Evaluating land use options at the wildlife/livestock interface: An integrated spatial land use analysis

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Thesis

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Contents

Abstract

In Africa, rural development and biodiversity conservation, are both important, but sometimes potentially conflicting priorities. Most rural areas adjacent to wildlife protected areas in Southern Africa have high biodiversity potential, but are characterised by high poverty, unemployment, and limited economic activity. The problems in these rural areas are further compounded by problems of crop destruction, and livestock depredation by wildlife. Transfrontier conservation areas (TFCAs), recently introduced in Southern Africa, have potential to address both biodiversity and poverty alleviation through promotion of multiple land uses such as wildlife ranching, tourism, livestock and crop production. It is however, not clear how these land uses can be combined, and what the associated socio-economic costs and benefits of alternative land use options in these areas are. This study proposed a spatial land use model for evaluating alternative land uses and development pathways in these rural areas. The model maximised net revenues from the land, assuming the presence of a social planner. The model proposed, considered a range of socio-economic and biophysical factors, identified jointly with rural communities. The study comprised five empirical chapters in which the following issues are addressed; (i) socioeconomic risks associated with agriculture at the interface, and community attitudes towards wildlife tourism land uses (ii) contribution of existing livelihood strategies to household incomes, (iii) potential for tourism development and (iv) trade-offs in net revenues between different options for land use. The case study areas was Mhinga, one of the rural areas within the Great Limpopo TFCA in South Africa. The study area is situated on the north-western border of Kruger National Park (KNP), next to the Punda Maria park gate. Results showed that the costs by wildlife related damage such as livestock depredation and diseases, were higher than the benefits in employment and subsidies from the park for households. As a consequence attitudes towards wildlife by farmers were generally negative. There was also no mechanism to compensate households incurring wildlife damage. Households living closer to the park had more problems with wildlife damage. When the contribution of different livelihood activities to household incomes were considered, the study found that the main sources of income were the government welfare grants, formal employment and cattle farming. Cattle farmers were not in support of introducing wildlife based land use activities as they considered them to impose costs on other livelihood activities. Some community members were however of the opinion that introducing wildlife tourism could create employment and improve household incomes, especially for those households not engaged in cattle farming. When preferences of tourists, towards supporting forms of ecotourism outside the KNP were analysed, through a choice experiment approach, the study found that tourists were interested in village tours and crafts markets, but generally reluctant to use accommodation facilities outside the park. Analysis of options for land based development at the interface showed that existing land use practices were not optimal. The model results indicate that, by introducing irrigation, tourism and wildlife land uses, net revenues from land could be doubled in the future. It is concluded that, given the socio-economic and bio-physical constraints characteristic to the area, most income can be obtained by combining all four land uses in the area in optimal proportions. Factors such as property rights, and benefits distribution which could impact the ability of rural communities in the TFCA to support, utilize and benefit from wildlife resources need to be addressed before any land use changes are implemented.

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CHAPTER 1[1]: General Introduction

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1.1 The rural development and wildlife conservation nexus

Competition for land and other natural resources in the developing world is a major obstacle to rural development and sustainable use of resources (Giller et al., 2008). Conflicts arise due to competition between agriculture, natural resource conservation, tourism, industrial expansion, forestry and even residential needs of rapidly growing rural populations, the landless and the unemployed. For rural people, land is central to most livelihood activities. At the time that there are increasing calls for agriculture-led growth in Africa, there is also increased international awareness of the importance of biodiversity conservation, both of which are land-based. In Southern Africa there appear to be closely linked, yet parallel state-driven efforts to drive rural development through agricultural development, and at the same time to promote biodiversity conservation. In the past, challenges of biodiversity conservation and rural development were considered as two unrelated issues, and addressed separately in terms of land use (Torquebiau and Taylor, 2009), as well as governance structures.

The link between rural development goals, especially poverty alleviation, and biodiversity conservation, has for a long time been debated in the scientific literature (Barrett and Arcese, 1995; Kepe et al., 2004) with opposing views on whether or not the two can be simultaneously achieved. In the past it has been argued, particularly by proponents of conservation, that linking rural development goals with conservation was not possible because human activities such as land clearing and occupation inevitably lead to a loss in biodiversity (Kangwana, 1999; Adams et al., 2004). There are questions about the long term sustainability of local development strategies based on consumptive uses of wildlife such as hunting, given an increasing human population and unstable wildlife growth (Barrett and Arcese, 1995). The counterview holds that rural development is a necessary condition for conservation. Evidence to back this view is drawn from experiences in wildlife conservation approaches which have failed to achieve their goals, primarily because of failure to create incentives for local communities to support conservation (Kangwana, 1999; Songorwa, 1999,). Despite their good intentions, conservation projects, if not properly implemented, can disadvantage local people and threaten their livelihoods, whilst land based rural development efforts which are not accompanied by clear commitment to biodiversity conservation are likely to be unsustainable (Emerton, 2001; Adams et al., 2004).

Despite the general growing consensus in the scientific literature that conservation and rural development goals are complementary and should be addressed together, there are different views about how to integrate them and the relative importance attached to each of the goals. Sanderson and Redford (2003) argue that *'...such complementarity can only be achieved if we respect the strengths and weaknesses of both conservation and poverty alleviation efforts and the trade-offs inherent in integrating them.'*. They further argue that failure to acknowledge the tradeoffs in these goals, particularly in poverty and development programs in the new millennial, will likely end up further impoverishing the poor and threatening biodiversity. Similarly, 'win-win' solutions that underplay the incompatibilities between the two goals are likely to be unsuccessful (Adams et al., 2004). The general change in thinking on the relationship between conservation and rural development goals is reflected in the evolution of conservation approaches over the years.

1.2 Evolution of wildlife conservation approaches and the link with rural development

Wildlife conservation has moved from largely exclusionary policies aimed at keeping out humans from protected areas through use of fences and punitive measures for poaching, towards approaches that are inclusive of local communities (Barrett and Arcese, 1995; Songorwa, 1999). This type of conservation, which was followed when parks such as the Kruger National park in South Africa, and Amboseli National Park in Kenya were first established in the 1890s is referred to as 'fortress conservation' (Adams and Hulme, 2001). In most cases the establishment of national parks resulted in the legislative banning of hunting for cultural purposes, or for trade by rural African communities, whereas European settlers accounted for a greater loss of biodiversity through hunting and land clearing (Child, 2009). Between 1930 and 1960, there was a proliferation of international conservation agencies such as the International Union for Protection of Nature (IUCN), which was later renamed International Union for Conservation of Nature, and the World Wildlife Fund (WWF), which sought to promote management of protected areas based on scientific principles (Adams and Hulme, 2001). At the same time, special attention was paid to conservation in Africa, following concerns that there was rapid landscape change and increasing development (Adams and Hulme, 2001). Exclusionary approaches reflected the idea that wildlife is an international public good to be conserved, and

not a local economic asset to be developed (Ashley and Elliott, 2003), and generally failed to achieve the intended conservation objectives (Songorwa, 1999). With the background of eviction of local communities to make way for establishment of parks, fortress conservation was characterized by conflict between park authorities and local communities, fundamentally caused by restrictions in resource access and land rights (Laudati, 2010).

The next phase in conservation approaches signified acknowledgement of the role of rural communities in successful natural resource management. This came to be broadly referred to as 'community conservation', and resulted in preference for conservation strategies that involved local communities in natural resource management decisions (Adams and Hulme, 2001) setting the stage for most conservation approaches that exist today. These communities, although not agents of the state, were resident in locations and involved in activities where they could enhance or degrade natural resources (Adams and Hulme, 2001; Barrow and Murphree, 2001). In addition, such communities despite bearing the costs of conservation, had previously been excluded from any conservation benefits (Songorwa, 1999; Adams and Hulme, 2001). Barrow and Murphree (2001), give a typology of community conservation initiatives and categorize them into three approaches based on the objectives, tenure status, management characteristics and geographic area of focus. They distinguish between protected area outreach, whose main objectives is conservation of ecosystems, collaborative management, which emphasizes conservation with some livelihood benefits, and community based conservation whose focus is sustainable rural livelihoods.

Community based conservation, which later came to be widely known as 'community based natural resource management (CBNRM)' covers a broad spectrum of arrangements for (i) benefit sharing with, and (ii) involvement of rural communities in natural resource management (Barrow and Murphree, 2001). When the underlying goal of conservation is considered, three pillars of community conservation are identified by Murphree (2009) as (i) benefit, (ii) empowerment and (iii) conservation. Within these pillars or dimensions, lies great variety of conservation interventions, depending on the underlying objective of the intervention (Adams and Hulme, 2001; Murphree, 2009).

Among the models of CBNRM were 'Integrated Conservation Development Projects' which sought to link conservation and development (Barrett and Arcese, 1995) or in the specific case of wildlife, 'Community Based Wildlife Management Programmes' (Songorwa, 1999), and in the case of Zimbabwe, Communal Area Management Programme for Indigenous Resources (CAMPFIRE) (Bond, 2001; Murphree, 2009; Taylor, 2009). Another approach, which originated from East Africa was called 'Integrated Wildlife and Livestock Management' (Boyd et al., 1999, Flyman, 2003), and was based on co-existence of livestock and wildlife and sustainable use of wildlife resources for the benefit of communities. For wildlife, these localized conservation efforts were expected to result in improved conservation of wildlife species, and yield social and economic benefits for the communities involved. Donor agencies adopted the concept of CBNRM and made available substantial funding for implementation of these projects across Africa (Adams and Hulme, 2001). Consequently, there was a huge influence of multilateral and bilateral agencies in domestic policies on resource use and management in Africa (Adams and Hulme, 2001).

Community based conservation development projects, registered some notable cases of successful implementation. These include, for example, CAMPFIRE in Masoka community of Zimbabwe (Murphree, 2009; Taylor, 2009) and more prominently in Namibia the establishment of conservancies (Jones and Weaver, 2009). Despite their well-meaning efforts, several criticisms have been levelled against most of the early CBNRM initiatives. These criticisms include the dependence on donor funding, and limited sustainability of consumptive resource uses (Barrett and Arcese, 1995). The commoditisation of natural resources raised concerns about overharvesting, unsustainability, and market related issues such as the proliferation of middlemen who stood to benefit the most in the value chain, disadvantaging rural communities, and the instability of tourism markets. The problems at community level were corruption, nepotism and inequitable distribution of benefits (Murphree, 2009). Lastly, it has been suggested that the primary focus of early CBNRM interventions was on conservation rather than poverty alleviation and they failed to deliver tangible economic benefits at household level (Emerton, 2001; Roe and Elliot, 2006). The United Kingdom's Department for International Development (DFID) 'pro-poor conservation' concept (Roe and Elliot, 2006), evolved in an effort to shift the

focus of international agencies involved in conservation towards delivering on poverty reduction and social justice objectives.

Transfrontier Parks, also known as "Peace-Parks" (Peace Parks, 2011), comprise protected areas straddling national boundaries, and represent the latest development in conservation approaches in Africa. They represent up scaling of CBNRM, to a higher scale of Transboundary Natural Resource Management (TBNRM) (Wolmer, 2003). This approach to conservation has gained momentum in sub-Saharan Africa, with the introduction of several transfrontier parks in the region, one of which is the Great Limpopo Transfrontier Park (GLTP) straddling Zimbabwe, South Africa and Mozambique (Munthali, 2007). The GLTP comprises the Kruger National Park (KNP) in South Africa, Gonarezhou National Park in Zimbabwe and Limpopo National Park in Mozambique. The rationale behind this form of conservation is explained by Wolmer (2003), as being bioregionalism, ecological integrity, cultural integrity, economic integration and community development. In addition to enabling cooperation in conservation across national boundaries, the concept of transfrontier conservation, has also been hailed for presenting opportunities to combine the goals of poverty alleviation and rural development with biodiversity conservation (both of which are enshrined in the Millennium Development Goals), through Transfrontier Conservation Areas (TFCAs). TFCAs comprise protected areas transcending national boundaries and surrounding areas, and have been described as having potential to promote conservation, economic integration between countries and increased trade and job opportunities (Mbaiwa, 2003; Wolmer, 2003; Bengis, 2005; Munthali, 2007).

1.3 The Great Limpopo Transfrontier Conservation Area and changing land uses

Foundations for the establishment of the Great Limpopo Transfrontier Conservation Area (GLTFCA) were laid when the GLTP Treaty to establish the transfrontier park was signed in 2002[2] (Wolmer, 2003; Spenceley, 2006; Whande and Suich, 2009). The GLTFCA which covers almost 100 000 km^2 has generated support and interest from politicians, national and international organisations, rural communities and scientists. The support from groups that

[2] Despite the GLTP being formally established in 2002, as late as 2006 the GLTFCA was still in the early stages of development and planning (see Spenceley 2006). The boundaries of the GLTFCA are not formally designated, whereas the GLTP is clearly designated., and stipulated in the GLTP treaty.

normally have differing views is due to its potential to integrate multiple land use practices and multi-stakeholder interests whilst contributing towards poverty alleviation in rural areas (Wolmer, 2003; Spenceley, 2006; Munthali, 2007). The GLTFCA comprises national protected areas forming the GLTP (see Figure 1.1), surrounding rural communal settlements, livestock grazing land, private game farms and cultivated land. The TFCA concept aims to convert land of marginal agricultural potential in rural areas surrounding protected areas for biodiversity use and tourism (Munthali, 2007). According to Cumming et al., (2007), the concept of a transfrontier conservation area is not as well defined as that of a transfrontier park, and many people regard a conservation area as a place in which wildlife based tourism is the predominant land use.

The potential shift towards land being used for wildlife-based tourism rather than subsistence agriculture has raised several questions. These questions concern, among others: (i) impacts of emerging land uses on existing agricultural activities such as livestock farming and livelihoods of people residing in the rural communities (Cumming et al., 2007; Munthali, 2007; Cumming, 2011); (ii) the potential of wildlife tourism to create employment and generate incomes (Spenceley, 2006); and (iii) the impacts of increased interaction between wildlife and livestock on disease and animal health (Bengis, 2005). Several factors should be considered in making decisions regarding land at the border of protected areas (also called the wildlife/livestock/human interface). These factors include multiple socio-economic objectives to be met, concern for rural communities regarding wildlife damage on crops and livestock, and biophysical factors such as land carrying capacity and water availability. The challenge is to address the growing need for agricultural land in rural communities, whilst serving the additional demand for land that will come from expanding the area under wildlife in the TFCA (Spenceley, 2006; Munthali, 2007), to meet poverty alleviation and biodiversity goals.

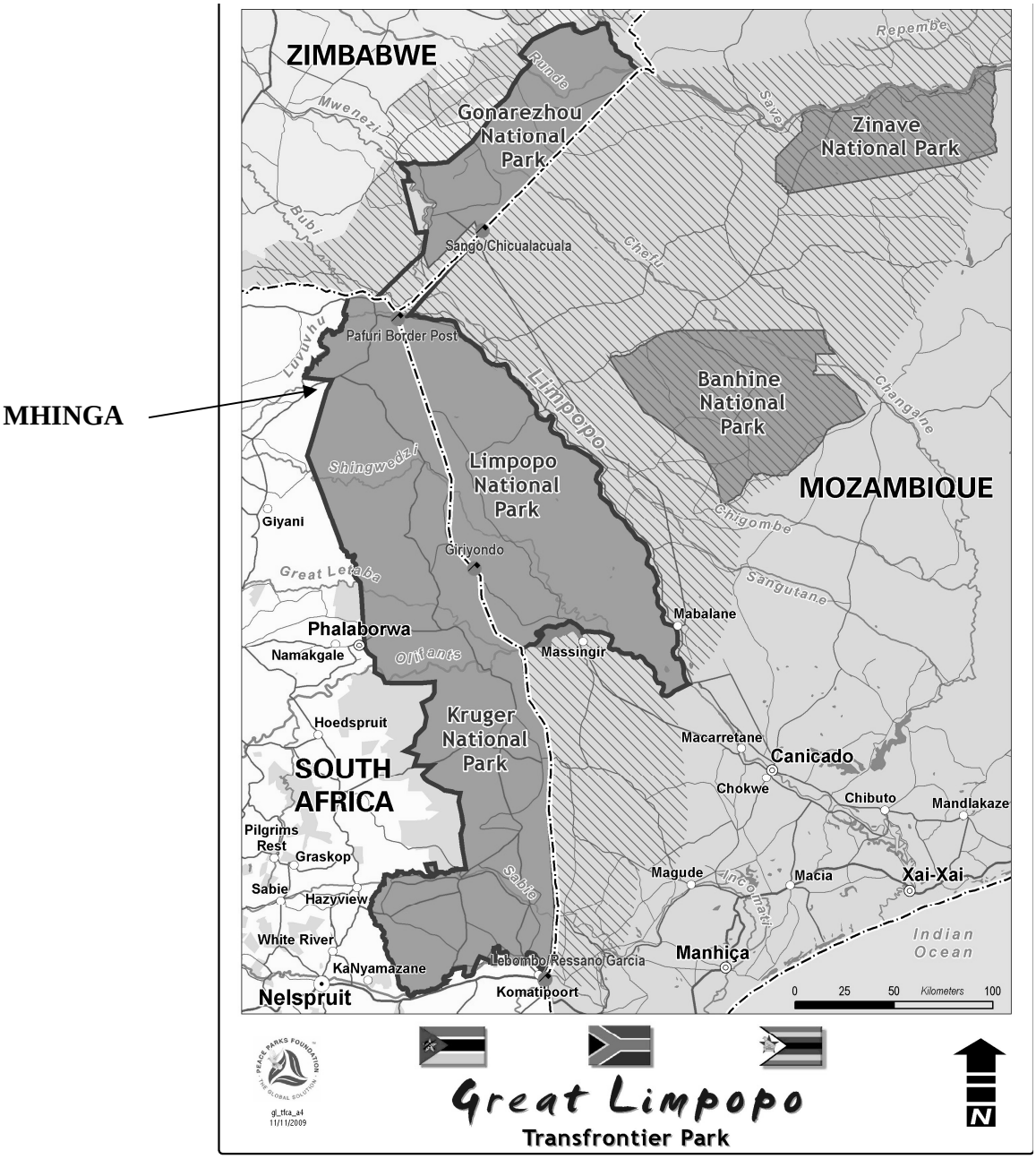


Figure 1.1 Great Limpopo Transfrontier Park and position of Mhinga
Source: Peace Parks, 2011

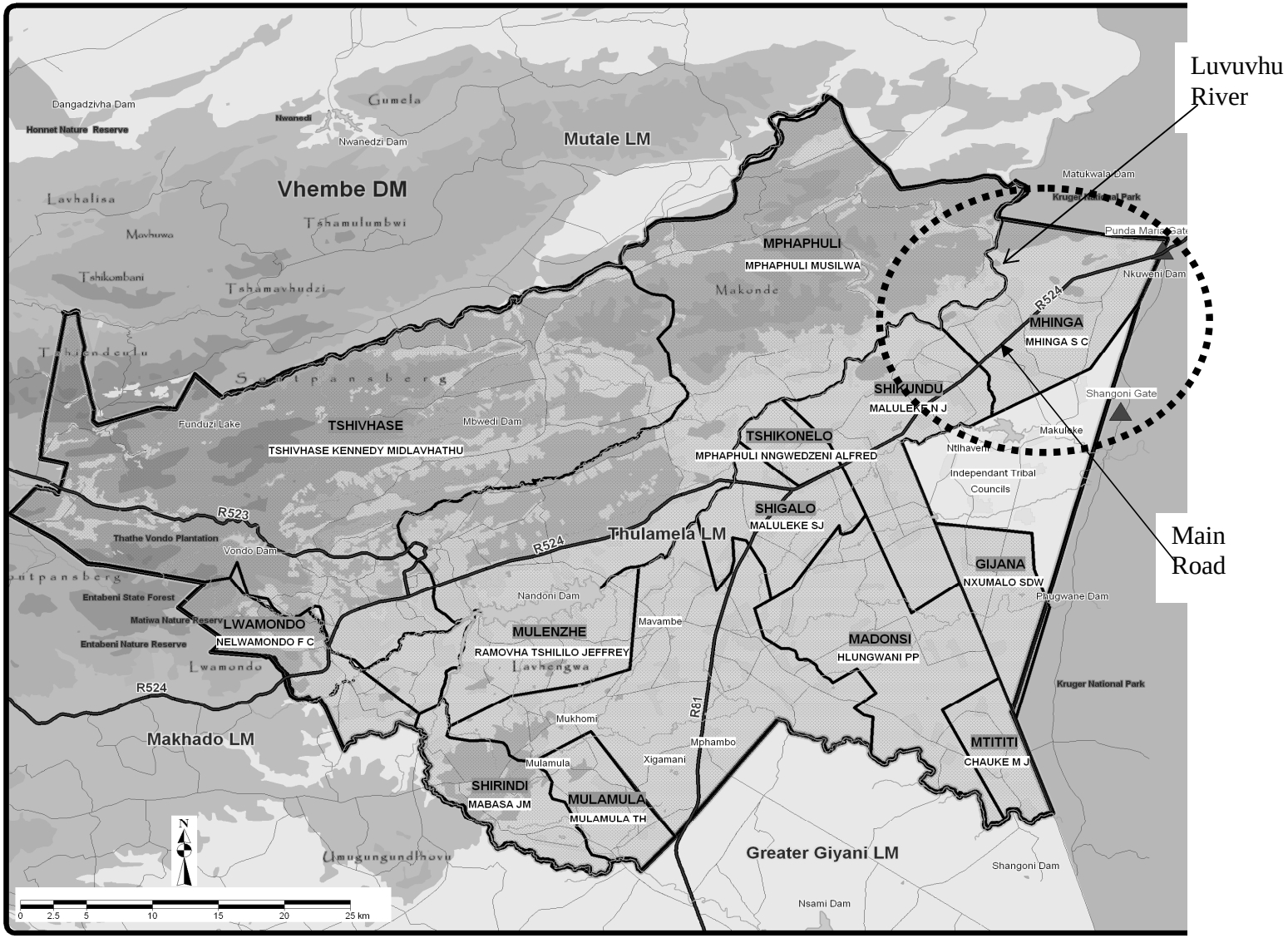


Figure 1.2 Thulamela Local Municipality-Traditional Authorities' Borders. *Source: Thulamela Local Municipality (2009)*

1.4 Overview of competing claims for land in Mhinga

This study considers the case of Mhinga, one of the rural areas within GLTFCA in South Africa. It falls under Thulamela Local Municipality of Vhembe District in Limpopo Province. The Mhinga Traditional Authority area is on the north-western border of KNP, next to the Punda Maria park gate. Its western border is the Luvuvhu river and the eastern, and northern side border is the KNP fence. The main road to the Punda Maria KNP gate, the R524 road passes through the Mhinga area (see Figure 1.1 and 1.2). In the figure, boundaries of the different traditional authorities are indicated with the thick solid black lines. The area falls within the buffer zone where veterinary controls are in place to prevent spread of foot and mouth disease (Bruckner et al., 2002). Opportunities for wildlife-based tourism exist in the area, and it is also recognized at local government level as having high tourism potential (Thulamela Local Municipality, 2009). The main land uses in the area are communal livestock grazing, dryland crop production and human settlements. Within the context of the GLTFCA, this is one of the places where policy makers and authorities expect that there will be a shift from the current predominant agricultural land uses towards wildlife tourism based land uses (Thulamela Local Municipality, 2009).

Shifting to wildlife tourism based land uses requires that community land be made available for such alternate land uses. Speaking at the World Parks Conference in 2003, the traditional leader for the Mhinga community, Hosi Shilungwa Mhinga said ‘The concept is to incorporate into Kruger National Park a 2000 hectare area of community land that has already been designated for tourism development.’ (Mhinga, Undated). Since then, more plans have been made for development in ecotourism and for wildlife hunting on unspecified amounts of land in and around Mhinga. Furthermore, Mhinga and surrounding areas have also been identified as tourism nodal points in the local municipality (Thulamela Local Municipality, 2009). These plans require diversion of land from existing uses, particularly grazing areas. The total amount of grazing areas available in Mhinga is estimated at about 11 000ha (Mhinga Traditional Authority, 2008). Such competition for land between wildlife tourism and livestock grazing has also been observed elsewhere in South Africa (Cousins and Kepe, 2004). Part of the mission statement for Thulamela local municipality says that the people would like their area ‘to become a tourist destination and a productive agricultural area’ (Thulamela Local Municipality, 2009), thus reflecting the importance attached to tourism and agriculture.

Table 1.1 shows an overview of key stakeholders in Mhinga and their interests on the communal land. Apart from the livestock farmers who have an interest in maintaining livestock grazing for their livelihoods, there are other stakeholders interested in having access to the same land. Community members interested in tourism require land for this. On the other hand, the growing population needs more land for residential purposes, agriculture and natural resource harvesting. As implementation of the GLTFCA gains momentum, it is likely that such competing claims for land will increase and emerging land uses will have to be accommodated. Decisions on land use are made at community level as the land falls under communal tenure.

Table 1.1 Key stakeholders in Mhinga and their interests on communal land

Stakeholder	Interest
Livestock farmers	Need land for cattle grazing, have problems with wildlife, feel threatened by tourism development
Crop farmers	Need more land for subsistence cultivation
Tourism entrepreneurs	Need land for wildlife tourism investments, seeking livelihoods diversification
Ordinary villagers	Collect firewood and grass from grazing land, need jobs from tourism development, need land for residential purposes

About 12.2% of land in South Africa falls under communal tenure systems, and about 83% of the rural population live on this land (Isaacs and Mohamed, 2000), which legally belongs to the state and is administered by traditional authorities. One of the problems associated with this type of tenure is that despite being administered by tribal authorities, the land legally belongs to the state. Therefore, tensions and disputes over land use decisions of local government and those of tribal authorities on communal land, and within the community itself, are common (Cousins and Kepe, 2004). The government plans to address these problems through the Communal Land Rights Act (CLaRA), promulgated in 2004, which is still being piloted in selected areas. The aim of the CLaRA is to transfer communal land currently held by the state to communities and individuals who reside on and have rights to that land (Cousins and Hornby, 2005). Even with the introduction of the CLaRA it is anticipated that competition for land between wildlife and tourism-based uses and livestock will continue.

1.5 Problem definition

To facilitate land use decisions that can have sustainable outcomes for both rural development and conservation requires integrated assessment of existing and emerging land uses at the interface. Such an approach, if spatially explicit, enables analysis of the tradeoffs associated with different land uses whilst providing a means through which development-oriented and conservation-oriented goals can be reconciled. AHEAD (Animal and Human Health for the Environment And Development) – GLTFCA, a working group of experts, practitioners and scientists working in the GLTFCA, identified the need for interdisciplinary research, to study uncertainties and explore costs, benefits and implications of possible development pathways (Cumming et al., 2007; AHEAD-GLTFCA, 2010).

