable thatching grass (van Oudtshoorn, 2009). Thatching grass has been shown to be used by about 50% of rural South African households (Shackleton *et al.*, 2002; Shackleton and Shackleton, 2003; Twine *et al.*, 2003) and, thus, may provide other benefits to LRUs, although the use of thatching grass for roofing is in decline (from personal observation during visits to the area). The low biomass and overall cover may indicate higher levels of degradation on the "poor" sites at Allandale and Share. *Hyperthelia dissoluta* is an Increaser I grass species under conditions of low utilization (van Oudtshoorn, 2009) thus, its dominance indicates low levels of utilisation which occurred on this site.

Grass growth form and species composition may change as a response to grazing pressure, plasticity in grass growth forms may result in a change from erect plant forms such as bunch or tussock grasses (classified as standing grass forms in this study) to prostrate growth forms with lateral spread either above (stoloniferous) or below (rhizomatous) ground (Diaz *et* al., 2007; Wesuls *et al.*, 2012). Diaz *et al.* (2007) also found that high levels of grazing promoted annual plants over perennials and shorter rather than taller plants. These changes may be a grazing-avoidance strategy but this is limited in semi-arid systems with high proportions of bare ground (Parsons *et al.*, 1997; Wesuls *et al.*, 2012). In a study by Parsons *et al.* (1997), tuft density was found to be greatest in communal grazing lands, compared with commercial cattle farms and private game farms, although tuft size was smaller. This was attributed to a response to higher grazing levels, as it reduces risks of defoliation (Parsons *et al.*, 1997). These changes can be a result of a number of interacting factors and perturbations, including those that are environmental, such as substrate and rainfall, and other variables, such as the length of exposure to grazing (Scholes & Walker, 1993, Wesuls *et al.*, 2012). Although these factors should be minimised in this study as sites have similar environmental factors and variables such as length of exposure to grazing. Except in the case of sites at Clare A which had a shorter

length of exposure to graing compared with Allandale and Share. In this way other land use practices such as intensity of use may be the primary reason for differences between these growth forms. The number and abundance of palatable species present has been shown to decrease with high grazing pressures (Harrison and Shackleton, 1999) with sites under communal land tenure being shown to have decreased palatability compared with commercial cattle farms and private game farms (Parsons *et al.*, 1997), although, herbaceous productivity does not necessarily decline in communally grazed systems, compared with commercial cattle farms or private game farms (Shackleton, 1993; Parsons *et al.*, 1997). All sites in this study were dominated by grasses, however proportions of "standing grass" and "creeping grass" varied between sites. Notably, Clare A was dominated by the tall standing grass *Hyperthelia dissoluta*, described above, while the "good" site was dominated by "creeping grass". At Share the "good" site had significantly more "standing grass" than the "poor" site which had significantly more "creeping grass". This may indicate a higher grazing pressure at the "poor" site than the "good" site for Share, especially when coupled with the biomass results. However, further sampling would be required to determine grazing level at Allandale and Clare A.

Higher levels of use and degradation could not be associated with any of the sites or villages based on these results alone. Although some trends were evident, for example, the pattern in woody species diversity which indicates possible vegetation degradation and in herbaceous biomass and total cover in Allandale and Share at the "poor" sites compared with the "good". Differences in woody vegetation structure and functional types and their proportion of cover of herbaceous vegetation did not differ significantly between sites.

There were higher woody densities (individuals and stems) at the "good" sites than the "poor" sites. The broad trends that were identified for basal area and height did not equate to clear trends at the site or village scale. Greater species richness and diversity index values were found at the "good" sites for all villages compared with the "poor" sites. One individual from a non-indigenous species was found across all sites, this was a fruit tree at the "poor" site in Share.There was less herbaceous biomass and a lower percentage of herbaceous cover at the "poor" sites for both Allandale and Share. The "poor" site at Clare A which was dominated by thatching grass, *Hyperthelia dissoluta*, and had both high biomass and a greater percentage herbaceous cover compared with the "good" site. The herbaceous vegetation at all sites in this study were dominated by grasses, however proportions of "standing grass" and "creeping grass" varied between sites. The "poor" site at Clare A was dominated by tall "standing grass", while the "good" site was dominated by "creeping grass". At Share the "good" site had significantly more "standing grass" than the "poor" site which had significantly more "creeping grass". These findings indicate that the "poor" sites that were described by LRUs may be more degraded than the "good" sites when observed by scientists. This will have implications for CBNRM projects and is discussed in Chapter 5.

A limited number of transects were sampled for each of these sites in this research and these samples were taken up a catenal sequence. In future research, these sites should be sampled at upland and bottomland sites, as these were found to support different plant communities (Witkowski and O'Connor, 1996). Future research should also include measures of the grazing intensity at these sites to determine if the pattern observed in herbaceous vegetation occurred as a result of utilisation by livestock. In order to ascertain whether Land Degradation is occurring in a system it is important to measure that system over time. In this study, degradation was measured comparatively between two sites at each village. In order to identify degradation at each site further monitoring over time will be required.

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4.7. Appendix

Appendix 3: Woody species and family list for all species at all sites. Species were identified using Trees and Shrubs of Mpumalanga and Kruger National Park (Schmidt *et al.*, 2002)

		Allandale						Clare A						Share						
	Sites	**Good**			**Poor**			**Good**			**Poor**			**Good**			**Poor**			**Total**
	Transect	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	
Families	**Individuals**	34	78	44	55	71	36	35	68	15	36	26	24	72	56	45	47	14	17	
Mimosaceae	***Acacia caffra***	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	3	0	0	8
Mimosaceae	***Acacia exuvialis***	1	15	4	3	3	0	1	9	1	1	4	0	13	1	13	2	2	1	74
Mimosaceae	***Acacia gerrardii***	5	4	1	0	0	0	0	2	0	1	3	2	25	16	1	0	0	0	60
Mimosaceae	***Acacia karroo***	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4
Mimosaceae	***Acacia nilotica***	0	0	0	0	0	0	7	4	4	0	1	0	0	0	1	0	0	1	18
Mimosaceae	***Acacia robusta***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Mimosaceae	***Acacia sieberiana***	0	3	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5
Mimosaceae	***Albizia harveyi***	0	0	0	0	0	0	3	7	0	1	0	1	0	5	0	0	0	0	17
Caesalpiniaceae	***Bauhinia galpinii***	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Capparaceae	***Boscia albitrunca***	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Apocynaceae	***Carissa edulis***	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Combretaceae	***Combretum apiculatum***	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5
Combretaceae	***Combretum hereroense***	6	8	0	0	0	0	12	15	2	0	0	4	0	3	1	0	0	0	51
Combretaceae	***Combretum imberbe***	1	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	5
Combretaceae	***Combretum kraussii***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Combretaceae	***Combretum zeyheri***	0	1	0	5	0	6	0	0	0	0	0	0	0	0	0	0	0	0	12
Fabaceae	***Dalbergia melanoxylon***	0	0	1	0	0	0	0	0	0	0	0	0	0	3	2	5	0	0	11
Mimosaceae	***Dichrostachys cinerea***	9	26	28	14	13	3	5	26	4	4	5	9	15	12	9	16	5	0	203
Ebenaceae	***Diospyros mespiliformis***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Ebenaceae	***Euclea divinorum***	0	2	0	0	2	0	0	1	2	0	0	1	0	0	0	2	1	0	11
Ebenaceae	***Euclea schimperi***	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4
Flacourtiaceae	***Flacourtia indica***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Euphorbiaceae	***Flueggea virosa***	0	1	0	0	0	0	2	4	2	0	0	0	0	4	3	1	1	0	18