Past research efforts on TFCAs have focussed on involvement of communities in planning of conservation areas (DeMotts, 2005; Spenceley, 2006), as well as ecological aspects (Hanks, 2003). Detailed studies on the socioeconomic impacts of TFCAs in Africa, alternative land use options and methodologies to gather and analyse data are scanty in the published literature (Katerere, 1997; Spenceley, 2006; Cumming et al., 2007; Munthali, 2007). Outside of the TFCAs, substantial work exists documenting case studies and models of integrating livestock and wildlife land uses (for example (Barnes, 1998; Ando et al., 1998; Boyd et al., 1999; Bulte and Horan, 2003). Despite the important contributions made by these studies, there still exists a gap in terms of spatial land use analysis, and quantitative studies to determine the extent of wildlife disease and depredation damage on agriculture (Anthony, 2006; AHEAD-GLTFCA, 2010) and the potential for tourism in rural communities (Spenceley, 2006). Information is required on the likely impacts of different land use practices on disease management, depredation incidence, and environmental management. It is also important to establish whether there is potential for sustainable forms of tourism such as ecotourism in such communities (Cumming et al., 2007; AHEAD-GLTFCA, 2010).

This study, therefore, seeks to explore different pathways for rural development that allow recommendations based on land use scenarios developed with participation and inputs by stakeholders, economic evaluations and spatial land use modelling. Involvement of stakeholders

will allow exploration of the benefits and incentive structure, to act or not act in a particular manner, in order to promote rural development and biodiversity conservation.

1.6 Research objectives and questions

The main objective of this study is to develop a framework for evaluating land use options and tradeoffs for alternative pathways towards improved livelihoods at the interface of conservation and rural development. In order to achieve this goal five specific objectives will be addressed;

- To develop a theoretical spatial land use framework for analysing alternative land uses at the wildlife/livestock interface
- To estimate socioeconomic risks associated with agriculture at the interface
- To evaluate the relative contribution of existing livelihood strategies, particularly livestock farming, to household income at the interface
- To analyse tourist preferences for ecotourism and their willingness to pay for specific ecotourism attributes in rural communities at the interface
- To analyse the tradeoffs associated with different spatial land use patterns and rural development pathways at the interface.

The following research questions will guide the study;

1. How can alternative spatial land use options for improving local community incomes be evaluated, taking into consideration biophysical and socioeconomic constraints?
2. What are the risks and costs associated with livestock farming at the interface, and how do these affect the attitude of farmers towards wildlife and conservation?
3. What are the social and economic benefits of livestock production systems and how would an increase in wildlife/livestock interactions impact the system?
4. What is the potential to develop ecotourism and what are the tourist preferences, and community capabilities?
5. Given a set of bio-physical and socio-economic constraints, what spatial land use alternatives exist to improve net revenues from land use, and stimulate rural development and conservation in the GLTFCA?

1.7 Research approach

The study is multidisciplinary in nature and combines techniques from different disciplines to address the research questions. The general approach in this study follows the Describe-Explain-Explore-Design (DEED) research cycle described by Giller et al., (2008) to analyse competing claims on natural resources. The stages in the methodology are not linear, there are feedback and feed-forwards mechanisms, and if required it is possible to adapt the method to suit the context. Such an approach, which combines social and natural science perspectives, is most suitable for analyzing competition for land in a complex environment with multiple stakeholder interests (Giller et al., 2008; AHEAD-GLTFCA, 2010). The Describe phase is covered in the literature study and the consultation of the key informants and the stakeholders. The Explain phase is also covered in the literature review and in the discussions with key informants and the stakeholders and the analyses of the surveys that have been done. The Explore phase focused on alternative land use options in the choice experiment and in the modelling analyses, supported by the insights obtained in the Describe and Explore phases. Finally, the Design phase focused on scenarios for alternative land uses. Given the research character of the project the Negotiating aspects have been left to the stakeholders, but of course the discussions with the stakeholders will also have contributed to the perspectives of stakeholders on issues that were and will be part of the negotiations.The study in its totality, seeks to follow this approach, not in the individual chapters.

The first research question is addressed by developing a theoretical model that allows analysis of the effects of several land use scenarios on local incomes. The model includes economic, biophysical and spatial considerations, including (i) the spatial effects of wildlife damage on agriculture; (ii) connectivity constraints to ensure that wildlife plots are not scattered over the study area; (iii) fences to minimize interaction between wildlife and other land uses; and (iv) endogenous nuisance effects of wildlife on other land uses. The resulting theoretical model includes issues of importance from a socio-economic and biophysical perspective. The model is illustrated in a simplified setting using parameter values mainly from secondary data sources.

The second research question is addressed through a partial budgeting approach based on a framework for analysing local communities' costs and benefits of coexisting with wildlife. The

framework considers three types of costs: (i) losses which pertain to the loss of the actual animal; (ii) direct costs such as veterinary costs for disease and pen securing costs; and (iii) social and indirect costs such as negative attitudes to wildlife and food safety concerns. The social indirect costs, however, are not addressed in the study. Although this approach does not enable analysis of the temporal and spatial dimensions of costs and benefits at the interface, it gives a snapshot view of how costs and benefits compare, which can aid decision-making. The analysis is based on data collected through inspection of dip records and a household survey that captured the number of cattle lost to wildlife and incidence of disease in the cattle herd. Focus groups discussions and key informant interviews augmented the data used.

The third research question is addressed by using a combination of qualitative and quantitative techniques. A livelihoods analytical framework allows analysis of the contribution of cattle under five categories of capital, namely physical, natural, financial, social and human capital. Quantitative techniques are used to estimate marketed products and intangible roles of cattle such as financing, status display and insurance functions. The monetary values of the intangible roles of cattle are estimated following an approach proposed by Bosman et al. (1997) and Moll (2005). By using both economic calculations and the qualitative views of the rural households in contrast to only qualitative or quantitative approaches the strengths of either method are combined. This facilitates understanding of the complexity of rural livestock systems and generation of results that are useful for policy making. To answer this research question I use data collected through a household survey with both cattle owning and non-cattle owning households. Focused group discussions, key informant interviews and community workshops provide qualitative data.

The fourth research question is addressed through the use of a choice modeling survey. The approach is a stated preference method normally employed to provide information about a nonmarket good or service. Through this approach it is possible to determine the importance of different attributes of a good, and the likely effects of changing the value of any one of the attributes at once (Louviere 2000). The approach also enables estimation of respondents' willingness to pay for each of the attributes considered, where one of the attributes of the good is

the price. Data were collected through a survey with tourists, which enabled them to select the preferred option from each of the seven choice sets.

The fifth research question is addressed by empirical application of the theoretical model developed from the first research question. The data for parameterisation of the model is derived from secondary data sources, the other three chapters and key informant interviews. Some workshops were also held with the community members to discuss their views on different pathways for land based development in the area. This involvement of stakeholders in determining the key components of the model and the scenarios to be considered enables the outcomes to be based on more than just a theoretical exercise but an approach that generate solutions from different disciplinary perspectives in a complex environment.

Although the presentation in the thesis is such that the theoretical model is presented first, in implementing the study, different steps were followed. The first step involved describing the existing livelihood activities, opportunities and challenges for land use and the different competing claims for land as perceived by different stakeholders in the community. Thereafter I go deeper into the competing claims for land by explaining the risks associated with the current main land uses at the interface and concerns that communities have regarding any future land use options, especially wildlife tourism-based ones. The next stage involves exploring the possibility for new land use options and livelihood activities such as ecotourism, irrigation and wildlife farming at the interface. In each of these stages, community level stakeholders were involved, albeit to different extent in the different stages. Engaging with stakeholders in the DEED framework allows collaboration with them when identifying research problems, exploring suitable options, and, in seeking multi-faceted solutions (Giller et al., 2008).

1.8 Contributions of the thesis

The novelty of this study lies in the combination of different analytical techniques and approaches to evaluate options for land based development at the wildlife/livestock interface. The thesis also contributes in terms empirical information to the rural development conservation debate, and more specifically within the area of transfrontier conservation.

The absence of a systematic method and empirical studies to evaluate tradeoffs between livestock and wildlife-based land uses both within the GLTFCA has been highlighted (Cumming et al., 2007; Munthali, 2007). Existing methods that have been proposed to evaluate alternative land uses where wildlife and livestock compete (for example (Skonhoft and Solstad, 1998; Bulte and Horan, 2003; Munthali, 2007)) are either non-spatial or do not consider key socioeconomic concerns at the interface. This study fills in this gap by developing a framework for land use analysis that includes connectivity, endogenous effects of wildlife and fencing constraints. These connectivity issues and the endogenous nature of wildlife externalities have not, to my knowledge, previously been applied in studies on land use modelling in Africa.

Although there is an abundance of literature that describes the problems of wildlife in rural communities, particularly depredation (Butler, 2000; Patterson et al., 2004; Graham et al., 2005; Anthony, 2006), the studies do not consider and quantify the combined costs of livestock disease and depredation in rural communities. Most of these studies also likely underestimate the effects of household losses to depredation, as they are only based on the market prices of the animal, and not the other benefits of livestock to the household such as dung and draught power.

The combined use of livelihoods analysis and quantitative methods to analyse livestock systems contributes to the literature. Most of the existing studies are either based on qualitative approaches (Ainslie, 2005) or quantitative approaches (Randela, 2003; Moll, 2005; Dovie et al., 2006). By combining these approaches, and illustrating the disjuncture between farmer rankings of the most important livestock functions and economic estimation, the study makes an important argument for use of combined techniques in complex environments such as the wildlife/livestock interface.

The use of choice experiments in this study contributes to the limited amount of nonmarket valuation studies and specifically in ecotourism in sub-Saharan Africa. Previous studies on the potential of ecotourism have been largely descriptive in nature (Kepe, 2001; Cousins and Kepe, 2004) and based on secondary data (Spenceley, 2006).

Lastly, this thesis represents a multidisciplinary study to combine issues of diseases, depredation, tourism and land use decisions, based on engagement of rural communities and other relevant stakeholders in the GLTFCA. Because of this, the thesis addresses a number of key thematic areas in research and information gaps that have been identified at the interface by scientists (Anthony, 2006; Spenceley, 2006; Cumming et al., 2007; Munthali, 2007; AHEAD-GLTFCA, 2010; Cumming, 2011) and decision makers (Joint Management Plan Working Group, 2001; Thulamela Local Municipality, 2009).

1.9 Outline of the thesis

This thesis comprises seven chapters, including the general introduction. Chapters 2, 5 and 6 have been prepared and submitted to journals, whilst Chapters 3 and 4 have been published in peer-reviewed journals as stand-alone articles. Thus there is some overlap in the description of the study area and data in various chapters.

In Chapter 2 a theoretical model for evaluating alternative land uses at the wildlife/livestock interface, which considers the key elements of concern to farmers, conservationists and policy makers, is developed. In Chapter 3 the risks and costs of farming with cattle at the wildlife/ livestock interface are analysed. A framework for analysing the costs and benefits of coexisting with wildlife for rural communities is presented, and applied in the analysis. Chapter 4 analyses the benefits of cattle farming and gives an overview of other livelihood activities such as cropping and small stock, and discusses the importance and relationships between different livelihood sources.

Chapter 5 considers the prospects for development of ecotourism in rural communities at the interface. Chapter 6 explores options for development at the interface using the land use model developed in Chapter 2, and considering the possible benefits and constraints of each land use emanating from Chapters 3, 4 and 5. I discuss the pros and cons of specific spatial land allocation options, and land based development scenarios.

In Chapter 7, the key findings emanating from the thesis are summarized. The implications for the rural development and conservation debate are discussed, and specific recommendations for land based development in the GLTFCA are drawn. Areas for further studies are also identified.

CHAPTER TWO: Reconciling Interests of Wildlife and Livestock Near Conservation Areas: A Theoretical Model for Analysing Alternative Land Uses

Petronella Chaminuka, Rolf A. Groeneveld, and Ekko C. van Ierland

Abstract

Land use decisions are central to both biodiversity conservation and rural development objectives, at local, national and international levels. Transfrontier Conservation Areas (TFCAs) which aim to simultaneously address rural development and biodiversity conservation goals have led to competing claims on land and natural resources in Southern Africa. In this paper we develop a theoretical spatial land allocation model that enables analysis of alternative scenarios for land-based rural development within TFCAs. The model includes socioeconomic and ecological factors such as income, water availability, fencing, connectivity, predation and disease costs, allowing for clarification of opportunities and tradeoffs in rural development and biodiversity conservation. We show how well-designed zoning, based on land use analyses which integrate the potential of the land, its spatial characteristics, externalities of different land use activities and socioeconomic factors can reconcile interests where competing claims for land exist. The results of the scenarios show spatial patterns of land use that provide the best results in terms of income generation in the region under different constraints. The results demonstrate alternative spatial options for diversification in land use and related income tradeoffs, whilst accommodating the connectivity requirements and endogenous effects of wildlife on other land uses. This model can be applied in similar contexts and used to inform land use planning decisions at local and regional levels and stimulate rural development and conservation policy discussion.

***Keywords*: Connectivity, endogeneous effects, fences, spatial characteristics, wildlife damage.**

2.1 Introduction

Transfrontier Conservation Areas (TFCAs) have recently been introduced into Southern Africa with the aim to simultaneously address rural development and biodiversity conservation goals (Wolmer, 2003; Metcalfe and Kepe, 2008). TFCAs reinforce the idea that conservation and rural development are not mutually exclusive, but must be linked (Barnes et al., 2002) through conservation approaches that focus on community involvement and multiple land use practices. The Great Limpopo Transfrontier Conservation Area (GLTFCA) straddling Zimbabwe, South Africa and Mozambique seeks to promote multiple land use practices, with emphasis on wildlife tourism. This should promote biodiversity conservation and rural development in areas that are next to protected areas (Cumming et al., 2007; Metcalfe and Kepe, 2008; Munthali, 2007), which are sometimes called buffer zones. In these buffer zones, land can be used for agriculture as well as emerging land uses such as biodiversity conservation and provision of ecosystem goods services (Blignaut and Moolman, 2006) or wildlife farming. It has been argued that under highly variable environmental conditions and low potential land, wildlife can complement livestock, or serve as an alternative land use option to livestock (Skonhoft and Solstad, 1998; Barnes, 1998).

Several questions have, however, been raised regarding these emerging land uses within the GLTFCA (Cumming et al., 2007; Munthali, 2007). The area around the protected area in the GLTFCA is a mosaic of human settlement, livestock grazing, private game reserves and cultivation. Some authors (Cumming et al., 2007; Munthali, 2007) question the compatibility and related tradeoffs of existing and emerging land uses at the interface between wildlife, humans, and livestock (hereafter referred to as the interface), and also known as the buffer zone. Furthermore, there is limited information on the likely impacts of different land use practices on disease management, depredation incidence, and environmental management (Joint Management Plan Working Group, 2001; Bengis, 2005; Munthali, 2007). Depredation and diseases costs are described by Naidoo et al., (2006) as damage costs and can result in significant losses in income in areas adjacent to protected areas.

To facilitate decision making and sustainable conservation practices in the GLTFCA there is need for assessment of the tradeoffs between different land uses in respect of livelihood

objectives, environmental considerations and veterinary considerations (Cumming et al., 2007). It has been noted that most approaches to environmental planning and decision making do not consider the ecological, socio-cultural and economic values of land and hence such decisions often result in single-function land use types that are not sustainable (de Groot 2006). A key challenge in integrating wildlife, tourism and agricultural activities lies in determining the suitable spatial locations of the various land uses and integrating them into already existing patterns of settlement and land use. Spatial analysis of how proposed wildlife related land uses can fit in with existing patterns of settlement and agricultural practices can help to fill some of the information gaps that have been identified in the GLTFCA.

The need for considering the spatial location of different land use alternatives arises from several factors, four of which are particularly relevant to GLTFCA. First, it is not clear what types of land use activities are suitable within the immediate vicinity of protected areas due to existing problems of crop and livestock destruction by wildlife, and the likely impact of these activities on conservation goals. Second, environmental conditions vary spatially, and so does the suitability of locations for different land uses. Third, wildlife reserve planning requires that issues of connectivity and shape are considered (Önal and Briers, 2003; Williams et al., 2005). Fourth, besides the area of game ranches, border length is important as longer fences are more expensive to maintain and broaden the interface, thereby increasing the problems of human-wildlife conflict. Within the GLTFCA, wildlife fences, in one form or another, are set to remain a part of the landscape at the interface, thus there is need for analysis of different scenarios with regard to fencing to facilitate decision making in the GLTFCA (Ferguson, 2010). Such analysis is not only important for planning purposes but also for evaluation of how the available land can best be utilized within the constraints imposed and the opportunities created for communities in the buffer zone.

To help clarify and address some of the land use concerns at the interface outlined above, this paper develops a theoretical model for assessing the potential for alternative land uses in a rural area close to the GLTFCA. The model considers socio-economic, spatial and physical characteristics such as vertical slope and carrying capacity of the land, and enables analysis of benefits and costs of different land uses, in relation to existing geographical features. We further

propose extensions to the model regarding the spatial attributes of the location of wildlife-based land use, by applying a technique to determine the location of wildlife land uses within specified connectivity attributes constraints, and considering the externality costs between land uses by making disease and depredation from wildlife endogenous to the land allocation model. These connectivity issues and the endogenous nature of wildlife externalities have not, to our knowledge, previously been applied in studies on land use modelling in Africa.

The model developed in this paper partly draws from the concept of ecosystem based development which seeks to match the available resources and the goals of development. Ecosystem based development combines economic development, biodiversity and environmental protection through planning and decision making using scientific methods to produce knowledge that is relevant within the limits of socio-economic and bio-physical constraints and the identification and valuation of different ecosystems functions and involvement of stakeholders in land use decision making processes (Slocombe, 1993; Millennium Ecosystems Assessment, 2004). The paper contributes towards the broader debate on reconciling rural development with conservation objectives and the growing literature on land use planning which incorporates bio-physical and socioeconomic factors in rural development planning and protected area management.

2.2 An overview of competing claims for land in the GLTFCA

We consider the case of rural communities that lie adjacent to the north-western border of Kruger National Park (KNP), South Africa (Figure 2.1). The communities are within the designated GLTFCA. Poverty incidence rates in the area are more than 60%, unemployment levels are high and average annual household income was only US$960 in 2005 (Pauw, 2005). The area has potential for wildlife tourism because of its proximity to the KNP. At present the predominant land use is livestock farming and dryland cropping. The area has low rainfall levels (400 to 600 mm per year) and experiences frequent droughts hence it is not suitable for dryland cropping (CGIAR, 2003). The Luvhuvhu river runs through the area and is part of the northern catchment area of the Limpopo River which it joins in the KNP.

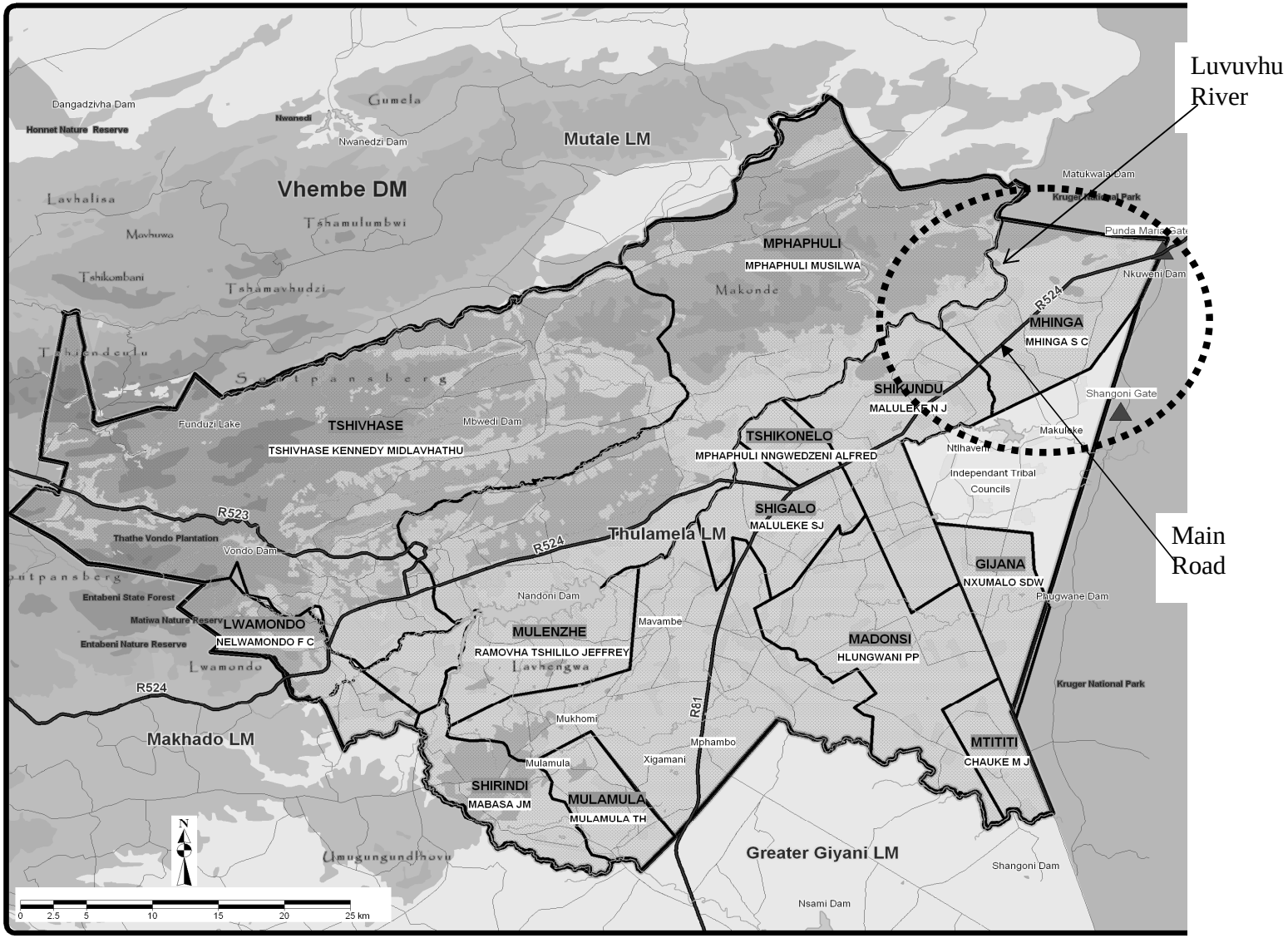


Figure 2.1 Case study area in relation to Kruger Park *Source: Thulamela Local Municipality (2009)*

Grazing land, although legally state land, is administered by the traditional authority and access is open for all members of the community. National efforts by the government to transfer ownership of such land to communities through the Communal Land Rights Act (CLaRA), are still in the pilot phase (Cousins, 2009). Possibilities exist to convert grazing land to emerging land uses. Four competing potential and existing land uses which are in line with the broader vision of the GLTFCA have been identified from the local municipality's integrated development plans (Thulamela Local Municipality, 2009) and discussion with the traditional authorities in the area. The land uses are (i) wildlife ranches with an option for trophy hunting (ii) livestock farming (iii) tourism with accommodation facilities and (iv) irrigated crop farming. Wildlife ranching is currently practiced on the southern side of the KNP on private land (Associated Private Nature Reserves, 2005).

Introducing wildlife land uses in the buffer zone in communal areas presents some challenges. Very little wildlife currently exists on communal land, most of the wildlife exists inside the KNP which is currently separated from the villages only by a fence. Following the model that has been applied on the western boundary of the KNP, where fences were removed between the KNP and private game reserves (Associated Private Nature Reserves, 2005), it would be possible to take down part of the KNP to allow wildlife based activities such as trophy hunting and wildlife viewing to take place on communal land. Such plans would however require a direct or indirect connection between the park and the land reserved for wildlife in the buffer zone. Other considerations to be made on movement of wildlife from the park into the buffer zone would require compliance with national regulations on disease control and movement of livestock and wildlife as set out in the amended Animal Diseases Act No. 35 of 1984 (NDA, 2000). It is not possible to sell live wildlife or wildlife products due to the restrictions imposed by this act, hence wildlife ranching revenues would mainly be generated from trophy hunting and wildlife viewing[3]. Furthermore, fencing would be required for land allocated to wildlife. These issues are considered in the model specification in this paper.

[3] Although it is possible to trade wildlife and wildlife products within the buffer zone, it is unlikely that this would be a vibrant market as it would mainly comprise the local traders as the buyers.

2.3 Overview of land use models and wildlife management

The land use model in this study follows earlier models described by Bulte and Horan (2003), Schulz and Skonhoft (1996), and Tomlinson et al. (2002) but introduces novel elements that enable analysis of competing claims for land within the context of TFCAs. Bulte and Horan (2003) give an overview of wildlife management models, dividing existing models into four broad categories, and propose a fifth model type. Two types of the models described and the fifth model type proposed by Bulte and Horan (2003) bear relevance here. The first one involved modelling the competition for grazing between wildlife and livestock and the possible bio-social and physical interactions. The model assumed two groups of stakeholders, namely the park agency and the community, each owning land. The second type of model is based on a single agent making decisions about alternative agricultural or wildlife related land use options. In this paper, we follow the assumption of a single agent or central planner who tries to maximize social benefits on behalf of the community. The main reason for such an assumption is that land use decisions are implemented by a single agency i.e. the local municipality, based on inputs from different stakeholders at local level. The traditional leaders and locally elected councillors all sit in the local municipal council.

The importance of stakeholder collaboration and participation in environmental modeling processes is discussed by Voinov and Bousquet (2010) who explain the various types of approaches which can be followed in modeling with stakeholders. These include participatory modeling, group model building, mediated modeling, companion modeling and are mainly associated with certain groups of researchers. The approaches are not exclusive, and are fundamentally based on involvement of stakeholders in modeling and/or the use of modeling to support decision making by stakeholders. They further outline the basic principles of participatory modeling. The modeling process is not linear, there is room for feedbacks and loops in between different stages of the modeling, the process is dynamic and open in space. In addition, they point out the need for compromise on the part of both the stakeholders and the scientists involved in the modeling process. Differences in attitudes of stakeholder groups, expectations, and expertise are also discussed.

The other land use model by Bulte and Horan (2003) assumes that a local group of people decide between agriculture and wildlife hunting as land use options. Their model illustrated alternative patterns of land allocation given different institutional arrangements and related policy scenarios, and showed that it is possible for different patterns of conservation and agriculture development to emerge in developing countries. They emphasize the need to consider local institutional settings, spill-over effects of some land uses and the supply and demand characteristics of agricultural and wildlife markets amongst other issues in policy planning. By introducing spill-over effects or externalities associated with some of the land uses on other activities, they make an important contribution which is also considered in this paper. Similarly, Schulz and Skonhoft (1996), developed a theoretical model for analysing land use conflict between wildlife conservation and agro-pastoralism in East Africa considering wildlife damage on agro-pastoral production through depredation and crop destruction, and the positive public good nature of wildlife through existence and biodiversity values. The optimal land allocation and stock size for wildlife and agro-pastoralism varied with the management schemes considered and externally determined parameters such as subsidy levels, and international prices. Another study by Tomlinson et al., (2002) analysing the relationship between property size and profitability of wildlife, livestock and ecotourism in South Africa found that wildlife investments only became profitable for land sizes greater than 3000 ha, whilst livestock production was more profitable for smaller land sizes. The proposed model in this paper differs from the existing models in a number of respects. Models by Bulte and Horan (2003), Schulz and Skonhoft (1996), and Tomlinson et al. (2002), neither explicitly consider the spatial dimension of land use at the interface, nor address the critical question of where to locate alternative land use activities.