Malvaceae	***Grewia bicolor***	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	6
Malvaceae	***Grewia caffra***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	3
Malvaceae	***Grewia flavescens***	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Celastraceae	***Gymnosporia buxifolia***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Celastraceae	***Gymnosporia heterophylla***	1	3	0	0	0	0	0	0	0	0	0	0	16	1	1	0	1	1	24
Celastraceae	***Gymnosporia nemorosa***	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Celastraceae	***Gymnosporia senegalensis***	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Verbenaceae	***Lippia javanica***	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Euphorbiaceae	***Margaritaria discoidea var. nitida***	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Annonaceae	***Monodora junodii***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Fabaceae	***Ormocarpum trichocarpum***	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3
Caesalpiniaceae	***Peltophorum africanum***	2	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5
Fabaceae	***Philenoptera violacea***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	4
Caesalpiniaceae	***Piliostigma thonningii***	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Myrtaceae	***Psidium guajava***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Fabaceae	***Pterocarpus angolensis***	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Anacardiaceae	***Sclerocarya birrea***	0	1	0	1	0	1	0	0	0	0	2	0	0	0	0	0	1	0	6
Caesalpiniaceae	***Senna petersiana***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Strychnaceae	***Strychnos madagascariensis***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	9
Combretaceae	***Terminalia sericea***	0	8	2	28	51	26	0	0	0	26	11	5	1	0	3	2	0	9	172
Rhamnaceae	***Ziziphus mucronata***	0	1	1	0	1	0	1	0	0	3	0	0	0	1	2	1	0	0	11

Chapter 5

5. A Comparison of the Scientific Paradigm and Local Resource Users' Perspectives on Land Degradation in Bushbuckridge

5.1. Brief Background

The aim of this study was to examine land degradation around three villages in Bushbuckridge, Mpumalanga, from the perspectives of scientists and of LRUs, specifically related to areas categorised as being in "good" and "poor" condition for the collection of important natural resources by the communities of each village. A key objective of the study was to identify possible ways for these two assessment techniques (perceptions based on LEK and scientific evaluation) to be integrated in order to develop practical solutions to address degradation of these lands and improve the sustainable harvesting of necessary resources from communal lands.

Using 'participatory techniques' in these focus groups (including "Participatory Mapping"), the research was able to identify and demarcate sub-areas or sites within the communal lands that were being used for different local needs including the harvesting of fuel wood, thatching grass, berries and fruits on the one hand, and grazing of livestock on the other.

In extended general discussions, participant's perceptions of physical conditions and changes (soils and vegetation characteristics) to the overall condition of these sites over the past 20 years, and what changes participants thought were likely to happen in the next 20 years were explored. Reasons for the observed changes and ways to mitigate the predicted changes were discussed. Based on an analysis of the findings of these initial focus groups, 6 study sites, 2 per village, were identified. The sites were categorised by the participants as either "good" or "poor" depending on their perception of their respective resource, be it fuel wood or grazing.

Scientific ecological assessment allowed for a comparative analysis of the findings of the respective focus group perceptions based on LEK, with ecological findings and indicators extracted from fieldwork analysis of the same sites.

5.2. Summary of results

Through focus group discussions we identified that male participants used the communal lands for acquiring grazing resources for livestock, while females harvested fuel wood and fruits predominantly but also harvested wood (for building), thatching grass, wild vegetables and mud (for housing) from these areas. All participants felt that the communal lands had changed negatively since 1990 and the majority felt that they would continue to deteriorate into the future, jeopardising their ability to acquire valuable resources from these lands. The changes were attributed largely to societal changes, especially to increases in human and livestock populations in these areas, as well as unemployment and a lack of electricity (either due to its expense or irregular availability), especially in the case of participants who harvested wood.

The boundaries of the communal lands of each village were identified and sites within them, where specific resources were collected, were also identified and the characteristics of each were discussed, especially characteristics that made the lands more or less useful for acquiring important resources.

All sites were unique and had features that could be characterised as both "good" and "poor". However overall, the "poor" sites tended to have characteristics associated with degradation and display more signs of utilisation compared with the "good" sites". More woody individuals showed signs of being harvested from the "poor" site compared with the "good" site, although this was not significant. No clear trends between the "good" and "poor" sites were found for woody vegetation structure, i.e. height and basal area. Both species richness and the Shannon Index of Diversity were significantly lower at the "poor" site than the "good" site and the Simpson's Index of Diversity score was lower at the "poor" sites. Herbaceous biomass and percentage of herbaceous vegetation cover were greater at two out of three "good" sites. The "poor" site at the third village was dominated by dense patches of tall thatching grass species. No clear trends in functional types of herbaceous cover were identified across sites, all sites were dominated by grasses with varying proportions of "standing" or "creeping" grass forms.

These results are indicated in the flow diagram below (Figure 5.1). The final three key questions will be discussed in the rest of this chapter:

1. What are the similarities between scientists' and LRUs' perceptions of these areas?
2. What are the differences between scientists' and LRUs perceptions of these areas?
3. What are the implications of these similarities and differences for the way that LRUs and ecologists communicate and for projects that involve LRUs and ecologists?

Aim

- The aim of this study was to examine land degradation in communal lands of 3 villages in Bushbuckridge, from the perspectives of ecologists and of LRUs.
- Especially related to "good" and "poor" areas for natural resource collection by LRUs.

Selection of Villages

- 3 villages selected from same rainfall gradient and on same substrate with variable NDVI values in communal lands around each village

Participatory Mapping

- "Good" and "poor" sites identified and described for each village
- Greater differences between gender groups than age groups

Focus group discussions

- All participants perceived a negative change since 1990
- Male and female groups perceived changes differently
- Majority perceived that problems would carry on in to the future
- Changes largely attributed to impacts of society, e.g. increased human and livestock populations
- Recommendation to mitigate changes were dependent on people's perceptions of the problems

Ecological fieldwork

- All sites had unique characteristics
- Overall, "poor" sites showed more signs of use and characteristics of degradation compared with "good" sites"
- More woody individuals showed signs of harvesting at "poor" sites than at "good" sites
- Species richness and diversity were lower at "poor" sites.
- No trends in vegetation height and basal area associated with "good" or "poor" sites.
- Herbaceous biomass and % cover greater at 2 of 3 "good" sites.
- "Poor" site at the third village was dominated by dense patches of tall thatching grass.

Integration of views

- Characteristics of the "good" sites largely corresponded with those that are considered "favourable" by ecologists
- Many characteristics of the "poor" sites could be indicative of vegetation degradation.
- However, no sites had only good or bad characteristics.
- Implications for CBNRM are discussed

Figure 5.1: A flow chart summary of the results discussed in the three previous chapters.

5.3. Comparing and Contrasting Information Gathered

The differences and similarities between scientists and LRUs perceptions of the 6 study areas are discussed under the following broad sub-headings:

1. people's value systems;
2. their knowledge systems; and,
3. their processes of learning

5.3.1 Differences

5.3.1.1 Differences between value systems

People value land and natural resources differently. The value placed on the land and natural resources is influenced by a number of factors including demographics, past experience and knowledge, current situation or circumstances, as well as dependence on the resource(s) that they use and how they are used (Barrow, 1991, Stocking, 1995; Inglehart, 1995; Anderson *et al.*, 2007; Hunter *et al.*, 2010). These value systems may differ between communities and scientists, within communities and between groups of scientists. Within communities, conflicting views may exist between different resource users groups. Indeed, conflicting perceptions of woody plant density over the past 20 years were identified between male and female focus groups; female groups perceived a decrease in woody density whilst the male groups perceived an increase. Such difference could be attributed to increased awareness of the resource resultant from its utilisation by the different focus group, i.e. the females rely on woody vegetation for fuel wood and fruit harvesting and thus see declines in these specific resources, whilst the males focus their use of the communal lands to graze their livestock and perceive bush encroachment. These contrasting, and somewhat conflicting resource uses can represent a threat, perceived or real, to their respective natural resource uses. Accordingly, in both instances their differing perceptions of woody vegetation density may relate to their perceptions of the future sustainability or unsustainability of these aspects of their current livelihoods.