Margules and Pressey (2000), discuss the importance of systematic conservation planning as an activity in which social, economic and political imperatives modify scientific conservation recommendations. According to them, most conservation reserves have in the past, tended to be situated on land is either too remote, or of little economic value. Conservation planning has also tended to be unsystematic, and consequently some reserves which have been established have not contributed much to biodiversity representation. They outline six, non-linear stages which can be followed in systematic conservation. In addition they discuss five spatial constraints which can influence reserve selection. The first of these is irreplaceability. It is important to map out those areas that are considered essentially irreplaceable as a first step in reserve selection.

The second factor is the costs involved. Where the opportunity costs of selecting a particular site are too high, it is possible that the site can sometimes be left out in reserve selection regardless of biodiversity representation. The third factor is when existing commitments such as previously identified reserves, have to be included, even when they have minimal biodiversity representation. Fourth, preferences for selecting some areas can also be influenced by factors such as low human population density. Lastly, some areas that are too small, or used for intensive agriculture can also sometimes not be considered even when they have high biodiversity representation.

Sahotra et. al (2006) discuss the different approaches to formalize conservation problems. One way is to formulate the problems as constrained optimization problems, with the most commonly used one being, minimization of the number of sites to meet biodiversity representation targets. They also discuss the conservation area network selection approach which makes use of mathematical programming techniques to solve 'set cover' or 'maximal cover' problems in conservation area network design. Another approach is the conservation scheduling problem which involves dynamic selection of sites on the basis of their vulnerability from agricultural expansion for example. A more widely applied approach which they also discuss is multicriteria analysis. A wide variety of methods for multicriteria analysis in reserve selection exist, most of them with foundations in utility theory. Two protocols can be followed in the multicriteria analysis. The first approach involves selecting each individual site on the basis of all the criteria stipulated, and the second approach involves selection involves formulation of potential networks on the basis of a particular criteria first (usually biodiversity representation), and then from these, selecting an entire network now considering the multicriteria. These approaches have been applied in spatial analyses of nature conservation and reserve selection studies in western countries by (Ando et al., 1998; Nalle et al., 2002; Önal and Briers, 2003; Polasky et al., 2008). In South Africa, reserve selection studies include Eeley et al. (2001), who considered indigenous forest reserve selection, and Freitag et al., (1996) on the species set covering problem in reserve selection for conservation of large mammals.

Extensive literature on conservation planning in the Cape Region in South Africa also exists. It is mostly based on the work of scholars at the South African National Biodiversity Institute and the

Nelson Mandela Metropolitan University in the Cape region. The approach followed in the Subtropical Thicket Ecosystem Planning Project (STEP), involved a wide variety of stakeholders that included government officials in different departments, communal and private landowners, and tourism sector representatives (Pierce et al., 2005; Knight et al., 2006; Knight et al., 2011). The approach involved an extensive assessment based on stakeholder inputs, allowed identification of large scale conservation corridors based on set targets for biodiversity processes, and enabled identification of conservation status categories for different species and development of conservation priority maps. Detailed handbooks, which could be used by local authorities and government departments to guide conservation decisions were developed. Some of the biodiversity features included in the conservation assessment were habitat types, wildlife suitability for specific species, spatially fixed processes such as riverine corridors, and spatially flexible processes such as upland-lowland gradients (Pierce et al., 2005).

Our approach somewhat differs from that outlined in the Cape Region studies. The focus of this analysis is economic in nature, with the explicit objective of maximizing net revenues from different land uses, subject to a range of constraints which are identified with mainly rural community stakeholders. The studies have also not been conducted within the framework of transfrontier conservation areas with multiple land use alternatives and do not consider externality effects of different land uses on each other, or connectivity attributes. We use an optimization approach to explicitly model land use decisions, with the intention of exploring the possibility to introduce wildlife conservation and tourism in an area that is currently used mainly for livestock. In this regard, we believe that this study contributes, in a different way to the literature on land use planning, with specific reference to the wildlife/livestock interface.

Connectivity has been considered in models that address both ecological and economic concerns through optimization models in general reserve selection (Groeneveld, 2004; 2010), bird migration (Williams et al., 2003) and wildlife reserve selection (Nalle et al., 2002). Williams et al., (2005) distinguish structural connectivity, which refers to the physical adjacency of reserve sites, from functional connectivity, which is related to species responses to landscape breaks. Structural connectivity is not species-specific and is an important attribute to be considered in all cases where land use decisions are made that involve wildlife.

Although most connectivity studies have been built on ecological foundations, this study considers connectivity as essential in two respects i.e. (i) wildlife ranches adjacent to the park have lower costs of getting the wildlife from the park to the hunting ground; and (ii) under the same wildlife ranch area, longer border length implies higher costs of fencing, maintenance, and damage to livestock. These are no ecological considerations but very practical technical spatial considerations. Such considerations build on the model formulation proposed by Williams et al. (2003), in their paper to determine the suitability of specific sites as stopover sites for migratory birds flying over the Atlantic flyway. They proposed a set of restrictions that ensured that each stopover within the network had another new or existing stopover site to its north or south, and within a specific distance. In specifying this model, a series of restrictions are laid out based on the location and distances of the counties which are supposed to harbor the stopover sites. The model which considers both ecological and economic objectives as indicated by wetland prevalence and land costs, is solved as an integer problem.

We model explicitly the costs of fencing which are an important investment cost that is considered in converting rangeland to wildlife use whereas Schulz and Skonhoft (1996), do not consider these costs. Fencing is an important factor to consider in the development of any wildlife reserves (ABSA, 2003). Fences have the potential to limit disease transmission by restricting contact between wildlife and livestock, whilst also protecting crops from wildlife destruction (Reid et al., 2004). One way to include the costs of fencing in modeling is to consider the boundary length, which also measures the compactness of a reserve site (Williams et al., 2005).

2.4 Relationships of land size, carrying capacity and profitability of different land uses

Because land plays a central role in our analysis, we first define the nature of production functions for different land uses considered and the role of land size. The impacts of land size on tourism, and wildlife ranching, irrigated agriculture and livestock profitability varies. The relationship between land size and livestock production can be assumed to be increasing and quasi concave in an extensive livestock system with limited livestock-crop interactions (Bulte

and Horan, 2003; Tomlinson et al., 2002) and irrigated agriculture follows a similar pattern. For wildlife ranching and tourism, however, this is not the case (Figure 2.2). Wildlife ranching is sensitive to minimum land sizes, after which close to constant marginal returns can be achieved beyond a certain land size (Tomlinson et al., 2002; ABSA, 2003). For tourism there is also a minimum size constraint, but once this is attained profits can be assumed to rise steadily till they quickly reach a peak, because the demand for tourism services in the relevant study area will be limited. This is so because once the supply of lodging space exceeds a certain amount it will not result in increased revenues where there are demand side constraints as is the case on the western side of the KNP and also given that the KNP in general registers occupancy rates below maximum in most of its camps for most of the year (South Africa National Parks, 2007; South Africa National Parks, 2008). The shape of the profit curves also depends on the initial investment, fixed and variable costs, and the value of the product associated with the different land uses (Tomlinson et al., 2002). The hypothetical relations in Figure 2.2 are composed by the author for illustrative purposes inspired by various sources.

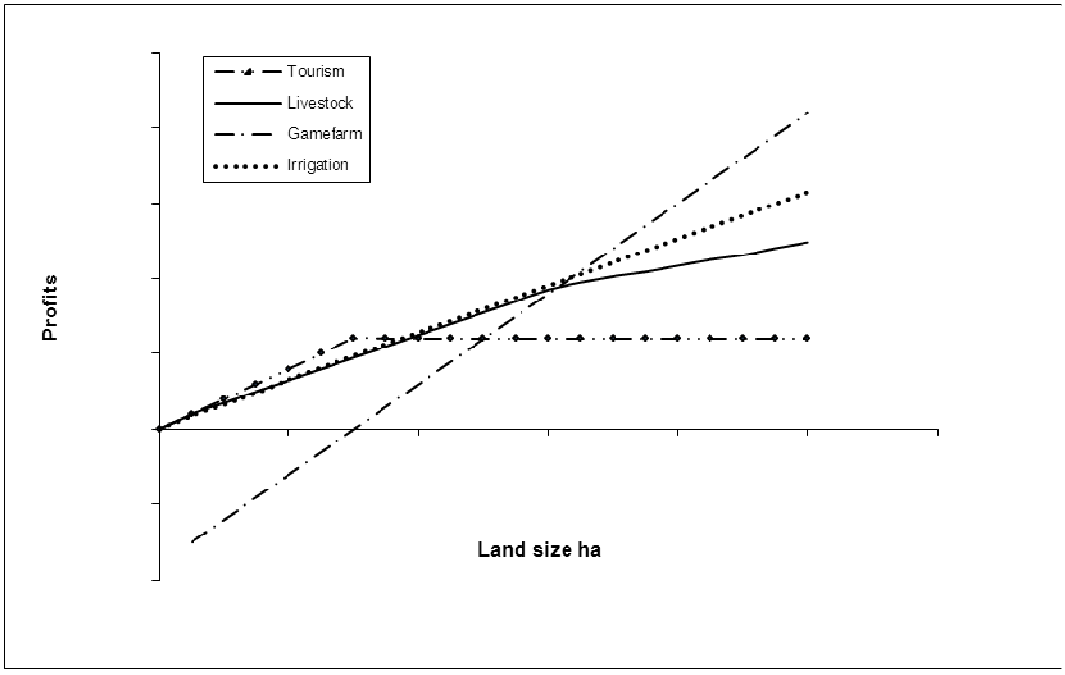


Fig 2.2 Hypothetical relationships between profit and land size for different land uses

Carrying capacities of wildlife and livestock farming are defined in large stock units per hectare (LSU/ha) and are indicative of the maximum number of animals that can be stocked on land without permanent damage to the rangeland per year (one LSU is equal to 450kg live weight or the equivalent of a mature dairy cow). Although the concept of carrying capacity has been criticized because in reality carrying capacity is neither fixed nor static and depends on rangeland management approaches and seasons, amongst other factors (Kinyua et al., 2000), it continues to be used in land use models to enable comparison of different land use scenarios (Schulz and Skonhoft, 1996; Tomlinson et al., 2002). For crops there are various means to define the land capacity. van Ittersum et al., (1998) explain that the potential yield is determined by growth-defining factors, such as solar radiation, temperature and characteristics of the crop. This yield is achievable under optimal water and nutrients and when the crop is completely protected against growth-limiting and reducing factors. If these growth limiting factors are considered, then the nutrient or water limited yield is achievable, which also differs from the actual yield realized when all other factors are considered. In this paper we consider the best measure defined by the potential yield since the crop is irrigated.

In ecotourism the specification is more difficult, because it depends not only on the biophysical capacity but also on complex social, political and economic factors (Tomlinson et al., 2002; Coccossis and Mexa, 2004). Tourism carrying capacity which has been defined in general terms as the maximum number of tourists per year that an area can assimilate without irreversible long term damage to the environment (Steele, 1995; McCool and Lime, 2001) has been extensively criticized. Part of the criticisms are that the concept is too abstract, methodologically difficult to measure, due to the fact that multidimensional and complex issues are involved, and it is difficult to arrive at a consensus on the carrying capacity limits because of different objectives and interests (McCool and Lime, 2001; Coccossis and Mexa, 2004). Despite the criticisms however, the concept remains useful in tourism development planning and land use decision making, and the carrying capacity can be determined by considering social, physical-ecological and political-economic capacity (Coccossis and Mexa, 2004). Some studies do not attempt to define the number of tourists per hectare but rather estimate the returns to tourism per hectare per year (Sims-Castley, 2002; Tomlinson et al., 2002). To facilitate comparison with other land uses, we use the carrying capacity concept in this study.

2.5 Method

2.5.1 Description of the land use model

Consider a social planner such as the district municipal manager who allocates land between different activities with the objective of maximising expected net revenue at community level. The distribution mechanisms of the income attained from the land are important, but are not the primary focus of our study. Constraints considered in the model include a vector of bio-physical and spatial characteristics of the land and a vector of socio-economic factors. There are no costs of land procurement considered because regardless of the chosen land use the community has full use rights on the land and there is no transfer of land ownership or acquisition of new land involved in the land uses being considered. In South Africa communal land belongs to the state but rural communities have full use rights on the land. Local administration of the land is overseen by the Traditional Authority. New legislation is being introduced to transfer ownership rights of the land to the communities. For more details see Cousins, (2009). Three fixed geographical features included in the model i.e. the park fence, a road and a river affect the spatial location of different land use activities (Table 2.1).

To illustrate the functioning of the model in a simple setting, land is divided into a square plot with thirty six plots (*g)* of equal size (the number of plots is for illustrative purposes arbitrarily chosen at 36 and can easily be expanded). These cells are assumed to be suitable for any of the four land uses being considered (Figure 2.3), but to a different extent. Wildlife from mainly inside the park moving onto communal land can impose damage or negative externalities on other land uses through depredation, disease transmission and crop destruction. The plots closer to the river and on flat land have less costs of pumping water, compared to those closer to the river and on steep sloped land. Thus the main differences between the cells pertain to their distances from the landmark features, slope and associated wildlife damage. It is assumed that land use options are mutually exclusive. Moreover, labour and capital are considered not to be limiting, because revenues should be able to cover the related capital costs. The major investment cost of wildlife is the fencing costs. All output prices are assumed to be fixed. Output

prices are based on full production capacity for all land uses. Prices for tourism services are similar to prices within the KNP.

Table 2.1 Land use options considered and relationships to the geographical features

Land use type	Type of production function assumed	Assumed relation to landmark features
Livestock	Linear relationship between land area and output Livestock prices are supply inelastic	Negative externalities (damage) from depredation and disease by wildlife decrease further from the park.
Tourism lodges offering accommodation and activities	Concave and increasing in land area, has a maximum land area size	WTP for tourism declines further from the park. Better view on steep sloping land, better closer to the road
Wildlife ranching	Linear relationship between land area and output, but negative returns below a certain size Wildlife prices are supply inelastic	Connectivity path established between different plots to allow migration of wildlife from the park
Irrigation	Linear relationship between land area and output Crop prices are supply inelastic	Damage from depredation and disease changes along a gradient away from the park Variable costs increase with distance from the river**; only** flat land is suitable

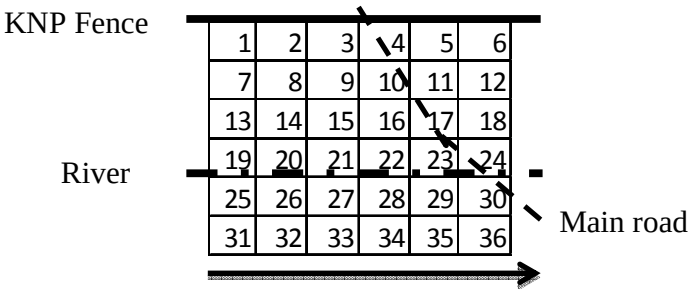


Figure 2.3 Layout of plots in hypothetical model in relation to key land features

2.5.2 The basic model

Throughout the chapter variables are indicated by italicised capital Latin symbols, parameters are lower case Greek symbols and lower case Latin symbols, indices are italicised lower case Latin symbols. The objective function is to maximise total profits (Y) from all land use types (u) from all plots (g):

$$\max\left\{Y = \sum_{g}\sum_{u} P_{ug} - \sum_{k} \varpi F_{k}\right\}, \qquad (1)$$

where ϖ denotes fencing costs in US$ for plots with wildlife, and $F_k \in \{0, 1\}$ denotes whether border k is fenced or not. The role of fencing is elaborated later on. P_{ug} is the profit per land use per plot and its estimation is outlined in the next few paragraphs.

The central instrument variable in the model is A_{ug} which denotes the total area of land in hectares (ha) allocated to a specific land use per plot of total size a_g. To model this problem as a mixed integer programming problem, we define B_{ug}, a binary variable denoting whether plot g is covered by land use type u or not. The relation between B_{ug} and A_{ug} is written as:

$$A_{ug} \leq a_g B_{ug} \qquad \forall u, g, \qquad (2)$$

Moreover, any given plot can have only one land use type:

$$\sum_{u} B_{ug} = 1 \qquad \forall g \qquad (3)$$

The total output (Q_{ug}) in tonnes, LSU or tourist bed nights from land use type u in plot g depends on the output that can be produced per ha and A_{ug}. This is expressed as

$$Q_{ug} = A_{ug}\beta_u, \qquad (4)$$

where β_u denotes the output in tonnes, LSU or tourist bed nights per ha. Equation (4) will be redefined in section 2.5.4 when the endogenous effects of wildlife damage are integrated into the model.

Gross benefits of land use type u in plot g (G_{ug}) in US$ are expressed as:

$$G_{ug} \leq \rho_{ug} Q_{ug} \quad (5)$$

where ρ_{ug} indicates the net benefits per land use per unit of output per plot. These benefits depend the gross land use benefits per plot ε_{ug} and the operating costs per land use per plot c_{ug}:

$$\rho_{ug} = max\left(0, \varepsilon_{ug} - c_{ug}\right) \quad (6)$$

Gross revenues per plot per land use ε_{ug} depend on the price per unit of output (γ_u), coefficient of negative externalities from wildlife in the park (δ_{ug}), negative effects of being far from the park for some land uses (λ_{ug}), the slope extent (η_g) , slope effects (ξ_u), distance from the road (χ_g) and effects of the road (φ_u). δ_{ug} is zero for wildlife and tourism. λ_{ug} indicates change in willingness to pay (WTP) for tourism services as one moves further from the park and $0 \leq \lambda_{ug} \leq 1$ for tourism. It is zero for livestock, irrigation and wildlife. Slope extent and distance from the road vary per plot. The effects of the road (φ_u) on revenue are positive for tourism but zero for other land uses, whilst slope effects (ξ_u) are negative for irrigation and positive for tourism, but zero for wildlife and livestock. ε_{ug} is thus indicated as:

$$\varepsilon_{ug} = \gamma_u \left[1 - \delta_{ug} - \lambda_{ug} - \xi_u \eta_g - \varphi_u \chi_g\right] \quad (7)$$

Profits per plot per land use (P_{ug}) are expressed as:

$$P_{ug} = G_{ug} - \sum_u t_u B_{ug} \quad (8)$$

where t_u are the annuitized capital costs for each land use.

2.5.3 Connectivity of wildlife plots

Because wildlife in this specific setting is stocked onto the land from KNP, the wildlife ranch plots must be connected to the KNP or connected to plots that are connected. This connectivity is

an important condition in deciding whether or not a plot is suitable as a wildlife ranch. Following the approach of Williams et al. (2003) connectivity is modeled in this paper as a mixed integer programming problem.

We express the wildlife suitability (W_q) of a plot q as a function of wildlife suitability W_g of an adjacent plot g i.e. $W_q = f(W_g)$. $W_g \in \{0, 1\}$ where 1 indicates the presence of a wildlife ranch in plot g. The suitability of plot q as a wildlife ranch is expressed as:

$$W_g \leq \sum_{q \in \mathbf{V}_g} W_q \qquad \forall g \qquad (9)$$

and

$$B_{ug} = W_g \qquad \forall u \in \mathbf{W} \qquad (10)$$

where $\mathbf{V}_g$ is a set that includes all plots q such that (i) $q \neq g$; (ii) border to border distance between g and q is zero (i.e. the plots share a border) and (iii) cartesian plane coordinates x and y are such that $x_g < x_q$ or $y_g < y_q$ or both, where x_g denotes the cartesian x-coordinate of plot g and similar notation for y and plot q. This formulation implies that a plot q is suitable as a wildlife ranch conditional upon sharing a border with a plot g that has wildlife, and q is located to the south, west or south-west of plot g, or sharing a border with a plot that meets the above requirements. **W** is wildlife land use.

The specification of the direction of migration forces the model to expand the park in a southwest direction, This is an acceptable formulation because (i) the park is the main source of wildlife stock, migration of wildlife mainly occurs from the park to the communal land (ii) the linear setting does not allow for extensions in two opposite directions; and (iii) the park is located in the northeast corner of the study area so that the most likely extension will be in a southwest direction.

2.5.4 Endogenising wildlife damage into the land use model

Wildlife related damage to other land uses are not only specified with reference to the park but also in reference to the resultant land use allocation in the model. If plot g is allocated to wildlife,

this will impact on the agricultural productivity of other plots in the vicinity of that cell, either through depredation or through damage to crops. Thus it is necessary to specify negative externalities of wildlife as being endogenous in the model specification. We extend the model by defining $\mathbf{Z_g}$ as the set of all plots h in the vicinity of plot g such that (i) $h \neq g$; and (ii) the centre-to-centre distance of g and h, $d_{gh} > \kappa$. $\mathbf{M}$ is the set of all wildlife related land uses i.e. wildlife ranch and tourism, v is the land use type in plot h.

We redefine equation (4) as:

$$Q_{ug} \leq m_{ug} + \sum_{h \in \mathbf{z}_q} \sum_{v \notin \mathbf{M}} \tau_{ugh} A_{vh} \qquad \forall u, g \qquad (11)$$

The first part of the equation m_{ug} denotes u's productivity on g if g were completely surrounded by wildlife land uses, and τ_{gh} denotes the extra productivity you gain in g from turning plot q into any land use type v other than wildlife. m_{ug} depends on the normal output from the land defined as β_u in equation (4) and a coefficient ψ_u which indicates the extent to which this output changes when the plot is completely surrounded by wildlife.

$$m_{ug} = A_{ug} \beta_u \psi_u \qquad (12)$$

In the second term on the RHS of equation (11) A_{vh} is the area of land allocated to land use type v in plot h measured in ha. τ_{ugh} represents the additional productivity that land use type u gains in plot g when plot h is converted from wildlife related land use to something else.

To choose a good value of τ_{ugh} we proceed as follows. From equation (11) we can deduce the maximum productivity possible in plot g (denoted by q_{ug}^{max}) for which the following holds:

$$a_g q_{ug}^{\max} = m_{ug} a_g + \sum_{h \in \mathbf{z}_g} \tau_{ugh} a_h \qquad (13)$$

The first term on the RHS reflects g's productivity if all surrounding plots are wildlife; the second term reflects the additional productivity if none of the surrounding plots are wildlife. We

assume that τ_{ugh} depends on the centre-to-centre distance between g and h ($d_{gh)}$ and a coefficient α_{ug} as follows:

$$\tau_{ugh} = \frac{\alpha_{ug}}{d_{gh}} \qquad (14)$$

Substituting (14) in (13) reorganising the result, and considering that the area is a square grid so that $a_g = a_h$ for all plots g and h we we can express α_{ug} in terms of the parameters q_{ug}^{max}, m_{ug}, a_g, and d_{gh}, whose value can be found in the literature or other sources:

$$\alpha_{ug} = \frac{q_{ug}^{\max} - m_{ug}}{\sum_{h \in \mathbf{z}_g} \frac{1}{d_{gh}}} \qquad (15)$$

The numerator of the RHS in equation (15) reflects the change in productivity that land use type u in plot g would get if all surrounding sites are converted to anything but wildlife related uses. The denominator spreads this over different plots, taking into account that plots allocated to non-wildlife uses closer to g add more to the plot's productivity than distant plots with non-wildlife uses.

From equation (11) it is possible that income from a land use can be earned from a plot that is not allocated to that land use for livestock and irrigation. To avoid this we place another restriction that G_{ug} does not exceed some very large number θ. This allows equation (13) to be non-binding if $B_{ug} = 1$, but ensures that in the case of $B_{ug} = 0$ no revenues are earned. This is expressed as:

$$G_{ug} \leq \vartheta B_{ug} \qquad \forall u, g \qquad (16)$$

2.5.5 The fencing constraint

Plots allocated to wildlife farms have to be bordered by a fence. To include restrictions on the fence length and hence the related costs in the model, we define a binary variable $F_j \in \{0, 1\}$ where 1 indicates the presence of a fence *j*. The fencing constraint is expressed as:

$$F_j = W_g - W_q \qquad \forall j \in \mathbf{K}_g \cap \mathbf{K}_q \text{ and } j \notin \mathbf{B} \qquad (17)$$

$$F_j = W_g \qquad \forall j \in \mathbf{K}_g \cap \mathbf{B} \qquad (18)$$

where *g,q* are indices of the plots as previously indicated, *j,k* indices of the all fences surrounding the plots *j, k*=1,…,*n*. **K** is the set of all the fences, $\mathbf{K}_g$ contains the fences *j* surrounding plot *g* and similarly $\mathbf{K}_q$ contains the fences *j* surrounding plot *q*. **B** is the set of all outer boundary fences belonging to only one plot i.e. the sum of plots *(g)* bordered by fence *j=1*. Thus $\mathbf{B} \subset \mathbf{K}$. ϖ is the costs of fencing per fence length. Thus equation (17) holds for the combination of adjacent plots that share the same fence, but excludes outer boundary plots, whilst equation (18) holds for the outer boundary cells. The ideal layout of wildlife reserves is one that minimizes the perimeter and fencing costs for plots containing wildlife.

The model developed in this paper is a mixed integer linear programming problem that solves in less than three minutes and is run with GAMS/CPLEX 12 (GAMS Development Corporation 2007). GAMS is powerful and flexible, allowing the user to build large maintainable models that can be adapted to new situations. It is designed for modeling many types of problems which include linear, nonlinear and mixed integer optimization problems (GAMS Development Corporation 2007). It was originally developed for applications related to economics and management science, and has recently received wide application in environmental and natural resource economics. GAMS can be used with a number of other programmes such as Microsoft Excel, Microsoft Access and Geographical Information System (GIS). Other software such as MATLAB, AIMMS, Mathematica and Analytica which can solve mixed integer programming problems can also be used. Smith et al., (2008) also used Marxan software to analyse alternative land use options based on a systematic conservation planning approach to facilitate conservation of land cover types, species, and ecological processes in Maputaland biodiversity hotspot of Lubombo TFCA. The Marxan software is compatible with other programmes such as GIS.

2.6 Results

2.6.1 Scenarios

To illustrate the functioning and the applicability of the model, we systematically develop hypothetical scenarios applicable to the case study area. The scenarios that are selected here are simple and highlight the main issues at stake to enable illustration of the key aspects of the model. A distinction is necessary between fixed wildlife and reserved wildlife plots for the purpose of enabling connectivity of wildlife farming. The fixed wildlife is a plot next to the park fence that is intentionally allocated to wildlife in the model to allow a reference point for the connectivity to the park in the allocation of wildlife and given that KNP is the main habitat of wildlife. The reserved wildlife is that amount of land which the model allocates to wildlife. Wildlife related damage in the model is considered both with regard to distance from the park and endogenously in relation to reserved wildlife in the optimization process.

In the base scenario, there is no restriction placed on the amount of land or location of any land use, the fixed wildlife is in plot six. In scenarios two to four we introduce a constraint on the maximum amount of land that can be allocated to some land uses. Tourism and irrigation in reality do not require as much land, as there are other factors limiting revenues such as demand constraints and water availability. Scenario three restricts the location of irrigation to plots along the river. In scenario four, we assume that location of irrigation is influenced by slope of land and restrict irrigation to flat land in plots 23, 24, 29 and 30. The effects of proximity to the road on land use allocation are considered in scenario five. In scenario six and seven the effects of increased fencing costs are considered. Scenarios eight to ten consider the effects of output price changes on land allocation. Scenarios eleven to fourteen explore the effects of changes in wildlife related damage and endogeneity effects of wildlife on land allocation outcomes. Table 2.2 shows the scenarios considered.

Table 2.2 Types of scenarios considered

Scenario number	Type of scenario	Description
Base (1)	Base scenario	No restrictions on land allocation, fixed wildlife in plot 6
2	Land area	Restrictions maximum tourism land allocation to 2 plots
3		Restriction that irrigation can only occur in plots along river Fixed wildlife in plots 6,
4		Restriction that irrigation can only occur on flat land.
5	Road effects	Scenario 4 with tourism proximity to road emphasized close to road.
6	Fencing costs	Scenario 4 with fencing costs doubled
7		Scenario 4 with fencing costs increased by tenfold.
8	Prices	Scenario 4 with livestock prices increased by 10%
9		Scenario 4 with game prices reduced by 10%
10		Scenario 4 with game prices halved
11	Wildlife damage and endogeneity effects	Scenario 4 with damage costs reduced by factor of five
12		Scenario 4 with damage costs eliminated
13		Scenario 4 with endogeneity effects of wildlife
14		Scenario 4 with damage costs and endogeneity effects of wildlife disregarded

The parameter values used are shown in Table 2.3 and are derived from range of primary and secondary sources.

Table 2.3 Key parameter values used in the base model

Symbol	Parameter	Value
α_g	Size of land plot	100ha
ρ	Total amount of land available	3600ha
γ_u	Price per unit of output	Livestock- \$972/LSU; Wildlife- \$1481/LSU; Irrigation-\$203/tonne; Tourism- \$5082/tourist bed nights
β_u	Maximum units of output produced per hectare of land	Livestock- 0.08LSU; Wildlife- 0.08LSU; Irrigation-5tonnes; Tourism- 0.31tourist beds nights
ψ	Factor for adjusting capacity of land adjusted for wildlife vicinity effects	Livestock- 0.8 for livestock; Irrigation-0.7 ; Wildlife and Tourism - 1
c	Operating costs	Livestock- \$119/LSU; Wildlife- \$377/LSU; Irrigation-\$89/tonne; Tourism- \$1270/tourist bed nights
t_u	Annuitised capital costs per 100 ha	Livestock- \$5; Wildlife- \$1513; Irrigation-\$316; Tourism- \$5082
ϖ	Annuitised fencing costs	\$119/km
χ_g	Distance from the different land marks for each cell (park, river, road)	Depending on the plot it is in the range of 0-6 km
σ_{ug}	Negative income effect of proximity to park (wildlife damage per parcel)	Depending on the plot and the land use type, it is in the range of 0-0.44
λ_{ug}	Extra income benefit from proximity to park (willingness of tourists to pay higher fees for accommodation closer to the park)	Depending on the plot and the land use type, it is in the range of 0-0.25
φ_u	Factor for adjusting loss in revenue as distance from road increases	Livestock- 0; Wildlife- 0; Irrigation-; Tourism- 0.01
η_g	Average slope of the parcel	Depending on the plot it is in the range of 0-0.12 percent rise
ξ_u	Factor for adjusting slope effects on parcel revenue	Livestock- 0; Wildlife- 0; Irrigation- -0.1; Tourism- 0.1
d_{gh}	Centre to centre distance between the parcels	Ranges from 0-5 km

2.6.2 Illustration of the model

Table 2.4 and Figure 2.4 show the outcome of the different scenarios considered. Because of the profit maximizing assumption, the model yields results with the highest benefits. If there are no restrictions allowed on the maximum land allocated to any land use in the base scenario, it is possible that the model allocates all of the available land to the most profitable land uses thereby excluding some of the land uses like livestock. In this base scenario all the land is allocated to tourism because it yields the highest benefits on per hectare basis. It is however not realistic to devote all available land to only tourism due to a number factors that include the seasonality of tourism, demand side constraints and preferences for other land uses such as irrigation and livestock. The other scenarios deviating from the base scenario allow to combine various constraints in a manner that is close to reality.

When tourism land is restricted to only two plots in scenario two, land is allocated to the next profitable land use, in this case irrigation. The two tourism plots are situated close to the park fence. In scenario three when irrigation is restricted to land along the river, the land allocated to wildlife increases and is located closer to the park, whilst land in the plots further from the park is allocated to livestock. Most of the irrigated land is however surrounded by livestock. When irrigation is restricted to flat land in scenario four, the connectivity path for wildlife is reestablished to the west of the grid and more land is allocated to wildlife, even in plots on the south side of the river. As in scenario three however, irrigated land is closer to livestock than wildlife, suggesting that livestock is being used as a buffer from wildlife. This could be because wildlife damage is higher for irrigation than livestock.

In scenario five when the preference for tourism to be situated next to the road is emphasized, the model allocates tourism to plots further from the park but close to the road. The doubling of fencing costs in scenario six does not result in land allocation that is different from that in scenario four. It is only when fencing costs are increased by tenfold in scenario seven that the model allocates less land to wildlife as expected. This shows that fencing costs although important, when considered in this simplified model, might not influence the resultant land allocation.

A 10% increase in the price of livestock in scenario eight makes livestock more profitable, hence more land is allocated to livestock in the model, whilst in scenario nine, a 10% decrease in wildlife prices also makes livestock more favourable and thereby increases the amount of land allocated to livestock, even allowing livestock to be in plots right next to the park. When wildlife prices are halved in scenario ten, all the land previously allocated to wildlife in the model gets allocated to livestock.

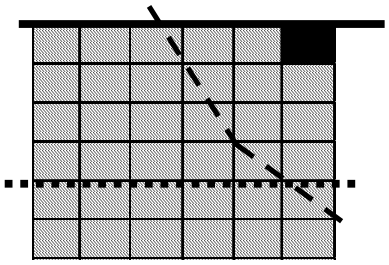
In scenario eleven and twelve when the probabilities attached to wildlife damage on livestock and irrigation are reduced, more land is allocated to livestock in the model as it becomes more profitable. This reduction of wildlife related damage also makes it possible for land next to the park to be allocated to livestock. Similarly when the endogenous effects of wildlife damage on other land uses are eliminated, thereby reducing the costs associated with wildlife on other land uses, this impacts land use allocation. In scenario thirteen, the amount of land allocated to wildlife is increased. When damage and endogenous effects of wildlife are reduced as in scenario fourteen both wildlife and livestock are accommodated with most of the land allocated to wildlife. In all the scenarios where endogenous effects of wildlife are considered in the model, irrigated land is always surrounded by livestock. It is only when the endogenous effects of wildlife are removed in scenario thirteen and fourteen that wildlife is allocated to plots next to the irrigated land.

As expected, a change from the base scenario results in a reduction in the possible income that can be obtained from the land. Most of the scenarios involve a more than 50% reduction in the income from the base case scenario. The base scenario, although most profitable, is not realistic and introducing constraints that are closer to reality results in loss in income. Scenario two which has the least income loss, is however also not realistic as it involves more irrigation than can be supported in the area. Reductions in the wildlife related damage in scenarios eleven to fourteen result in a slight gain in income. An 10% increase in the price of livestock in scenario eight, results in a slight improvement in the income.

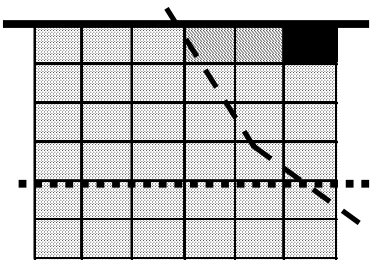
Table 2.4 Scenarios considered with related land allocations and percentage change in income

Scenario	% land allocation				Change in base income %*
	Wildlife	Livestock	Irriga-tion	Tourism	
Base- 1	2.8	0.0	0.0	97.2	-
2-Tourism restricted to two plots	2.8	0.0	91.7	5.6	-47.63
3- Irrigation only along river	30.6	30.6	33.3	5.6	-69.01
4-Irrigation only on flat land	63.9	19.4	11.1	5.6	-80.07
5-As 4, but tourism close to road	38.9	44.4	11.1	5.6	-82.65
6- As 4, fencing costs doubled	63.9	19.4	11.1	5.6	-80.16
7- As 4, but fencing costs increased by factor of fifteen	47.2	36.1	11.1	5.6	-80.83
8-As 4 but 10% increase in price of livestock output	47.2	36.1	11.1	5.6	-79.86
9- As 4 but 10% reduction in price of game ranch output	30.6	52.8	11.1	5.6	-80.68
10- As 4 but price of game ranch output reduced by 50%	2.8	80.6	11.1	5.6	-81.28
11-As 4 but wildlife damage costs reduced by factor of five	55.6	27.8	11.1	5.6	-79.75
12-As 4 but wildlife damage costs eliminated	55.6	27.8	11.1	5.6	-79.65
13-As 4 but endogeneity effects of wildlife eliminated	77.8	5.6	11.1	5.6	-79.70
14- As 4 but wildlife damage and endogeneity effects eliminated	69.4	13.9	11.1	5.6	-79.37

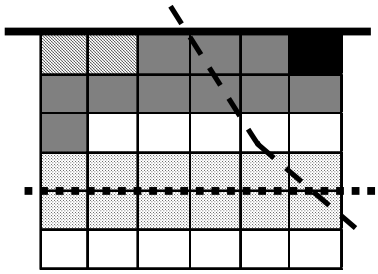
This is calculated as [(Scenario Income-Base Scenario Income)/ Base Scenario Income]*100



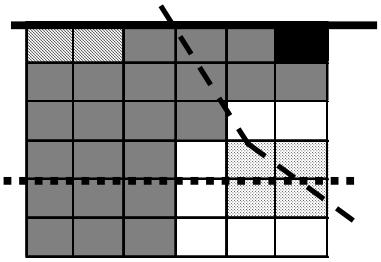
Scenario 1- No restrictions on land use



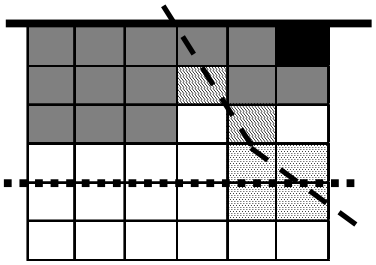
Scenario 2- Tourism restricted to 2 plots



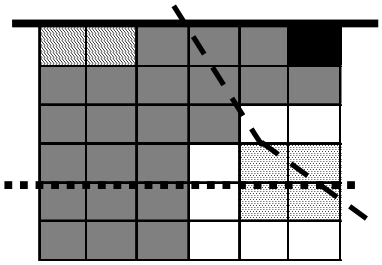
Scenario 3- Irrigation restricted to the river only



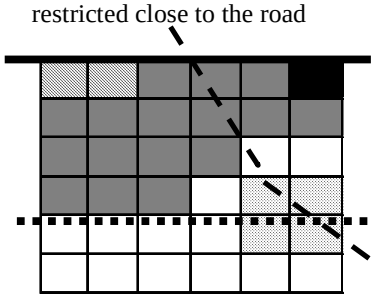
Scenario 4- Irrigation restricted to four plots river plots along on flat land only



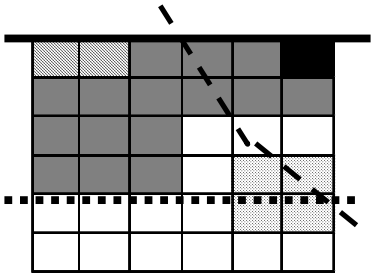
Scenario 5- As 4, but tourism restricted close to the road



Scenario 6- As 4 but fencing costs doubled

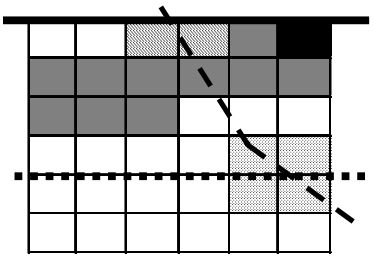


Scenario 7 -As 4 but fencing costs increased ten fold

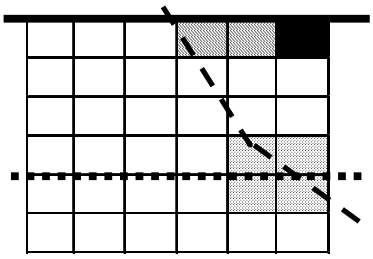


Scenario 8- As 4, but 10% increase in livestock prices

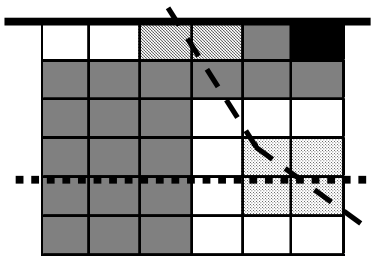
Figure 2.4 Some alternative configurations of land allocation and wildlife reserve shape under different scenarios



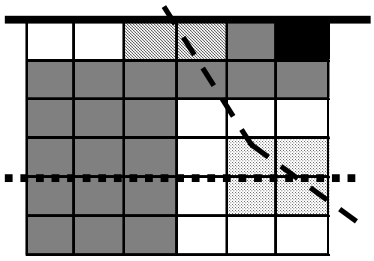
Scenario 9- As 4, but game output prices reduced by 10%



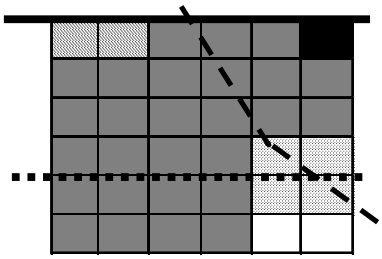
Scenario 10- As 4, but game output prices halved



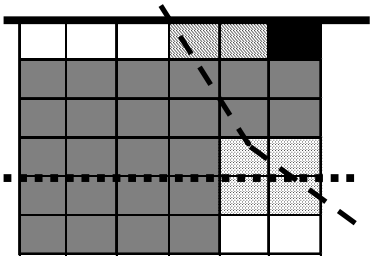
Scenario 11- As 4, but wildlife related damage reduced by factor five



Scenario 12- As 4, wildlife damage eliminated



Scenario 13- As 4, but endogenous effects of wildlife eliminated



Scenario 14- As 4, but damage and endogenous effects of wildlife eliminated

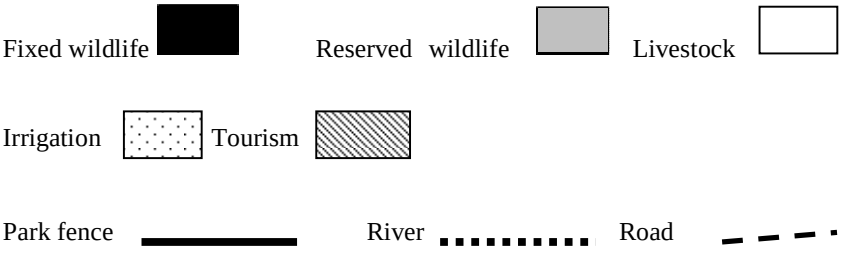


Figure 2.4 continued. Some alternative configurations of land allocation and wildlife reserve shape under different scenarios

2.7 Discussion and conclusion

Most land use planning decisions in developing countries are made with limited understanding of how different goals such as biodiversity conservation and agriculture can be combined (de Groot, 2006). This paper presents a model which can be used to analyse alternative land use options within buffer zones. Such evaluation of land use alternatives can aid decision making that meets specific objectives within existing socio-economic and biophysical limits defined by society and the environmental capacity. The model developed is simple and allows illustration of the key issues of concern at the interface such as wildlife damage costs (Bengis 2005; Naidoo et al., 2006), spatial location, and land use diversification (Munthali, 2007; Cumming et al., 2007), with possibility to apply it to a larger scale within the GLTFCA or other areas with a similar setting or land use problem.

The results from the model illustration although limited by the simplistic setting and the assumption that profit maximization is the main objective, give some important insights. Although according to the model, the optimal land allocation is tourism, followed by irrigation, placing the whole area of land under these two land uses is neither feasible nor practical. The potential for tourism lodges is limited due to demand side constraints and the competitive advantage of the KNP in supplying similar services. Similarly the shortage of water and negative externalities of wildlife on livestock and crop farming limit the possibilities for having irrigation as the major land use in reality. Change in some key parameters such as extent of wildlife damage, prices of different outputs, and fencing costs can influence both the spatial allocation of land use alternatives, and the amount of land to be allocated to different land uses. By considering socio-economic objectives and societal values and concerns (e.g. the need to maintain a minimum level of livestock, diversified land uses, depredation and diseases) together with biophysical capacity of the land, the model enables a broader and more realistic approach to reconciling varied interests in conservation and agriculture land use planning at the interface.

The presence of the park as a fixed landmark feature requires that all other ensuing land uses are planned around it. Location of different land uses affects the total revenue that can be derived from land based activities in the area, as well the feasibility of wildlife ranches as an emerging land use in the area. As illustrated by the analysis of various scenarios the model allows to

choose spatial allocations in a variety of settings and constraints, and analyzing the tradeoffs between conflicting land use objectives. By including connectivity and endogenising the effects of disease and depredation the model is able to take into account how land use options are related across space, and interactions between alternative land use options. Although it has been highlighted that models considering not only spatial characteristics of individual plots but the relationship between the plots themselves become complicated (Polasky et al., 2008), the additional value of such models is that they can help to address some of the key concerns at local level. The model framework enables analysis of relationships between alternative land use and competing claims for land at the interface.

The model structure can be extended to take into account a wide variety of bio-physical, socio-economic and environmental factors. This would allow detailed analysis of land use patterns and related tradeoffs between different objectives. We have used as an illustration the slope of the land, distance to the park or river, connectivity requirements for wildlife, maximum land area and the income objective, but other factors such as soil quality, nutrient availability, soil degradation measures, special flora and fauna protection, mineral resources can be included where necessary. Such data, if available can easily be included in the model. Depending on the objective function and the different criteria, alternative solutions can be sketched and stakeholders and policy makers can jointly decide about future land based development at the interface.

Empirical application of the model and its extension would also allow more detailed analysis of alternative scenarios, the minimum LSUs to sustain game hunting and determination of outcomes in situations where the objective function is altered. This would also provide some opportunity for improvement in the current situation. Further research can also consider whether there will be sufficient income and employment for the population from the available land and resources. Such analysis would allow determination of whether the available land and resources can provide sufficient means of living for the population, or explore the need for investment in education to enable people to earn a means of living outside the area, and options for alternative employment creation through activities that do not necessarily require a large area per unit of production.

CHAPTER 3[4]: Cattle Farming at the Wildlife/Livestock Interface: Assessment of Costs and Benefits

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Some of the text from this chapter is also contributed to de Garine-Wichatitsky M., Fritz H., Chaminuka P., Caron A., Guerbois C., Pfukenyi D., Matema C., Jori F., Murwira A. (*Forthcoming*) 'Consequences of animals crossing the edges of TFPs' in *Living on the Edge*, Earthscan.
An earlier version of this chapter was also presented at the World Conference on Animal Production held in Cape town, South Africa, November 2008.

Abstract

This study examined the extent and magnitude of cattle loss to wildlife depredation and diseases and also considered the benefits from the park for households adjacent to Kruger National Park. Data were from interviews with 540 randomly sampled households, inspection of records and focus group discussions. Households in villages close to the park reported higher incidence of livestock depredation (32%) than those further from the park (13%). Livestock diseases described by farmers included foot and mouth and heartwater. A partial budget was used to compare costs incurred and benefits derived by households. Mean annual costs of wildlife/livestock interactions, taking into account benefits associated with proximity to the park, averaged US$34 per household. Farmers viewed wildlife as an obstacle to cattle farming, and did not support the introduction of wildlife land use. Mechanisms to reduce effects of wildlife damage and increase livelihood benefits of coexistence with wildlife for households and the community are suggested.

***Keywords*: Costs and benefits, depredation, disease, wildlife/livestock interface.**

3.1 Introduction

Although wildlife conservation approaches have shifted over the years from largely exclusionary policies of using fences to keep out rural communities to approaches that recognize the role that rural communities can play in wildlife conservation (Songorwa, 1999), controversy still surrounds the human/wildlife/livestock interface and its socioeconomic impact on rural communities (Coetzer and Tustin, 2004; Kock, 2005; Anthony, 2006). The wildlife/livestock/human interface is multi-faceted and has both positive and negative implications for health, environment and economics (Kock, 2005). Transboundary conservation approaches such as the Great Limpopo Transfrontier Conservation Area (GLTFCA), straddling Zimbabwe, South Africa and Mozambique, could result in significant increases in environmental sustainability and positive economic spin-offs to rural communities (Bengis, 2005; Cumming et al., 2007). On the other hand, however, it is argued that increased wildlife/livestock interaction could lead to local level conflict (Kock, 2005), competition for land (Munthali, 2007), and increase the risk of transfer of transboundary animal diseases (Bengis, 2005).

Local level conflicts at the livestock/wildlife interface (hereafter referred to as the interface) may be linked to economic losses by livestock owners resulting from transfer of diseases from wildlife to livestock as well as losses due to depredation (Emerton, 2001; Bengis, 2005; Anthony, 2006). Crop destruction and wildlife depredation by wildlife is a major concern which farmers have about wildlife conservation and protected areas (Torquebiau and Taylor, 2009). Transboundary animal diseases are those diseases that can easily spread between countries resulting in negative economic and social impacts for affected countries. Such diseases can reach epidemic proportions, and cooperation between several countries is necessary for their effective control (DoA, 2008).

Limited information and understanding of the extent and nature of livestock disease and depredation at the interface, and the related livelihoods impacts, have been identified as potential problems in the establishment of the GLTFCA (Kock, 2005; Cumming et al., 2007). In South Africa, livestock depredation and disease transmission have also been identified as threatening conservation and rural development goals (Anthony, 2006), but there is limited information on

the financial and economic magnitude of these problems at the household level. The main objective of this study was to estimate the socioeconomic costs of cattle diseases and depredation to households at the north-western border of Kruger National Park (KNP) in South Africa, while also considering benefits derived by these households due to their proximity to the park, with the view to facilitate better understanding of the extent and nature of human/wildlife conflict at the interface for decision making.

Socioeconomic analysis of costs and benefits at the interface offers a means for objective measurement of the effects of wildlife on livestock based livelihoods. Such information, which is useful to managers of protected areas, land use planners and agriculturalists can assist in development of strategies for co-management of conflict and improved livelihoods around protected areas (Emerton 2001). Similar studies conducted in other developing countries have likely underestimated the costs of losing livestock for households. They only considered the direct loss of the animal itself by multiplying the market value of each animal with the number of animals (Mishra 1997; Butler 2000) and failed to consider potential livelihoods benefits for households living next to protected areas.

3.2 Overview of the main issues at the wildlife/livestock interface

Key issues at the interface include not only human and animal health, but also environmental and ecosystem conservation and economics (Kock 2005). Damage-causing animals that move into non-conservation areas from wildlife parks can cause problems for agro-pastoralist communities through depredation (Graham et al., 2005), and while the direct losses may appear to be low in monetary terms, or amount to small percentages of the total use values of wildlife (Barnes et al., 2002), the socioeconomic impacts may be highly significant for households where the investment in cattle represents a high proportion of household resources or savings (Graham et al., 2005). In South Africa, Anthony (2007) reported that 12.1% of the households interviewed in villages adjacent to the KNP had experienced losses of crops to wildlife or livestock depredation within the two years prior to his survey.

South Africa generally classifies wild animals in state protected areas in common law as *res nullius*, which means without a legal owner, belonging to no one in general (Hopkinson et al., 2007). Although there are exceptions to this legislation pertaining to private ownership of game animals, in the context of predation by animals from state protected areas, there is no effective legislation that allows farmers to claim wildlife related damages from the government or the park (Hopkinson et al., 2007). Predators from KNP that have been implicated by rural communities in livestock depredation include the leopard (*Panthera pardus*), lion (*Panthera leo*), cheetah (*Acinonyx jubatus*) and spotted hyena *(Crocuta crocuta)* (Anthony, 2006). In the IUCN's Red List, wild dogs are classified as endangered, lions and cheetah as threatened, leopards as near threatened and spotted hyenas as least concern (IUCN 2009).

In Africa, the interface is regarded as having the potential for bi-directional transmission of diseases. Many infectious diseases of livestock are propagated in wildlife reservoirs where control strategies are difficult or impossible to maintain (Bengis et al., 2004; Wobeser, 2007). In KNP, the Cape buffalo (*Syncerus caffer*) are permanent carriers of foot and mouth disease (FMD) and they also carry brown ear ticks which are vectors for theileriosis (Corridor Disease or East Coast Fever). Furthermore, the buffalo in KNP are maintenance hosts for bovine tuberculosis (*Mycobacterium bovis*), which was originally introduced to South Africa by infected cattle from Europe (Michel, 2005). Bovine tuberculosis can be transmitted to other wildlife, cattle and humans and is difficult to control due to lack of an effective vaccine (Kock, 2005; Michel, 2005). For purposes of transboundary disease control, livestock movement and marketing are controlled, in designated areas (zones) close to KNP. Veterinary cordon fences have been used around KNP, allowing cattle production without depopulation of infected wildlife. However, such fences are expensive to erect and need continual maintenance and, for vector transmitted disease, double fences are required (Bruckner et al., 2002).

3.3 Theoretical framework

Objective assessment of socioeconomic effects of conservation for communities at the interface requires consideration of potential benefits accruing from proximity to wildlife as well as the costs associated with wildlife activities (Emerton 2001; Mizutani et al., 2005). The costs and

benefits vary and can be considered at the household level, community level, or a more aggregate level. Benefits such as revenue sharing and social infrastructure investments have been implemented as incentives to communities living at the interface, but in most instances these benefits fail to outweigh the costs, especially at the household level (Emerton 2001; Jones and Barnes 2006). At the household level, the benefits include employment creation, business development opportunities, and capacity development (Mahony and Van Zyl 2001). Although wildlife has other indirect and non-use values such as option and existence values, realised both locally and nationally, in the absence of direct economic gain from wildlife at local levels, the indirect values of wildlife might not provide sufficient incentives for local communities to support conservation (Emerton 2001).

The extent to which the costs of depredation impact households depends on their magnitude and the range of livelihood options at the interface, amongst other factors (Graham et al., 2005; Mizutani et al., 2005). In addition to losses related to the value of the individual animal, long term contributions of livestock such as milk, dung and draft power to livelihoods are lost if replacement animals are not found. All these factors should be considered when determining the effects of wildlife depredation or conflict (Jones and Barnes 2006). Other costs associated with depredation, such as expenses incurred in constructing secure animal pens and the opportunity costs of labour associated with intensive guarding and herding of livestock for example, should also be considered (Emerton 2001; Mburu and Birner 2002).

Similarly, socioeconomic costs of livestock diseases involve more than just estimating the monetary value of the livestock lost (McInerney 1996; Otte et al., 2004; Perry et al., 2004). In addition to the death of an individual animal and long term loss of production, animals that recover will show decreased production, and recovery may entail substantial veterinary costs. There may also be macro-economic effects due to market adjustment factors such as increased prices for consumers as a result of reduced supply of livestock and livestock products to markets, or consumer perceptions about products from diseased livestock (McInerney 1996). To accommodate the various economic aspects relating to the presence of disease in a herd, McInerney (1996) proposes splitting the costs (C) of disease into loss (L) and expenditure (E) where C=L+E. Losses refer to the direct economic effects from livestock mortalities and reduced

productivity (e.g., reduced calving rates, decreased milk production, reduced off take), whilst expenditures refer to resources used in managing the disease. Depending on the purpose of the analysis, other dimensions such as the type of disease, specific control measures, and temporal and spatial aspects can be considered (Dijkhuizen et al., 1995; Perry et al., 2004).