Differences of opinion or perceptions, like these, need to be identified, understood and addressed before a CBNRM project can be established. Failure to do so is likely to result in one or both user group dissatisfaction with the aims and objectives of the project and may result in its under-performance or even failure. By contrast, knowledge of these perceived differences may assist in the development of projects that service the goals of multiple groups. For example the harvesting of *Dichrostachys cinerea*, an 'encroaching' bush species that male focus groups perceived as a threat to the sustainability of their grazing practices, but which is also a good fuel wood species utilised by the female focus groups. Projects that focus on harvesting large or sustainable amounts of this species, may reduce or, even better, control bush encroachment while also reducing harvesting pressure on species that may be less common (Shackleton *et al.,* 2005). Hence a win-win situation can be achieved if *Dichrostachys cinerea* is targeted to a greater extent for fuelwood harvesting and other uses such as in making thorny fences around crop fields or to protect saplings of valued tree species (Venter and Witkowski 2013). A small project was underway in Clare A during the time of sampling where *Dichrostachys cinerea* was being removed. However once it was harvested it was left to dry and then burnt on the sites. Thus, no benefits were received from the utilisation of this fuelwood.

Focus group research found that the differences in perceptions between different groups within a community were most stark between male and female groups. However, the research also identified differences between age groups within these communities. For example, younger male

groups perceived the amount of livestock present in the communal lands as being too great and as such resulting in degradation of the grazing resource, whilst older males did not perceive this as a problem. These age group based findings are consistent with those reported from other studies, for example Dovie *et al.* (2008) found that males between the ages of 31 and 50 were often less knowledgeable of woody plant diversity in the communal lands of their home villages than younger males and, in particular older males. The lack of knowledge in the male, middle age group was attributed to these individuals often leaving their home areas to work in cities as migrant labourers.

Differences in perceptions of the values of land and natural resources are not limited to LRUs, members within the scientific community value these same resources differently, for example, for their "intrinsic values" (Soulé, 1985; Noss and Cooperrider, 1994; Ghilarov, 2000; van Bueren *et al.*, 2003; McCauley, 2006; Chan *et al.*, 2007) or for the economic benefits that may be accrued from them (Aylward and Barbier, 1992; Sinden, 1994; Costanza *et al.*, 1997; Edwards and Abivardi, 1998; Dasgupta *et al.*, 1999; Bateman *et al.*, 2002; Hicks *et al.*, 2009). For the same reasons cited above for the successful launch of CBNRM, contrasting 'scientist viewpoints' need to be taken into account when developing systems, projects, programmes or laws to tackle perceived or confirmed environmental problems. Scientists also need to be mindful that, just as there are differences of opinion and perception within the scientific fraternity, there are also differences between the science fraternity and LRUs.

The differences between the LRU groups and the scientific fraternity can be argued as 'materialist' versus 'postmaterialist' in nature. That is, the LRUs place a materialistic value on the natural environment as they are directly and inextricably dependant on it for resource harvesting, for example fuel wood and grazing (Martinez-Allier, 1995). The LRUs intimacy with the environment enables him/her to place a value on the condition of the natural environment as this will influence his/her future wealth or living standard. By contrast the scientific or wealthier people from industrial societies, are perceived to value the environment more for intellectual and aesthetic reasons as the link between the consumables and the natural environment are often not easily identified through the food supply chain that at a basic level involves the purchase of a commodity from a seemingly endless supply chain. Consequently the material goods they receive and consume from the environment have a lower value than that for the LRU where the same good may be seen as a luxury, such as electricity (Inglehart, 1971; Inglehart, 1990, Martinez-Allier, 1995). This view, however, has been proposed to not only underestimate the intellectual and aesthetic values that "the poor" or LRU may hold for their environment (Pretty, 2002) but also for not taking into account the materialist values of "the rich" that may be at the root of some aspect of environmentalism (Martinez-Allier, 1995). Thus, materialist and postmaterialist value theory alone is not sufficient to explain differences between these two groups. Indeed, given the variety of value systems that exists within each of these groups, as well as between them, it is difficult to define the differences between the value systems that exist between these two groups and it may be important to identify the motivation that drives individuals from both groups or the reasons that they value their environment or natural resources on a 'case by case' basis when implementing CBNRM projects.