We propose that at household level the effects of both depredation and disease at the interface can be summarised as shown in Table 3.1. These effects can be analysed using a partial budgeting approach which enables analysis of financial implications of livestock losses due to depredation and diseases for livestock households at the interface, whilst considering the potential benefits to households of proximity to protected areas. Although this approach does not enable analysis of the temporal and spatial dimensions of costs and benefits at the interface it gives a snapshot view of how costs and benefits compare, which can aid decision making.

Table 3.1 A framework for analysing local communities' costs and benefits of co-existing with wildlife

	Costs			Benefits
	Losses	**Direct costs**	**Social and indirect costs**[a]	
Depredation	-Loss of cattle -Loss of potential income from livestock products and functions.	-Increased costs of cattle pen construction -Increased labour costs	-Reduced options for livelihood diversification -Negative attitudes to wildlife	-Employment opportunities -Small business development -Resource harvesting[b] -Subsidies in veterinary care of animals -Reduced park entrance fees
Disease	-Losses in production of livestock & livestock products -Market adjustment effects	-Increased veterinary costs -Labour costs for treatment and handling	-Risk of zoonotic diseases -Food safety concerns -Reduced options for livelihood diversification	

[a] not measured in this study [b] not applicable in case study area.

Table modified after Otte et al. 2004.

3.4 Study area and data sources

The study was conducted in the Mhinga Traditional Authority (TA) in the Vhembe District of Limpopo Province, South Africa. The Mhinga TA, adjacent to KNP, has ten villages under its jurisdiction, namely Mhinga 1, Mhinga 2, Mhinga 3, Ka-Matiani, Joseph, Botsoleni, Maphophe, Mabililigwe, Makuleke and Nthlaveni (Figure 1). It covers an area of about 20,000 ha and comprises communal grazing on unimproved pasture, some land under cropping and village settlements with an estimated 6,880 households and 43,450 people (Mhinga Traditional Authority, 2008). The study area was chosen because of its proximity to KNP and being representative demographically and socioeconomically of most villages bordering KNP on the northern and western sides (Anthony 2006).

The rainfall is low (400 to 600 mm per year), with long drought periods. The grassland type is tropical bush and savannah with a grazing capacity of between 11-13 ha per livestock unit (AGIS 2009). Although the Department of Labour (2006) unemployment levels for the Limpopo Province are indicated as 37% on average, other estimates specific to the study area indicate that unemployment levels range from 60-80% (Mahony and Van Zyl 2001; Statistics SA 2001; Anthony 2006). Key livestock production features in the study area are movement and marketing restrictions on livestock within the "redline zone," or FMD control area. KNP and the surrounding areas are a declared FMD controlled area in terms of the regulations pertaining to the Animal Diseases Act (NDA 2000).

3.4.1 Data collection and analysis

Data were collected between July and September 2008. A household survey using a structured questionnaire covered seven villages, namely Mhinga 1, Mhinga 2, Mhinga 3, Ka-Matiani, Joseph, Botsoleni and Maphophe, where permission had been granted to conduct the study (see Figure 3.1). Within these villages there were five dip tanks (Mhinga 1, 2 and 3 shared a dip tank). Two of the villages studied, Ka-Matiani and Joseph, share a common border with the fence of KNP, and the rest are within 15km of the fence. The remaining villages (Mabililigwe, Makuleke and Nthlaveni) were subject to a chieftaincy dispute, and permission to conduct the study was not obtained.

Stratified random sampling techniques were used to select survey households using village lists obtained from tindhunas (headmen) as the sampling frame. Households in each village were stratified into cattle owning households (757, 11% of the estimated 6,880 households) and non-cattle owning households; from each stratum, households were randomly selected to make up the required sample sizes of 270 households for each stratum. The cattle owning households were identified through the Dip Register kept by the local Animal Health Technician (AHT). Sample size estimation was based on the method proposed by Cochran (1977), assuming 90% confidence level and a confidence interval of ±4.0.

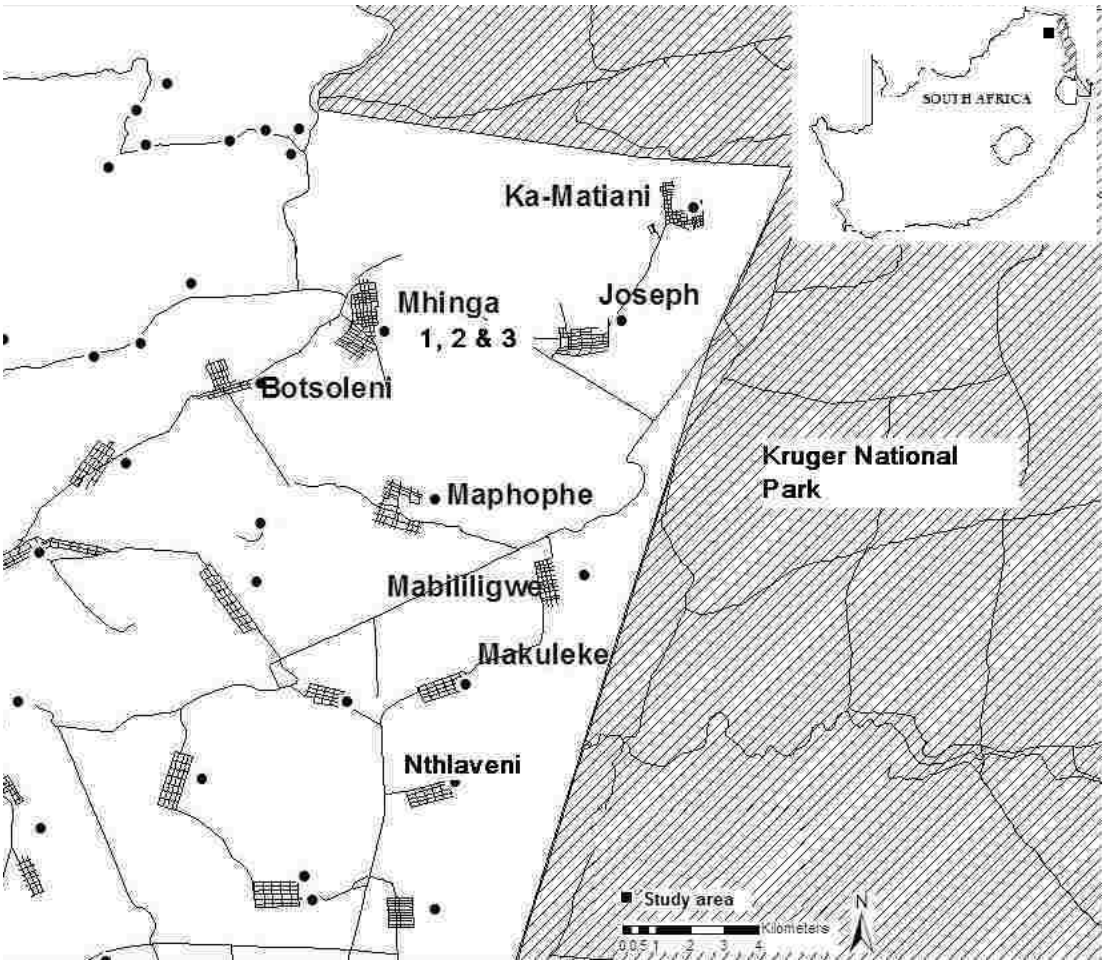

Figure 3.1 Location of Mhinga villages in relation to Kruger National Park

Structured questionnaires translated from English to the local Tsonga language solicited information on cattle ownership patterns, causes of cattle mortality and livelihood sources. Enumerators recruited from local villages and a local university

were trained prior to the survey. Follow ups to household interviews were done through a total of four focus group discussions, two for each stratum, covering perceptions of depredation and disease problems, relationships with the KNP and the future of cattle farming. The focus group discussions were held in two time periods, two months and four months after the survey. On each occasion two sets of discussions were held, one group comprising cattle owners and the other group comprising non-cattle owners. The attendees were initially identified through the village heads and farmer organization. On average each of the groups comprised twelve people, and discussions were conducted in Tsonga language. Eight key informant interviews with the AHT, headmen, local traders, leaders of the Farmer's Association, the chairperson and secretary of the Hlanganani Forum (a forum comprising village representatives, KNP and government officials) provided the necessary background and secondary information as well as a means to triangulate information from household interviews. Data on depredation and disease were also compiled from a retrospective study of formal written complaints made to the Hlanganani Forum over three years (July 2005-June 2008) and veterinary services records. Where such numbers differed with household information, the veterinary records were considered more accurate, to minimize the bias that normally arises in such studies if households exaggerate their losses (Mishra, 1997). Quantitative data on the benefits of cattle production were obtained through household interviews. Average market prices for cattle and cattle products were calculated from prices provided by trading households and from local butchery owners.

Net benefits of co-existence with wildlife at the interface for the i^{th} household X_i, were estimated per annum as;

$$X_i = \left[\alpha W_i + \beta F_i + \gamma \sum_{j=1}^{n} S_{ij} \right] - \left[v(D_i + E_i) + (D_i + E_i) \sum_{k=1}^{n} p_k Q_{ik} \right] - T_i - nR_i$$

where α is the probability of earning wage employment in KNP; W_i is the annual average wage income in KNP; β is the probability of selling crafts in KNP; F_i is the average amount of money earned by selling crafts in KNP; S_{ij} is the j^{th} subsidy received by the i^{th} household due to proximity to KNP such as half price park entrance fees, and free livestock vaccination; γ is the probability that the household accesses the S subsidy ; ν is the average selling price of cattle; D_i is the number of cattle lost to

predation per household; E_i is the number of cattle lost to disease per household; p_k is the unit selling price of the k^{th} livestock benefit such as milk, dung and draft power; and Q_k is the annual average quantity of milk, dung and draft power per animal. The average costs of pen securing per household are indicated by T_i and additional costs of veterinary care per animal are R_i per household, whilst n is the average cattle herd size per household.

The monthly wage for KNP employment was assumed to be equivalent to the minimum wage of R2,270 (US$ 287.3 using an exchange rate of US$1- R7.9 as of July 2008) indicated in the 2007-2008 SANParks annual report. Earnings from crafts were based on figures obtained from sales of crafts sold in the community craft shop at the Punda Maria gate. The probability of a household having a member employed in KNP or selling crafts was calculated from survey data.

Pearson's chi-square was used to analyse independence between a range of categorical variables observed in response to questions relating to depredation and disease by village. F-tests were conducted to test for difference of means for cattle lost to various causes between farmers in different villages when pooled. The three villages (Mhinga 1, 2 and 3) which shared a dip tank also shared grazing camps and were thus considered as one unit in analysing the differences between the extent of predation in relation to distance from KNP and disease incidence. This implies that comparisons were made for five dip tanks and grazing camps covering seven villages. Weighted ranking was used to analyse farmer responses on the most important livestock diseases in the area through;

$$W_j = \sum_{i=1}^{3} (A_{ji} \times \varphi_i)$$

where W_j is the rank accorded to the disease by the respondent, A_{ji} indicates the number of times that disease j is ranked by respondents, φ_i is the weighted attached to the *ith* rank. Rank one denotes the most important disease and has a weight of one, rank two carries a weight of 0.5, and rank three carries a weight of 0.33.

3.5 Results

3.5.1 Household structure and livestock production

The average household size for cattle owning households was 7.3 (SE= 0.21), and the average age of the household head was 58 years (SE=0.8). For the non-cattle owning households average household size was 6.0 (SE= 0.15), and the average age of the household head was 50 years (SE= 0.80). There were statistically significant differences between the two groups for both the average household size (F=23.06, df=1; p=.00) and age of the household (F=47.76, df=1; p=.00). About 27% of cattle owning household heads indicated farming as their occupation, whilst 42% considered themselves as unemployed. Thus about 69% of the heads in cattle owning household group were not formally employed. Livelihood activities comprised subsistence crop farming, large and small stock farming, small local businesses (self-employment), and formal employment. Important livelihood sources were remittances from non-resident household members and child support and old age grants.

Although livestock in the area included cattle, goats, sheep, pigs, and donkeys, it was established prior to the survey that there were hardly any cases of depredation of goats and sheep since they grazed close to the homestead. When we checked on the list of reported incidences of depredation to the KNP, we also did not find reported cases of small stock depredation. Total cattle numbers in the whole area of Mhinga fluctuated over the years, but showed a general increase over a twenty-year period (1989-2008), rising from 1,500 to slightly more than 4,000. Although the grazing capacity was about 11-13ha/LSU (AGIS, 2009), the actual stocking rate in July 2008 was about 5ha/LSU. The average herd size per household in the cattle owning stratum was 9.2 (SE=0.60), although about 42% of the households had fewer than five cattle. When both groups of households were considered this was reduced to 4.6 (SE=0.36) cattle per household. About 43% of households indicated that cattle income constituted more than 50% of their total income. The average market price for cattle was R3439 (SE=107.9) or US$ 435.3. Benefits derived by households from cattle farming included milk, dung, draft power, and easy access to animals for ceremonial activities.

3.5.2 Depredation

About 25% of cattle households lost cattle to depredation between and including July 2005- June 2008. The level of depredation that was reported for different villages is shown in Figure 2. Pearson chi-square tests showed statistically significant differences in percentage of households experiencing depredation across different villages ($\chi 2=11.7$, df=4, p=.02). The mean number of cattle lost to predators between 2005 and 2008 was 0.73 (SE= 0.10) per cattle owning household. Pooled tests of mean differences of cattle lost/household in the different villages were statistically significant (F=2.5, df= 4, p=.05). The reported incidence of depredation and number of cattle killed generally decreased further from the park (see Figure 3.2) with the exception of Maphophe village. The reason for this might be that on one edge of the village there are thick bushes where predators that escape from the park can hide for some days. In fact, during one of the days the survey was conducted in the village, it was alleged that two lions had been spotted in the bushes on the outskirts of the village early in the morning. Some (5%) of non-cattle households had stopped keeping cattle because of previous losses to depredation, and others (13%) cited problems with wildlife as the main reason they did not want to own cattle.

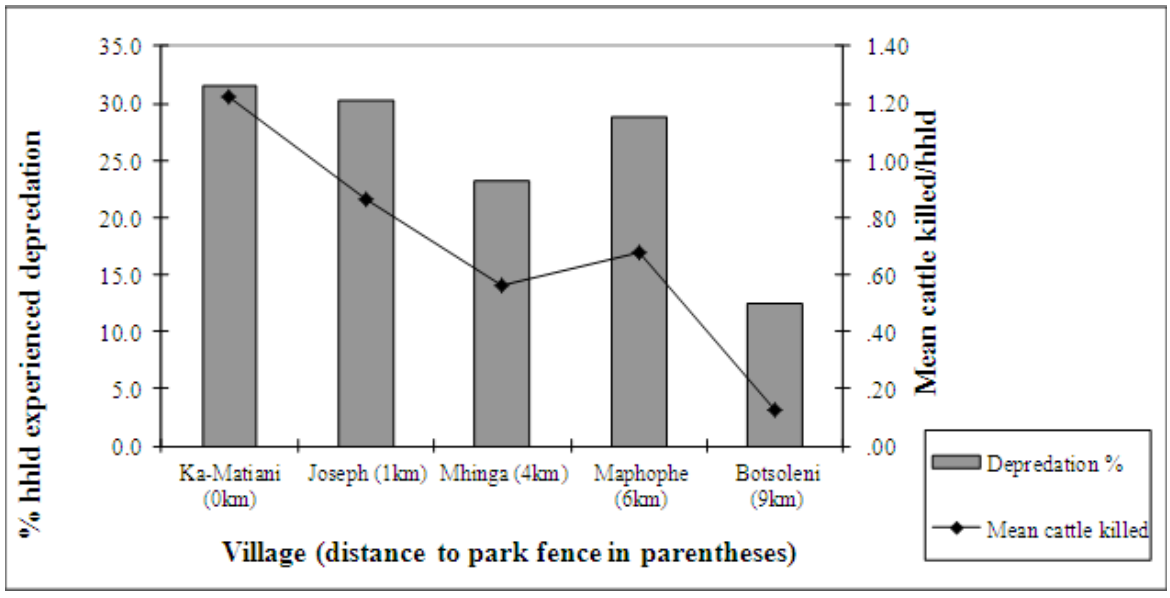

Figure 3.2 Percentage of households experiencing depredation and mean cattle killed per household per village 2005-2008

In focus group discussions it was reported that the most common cattle predators were lions and most killings occurred at night. There did not seem to be uniformity regarding the procedures for reporting depredation in this area. Reports of cattle loss had been made to the local traditional authority (53%), officials from the Department of Environmental Affairs and Tourism (16%), directly to the Hlanganani Forum (13%), the police (5%) and KNP officials (13%). All reports made to different authorities were, however, collated by the Hlanganani Forum and recorded. In focus group discussions farmer attitudes towards wildlife conservation authorities were generally negative mainly due to the perception that not enough was being done to curb depredation. They suggested that they should be allowed to kill predators, and officials should respond more quickly to reports of depredation and regard repairs to damaged fences as a priority. It also emerged during discussions with farmers that the poor state of the KNP fence, and lack of clarity on whose responsibility it is to maintain the fence, was the main cause of conflict.

3.5.3 Livestock diseases

Cattle diseases were an issue of major concern for both the Department of Agriculture (DoA) officials and the farmers in this area. Measures in place to reduce disease were mandatory weekly dipping in summer and fortnightly in winter, vaccination programmes and livestock movement controls. Dipping chemicals were supplied by state veterinary services and AHT supervised dipping and inspected cattle for signs of FMD. The DoA provided free vaccines inside the redline zone for FMD (twice a year around April and November), for brucellosis (once a year no specific month), and jointly for anthrax and black quarter (once a year around October). Approximately 36% of the cattle farmers indicated that they had lost cattle to diseases in the last three years. The mean cattle lost to disease per household in the period July 2005-June 2008 was 1.17 (SE= 0.171) and also differed significantly between villages (F=3.9, df= 4, p=.005).

Farmers considered prevalent cattle diseases in this area as FMD, lumpy skin disease, heartwater, and tick damage. Calculated weights of farmer rankings of important diseases shown in Table 3.2 indicate that farmers are most concerned about FMD and tick damage. The last FMD outbreak in this area was in August 2006 and was

confirmed by state veterinary services at Ka-Matiani and Joseph villages. Not all diseases indicated by farmers as being of concern are associated with, or confined to the wildlife/livestock interface and not all have high mortality rates. Although all cattle mortalities were indicated in the veterinary records, the specific diseases causing mortalities were not recorded.

Table 3.2 Farmer ranking of livestock diseases of concern

	Rank given				
	Rank 1 Weight- 1	**Rank 2** Weight - 0.5	**Rank 3** Weight -0.33	**Times ranked**	**Weighted ranking**
Foot and mouth**	59	7	1	67	63
Tick damage and abscesses	24	7	1	32	28
Heart water*	25	4	1	30	27
Lumpy skin disease	17	7	5	29	22
Worms	11	3	0	14	13
Brucellosis*	1	1	0	2	2
Unknown causes	11	9	1	21	16

* Diseases commonly associated with, but not exclusive to the wildlife/livestock interface. ** Diseases associated with the wildlife/livestock interface.

3.5.4 Estimation of costs and benefits to cattle owning households

Benefits from proximity to KNP are identified as employment opportunities, small business development in the area of crafts and retailing, and discounted (50%) entrance fees into KNP. Harvesting of resources from the park is not permitted in line with the Animal Health Act No. 7 of 2002 and the National Parks Act of 1976 (Anthony 2006). Only 8.3% of the households indicated that they had members who were employed by KNP on a full time basis, and only 3% had members who produced crafts for sale in KNP. The main KNP jobs cited were game guides and unskilled labourers on a temporary basis or permanent basis.

Table 3.3 shows a partial budget of the financial implications of wildlife/livestock interactions at the household level in Mhinga for cattle-owning households. Calculations are based on the price of an adult animal which was R3,439 (US$ 435.3) as of June 2008. Benefits of discounts (US$2.2/person) for KNP entrance fees are calculated using the average household size of seven people. Due to lack of

alternative estimates, we assume that 27% of the households visit KNP based on findings by Anthony (2006). It is important to point out however, that the 27% were actually households that indicated that they had ever visited the KNP and not only in one year, hence the figures in Table 3 would overestimate the value of discounts for the park entrance fees. Earnings from the craft shop are on average US$19/month per selling household, and only 3% of the households produced crafts for sale in the shop. The potential for high sales in the craft shop next to the Punda Maria gate is very limited because the shop is located about 150m away from the gate and is not very visible to tourists, who rarely stop.

The estimated annual losses for depredation are 0.24 cattle per household (from 0.73 in three years) and 0.39 cattle per annum per household to disease (from 1.17 for three years). This gives a combined total of 0.63 cattle per annum per household. Apart from the loss of the actual animal itself, other costs incurred by households at the interface are the loss of value of products from the animal that are foregone once it is dead and extra veterinary costs that farmers incur in the redline. The proportion of cows in the herd was 0.46, and farmers milked on average 3.8 litres per cows per day and sold the milk locally at US$0.6/litre. Cows were milked for only two months on average, although calves were weaned at about eight months. Farmers explained that the short milking period was because the area was dry area with limited fodder, and the cows were usually not fed supplements. Estimated milk revenues lost for the 0.63 cattle that die due to predation and disease are thus US$41.3. About 5kg dung was collected from a penned animal at night and this dung was sold for US$0.8/40kg; the revenue loss is estimated for 0.63 cattle. Average earnings from use and sale of draft power per household were US$56.1/year based on survey estimates. The proportion of draft cattle in the herd was 0.27; for 0.63 cattle lost to depredation and disease, potential earnings lost were US$9.5. Reduced productivity of milk and draft power performance could not be estimated with the data available.

Discussions with the AHT and some farmers indicated that extra measures were taken by some individual farmers to vaccinate their cattle against parasite infections, more specifically for theileriosis. The costs of these extra vaccinations borne by individual farmers estimated together with the AHT and farmers were US$2.4 per animal. Prices of the vaccines administered to cattle were obtained in a farmer's shop in the nearby

Malamulele township, and administered dosages were obtained from the package insert as well as the local AHT. Pens were also enhanced to minimize predation using meshed fencing material at the bottom of the kraal to prevent predators crawling in. These costs were estimated to be an average of US$27.9 per household for both labour and materials. Farmers indicated in the focus group discussions that there was no night guarding of animals or intensive herding of livestock in the grassland to reduce depredation. The farmers also received some subsidies for fodder, free dipping, and free cattle vaccinations from DoA. On average, the costs of the vaccines administered by DoA were US$2.3 per year per animal and for a herd size of nine the subsidies are worth US$20.5. Free dipping services and subsidies in fodder are received by farmers both inside and outside the redline zone, hence they are not an extra benefit to farmers inside the redline zone and we do not consider them in the partial budget.

It might be considered that the fact that only 11% of the households owned cattle indicates that the direct effects of wildlife damages are not borne by the majority of households. Furthermore, cattle ownership was skewed with the more than 40% of the cattle owning households having less than five cattle. Analysis of equality of distribution of cattle amongst the cattle owning households, yielded a gini coefficient of 0.6. About 50% of the households owned only 19% of the cattle, and 75% of households owned 43% of the cattle. The top 10% of cattle owning households accounted for about 30% of the cattle in Mhinga. It is possible that wildlife conservation and wildlife tourism projects could receive support from those households that do not themselves have cattle or those that have a few cattle.

Table 3.3 Costs and benefits of wildlife/livestock interactions per annum per cattle owning household

	US$ per beneficiary or affected household	Proportion of households affected or benefitting (%)	Average in US$ per cattle owning sample household (n=270)
Extra benefits			
• Employment opportunities in KNP	3448.1	8.3	286.2
• Small business opportunities	227.9	3	6.8
Reduced costs			
• Free cattle vaccinations	20.5	100	20.5
• Subsidized entrance to KNP	15.5	27	4.2
Total inflows	3712.0		317.7
Extra costs			
• Disease mortality	471.7	36	169.8
• Depredation mortality	423.8	25	106.0
• Veterinary care	21.5	40	8.6
• Pen securing	27.9	100	27.9
Foregone benefits			
• Milk	41.3	41	16.9
• Dung and manure	21.8	90	19.7
• Draft power	9.5	27	2.6
Total outflows	1017.6		351.4
Net benefit[a]			(33.7)

[a] The net benefit per affected or beneficiary household is not calculated because not all the costs and benefits apply to the same user household

3.6 Discussion

This study used a partial budgeting analysis framework to estimate the net effects of co-existence with wildlife for households at the north-western border of KNP in South Africa. In the analysis, the costs of cattle diseases and depredation and the benefits derived by households from the park are considered. Although in monetary terms the difference between the costs and benefits is only US$34 or 3.5% of average annual

household incomes of US$960 (PROVIDE 2005), when other factors discussed below are considered, then the impacts of such losses are more clearly understood. Poverty incidence rates in this area are more than 60% (PROVIDE 2005; AGIS 2009), and the average cattle herd sizes are low with 42% of households having less than five cattle. As noted by Graham et al., (2005), the loss of one animal, although low in monetary terms, could have significant impacts where the investment in cattle represents a high proportion of household resources or savings. On the other hand, those households with few cattle might be more willing to support conservation and wildlife tourism projects if the perceived benefits from such projects were greater than the losses incurred by wildlife related damages. The focus on average losses can also mask the variation in losses suffered by households or villages to the detriment of those who suffer the highest losses (Naughton-Treves 1998). In the case of disease the death or culling of even few animals following disease outbreaks can potentially have severe effects on livestock based livelihoods and practices (Bruckner et al., 2002; Mizutani et al., 2005). Furthermore, the impacts of depredation and disease mortality can also be felt by households without cattle, who stand to lose benefits such as milk and dung, whilst for other households depredation could be a deterrent from engaging in livestock based livelihoods, as noted in this study.

The benefits such as wage employment and subsidies associated with proximity to KNP, although substantial for beneficiary households, however, do not accrue to all households. The households affected by depredation are not necessarily the same ones that are able to secure employment in KNP, although the opportunity to sell crafts in KNP is open to any household in the community. Other interventions by KNP to support adjacent communities through educational opportunities, employment generation and enterprise development (Anthony 2006; SANParks 2008) are at aggregated levels and might not be sufficient where the direct costs of conservation are borne by individual households. This imbalance between accrual of benefits and costs has also been highlighted by Emerton (2001), who indicated that non-targeted, broad benefit based approaches to wildlife conservation usually do not provide day-to-day income, employment or livelihood benefits to the majority of households.

The generally negative attitudes to the park displayed by farmers in this study and linked to perceptions that not enough is being done by the KNP about damage causing

animals that was also described by Anthony (2007) is likely to continue. This is partly related to the fact that farmers who have suffered damage by wildlife are not directly compensated, and there is lack of clarity on the procedures for reporting damages to wildlife (Anthony et al., 2010). The current situation where farmers feel that there are no clear channels to communicate problems of damage causing animals, and both KNP and the government do not take responsibility for any damage caused by wildlife could be addressed by considering some options for compensation. Financial compensation schemes have been used elsewhere to manage human-wildlife conflict although in developing countries the implementation of such schemes is hampered by administrative and long term financing problems (Graham et al., 2005). Other alternatives to compensate affected communities that are not necessarily direct financial payments could be possible. The government could create improved opportunities for livelihood diversification in this area through infrastructural investment and support to small local and tourism based businesses and activities. Similarly interventions to increase productivity of cattle farming for households or communities suffering wildlife related damage (Emerton, 2001; Mizutani et al., 2005) could be explored.

The KNP could also explore mechanisms for revenue sharing with those communities where wildlife damage disrupts agricultural opportunities. It is important that such a mechanism, if established is set within a clear administrative and legal framework. Chaminuka et al., (2011) described the problems of institutional failure and a mismatch between policies and practice which have hampered the development and implementation of a mechanism for compensation in this area. The authors recommend the active engagement of rural communities and all relevant stakeholder institutions in developing a system for managing conflict in the area. We further suggest that the community should not be treated as a homogenous entity represented by the Hlanganani Forum, but rather households who have suffered damage from wildlife be identified, and livestock farmers be specifically included in any such processes. The direct effects of wildlife related damages are borne by only 11% of the households that own cattle, and there could be opportunities to garner support for conservation and wildlife tourism from those households that do not directly suffer wildlife damages. Such households, together with those that own cattle, but whose

main source of income is not cattle, could support wildlife tourism and conservation if there were prospects for income generation and employment creation.

Although this study did not investigate the incidence of livestock disease outside the redline, the impact of wildlife/livestock interactions in terms of disease cannot be disregarded in the area. The Mhinga area, like other areas falling within the redline zone is considered to have higher potential for wildlife-livestock transmitted disease. Cattle dipping inside the redline zone occurs weekly and is mandatory, whereas outside it occurs fortnightly. It is also understood that contact between wildlife and livestock at the interface increases the risk of disease transmission (Coetzer and Tustin, 2004), and in addition controlling diseases in wildlife without eradication is difficult (Wobeser, 2007). It is worthwhile, however, for future studies that are focused specifically on issues of disease to investigate whether losses due to disease are higher for cattle households at the interface compared to those that are not.

3.7 Conclusion

This study is based on a partial budgeting financial analysis and only considered the community level benefits associated with proximity to wildlife. Whilst this information has limitations for policy making, it is however relevant for decisions concerning community based conservation initiatives. The argument that expanding wildlife conservation through Transfrontier Conservation Areas (TFCAs) will have positive economic spin-offs for rural communities (Kock, 2005; Munthali, 2007) should be more closely examined, given that the costs of proximity to wildlife outweigh the benefits for some households. Should there be increased livestock/wildlife interactions in the TFCA, depredation and disease incidence, if not controlled, could derail the objectives of livelihood diversification and poverty reduction. Reduction in livestock depredation and wildlife related conflict can provide long term incentives for partnerships in conservation (Mburu and Birner, 2007), which is one of the pillars of the TFCA approach. In the longer term, the current situation where there is no platform to seek recourse for damage from predation should be debated at a higher policy level to facilitate change in such legislation or minimize the negative effects of this legislation on rural communities. We suggested

possible mitigation strategies for the problem in Mhinga. There is however, no standardised prescription for mitigation of conflict at the interface, nor can the problem be entirely solved as long as people live with wildlife (Torquebiau and Taylor, 2009). Because of differences in the extent of the problems concerning damage causing wildlife within countries in the GLTFCA, and, between different communities in South Africa, there will be variation in the manner in which these issues are addressed, and the priority attached to them. The intervention within the different countries will also be guided by existing legislation on damage causing animals and property rights and governance systems.

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CHAPTER 4: Livelihood Roles of Cattle and Prospects for Alternative Land Use Development at the Wildlife/Livestock Interface in South Africa

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Abstract

Livestock farming, and its contribution to livelihoods at the wildlife/livestock interface is being questioned due to possible expansion towards wildlife land uses. This study analysed the contribution of cattle to livelihoods and the relationships between cattle and other income generating activities, particularly wildlife land uses at the interface. A combination of monetary valuation techniques and livelihoods analysis was used. Data was collected through interviews with 270 sampled cattle owning households (CH) and 270 non-cattle households (NCH), focus group discussions and workshops. About 11% of the households in the study area owned cattle, and cattle income constituted 29% of total income in CH. NCH received some benefits from cattle, contributing towards their physical, human, social and natural livelihood capital. About 71% of the households had at least three sources of income, reflecting the diverse nature of livelihoods at the interface. Wildlife related land uses were perceived by CH as threatening cattle production, whilst NCH viewed them as opportunities to create alternative livelihood options in the future. We suggest ways to improve cattle farming whilst encouraging emerging livelihood activities like wildlife farming.

Keywords: Cattle, competition for land, livelihoods, non-market valuation, wildlife

4.1 Introduction

Transfrontier Conservation Areas (TFCAs) in Southern Africa have potential to integrate rural development, and wildlife conservation goals by promoting land use diversification and wildlife tourism in rural communities at the periphery of protected areas (Munthali, 2007). By presenting opportunities for rural communities to shift from marginal agricultural production towards wildlife tourism based land uses, TFCAs can improve rural livelihoods and contribute towards poverty alleviation (Munthali, 2007; Whande, 2007). On the other hand, TFCA's could result in further marginalization of rural people thereby making livelihoods more vulnerable due to increased human-wildlife conflict and competition for land (Munthali, 2007; Metcalfe and Kepe, 2008). For livestock farming, competition for land from wildlife is real and increasing. It has also been argued that under uncertain environmental conditions, wildlife ranching can complement or replace agriculture (Barnes, 1998; Skonhoft and Solstad, 1998; Tomlinson et al., 2002).

Concerns have been raised about the possible impacts of the Great Limpopo Transfrontier Conservation Area (GLTFCA) on the livelihoods, land use practices and future development prospects in rural communities residing near protected areas (Cumming, et al., 2007; Whande, 2007). A shift in land use towards wildlife based tourism and biodiversity conservation, could result in increased wildlife/livestock interaction in rural areas and also impact traditional land uses such as livestock farming and agriculture in these areas (Munthali, 2007). In South Africa, on the north western side of the Kruger National Park (KNP), plans are already being made to turn communal land currently under livestock grazing and crop farming towards wildlife tourism based development projects such as tourist accommodation facilities and game ranches (Mhinga, Undated; Thulamela Local Municipality, 2009). As wildlife tourism based development is introduced as an alternative livelihood source in rural communities of the GLTFCA, it is important to understand the nature and role of existing livelihood activities such as livestock farming at the wildlife/livestock interface (hereafter referred to as the interface) and relationships between existing and upcoming livelihood strategies (Cumming et al., 2007; Munthali, 2007). Understanding the importance and role of livestock and other existing livelihood

options at the interface is critical for the reconciliation of rural development and conservation goals.

Although the cultural, economic and social roles of communal livestock systems have been widely studied in Africa (Scoones, 1992; Shackelton et al., 1999; Ainslie, 2005), there is need for such analysis within the context of TFCAs due to several reasons. First, the role of cattle in livelihoods is dynamic and can be influenced by climatic conditions, land use changes and socio-economic developments (Cousins, 1999). Second, most studies on estimating the contribution of livestock to livelihoods have either focused only on quantification of livestock products, both marketed and non-marketed (Bosman et al., 1997; Randela, 2003; Moll, 2005; Dovie et al., 2006) and in other cases applied only qualitative analysis (Ainslie, 2005). Each of these approaches has its own merits and shortcomings. Quantitative methods have been said to be too simplistic, whilst qualitative approaches on the other hand have been criticized for failing to provide quantified measures which are required for policy making (Alary et al., 2011). Lastly, there is limited information within the context of GLTFCA on the relationship between emerging and existing land uses and livelihood options (Cumming et al., 2007).

This study seeks to establish the contribution of cattle to livelihoods and to explore the relationship between cattle farming and other income generating activities at the interface through a combination of monetary valuation techniques and livelihoods analysis. This will contribute to the discussion about the future of cattle farming at the interface in relation to other livelihoods activities, specifically wildlife based land uses. The study combines monetary valuation techniques with livelihoods analysis to enable better understanding of observed multiple roles of livestock in relation to other livelihood activities whilst also providing quantified measures which are useful for decision making. It is expected that the results from this study can contribute towards a broader debate on appropriate pathways for rural development in transfrontier conservation areas and the future of livestock farming at the interface.

4.2 Theoretical framework

Several approaches and perspectives on livelihoods analysis and poverty reduction have developed since the 1990s (Chambers, 1995; Scoones, 1998; DFID, 1999). Livelihoods approaches argue that survival of people depend not only on their financial resources but also on the assets that they have at their disposal (Chambers, 1995). These assets are broadly classified into five categories namely: human, social, physical, natural and financial assets. The assets include social networks, local knowledge, communal land and cattle. Depending on the specific institutional environment, the assets are key to the livelihood activities that household members can do to gain a means to live. In this paper we consider livelihoods as the activities and sources from which people gain a living *'including livelihood capabilities, tangible assets and intangible assets'* as defined by Chambers (1995).

Livelihoods approaches provide a useful framework for understanding local realities, learning together with the farmers, and are particularly useful for analyzing complex, multidisciplinary problems (Scoones, 2009; DFID, 1999). They allow analysis of the diversity of rural households and interaction of socio-political, economic and environmental processes at various levels (Shackelton et al., 1999, Scoones, 2009). Tradeoffs and relationships between different livelihood strategies and outcomes can also be analysed. Criticisms of livelihoods approaches are that they are too complex, fail to meet real world challenges at different scales, and are unable to grasp political structures and processes (Scoones, 2009). Emphasis on the local context also render the approaches inappropriate to deal with issues at meso, macro, and global scale levels (Scoones, 2009). Another weakness of livelihoods approaches is that there are overlaps among the different capitals and it is not always easy to distinguish clearly between the different types of livelihood capital. Despite these criticisms, livelihoods approaches are particularly useful because they put the household at the centre thereby enabling one to understand the value of alternatives for development from the household perspective.

In determining the role and importance of cattle in relation to other livelihood options, it is possible to combine qualitative and quantitative techniques to allow a better understanding of complex and multifunctional roles of livestock and rural livelihoods,

whilst also generating results that can be used for policy making (Alary et al., 2011). In this study we use a livelihoods analysis framework, combined with monetary valuation approaches to determine the livelihoods contribution of marketed and non-marketed physical cattle products, and the value of intangible roles of cattle .

Existing approaches to estimate benefits of livestock in monetary value vary with regard to the range of benefits considered, the context, the objective of the analysis and the unit of analysis. Randela (2003) and Scoones (1992) determined the livestock benefits per animal, whilst other studies determined the value per hectare (Scoones, 1992; Shackleton et al., 2005) or per household herd (Moll, 2005; Dovie et al., 2006). The approach we follow was used by Moll (2005) in Zambia, to quantify marketed and non-marketed livestock products, and also value intangible roles of livestock such as financing, status display and insurance functions. These have been identified as being important in communal grazing systems in South Africa (Dovie et al., 2006; Stroebel et al., 2008) but have not previously been quantified.

In quantifying the role of cattle, we estimate the net value of cattle for the i^{th} household (V_i) as;

$$Vi = \sum_{k=1}^{n} p_k Q_{ik} + mL_i + F_i + C_i + S_i - X_i \qquad (1)$$

where p_k is the unit selling or estimated market price of the k^{th} recurrent livestock benefit such as milk, dung and draft power and Q_{ik} is the total amount of product (i.e. consumed by household, sold and given away in kind) of the k^{th} recurrent output produced by the i^{th} household per year. L_i is the number of live cattle sales from the i^{th} household, and m is the unit price per animal sold. X_i are the cattle production costs incurred by the household. Following the approach of Bosman et al. (1997) and Moll (2005), we can also estimate the benefits derived by the household from functions of cattle as a financing mechanism (F_i) i.e. substitute for banking facilities, as insurance (S_i) against unforeseen problems such as sickness and death and for use as a status symbol in some cultures (C_i) as outlined below.

The value of cattle as a financing mechanism lies in the ability of the household to sell cattle to meet immediate cash needs without having to store cash, or borrow from

banks and other sources of credit that require interest repayment (Moll, 2005). This function is evident where cattle are considered as a form of investment and excess income is used to purchase cattle, and where immediate cash needs are met through cattle sales (Moll, 2005). The use of cattle in weddings can be considered as financing as it enables the household to meet these obligations without necessarily having to store cash. Depending on alternative ways of financing available, it is possible to put a value on this financing function as proposed by Bosman et al. (1997) and Moll (2005). Following this approach, the financing function is valued as;

$$F_i = \alpha m \qquad (2)$$

where α is the proportion of the sale price of a live animal. The size of α depends on the costs of alternative sources of income such as credit, costs of having a savings account or the costs of having to sell other durable consumer goods It indicates the incentive for the use of cattle as a form of financing and we estimate it as the difference between the nominal interest rate and the inflation rate. Hence it reflects the real value in prices that is gained by keeping an animal instead of selling it.

The insurance value of cattle derives from the ability of a household to sell or use cattle in emergency situations such as death or illness that would normally be covered by insurance. The advantage of cattle over taking out insurance is the avoidance of paying premiums, and this function is realized in areas where there are limited insurance options (Moll, 2005). To estimate the value of cattle as insurance the change in the value of the animal between two time periods is considered;

$$S_i = \frac{\beta(m_{t-1} + m_t)}{2} \qquad (3)$$

where β is a proportion of the average sale value between two time periods. The size of β is determined by the alternative insurance options.

The status value of cattle lies in the use of cattle as a status symbol where there are no alternative ways to display wealth, and where cattle can be used to strengthen social ties through gifts and the value of this can be calculated in a way similar to the insurance calculation (Moll, 2005). This can also be described as the cultural role of cattle. It can be calculated in the same way as the insurance function (Moll, 2005) as;

$$C_i = \frac{\delta(m_{t-1} + m_t)}{2}$$

where δ is the proportion of the average sale value between two time periods. Moll (2005), suggest that the value of δ can be lower than that of β if the insurance function is considered more important than the culture function. In this study we use the same value for δ and β as farmers sometimes considered them important. The other cultural roles of cattle relate to use of cattle at weddings and funerals which are covered under the financing and insurance functions.

4.3 Study area and data sources

4.3.1 Study area

The study was conducted in the Mhinga Traditional Authority (TA) in the Vhembe District of Limpopo Province, South Africa. The Mhinga TA, adjacent to KNP, has ten villages under its jurisdiction, namely Mhinga 1, Mhinga 2, Mhinga 3, Ka-Matiani, Joseph, Botsoleni, Maphophe, Mabililigwe, Makuleke and Nthlaveni (Figure 4.1). It covers an area of about 20,000 ha and comprises communal grazing on unimproved pasture, some land under cropping and village settlements with an estimated 6,880 households and 43,450 people (Mhinga Traditional Authority, 2008).

A key feature of the livestock production systems in this area is the movement and marketing restrictions within the "redline zone" or FMD control area. The KNP and the surrounding areas are a declared FMD controlled area in terms of the Regulations pertaining to the Animal Diseases Act (NDA, 2000). This implies that there are restrictions in terms of livestock marketing in the area. All Mhinga villages fall within the redline zone. In Mhinga 3 and Botsoleni adjacent to the free zone, there are physical barriers with 24 hour surveillance, managed by the District Veterinary Services, to prevent movement of all cloven hoofed animals and their products.

Rainfall is low (400 to 600 mm per year) with long drought periods (CGIAR, 2003). Grazing land is state owned but administered by the tribal authority, with access for all village members. The veld (grassland) type is tropical bush and savannah with a grazing capacity of between 11-13 ha per livestock unit (AGIS, 2009). Cattle rely mostly on natural grazing with no supplements, except in drought years. Cyclical

drought, stock theft and tick borne diseases are constraints to livestock production (Chaminuka et al., 2011).

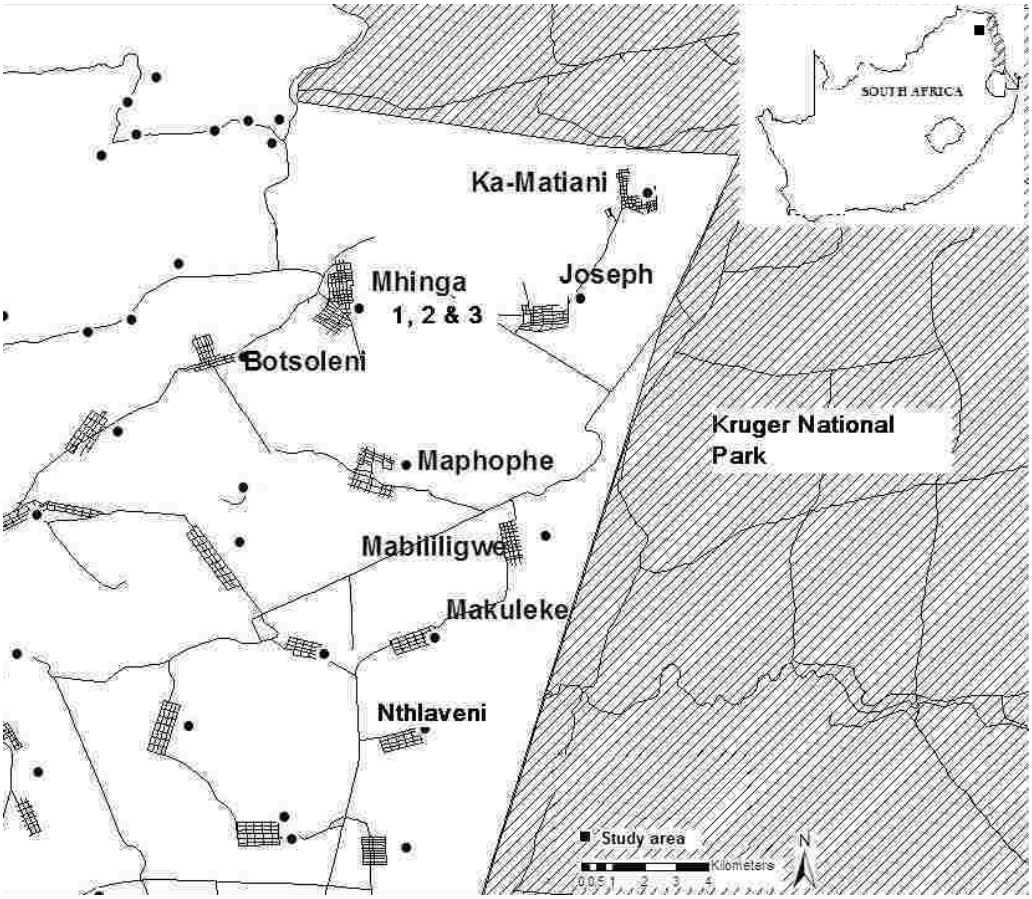

Figure 4.1 Location of Mhinga villages in relation to Kruger National Park

4.3.2 Sampling and data collection

Data were collected using three approaches: (i) key informant interviews, (ii) a household survey and (iii) community workshops between June 2008- May 2010. Eight key informant interviews with the Animal Health Technician (AHT), headmen, local traders, leaders of the Farmer's Association and the village-park forum provided the necessary background and secondary information. Households that took part in the survey were selected through a stratified random sampling process covering seven villages under the Mhinga TA, i.e. Mhinga 1, Mhinga 2, Mhinga 3, Ka-Matiani, Joseph, Botsoleni, Maphophe. The villages that were not covered are the subject of a

chieftaincy dispute. Households in each village were stratified into cattle owning households (CH) and non-cattle owning households (NCH). The population size for CH as indicated in the dip register was 757, equivalent to 11% of the estimated 6,880 households, whilst the NCH comprised the remainder of the 89% of the population. From each stratum, households were randomly selected to make up the required sample size of 270 households for each stratum. Sample size estimation was based on the method proposed by Cochran (1977), assuming 90% confidence level and a confidence interval of ±4.0.

Structured questionnaires translated from English to the local Tsonga language were used to collect data on household socio-economic characteristics, income sources, livestock outputs, herd sizes, and livestock husbandry practices. Two consecutive workshops were organized with the same group of 40 participants, to discuss and follow up on issues arising from the survey. The range of issues to be discussed were too much to be covered in one day. The participants included cattle and non-cattle farmers, youth, entrepreneurs and those with a specific interest in tourism related activities. The workshops started with plenary sessions where the purpose was explained and presentations on the research project. After this session, participants would break up into four groups and engage in discussions, ranking and scoring exercises for questions related to the importance of cattle benefits in relation to livelihood assets and other livelihood strategies. Options for future land based-development in the area were also discussed. All groups discussed the same set of questions, after which there was a report back session and summary of key points of both agreement and disagreement from the different groups.

Secondary data sources were also consulted for information on insurance options and banking services not specific to village level. Access to financial services for rural people in South Africa, is now considerably higher than in other developing countries (Claessens, 2006). In 2004, the government introduced the Mzansi account, a low cost bank account which was aimed at making financial services more available to previously unbanked people (FinScope, 2009). By 2008, 49% of people in the low income category were banked. Real interest rates in South Africa were 3.58% in 2006, 3.83% in 2007 and 3.86% in 2008 (Encylopedia of the nations, 2008). In this study we

use 0.0386 as the proportion of the sale price indicating the financing function. Because of the relative accessibility of financial services in South Africa compared to other developing countries, this figure is lower than estimates of 0.1 used by Moll (2005) in Zambia, and Bosman et al. (1997) in Nigeria. Another reason for using the lower figure is that access to financial services for developing countries has increased since the time these studies were conducted. The factor to use in estimating the value of cattle as a form of insurance in the case of South Africa is derived from one of the cheapest insurance options the '*Pay-when you can funeral cover*' offered by a leading retail outlet and easily accessible throughout the country. The premium for this is about 5% of the value of annual cover (Old Mutual, 2011). This is the same as 0.05 for stable situations suggested by Moll (2005). Due to the availability of alternative ways to display wealth such as houses and cars in South Africa, the status value of livestock is expected to be lower than in other countries so a factor of 0.05 is used. Studies by Shackelton et al., (1999) and Ainslie (2005) in South Africa also found evidence to refute the notion that cattle were mainly kept for status value.

The wage rate for KNP employment was equivalent to the minimum monthly wage of R2,270 (South Africa National Parks, 2008). Income from formal employment outside the KNP is taken to be R3000/month equivalent to an average teacher's salary in 2008, since this was the most commonly cited formal job. The Pearson's chi-square and pooled sample t-tests were used to analyze differences between CH and NCH for socio-economic variables in the data.

4.4 Results

4.4.1 Overview of household demographic characteristics and livelihood activities

CH have older heads, larger household sizes, and have less educated household heads and more heads based locally than NCH. The average household size for CH was 7.3 (SE= 0.21), whilst for NCH it was 6.0 (SE= 0.15). The average age of a household head in CH was 58 years (SE=0.8), whereas in NCH it was 50 years (SE= 0.80). T-tests showed that for the two groups of households, there were statistically significant differences for both the average household size ($F=23.06$, $df=1$; $P<0.01$) and age of

the household (F=47.76, df=1; P<0.01). Table 4.1 shows that the differences in terms of the percentage household heads based locally, and the percentage household heads with more than ten years of education for the two groups of households were statistically significant. Livelihood activities included crop farming at mostly subsistence levels, livestock farming, small enterprises (self-employment) and formal employment locally (mostly civil service and from the KNP) and in the cities (Table 4.1). Apart from the employment opportunities there were no other direct income benefits for households from the KNP. Some households received financial support (remittances) from non-resident household members (see Table 4.1). The social grants which are part of the government's social security system aimed at alleviating poverty and reducing income inequality constituted a significant livelihood means for most households in the two groups. CH received more social grants (P<0.01) and have less formal employment than the NCH (P<0.01). A possible explanation for the former could be that because on average CH heads were older, they are more likely to be recipients of the old age grant. The latter difference could be attributed to the fact that CH were less educated, and older, so they were less likely to be in formal employment. Most households (71%) had at least three sources of income, reflecting the diverse nature of livelihoods in Mhinga.

Table 4.1 Pearson chi- square comparisons of livelihood sources for CH and NCH

	Cattle households n=270	Non-cattle households n=270	Pearson χ^2 (1 df)/ F value
Demographic characteristics			
Gender of HH (% Female)	29	20	5.3**
% HH with no formal education	34	26	3.9**
% HH with +10 years education	7	17	13.5***
Locally based %	79	65	14.1***
Livelihood activities/Income source %			
Crop farming	90.4	82.2	7.6***
Cattle and small stock	100.0	21.9	-
Formal employment	22.2	35.6	11.7***
Small enterprises	6.7	12.2	4.9**
Social grants	85.6	74.4	10.4***
Remittances	7.4	14.8	7.5***
Private pensions	2.2	1.9	0.1
% owning physical asset			
Wheelbarrow	85.6	84.1	0.2
Plough	40.0	3.0	109.8***
Cart	10.7	1.9	18.1***
Tractor	3.3	2.2	0.6
Car	17.8	12.0	3.5*

Significant at *10%, ** 5% and ***1%.

4.4.2 Livelihood roles of cattle

Cattle are used for many purposes and are considered an important part of day to day lives of the people and their culture. The reasons given by farmers for owning cattle were selling and consumption of milk and meat, live cattle sales, dung and manure, draft power, insurance, and culture. The Tsonga people in this area do not pay the bride price with cattle but use cash, hence, lobola (bride price) which is commonly considered an important reason for keeping cattle in traditional African societies is not mentioned in this area. Benefits of cattle production in rural communities often extend to those households that do not own cattle. Up to 90% of the NCH responded that they derived some indirect benefits from cattle farming in the area. The most common benefit (86%) for NCH was cattle dung which mainly was used for decorating houses and as floor polish common in the Tsonga culture and to a lesser extent for field crop manure. Other benefits were access to milk (66%), meat (56%), draught power (16%),

and a readily available cattle market for ceremonial purposes such as funerals and circumcision celebrations.

Next we outline the contribution of cattle to specific livelihood capitals.

Human capital: refers to factors which enable household members to engage in livelihood activities. Variables such as household size, education level, health status and labour availability are important. About 40% of the CH had in the three years prior to the survey sold cattle to meet educational needs of the family. Cattle sales enabled farmers to invest in the education of their children for school and university fees. Cattle also contributed to the well-being of more than 40% of the CH by providing animal protein through milk and, less frequently meat.

Natural capital: refers to natural resource stocks that can provide flows and services which enhance people's livelihoods. The most common breed of cattle was the Nguni-type, although in some instances Nguni-Brahman crosses were kept. Animals graze on communal land with each village having its own grazing camp, although in some instances cattle from one village grazed in other village camps. Grazing areas also provide ecosystem services and natural capital to the community through benefits derived from firewood and grass collection as well as harvesting of natural herbs and selling. The sample mean number of cattle per household was 9.2 (SE=0.6) and household herd sizes ranged from one to 94. Despite the high mean cattle/household in the sample, about 42% of the households had less than five cattle (Table 4.2).