5.3.1.2 Differences between knowledge systems

While value systems may differ on an individual basis, the knowledge systems of LRUs and scientists, in this case ecologists, may vary in more predictable ways. This is important because the knowledge systems of people, LRUs or ecologists, may also play an important role in how they use their environment respectively. For example, the types and amount of natural resources harvested

from the environment, their uses for these natural resources and the methods they use to extract them (Mandondo, 1997) may vary between these two groups. This is based on their respective understanding of that environment, sustainability considerations, survival needs and harvesting techniques.

TEK (or LEK as I have referred to it in Chapters 2 and 3) has been defined as a cumulative and adaptive group of knowledge, practices and beliefs which are specific to a particular place or people. They are focused on relationships between living beings and the environment, and have and are evolving from detailed observations and adaptive learning (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). TEK is tested by trial-and-error and handed down from previous generations and across present communities through cultural transmission, orally or by shared practical experiences (Gadgil *et al.*, 1993; Berkes *et al.*, 2000; Fernandez-Gimenez, 2000).

In comparison scientific knowledge is generated through the application of the scientific method and is said to refer to systematic recorded knowledge or practice. Scientific knowledge is said to be explicit in that knowledge is written and readily available, and formal (Fazey *et al.*, 2004; Fabricius *et al.*,2006, Fazey *et al.*, 2006; Raymond *et al.*, 2010). Although, the body of scientific knowledge may be built up over many generations, ecological assessments at the specific study sites are made over a much shorter timespan than those generated by LRUs living within those systems (Berkes *et al.*, 1998; Berkes *et al.*, 2000; Roba and Oba, 2009). However the wider ecological knowledge in the literature of similar sites across the globe is gradually becoming more mature as more case studies are incorporated into the body of knowledge and understanding of the discipline. The roles of science have been described as the discovery, communication and application of knowledge, and the training of future scientists (Lubchenco, 1998). However, this has tended to be to the benefit of a limited number of people. In order for this knowledge to be more useful for LRUs and more applicable for CBNRM projects and other grass-roots conservation or sustainability initiatives, it must become more available and be disseminated in a way that is appropriate for different groups of people.

TEK does have some attributes in common with scientific knowledge. For example they are both based on a series of observations and on practical experience and may be complementary (Berkes *et al.*, 2000). Both forms of knowledge may be subjective and limited to the geographic area they have knowledge and experience with and the way they are used may also be subjective or directed (Stocking, 1995). However they are accumulated and transmitted in different ways (Berkes *et al.,* 2000). Where TEK includes aspects of local observation related knowledge of their environment, the ways that resource use activities are affected and the belief of how environmental systems function, especially in relation to humans, is transmitted through observation and demonstration (Berkes *et al.*, 2000). In this way the transmission of TEK can be viewed as informal, whereas scientific knowledge is transmitted through more formalised pathways (Fabricius *et al.,* 2006). For example, during schooling and tertiary education and also through the written form, such as peer-reviewed articles and published books. However, individuals acquire knowledge through a range of pathways, with information collected from participants such as community members, showing opinions that have been acquired from personal experiences, through traditionally encoded knowledge, formal schooling and guesswork (Kaschula *et al.*, 2005).

Members of the younger focus groups who participated in this study showed a greater familiarity with terms that are associated with scientific knowledge more than TEK. For example the term "loam" to describe the soil types that occur in their communal areas. As well as identifying and describing erosion that was perceived to be occurring in their communal lands. This is indicative of

the changing lifestyles of members of these communities, especially regarding the formal education they receive at school. Concern was also expressed, among older participants in focus groups and through personal communications with older members of these communities, that younger people were not learning about traditional practices of resource use and collection. This trend has also been identified in other communities (Tsuji, 1996; Ohmagari and Berkes, 1997; Zent, 2001) where traditional practices are being lost as a result of changes in the educational environment and their lifestyles. This will have implications for the future of CBNRM projects as a result of this loss of intellectual capital.

5.3.2 Similarities

5.3.2.1 Similarities in perceptions of the communal lands

In spite of the different value systems and knowledge systems that exist between these LRUs and scientists, similarities existed between the patterns that they observed in the communal areas of the three villages that were investigated. For example, this ecological study confirmed that sites that were described as "poor" by LRUs, showed higher levels of use and characteristics associated with degradation compared with the "good" sites. Furthermore, more woody individuals showed signs of being harvested from the "poor" site as compared with the "good" site. There were also lower levels of species richness and diversity identified in the ecological assessment at the "poor" sites compared with the "good" sites. Herbaceous biomass and proportions of vegetation cover were also found to be greater at the "good" than the "poor" sites for two out of three of the villages. At the third village the "poor" site was found to be dominated by dense stands of thatching grass, *Hyperthelia dissoluta,* which has low grazing value, especially later in the growing season, although it may be valuable for thatching (van Oudtshoorn, 2009).

Other studies that looked at the integration of scientific and local forms of knowledge had mixed results in this regard. Kaschula *et al.* (2005) found that although some indigenous knowledge was in line with the biological data they acquired, overall it was difficult to define straightforward parallels between the two forms of knowledge attributing this to the variability in responses that they received, as well as the diverse scales at which both forms of knowledge were involved. Oba *et al.* (2008) found that the definition of biodiversity differed between herders in Uganda and the conventional scientific terminology which focussed on the conservation of the total number of species while herders displayed a more utilitarian perspective. Results from this study indicate that although differences exist within the value and knowledge systems of the two groups, the similarities that exist between their overall perceptions of the state of the vegetation in their communal lands may aid in the implementation of natural resource management projects that may be started in this area.

5.4. How can these paradigms be integrated to develop solutions to problems faced by LRUs

This study aimed to examine land degradation in three villages in Bushbuckridge from the perspective of ecologists, or the researcher, and Local Resource Users. The study specifically focussed on "good" and "poor" areas in the communal lands of each village as identified through participative mapping with community focus groups. Based on the findings of the study, information was generated that may be useful for the implementation of CBNRM projects.

Selected difference and similarities in the perceptions of these two groups have been discussed above. Many people advocate the role of CBNRM projects in improving human livelihoods and welfare while simultaneously serving the interests of biodiversity and conservation (Rosenzweig 2003; Millennium Ecosystem Assessment 2005). However, there have been mixed reviews for these methods and their successes.