Table 4.2 Cattle herd size and composition per cattle owning household

Herd size	**% households**	
Less than 5	41.9	
6-10	27.0	
11-30	27.4	
More than 30	3.7	
Total	100.0	
Herd Composition	**% in herd**	**Mean number (std dev)/household**
Breeding cows	46.3	4.59 (7.8)
Bulls	17.0	1.68 (2.5)
Heifers	12.9	1.28 (2.1)
Oxen and bulls under 2	10.4	1.03 (2.1)
Suckling calves	13.4	1.33 (1.7)

About 91% of the CH, and 82% of the NCH had access to arable land, with plot sizes averaging 1.2 ha (SE=0.05) for CH, and 0.58 ha (SE=0.04) for NCH. Not all CH, however, used cattle dung for manure. Cattle dung was used for manure in only 46% of the CH and in 8% of the NCH. The use of cattle manure is limited because the area is very dry and crop production is minimal. Only 17% of the households in the full sample considered soil fertility a problem in this area.

Social capital: refers to the networks, relationships that people utilize in order to pursue livelihood activities. Cattle can generate social capital through cultural values that are bestowed on it, and through strengthening social relationships. The most common reasons for cattle slaughter were traditional ceremonies (34%) such as thanksgiving, and funerals and selling meat (8%). The benefits such as dung, milk and meat donations derived by NCH from cattle farming can be considered as social capital. About 10% of the CH reported that they had given away live cattle as gifts to other households in the three years prior to the survey and 80% had given away cattle dung for free to other households. In some instances households (18.5%) kept cattle that belonged to non-household members. Where this was the case, 66% of the households was not paid for looking after these cattle. Where made, payment was in cash given monthly or in the form of a calf at the end of each year to the herder.

Physical capital: is the infrastructure, equipment and goods required to make a living. Cattle contribute to physical capital directly through provision of draft power to 28% of the NCH and 27% of the CH for ploughing in crop production and indirectly through financing the acquisition of household and production assets. Table 1 shows that CH generally own more agricultural assets than NCH. More CH owned plough, cart and car than NCH ($P<0.01$). For the plough or cart this was expected as NCH are not likely to have use for these assets. Such assets however make it easier for CH to engage in cropping activities compared to NCH.

Financial capital: In livelihoods literature financial capital refers to economic assets, stocks and flows of income which are essential to achieve certain livelihood objectives. Cattle contribute to both stock and flow of financial capital in the household. Households were asked in the survey to indicate what proportion of their income came from cattle. Only 5% of the CH in Mhinga indicated that they derived almost all their income from cattle.

Table 4.3 shows the monetary estimates of the value of different cattle benefits. Households milked an average of 2.6 cows a day for about two months per year. The average milk yield was 3.75 litres per day per cow, and milk was sold locally for R5/l. Farmers explained that calves were weaned at eight months, but they only milked the cows for two months because the area is dry and cows do not get supplements. The most commonly used product of cattle by both CH and NCH was dung. The total dung is estimated at 5kg per penned adult animal per night. The average selling price of dung locally was indicated as R6.00/40kg. Only 32% of the households sold cattle dung, the rest gave it away for free. Using local prices and area cultivated average earnings from use and sale of draft power per household are estimated to be R443/year.

Table 4.3 Value of cattle benefits per CH per year (n=270)

	Estimated value R	% hhds using	Value to all CH in R	Value in US$ for CH	% of gross value
Milk	2925	41	1199	152	21
Dung*	2519	32	806	102	14
Draft power	443	27	120	15	2
Meat slaughter	2063	49	1011	128	18
Live sales	2935	59	1731	219	31
Gifts	115	6	7	1	0
Financing	1189	50	595	75	11
Insurance	137	69	95	12	2
Status	137	44	60	8	1
Gross value			*5624*	*712*	
Costs			1158	147	
Net value			*4466*	*565*	

1US$=R7.9

*Only dung sold, dung as a gift not valued

About 49% of the households had slaughtered an average of two cattle in the last three years prior to the survey. The monetary value of meat from the slaughter was calculated by using carcass-live weight ratio estimates of 0.5 given by local butcheries, and an average weight of 250kg/animal and local beef prices of R25/kg. Earnings from live cattle sales were calculated based on the average price of R3,439/cow obtained from households and checked with the local cattle traders. The main costs related to cattle production were veterinary costs, construction of secured cattle pens, and hired labour for some households. Dipping is free inside the redline, and in case of a drought farmers receive subsidized supplementary feed from government.

Table 4.4 shows the estimates of other sources of income in Mhinga in comparison to cattle. Although most of the households in Mhinga grew crops, this is not a profitable activity. The area is very dry and most households practicing cropping do not harvest anything in most years. Exceptions are for 15 households that grow crops along the banks of the river and draw water for irrigation. Of these 15 households only three households considered this a main livelihood source and were able to harvest enough to sell to the market. This practice is also not encouraged by the local extension

officer and it is unlikely that more households could be accommodated in cropping next to the river, particularly as water shortage is considered a problem in this area. In 2007/2008 the average harvest of households engaged in dryland cropping was 210kg of maize and 35kg of sorghum. Due to the absence of a maize market in the area we used national prices of R1600/ton for maize and R1450/ton for sorghum (DoA, 2008) in December 2007 to estimate the value of crops. Costs related to crop production were seeds, fertilizers and ploughing.

4.4.3 Relationship between cattle and other livelihood activities

Cattle are closely related to other livelihood activities in the household because of their multiple roles and their cultural and social significance. The way in which a household acquires initial cattle stock can be indicative of the relationship between cattle and other livelihood strategies. Most of the households (56%) had acquired cattle through income earned from current or previous employment and through inheritance (33%). Even old age grants had been used to start up a cattle herd (7%) and in a few of the households (4%) cattle were acquired through cash loans, small enterprise incomes or savings clubs.

Table 4.4 shows the relative contribution of different categories of income to total household income. Cattle income constitutes 29% of total household income for CH households, when considered together with other sources of income such as grants and employment. For both groups of households, grants income constitute the highest source of household income. Thus even the NCH, derive their main income source from grants followed by formal employment. Small enterprise and cropping incomes are low for both categories of households.

Table 4.4 Comparison of income sources by household category and contribution to total income per year

Income source and household category	% households benefitting	Average US$ per beneficiary household	Average US$ per household	% contribution to total income per household
Cattle income				
▪ CH	100	565	565	29
▪ NCH	0	0	0	0
Crop				
▪ CH	90	36	33	2
▪ NCH	82	19	16	1
Formal employment				
▪ CH	22	937	208	11
▪ NCH	36	1511	538	44
Small enterprises				
▪ CH	7	101	7	0
▪ NCH	12	186	23	2
Grants				
▪ CH	86	1318	1128	58
▪ NCH	74	865	643	53
TOTAL INCOME				
▪ CH		2957	1941	
▪ NCH		2581	1220	

In one of the workshops participants were divided into three groups and asked to rank the sources of income in order of importance. There was consensus in all groups that social grants (which can be regarded as an external subsidy to the agricultural system) constituted the most important source of income for people in the area, followed by formal employment and cattle income for the relevant households. Wildlife related benefits were considered minimal and largely in the form of formal employment earnings from KNP on a contract basis of a maximum of three years.

In participatory exercises during the workshop farmers were asked to rank the different roles of cattle in order of importance. Figure 4.2 shows the extent to which farmers ranked the contribution of cattle to the different livelihood capitals. The representation in the figure does not imply that cattle farming is the key driver of economic activity in Mhinga, but that cattle farming was used as a starting point in the discussion on the relationship between different livelihood activities in Mhinga. The

role of cattle in generating cash income (financial capital) was ranked as being most important by the farmers with a weight of six out of ten. This was followed by the role of cattle in contributing to the purchase of goods such as ploughs, carts and cars (physical capital ranked 2 out of 10). Both roles are related to the financial functions of cattle as a savings mechanism, and as an insurance mechanism, as well as a ready source of cash in the absence of credit markets. The role of cattle in educational fees and providing protein (human capital component) was ranked one out of ten. The use of cattle for manure and importance of grazing land for other purposes (natural capital ranked 0.5 out of 10) and the role of cattle in strengthening social ties (social capital) through gifts and ceremonial slaughtering was also mentioned, though given a low ranking.

Participants in the workshop were able to explain and illustrate the various roles of cattle and the relationship between cattle and other livelihood activities in the area in the workshops (Figure 4.2). Cattle keeping was perceived to be an important livelihood strategy that facilitated the development of other livelihood strategies such as small enterprises, cropping and formal employment through building up different livelihood capitals. For example the cash income from cattle could be used to send one's children to school which in turn increased the chances of the child to get formal employment or to start a small enterprise in the long term. On the other hand, money from these alternative livelihood strategies such as employment could also be used to acquire cattle or finance the purchase of veterinary inputs for cattle. Cropping benefited from livestock farming through manure and draft power, and natural resource harvesting could take place in the livestock grazing areas. It was agreed that wildlife from the park threatened the sustainability of cattle as a livelihood strategy in Mhinga, as they increased the risk of cattle diseases and caused farmers to incur losses through depredation (Figure 4.2). The participants agreed that because there is currently no compensation for loss of cattle to wildlife from the park, interaction with wildlife constituted an outflow from the livestock system.

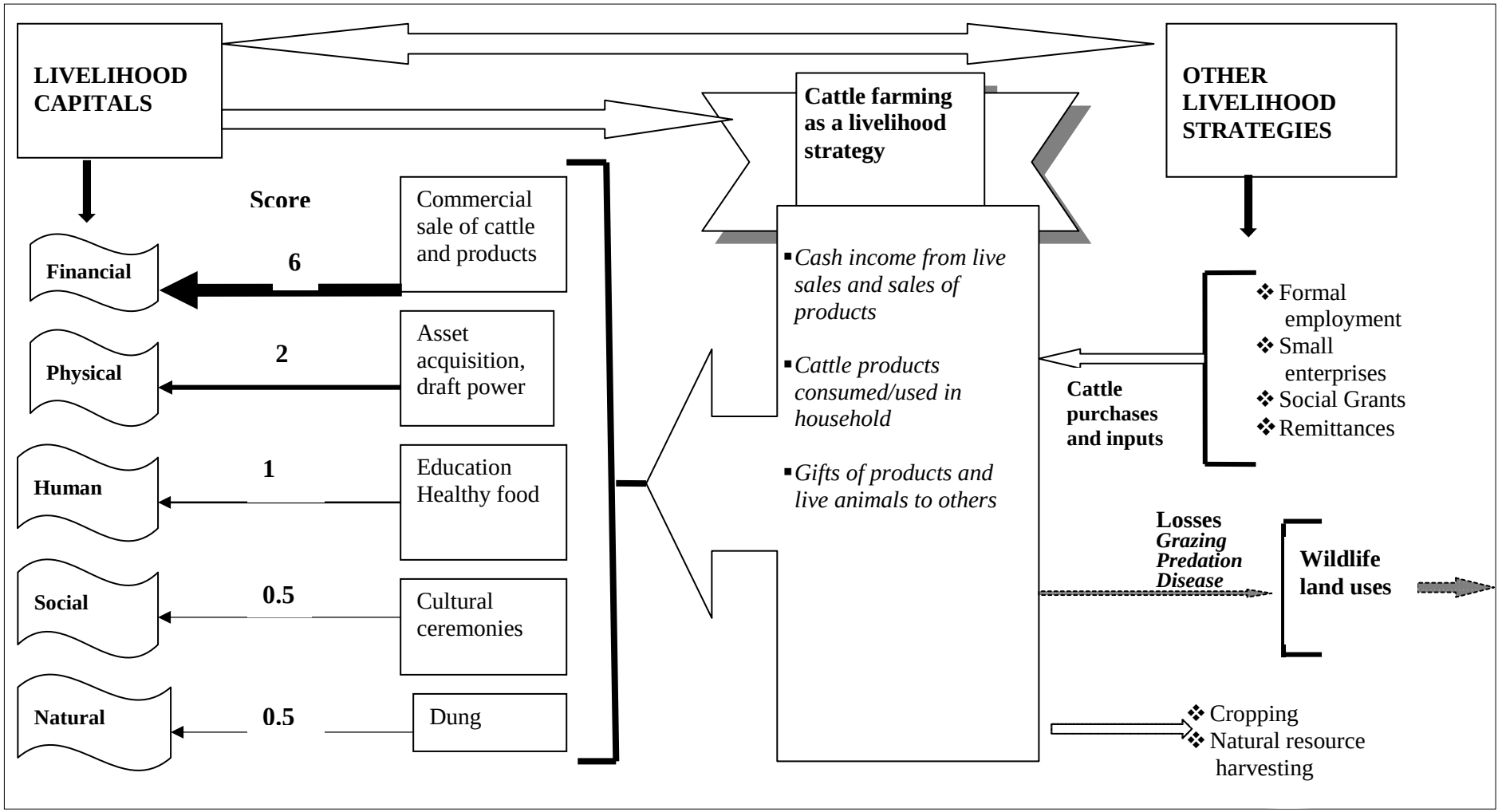

Figure 4.2 Farmers' conceptualization of the role of cattle in livelihoods in relation to other livelihood strategies

4.4.4 Perceptions on future land based development in Mhinga

When prompted to discuss prospects for future development in the area in one of the workshops, there were divergent views between different participant groups about the relationship between livestock and wildlife based land uses and the future of cattle farming in the area. The group comprising cattle farmers argued that in their view, wildlife related land uses had lesser ability to accommodate and enhance other livelihood activities in Mhinga than cattle farming. They explained that this was because wildlife posed a threat to livestock and crop farming in the area because of problems such as disease, livestock depredation, crop destruction and possible competition for land. In their view it is not possible to have both wildlife and livestock land uses in the area. The youth group and another group comprising small business entrepreneurs, however, argued that there was room to accommodate wildlife based land uses, without eliminating cattle production. They argued that livestock farming could only sustain a few households because incomes were low and only a few jobs were created. In their view, being close to the park presented the community with opportunities to improve livelihoods and employment through investment in tourism lodges, wildlife farming and provision of cultural tourism services.

Both the farmers and the other community groups agreed that whilst livestock is important, there is limited capacity for more households above the current 11% to engage in livestock farming. The main point of disagreement regarding prospects for future development was thus whether or not wildlife tourism based land uses were the next best alternative to create employment and sustain livelihoods in this area without compromising livestock production in the area.

4.4.5 Other livestock

Data on other livestock (including poultry) were also collected, although issues pertaining to the production of other livestock did not come up in discussions regarding the problems at the interface or future development prospects. The reasons for this could have been that the issues of production of other livestock were indeed not considered relevant to discussions regarding future livelihood options at the interface by the

community members themselves, or the researcher might not have sufficiently probed community views on this matter. This however does not mean that such livestock is not important in livelihoods at the interface. Table 4.5 shows the ownership of different types of other livestock in Mhinga. There were significant differences in terms of the extent of ownership of the other types of livestock between the NCH and the CH. It appears that more CH owned other types of livestock, than NCH. Chickens were most commonly owned in both CH and NCH. Sheep and pigs were owned by very few households in Mhinga.

Table 4.5 Ownership of other livestock by household category

Other livestock	**CH**	**NCH**	**Total**	
	% owning	% owning	% owning	Pearson χ 2 (1 df)/ F value
Goats	17.4	5.1	11%	29.2***
Donkeys	6.3	1.8	4	14.3***
Chickens	41.1	33.7	37	12.3***
Sheep	0.4	0	0.2	1.0
Pigs	1.9	0.4	1	2.7
	Mean number n=270	Mean number n=270	Mean number n=540	Pooled T Test F value
Goats	2.3 (4.3)	0.8 (2.4)	1.5 (3.5)	25.4***
Donkeys	0.7(2.2)	0.2 (1.2)	0.5 (1.8)	11.8***
Chickens	9.8 (11.4)	6.6 (8.6)	8.1 (10.2)	13.6***
Sheep	0.0 (0.2)	0.0 (0.0)	0.0 (0.1)	1.0
Pigs	0.1 (0.7)	0.0 (0.5)	0.1 (0.6)	0.4

Significant at *10%, ** 5% and ***1.

4.5 Discussion

This study used a livelihoods analysis framework combined with economic valuation techniques to analyse the role of cattle farming and the relationship with other livelihood activities for households at the interface. The study differs from previous studies on livestock and livelihoods in South Africa in a number of ways due to the unique study setting and the methodology employed. By analysing the livelihood roles of cattle using both economic calculations and the qualitative views of the rural households in contrast to only qualitative (Ainslie, 2005) or quantitative approaches

(Randela, 2003; Dovie et al., 2006), the strengths of either method are combined. Results from this combination of methods are able to capture the complexity of rural livestock systems and are useful for both local economic growth and broader poverty alleviation purposes. Furthermore quantification of the savings, insurance and cultural roles of cattle makes a new contribution to previous studies conducted in South African (Cousins, 1999; Randela, 2003; Dovie et al., 2006). The setting of the study at the wildlife/livestock interface and the related challenges thereof, reinforce the view that the role and contribution of cattle varies even under communal systems and can be influenced by land use changes and socio-economic developments (Cousins, 1999; Shackleton et al., 2005). Lastly, the study not only considers the livelihood roles of cattle, but the relation to other current livelihood sources such as formal employment, social grants and emerging wildlife tourism based livelihood activities at the interface.

When the roles of cattle are quantified in monetary terms, based on economic indicators such as inflation and access to financial services, the monetary value of the security, financing and cultural functions of livestock are much less than the other functions. Yet when farmers are asked to rank the most important reasons for keeping cattle, these functions are given a higher weight. This discrepancy between farmer weighting of the importance of certain functions of cattle as indicated in Figure 4.2 and economic valuation of these functions indicates that the reasons farmers keep cattle, might in some cases not be in line with the economic estimations, on which most policies are based. This disjuncture between economic and farmer logic could be due to the assumptions that we used in economic calculations regarding interest rates, or other factors previously described such as the multiple objectives of the farm household, failure of markets and inability of economic estimates to consider the complex nature of rural livelihoods (Scoones, 2009; Alary et al., 2011). One of the shortcomings of the livelihood approach that is shown in this study, is the failure of the approach to distinguish clearly between the different livelihood capitals e.g. milk can be considered as contributing to the human, financial and social capitals.

Despite establishing complementarities between cattle farming and most of the livelihood strategies, wildlife based tourism was considered by farmers to be a

competing livelihood strategy with cattle farming. The perception by farmers that wildlife is a threat, which has also been discussed by Anthony, (2006) and Chaminuka et al., (2011) could be attributed to lack of tangible household benefits from wildlife and absence of a mechanism to compensate households that suffer wildlife damage. These problems if not addressed, could have implications for farmers' support for conservation and emerging land use alternatives in the GLTFCA such as game ranching and wildlife based tourism. Weaver and Skyer (2005) reported that rural communities in Namibia had a mindset change and started viewing wildlife as an asset rather than a community liability after they started receiving tangible benefits such as income, employment and meat from wildlife and the negative attitude towards wildlife changed. Cousins (1999), (Cumming, 2005), and Boyd et al. (1999) illustrate the potential tradeoffs between cattle farming and wildlife regarding competition for grazing, depredation of livestock by wildlife and diseases transmitted from wildlife to livestock. These negative externalities of wildlife can reduce the income from cattle, thereby making it necessary for households to engage in other livelihood strategies at the interface (Chaminuka et al., 2011). In Botswana, Mbaiwa (2008), found that growth in wildlife based tourism reduced household livelihood activities as some households stopped cropping and keeping cattle. Although wildlife based tourism was beneficial for some households, it increased rural urban migration as households sought to counter the seasonality of tourism income.

The fact that only five percent of the cattle households in Mhinga depended solely on cattle income indicates the need to explore other options for development as cattle alone cannot be sufficient as a driver of development in the area. This is more so when it is considered that the area is drought prone, and there are constraints to livestock marketing in the redline (Chaminuka et al., 2011). Furthermore, the current main source of income which is social grants could be considered an external subsidy to the system, which in the long term might not be sustainable, especially in the face of increasing population pressure. Dryland cropping is not a viable income generating option for most households, due to the dry conditions in the area. When it is considered that only 11% of the households in the area own cattle, and mainly benefit from the use of grazing area, it seems plausible that other households would support alternative land use option

such as community wildlife tourism projects that would enable them to also benefit from the use of grazing land. It has been shown that wildlife land use can generate more profits and provide a viable option to replace or complement livestock farming in dry marginal areas (Barnes, 1998). Several possibilities exist for enhancing the contribution of cattle to livelihoods for CH whilst accommodating other possibilities for livelihood diversification in line with plans of the (Joint Management Plan Working Group, 2001) in the GLTFCA.

Integrated wildlife and cattle farming where animals such as antelope and zebra graze together with cattle on the land could benefit both CH and NCH. It has been practiced in Kenya (Boyd et al., 1999) and on commercial farms in Zimbabwe (Kreuter and Workman, 1996). In Kenya, integrated wildlife livestock management was found to have positive benefits in terms of food security, cash income generation, asset building, reduced household vulnerability and sustainable natural resource use (Boyd et al., 1999). In Namibia, activities such as hunting, timber and forest products harvesting and tourism activities were found to have higher returns to land than agricultural land uses (Barnes, 1995). The advantage might be increased revenues from the land through wildlife harvesting and tourism incomes, without necessarily replacing livestock. The costs and benefits associated with wildlife livestock integration, however, need to be carefully assessed, and problems of disease transmission, predation and crop damage addressed. The CAMPFIRE model in Zimbabwe, where communities involved in normal agricultural practices, co-exist with wildlife, and earn revenues from sale of rights to access wildlife to external agents (Bond, 2001; Murphree, 2009) provides useful lessons for multiple land use possibilities. The success and possibilities for wildlife land use in communal areas depend on a variety of socio, economic, political and institutional factors which are beyond the scope of this paper.

Another possibility is to have the area declared as a conservation area with potential to generate income from payment for ecosystem services. Blignaut and Moolman (2006) argue that it is possible for the communal land adjacent on the southern border of the KNP to earn more value from conservation than current benefits obtained under subsistence livestock systems. Such a scheme would need to be considered in light of

various factors that include the fact that cattle has cultural values, the possible lack of a market for ecosystem goods and services and institutional and managerial challenges of establishing and operating such a scheme (Blignaut and Moolman, 2006). Lastly, even with conservation, tourism, and game ranching it is possible that sufficient incomes and employment would not be generated in the area so some households would still continue to live in poverty. Other ways to provide sufficient means of living for the population such as investment in education to enable people to seek employment outside the area can be explored.

Although this study did not delve into the subject of other livestock, it is possible that small stock and poultry could have an important role to play in supporting livelihoods at the interface. In Zambia, farmers who live with wildlife have benefitted from livelihood diversification in poultry and small stock production, amongst other activities. The initiative, spearheaded by a company called COMACO (Common Markets for Conservation) is aimed at saving wildlife habitat whilst reducing poverty and hunger in communities living with wildlife (COMACO, 2011). The initiative managed to increase productivity of goat and poultry production through interventions to reduce disease, improve husbandry practices and through provision of markets for these and other agricultural products. In Mozambique, improvement of husbandry practices and Newcastle disease control in village chickens was found to have positive effects on food security and poverty alleviation for households living in the Limpopo National Park (Radosavljevic et al., 2010). In the southern part of the KNP, Shackelton et al. (1999), found that household benefits from goats included cash sales, meat and ceremonial uses. In this study, the direct use value of goats to households was found to be about 9% of the value derived from cattle, and in another study by Dovie et al. (2006) the direct use value from goats was 2% of that derived by households from cattle. Regardless of the size, the contribution of small stock and poultry to rural livelihoods should not be understated, and particularly for countries such as Zimbabwe and Mozambique where the rural economy is mainly driven by agricultural production.

4.6 Conclusion

As the GLTFCA emerges it is important for communities, planners and policy makers to consider existing land uses and how they can be strengthened and integrated with

emerging land uses that have potential to increase incomes and employment. With increased livestock/wildlife interaction the perceived threats to cattle farming that are associated with the interface are likely to increase. This could further alienate farmers from supporting wildlife tourism based land uses. Nevertheless, the fact that the majority of the households do not actually own cattle (despite benefitting indirectly from cattle), could present an opportunity for wildlife tourism land use to be considered as an option that could result in more households benefitting from the use of available land. It has been suggested that there may be a need to review existing land uses within the GLTFCA and explore possible paths of development for communities like Mhinga that are adjacent to protected areas (Cumming et al., 2007). These calls to review land use practices at the interface indicate a possible change in terms of focus on livelihood strategies at the interface and hence revisiting the role cattle at the interface.

From a methodological point of view, advocating the use of qualitative approaches viz a viz quantitative approaches or vice versa in valuing the role of cattle, is not sufficient but rather the discourse should be towards developing methodologies that combine the two approaches. Policies or local programmes formulated on the basis of single-oriented approaches are not the most ideal approach to enhance the role of cattle and livelihoods at the interface.

The expected shift by proponents of the GLTFCA from agricultural based land uses towards wildlife tourism based land uses, might not be fully supported by rural communities given the importance of cattle in rural livelihoods for both cattle owners and non-cattle owners, and its relationships with other livelihood strategies. Although there is potential for livelihood diversification and multiple land uses in the GLTFCA for sustainable development, cattle have financial, cultural and human capital livelihood roles for households at the interface which should not be underestimated. The importance attached to cattle, and the prospective competition that could arise from wildlife-tourism based land uses will differ considerably between the three countries in the GLTFCA.

CHAPTER FIVE[5]: Tourist Preferences for Ecotourism in Rural Communities: A Choice Experiment Approach

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Abstract

This paper analyses the potential for development of ecotourism in rural communities adjacent to Kruger National Park (KNP) in South Africa. We determine preferences of tourists, according to origin and income levels, for ecotourism and their marginal willingness to pay (MWTP) for three ecotourism attributes: village accommodation, village tours and visits to crafts markets. Data were collected from 319 tourists through choice experiments, and analysed using a conditional probit model. Findings indicate reluctance on the part of all tourists to use accommodation facilities outside KNP, but interest to purchase village tours and visit village-based craft markets. MWTP was negative for accommodation for all income groups, but positive for village tours and crafts markets. Among international and high income groups of tourists, tourists were willing to pay much higher fees than proposed by communities. These findings suggest the potential for development of some limited ecotourism services in villages adjacent to KNP.

Keywords: **Ecotourism, Choice experiment, Village tours and accommodation, Craft markets, Marginal willingness to pay**

5. 1 Introduction

The concept of ecotourism and its implementation in the tourism industry has raised interest and debates on international fora such as the 2002 World Ecotourism Summit held in Quebec, the 2002 World Summit on Sustainable Development held in Johannesburg, and the Global Ecotourism Conference 2007 of Oslo. Although the potential of ecotourism to contribute towards poverty alleviation, biodiversity conservation, and employment creation has been acknowledged (Fennell, 2001; World Ecotourism Summit, 2002; Millennium Ecosystems Assessment, 2004), the challenge remains in finding ways to implement ecotourism in a manner that jointly addresses these issues.

The key principles of ecotourism as laid out in the Quebec Declaration on Ecotourism (World Ecotourism Summit, 2002) are (i) active contribution to cultural and natural heritage; (ii) inclusion of local and native communities in the planning of ecotourism and a contribution to their well-being; (iii) visitors are familiarized with the cultural and natural heritage of the places they visit; (iv) better independent travelers and organized tours of small-sized groups. It has been argued that ecotourism has a comparative advantage as a driver for rural development because it tends to occur in peripheral and non-industrialized or rural regions, where opportunities for expanding the economy can be realized at a relatively low cost (Boo, 1990). The involvement of local communities in ecotourism can also improve their attitudes towards conservation. Controversy exists, however, over the meaning of the concept, its operationalisation (Fennell, 2001; Weaver and Lawton, 2007) and its potential to yield socio-economic benefits for rural communities (Isaacs, 2000; Wunder, 2000).