When designing and implementing CBNRM projects it is important that the motivations for involvement, expectations and concerns for all the involved parties to be taken into account and addressed in order to sustain support for the project over time (Murphree, 1995; Songorwa, 1999; Alcorn *et al.*, 2002; Shackleton *et al.,* 2002; Masozera, 2006). Community-based projects have failed for a number of reasons (Chan *et al.*, 2007). For example, because a group bore a disproportionate amount of the costs or responsibilities involved in the project without receiving an appropriate share of the benefits, and this is often the fate of local people (Songorwa *et al.*, 2000; Salafsky *et al.*, 2001; Botha *et al.*, 2006). Alternatively, the benefits may be over-stated or may only emerge as long-term benefits, in which case involved parties may become disillusioned and lose enthusiasm or the start-up funding may run out before benefits are accrued (Shackleton *et al.,* 2002; Berkes, 2004; Botha *et al.*, 2006; Botha *et al.*, 2007). These benefits may also only be realised by certain members of a society, especially local elites (Chan *et al.,* 2007). Alternatively, projects may not adequately conserve or protect the resources that are involved (Barrett and Arcese 1995). Projects may also suffer as a result of socioeconomic conditions and a lack of skills, such as business management skills (Botha *et al.*, 2006). Failures of these projects has also been attributed to their attempting to change traditional patterns of land use and enforce management techniques that are not understood by local communities, which has weakened indigenous pastoral systems and exacerbated land degradation and economic decline (Kepe, 1997; Anonymous, 2004). Therefore, it is important to involve LRUs with these projects to promote their empowerment and engagement with conservation and the socioeconomic benefits that they will accrue (Western and Wright, 1994; Songorwa, 1999; Chan *et al.,* 2007). LRUs may also be more qualified for rule-making as they are likely to be more familiar with the local resource use systems (Agrawal and Gibson, 1999) with successful programs, in the past, having drawn on local knowledge systems and technologies (Hoffman and Ashwell, 2001). They are also more attuned to the cultural requirements and traditions of the community.

It is also important to involve institutions which can facilitate or restrain certain interactions, and may mediate social actors' access to resources and, therefore, the way in which they interact with their environment (Bates, 1989; North, 1990; Leach *et al.*, 1999). Institutions may also promote stability and consistency in expectations and actions and mediate, structure and facilitate particular outcomes and actions (Ensminger, 1992; Alston *et al.*, 1996; Agrawal, 1995; Agrawal and Gibson, 1999). Although the creation or inclusion of institutions will not necessarily lead to better outcomes of CBNRM projects, they can offer tools for increased understanding of local-level processes and outcomes and more identifiable points of intervention and design (Agrawal and Gibson, 1999).

No two projects are alike because of the unique environmental systems and the variety of parties that are involved, when designing a CBNRM project one can make no assumptions. Although previous studies and the personal experiences of those involved may contribute, and indeed may be difficult to exclude, one must take time to understand and discuss the goals, motivations, expectations and concerns of each involved party in order to develop a sustainable CBNRM project (Murphree, 1995; Songorwa, 1999; Alcorn *et al.*, 2002; Shackleton *et al.,* 2002; Masozera, 2006).

Additionally, viability studies must be conducted before the implementation of these studies (Botha *et al.*, 2006; Botha *et al.*, 2007).

Overall, similar vegetation characteristics were identified by both groups in these communal lands. This will support the development of solutions for the problems that people living in these areas may experience. However, the value systems and motivations of all the groups involved in the development of these solutions must also be understood. This is to create changes that are meaningful, that the impetuses for and methods involved are understood by all participants and that the benefits that may be accrued and time lines over which this may happen are understood and accepted by all participants.

Future studies should involve focus groups with a greater variety of resource users, for example including people who harvest thatch grasses or those that harvest plants for their medicinal value. It would also be of interest to conduct similar focus groups with various groups of scientists and land managers to deepen our understanding of how these different groups perceive land degradation. To deepen our understanding of how LRUs perceive their communal lands it would be valuable to conduct transect walks with key informants in areas that they have earmarked as having important characteristics (Roba and Oba, 2009). In terms of broadening the field study component of this study, aspects of soil degradation should be investigated as this has far-reaching consequences for productivity (Hoffman and Ashwell, 2001). It would also be valuable to increase the number of transects that are conducted and to repeat sampling over time to incorporate a temporal understanding of processes, especially degradation processes.

In applications of this research, full viability studies should be conducted prior to the development of any CBNRM studies. These should include meeting between all interested or affected parties in order to dovetail objectives and develop projects that are optimally beneficial for all groups.

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