Operationalisation of ecotourism that promotes the goals of contributing to nature conservation and rural development, requires that rural communities and managers of protected areas have information on the tourist preferences for ecotourism, its attributes and economic potential (Hearne and Salinas, 2002). From an economic perspective, demand and supply side considerations are also important. The success of ecotourism hinges on the extent to which local communities are willing and able to be involved, in the planning and implementation of ecotourism projects (Spenceley, 2006; Munthali,

2007). At the same time, the preferences of tourists for specific ecotourism activities and their willingness to pay for the ecotourism goods and services that communities supply is also important.

There is no consensus on the exact definition of ecotourism in literature (Weaver and Lawton, 2007). According to (Blamey, 2001), the first formal definition of ecotourism is credited to (Ceballos- Lascurain, 1987) who defined ecotourism as; '*Travelling to relatively undisturbed or uncontaminated natural areas with the specific objective of studying, admiring, and enjoying the scenery and its wild plants and animals, as well as existing local cultural manifestations (both past and present) found in these areas.'* A content analysis of the definition of ecotourism by Fennell (2001) based on 85 definitions of ecotourism revealed that the definition varies with context and overtime. The most common variables frequently cited in the definitions were; (i) reference to where ecotourism occurs, e.g. natural areas; (2) conservation; (3) culture; (4) benefits to locals; and (5) education.

Given the diversity of ecotourism options and related business models, it is understandable that there is a lack of information on tourist preferences for ecotourism and how it can be operationalised in local communities. Lack of capacity for business development in the local communities and limited information on possible ecotourism businesses have been identified as problems limiting the potential of ecotourism (Munthali, 2007; Spenceley et al., 2008) around protected areas in Southern Africa. A study conducted by Mabunda (2004), also indicated that although rural communities adjacent to the Kruger National Park (KNP) in South Africa were interested in sharing their cultural heritage with the tourists, the park management framework did not enable them to do so. Mabunda (2004) also highlights the need for research that investigates tourists' experiences and expectations in and around the KNP.

The main aim of this study is to analyse tourist preferences for ecotourism and their willingness to pay for ecotourism activities in rural communities adjacent to the KNP in the Great Limpopo Transfrontier Conservation Area (GLTFCA). In addition the study examines the opinions of tourists regarding the relationship between ecotourism and

rural development. There are plans at local, municipal and transfrontier levels to develop ecotourism in rural communities through investment in tourist accommodation facilities of various types and promotion of cultural tourism (Mhinga, Undated, Joint Management Plan Working Group, 2001; Thulamela Local Municipality, 2009). We provide answers to two questions. First, what sort of ecotourism goods and services are tourists interested in? And second, how much are tourists willing to pay for these services? To enable a better understanding of tourism preferences we distinguish between tourist nationality and income groups as preferences have been shown elsewhere to be heterogeneous between international and local tourists, and also between different income groups (Kepe, 2001; Hearne and Santos, 2005; Weaver and Lawton, 2007).

Our paper makes the following contributions to the literature. First, it adds to the limited amount of non-market valuation studies on ecotourism in sub-Saharan Africa by means of choice experiments which is a relatively new technique in this field of study. Second, our study contributes to the debate on the extent to which ecotourism can yield socio-economic benefits for rural communities. As such, the study describes a case study that provides information that can assist managers of protected areas, local level planners, entrepreneurs and rural communities in decision making processes and development of ecotourism in the GLTFCA.

5.1.1 Ecotourism in the GLTFCA

Transfrontier Conservation Areas (TFCAs) encompass one or more protected areas which cross frontiers between two or more countries. The GLTFCA was established in 2000 and straddles Zimbabwe, Mozambique and South Africa. In South Africa the GLTFCA encompasses the Kruger National Park, private game reserves and rural communities adjacent to the KNP (see Figure 5.1). In the GLTFCA, it is envisaged that communities residing on the borders of the park will be able to engage in ecotourism which is seen as a bridge between nature conservation and rural economic development. Ecotourism's main attraction lies in its potential to provide complementary or alternative solutions to problems of low incomes, high unemployment and limited economic opportunities for rural communities within the GLTFCA whilst ensuring

sustainability of wildlife conservation (Joint Management Plan Working Group, 2001; Munthali, 2007).

The KNP, which attracts over a million tourists per year, has in recent years made a concerted effort through its People and Conservation Division to contribute towards the socio-economic development of communities in and bordering the park (South Africa National Parks, 2008). Past studies by Spenceley (2006) and Spenceley et al. (2008), in the GLTFCA and KNP have noted that efforts to shift to conservation approaches that benefit local people have only resulted in a few community members being employed in existing and upcoming private tourism facilities, without proper empowerment of rural communities and creation of sustainable economic opportunities to enable them to benefit more from tourism.

Some of the rural communities interested in starting ecotourism projects, but lacking information on tourist preferences or possible ecotourism projects, are situated on the northern borders of the KNP, near Shingwedzi and Punda Maria camps (Figure 5.1). The communities fall under the jurisdiction of Mhinga Traditional Authority and are amongst those least developed in terms of opportunities for employment and tourism related businesses, and would benefit from viable ecotourism development. This study investigates possible ecotourism development on this remote side of the KNP using choice modeling approaches.

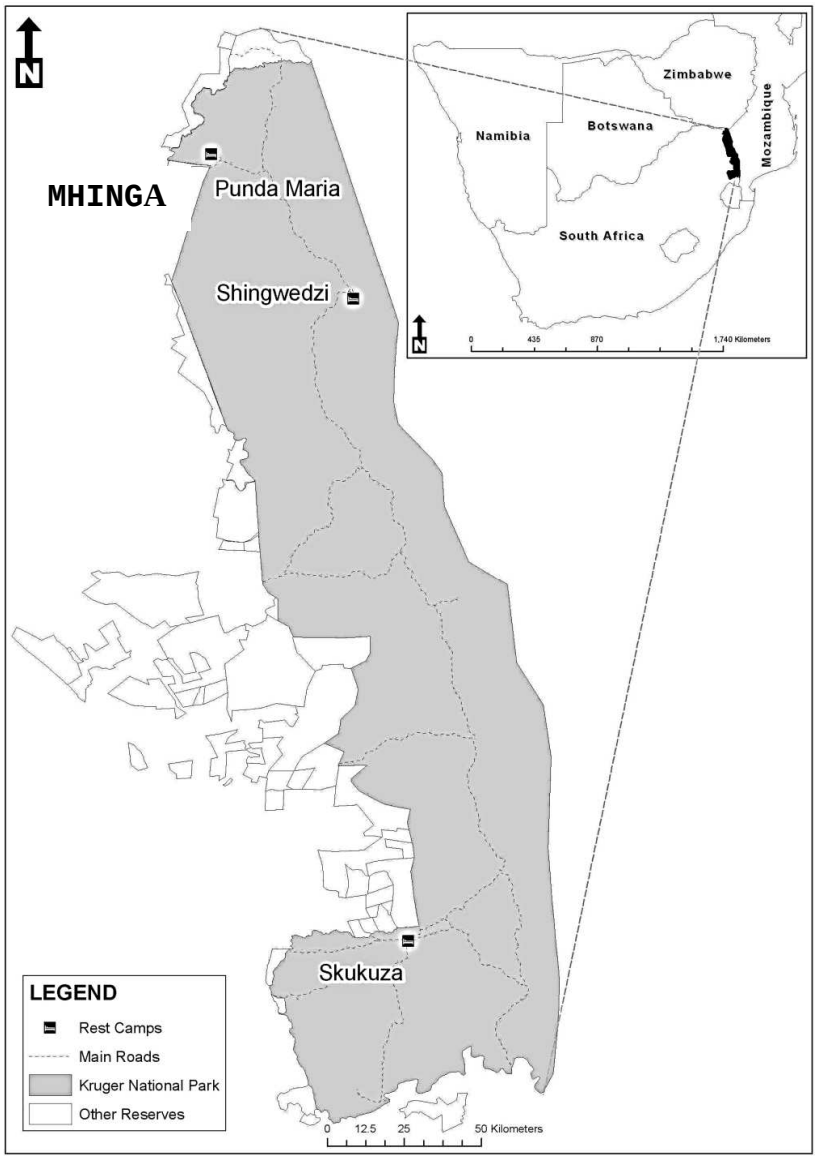

Figure 5.1 Location of the three KNP camps where the survey was conducted

Source: SANParks 2011

5.2 Theoretical background of the choice modelling approach

Microeconomic foundations for choice models derive from Lancasterian consumer theory (Lancaster, 1966) which postulates that a consumer derives utility not from the good itself but from attributes of the good that cannot be purchased independently. These attributes can in turn take on different levels, and by varying these attributes and their combinations it is possible to create different goods from which a consumer chooses (Hanley et al., 2001). Econometric representation of consumer choices in non-

market evaluation and marketing studies is most commonly done through random utility theory which can be used to model multinomial choices where there is no ordering in the alternatives.

To illustrate the basic model behind choice experiments, consider a tourist's choice for a trip from a set of different possible ecotourism trips. Suppose that each trip (j) consists of K different attributes, which among others include the location of accommodation, the price of the trip, and the possible inclusion of a village tour. Each of these attributes can take on different levels. Assuming that the utility that the tourist derives from trip j is a function of the trip's attributes (i.e., $U_{ij} = U_i(\mathbf{X}_j)$, where $\mathbf{X}_j$ is a $K\times1$ vector of attributes), and the tourist can choose from a set of J trips, then he or she will choose trip 1 if it gives the highest utility of all available trips:

$$U_i(\mathbf{X}_1) \geq U_i(\mathbf{X}_j) \; \forall \; j \in J. \tag{1}$$

Random utility theory assumes that U_i can be divided into a deterministic component (V_{ij}) and a non-deterministic component (ε_{ij}). The non-deterministic component follows a predetermined distribution and is due to unobservable characteristics (Manski, 1977). Accordingly, the utility (U_{ij}) derived by tourist i from trip j is expressed as:

$$U_{ij} = V_i(\mathbf{X}_j) + \varepsilon_{ij} \tag{2}$$

Under these assumptions, the probability of individual i choosing alternative 1 over all other alternatives in choice set J is equal to:

$$V_i(\mathbf{X}_1) + \varepsilon_{i1} \geq V_i(\mathbf{X}_j) + \varepsilon_{ij} \Rightarrow V_i(\mathbf{X}_1) - V_i(\mathbf{X}_j) \geq \varepsilon_{ij} - \varepsilon_{i1}. \tag{3}$$

The exact estimation method used depends on the assumptions made regarding the probability distribution of ε_{ij}. If ε_{ij} can be assumed to be independently and identically distributed, and to follow a Weibull distribution (Greene, 2003), one can use the conditional logit model. In this model the conditional probability of alternative 1 being selected out of a set of alternatives from set J is specified as:

$$P_{i1} = \frac{\exp(V_{i1})}{\sum_{j\in J}\exp(V_{ij})}. \tag{4}$$

This specification, however, implies that the selection from the choice set must obey the Independence from Irrelevant Alternatives (IIA) property. This property states that given, alternatives 1, 2, and 3, the relative probability of a person preferring 1 over 2 will not depend on 3 being available. This property is considered to impose strict restrictions on the use of the conditional logit model (CLM), and where it is violated then applying CLM will give biased results (Long and Freese, 2006). Where the alternatives that are contained in the choice set are close substitutes of each other the IIA becomes too restrictive and CLM cannot be applied.

One of the solutions to this problem is to use the conditional probit model which allows relaxation of the restriction imposed by the IIA property, and is able to generate unbiased estimates (Hausman and Wise, 1978). The conditional probit model assumes that the non-deterministic component (ε_{ij}) has a multivariate normal distribution and can be correlated across choices. So far the conditional probit model has not been widely used, mainly because of computational problems that make calculation of maximum likelihood infeasible (Swait, 2007), but recent developments in software development and computational capacity have largely solved these problems.

5. 3 Design of the choice experiments

Choice experiment studies require important decisions to be made on the number of attributes, the number of levels for each attribute, what those levels should be, and how those levels and attributes should be described (Hanley et al., 1998). The attributes and levels are combined such that a set of alternatives result, which is then presented to the respondents. The respondents are asked to choose their preferred alternative from this set. Among the alternatives, a status quo option is often also included, which expresses the current situation. Including the status quo option in the choice sets enables interpretation of results in standard welfare economics terms (Hanley et al., 2001)

The attributes in this study were developed after a consultation process with different stakeholders. Two workshops and three focus group discussions were held to discuss options for development of ecotourism in Mhinga and to identify possible goods or services that village members could offer tourists. Further discussions were held with

game rangers inside the KNP on possible attributes of an ecotourism package to tourists. Having the local communities participate in the process of attribute identification was also done to ensure that whatever choices were presented to tourists would reflect what the local community wanted to offer. This is particularly important given that by definition ecotourism entails community involvement and empowerment (Campbell, 1999; Fennell, 2001). This process identified village tours, craft markets and village lodges as possible ecotourism services, and hence possible attributes of an ecotourism package. A price level attribute was added to make four attributes with different levels that were used in the choice sets. The levels for the price attribute were based on the amount that villagers indicated that they would like to be paid for village tours and craft market entrance, and on the price that was being charged for similar village tours at the time of the survey by villagers on the far south side of the KNP.

The explanation of the attributes and the attribute levels in the choice experiment were as follows:

Accommodation- Tourists could have the opportunity to stay in village lodges or in the KNP as the current default option. These lodges would have similar prices or standards as those of the KNP. This attribute took on two levels: accommodation inside the park as is currently the case, or outside in village lodges

Craft markets-Currently crafts are sold in KNP shops, but tourists do not have the opportunity to see the making of these products. Establishing village craft markets will give tourists a chance to witness and participate in the process of making souvenirs as an ecotourism activity. This attribute also had two levels: visit to village crafts market or no visit.

Village cultural tours-The tour would last about 3-4 hours. Activities include interaction with locals in their day to day lives, photography, cultural entertainment group, visit a traditional healer, the Tribal court house and visit cultural village. This attribute also had two levels: cultural tour or no cultural tour.

Price- These activities would come at an additional cost above the KNP entrance fees. This attribute had three levels: R0 ($0), R160 ($20) or R320 ($40) at the exchange rate of US$1=R8.

The combination of all attributes and levels results in a full factorial design which has $2^3 \times 3 = 24$ different alternatives. A fractional factorial design was employed to obtain a smaller number of replicates in which all main effects and two-factor interactions could still be estimated (Johnson et al., 2007). Taking into account the problems of overlap and dominance or near dominance of some choice sets, a total of seven choice sets were generated for the questionnaire. However, utility balance between alternatives to reduce dominance (Johnson et al., 2007), could not be considered because of the lack of prior information on the tourist preferences in the area. Tourists were presented with seven choice sets, each with three options. The status quo option was included in all the choice sets giving room for a respondent to not select any of the two alternatives provided, which would in turn give an idea about the interest or lack thereof in the potential ecotourism activities to be offered. Given the limited literature on tourist preferences and choice experiments in studies in South Africa, attitude and opinion questions were included in this survey to assist with the understanding and explanation of some responses.

5.3.1 Data collection

Data were collected in December and January of 2008-2009 and 2009-2010. The choice of months was deliberate to maximize chances of interviewing a large number of tourists and to interview both domestic and international tourists as December is peak tourist season in KNP. The interviews were conducted in Shingwedzi and Punda Maria, which are the camps nearest to Mhinga, and Skukuza, which is the biggest camp in the KNP (see Figure 5.1). The questionnaire was pre-tested and revised prior to the surveys. Permission had been obtained from KNP to conduct this survey.

A trained enumerator in each camp administered the questionnaire. Because of the diversity in nationality and languages of the target group it was decided that all interviews be conducted in English. Enumerators randomly picked a number between 1 and 10 every morning, and thereafter approached every 10^{th} tourist for interviews. If the tourist declined to participate then they would approach the next one, and count again the 10^{th} one. This enabled some systematic random sampling of tourists, who were

approached inside the park at the reception area, in restaurants, utility shops, picnic areas and accommodation areas. In some cases enumerators administered the questionnaire face to face, or where preferred, left the questionnaires with tourists for them to fill in on their own and made arrangements for later collection. The questionnaire was self-explanatory.

5.4 Results

5.4.1 Tourist socio-economic characteristics

A total of 324 tourists took part in the survey, but only 319 questionnaires were usable. With three options and seven choice set per respondent this resulted in 6699 observations. General socio-economic characteristics of tourists that took part in the survey are shown in Table 5.1. The average age of respondents was 42.8 ± 15.2 years and there was a fair distribution between male and female respondents. Incomes were pre-classified into four categories, and for international tourists most of their incomes were in the two higher categories, whilst incomes of domestic tourists were concentrated in the two lower categories. As expected, the South African tourists comprised the bulk of the respondents, whilst international visitors accounted for about 36% of respondents. This sample distribution of nationality fits in with KNP statistics that show that international visitors comprise between 30-35% of total visitors to the park (South Africa National Parks, 2007). Very few of the respondents were travelling alone and most of them were not first time visitors, especially in the domestic group.

Table 5.1 Socio-economic characteristics of survey respondents

Characteristic	All tourists	Domestic tourists	International tourists
Mean age in years and standard deviation	42.8 (15.2)	40.4 (14.1)	47.4 (16.2)
% Male	49.8%	49.3%	45%
Income less than $12 000	20.1%	25.6%	9.4%
Income $12 001-$25 000	25.4%	35.5%	7.5%
Income $25 001-$50 000	32.3%	25.6%	43.4%
Income above $50 000	22.1%	13.3%	39.6%
Nationality South African	62.0%	93.5%	0
Stay of more than one day	75.2%	64.2%	97.2%
Travelling alone	1.9%	1.9%	0.9%
Respondent visited KNP before	72.2%	87.9%	41.3%
Respondent planning to return to KNP in next 5 years	89.4%	96.2%	75.7%

5.4.2 Results of the choice experiment

Data were analysed using Stata intercooled Version 10.1. Log-likelihood ratio tests for the IIA property comparing a model with correlated errors to the nested model with uncorrelated errors (Greene, 2003) revealed that the IIA assumption was violated *(χ^2=9.68; p=0.00; df=1)*. The conditional logit would not be appropriate, and hence a conditional probit model was estimated. Following Hausman and Wise (1978), the deterministic part of the estimated utility function for the i^{th} individual and j^{th} alternative takes the form:

$$V_{ij} = \delta_j + \beta_A A_{ij} + \beta_C C_{ij} + \beta_T T_{ij} + \beta_P P_{ij}, \quad (5)$$

where δ_j is an alternative specific term to capture a possible preference for one of the alternatives regardless of their attributes; β_A is the coefficient of the location of accommodation; A_{ij} is a binary variable indicating the location of accommodation (0 = inside KNP; 1 = in a village outside KNP); β_C is the coefficient of the crafts markets; C is a binary variable indicating whether the trip includes a crafts market; β_T is the coefficient of a cultural village tour; T is a binary variable indicating whether the trip includes a cultural village tour; β_P is the coefficient of the trip price; and P indicates the price of the alternative.

The conditional probit procedure in Stata (asmprobit) fixes the variance to 2 to solve identification problems commonly associated with conditional probit models (Long and Freese, 2006; Swait, 2007). In all cases, the Hammersley sequence, which has the advantage of speed (Long and Freese, 2006), was used as the integration option for simulated maximum likelihood estimation.

Normal calculator aggregation of choices made by respondents show that there was some interest in engaging in ecotourism. The status quo option (which entailed no ecotourism activities in surrounding villages) was chosen in only 28% of the cases in the pooled sample, with the respondents choosing the presented alternative options in most of the cases. In all cases, the status quo option is assumed to be the base alternative. Table 5.2 shows that all the attributes were significant in determining the choices that the tourists made, and the coefficient of both the accommodation and the price variables have negative signs, for the pooled sample. This suggests that tourists prefer accommodation in the park to accommodation outside the park, have an interest in the village tours and crafts market and also prefer a low fee to a high fee.

Respondents were asked to indicate their origin and income category, which enables us to investigate the effect of these characteristics on tourist preferences. In classifying by origin, two groups are used. The first group termed 'domestic tourists' are of South African and other African nationalities, and the second group 'international tourists' comprises all other nationalities. The other African nationalities comprise only 6.5% of the domestic group. The second classification of tourists is by income category, and the sample is spilt into four income categories. Although Pearson chi-square tests confirmed a relationship between the origin of tourists and income levels *($\chi^2=1400; p=0.00; df=3$)* by income categories, it was decided to continue the analysis with both classifications because both have been shown to be important determinants of tourist preferences (Hearne and Salinas, 2002; Hearne and Santos, 2005) and might not necessarily affect preferences in the same way.

Table 5.2 Conditional probit model estimates for all tourists, domestic tourists and international tourists

Attributes	All tourists	Domestic tourists	International tourists
Accommodation	-0.41***	-0.4 ***	-0.43 ***
	(0.09)	(0.11)	(0.15)
Craft markets	0.35***	0.33***	0.37***
	(0.05)	(0.06)	(0.1)
Village tours	0.41***	0.46***	0.33***
	(0.06)	(0.08)	(0.1)
Price	-0.01***	-0.01***	-0.01*
	(0.00)	(0.00)	(0.00)
Option1_ASC	0.42***	0.25**	0.79***
	(0.09)	(0.12)	(0.16)
Option2_ASC	0.34***	0.19	0.65***
	(0.1)	(0.13)	(0.17)
Log- likelihood	-2127	-1437	-676

Significant at * 10%, ** 5% and *** 1%. *Standard errors between brackets*

Effect of tourist origin and income on choices

When the sample is split by nationality, about 31% of domestic tourists preferred the status quo option, whilst in the international tourist group only 22% of the respondents preferred the status quo option. Conditional probit estimates for the two groups split by origin are also shown in Table 5.2. Similar to the pooled sample, the coefficient of both accommodation and price variables have negative signs, for both domestic and international tourist groups. Results suggest that all tourist groups show an interest in village tours and crafts markets, and prefer accommodation inside the park to village accommodation. A likelihood ratio test was conducted to investigate whether preferences differ between domestic and international tourist groups. The likelihood-ratio test statistic was 28.44 (P=0.0004). The null hypothesis is thus rejected and we conclude that there are statistically significant differences between the two groups, hence the groups should not be pooled in analyzing their choices.

Table 3 shows that there are differences in the extent to which tourists in different income groups respond to the attributes in the choice sets. All income groups prefer KNP accommodation to village accommodation, except for the lowest income group. In

the low income group, the accommodation attribute does not seem to be driving the choices made. All income groups show an interest in the craft markets and the village tours. The main difference between the income groups is that the price attribute is not significant in the highest income group and does not have a negative sign, whereas it is significant at 5% level in the second and third income groups. Likelihood ratio tests for the income groups and the pooled sample also show that the income groups should not be pooled but modeled separately. The likelihood ratio statistic is 308.35 (P=0.000).

Table 5.3 Conditional probit model estimates for tourists grouped by income groups

Attribute	**Income less than $12 000**	**Income $12 001-$25 000**	**Income $25 001-$50 000**	**Income above $50 000**
Accommodation	-0.16	-0.54**	-0.43***	-0.76**
	(0.11)	(0.22)	(0.14)	(0.27)
Craft markets	0.25***	0.40***	0.39***	0.38***
	(0.09)	(0.11)	(0.09)	(0.12)
Village tours	0.34***	0.46***	0.36***	0.59***
	(0.11)	(0.14)	(0.1)	(0.17)
Price	-0.01***	-0.01**	-0.01**	0.01
	(0.00)	(0.00)	(0.00)	(0.01)
Option1_ASC	0.20	0.61**	0.60***	0.22
	(0.17)	(0.24)	(0.15)	(0.28)
Option2_ASC	0.33**	0.25	0.56***	-0.01
	(0.13)	(0.27)	(0.14)	(0.34)
Log-likelihood	-414	-517	-625	-417

Not significant, Significant at * 10%, ** 5% and ***1%. *Standard errors between brackets*

Willingness to pay estimates for the different groups

From the estimates in Tables 5.2 and 5.3, it is possible to estimate the marginal willingness to pay (MWTP) for each of the variables. MWTP can be estimated from the marginal rate of substitution between the attribute coefficient and the coefficient for the price attribute, in the form of:

$$MWTP = -\frac{\beta_{attribute}}{\beta_P}.$$

For both the village tours and the crafts markets, the domestic tourists have a lower MWTP than their international counterparts (Table 5.4) or the pooled group. The MWTP estimates for the international tourists are also only significant at the 10% level, unlike in the pooled sample and for the domestic group. As expected MWTP for tourists to use village accommodation is negative. This suggests that tourists might need to be given a discount or some form of compensation for them to switch preferences from using current KNP accommodation to village accommodation. In almost all cases, MWTP for crafts and tours are higher than the maximum value of $40 that had been proposed in the choice sets.

Table 5.4 MWTP estimates for domestic and international tourists in $

Attribute	All tourists	Domestic tourists	International tourists
Accommodation	-56.8 ** (-94.8 ; -18.8) *19.4*	-48.8** (-86.6 ; -11.0) *19.3*	-82.4 (-197.9 ; 33.1) *58.9*
Craft markets	47.7*** (22.8 ; 72.5) *12.7*	39.8*** (16.1 ; 63.4) *12.1*	70.1* (-12.1 ; 152.3_ *42.0*
Village tours	56.7*** (27.0; 86.3) *15.1*	54.7*** (22.0; 87.4) *16.7*	63.4* (-8.4 ; 135.3) *36.7*

Significant at * 10%, ** 5% and ***1%. *Standard errors in italics, 95% confidence levels in brackets*

Table 5.5 shows the MWTP estimates for the different income groups. Expectedly, the lowest income group has the lowest MWTP. This group also has a MWTP that is within the $0-40 limits that were set. For all attributes the third income group has MWTP estimates that are higher than the $40 limit set in the questionnaire. All groups display negative MWTP estimates for accommodation outside the KNP.

Table 5.5 MWTP estimates for different income groups in $

Attribute	Income less than $12 000	Income $12 001-$25 000	Income $25 001-$50 000	Income above $50 000
	-15.3*	-46.9	-53.4**	142.1
Accommodation	(-33.1 ; 2.6)	(-103.9 ; 9.2)	(-103.0; -3.9)	(-174.1; 458.2)
	9.1	28.7	25.3	161.3
	23.7***	35.1**	48.3***	-70.4
Craft markets	(10.0 ; 37.4)	(1.8 ; 68.4)	(13.0 ; 83.7)	(-254.6; 113.7)
	7.0	17.0	18.0	93.9
	33.0***	40.9**	44.1***	-111.5
Village tours	(14.8; 51.1)	(2.0; 79.7)	(11.4; 76.7)	(-395.8; 172.7)
	9.3	19.8	16.6	145.0

Significant at * 10%, ** 5% and ***1%. *Standard errors in italics, 95% confidence levels in parentheses*

Tourist perceptions

In the supporting questions, tourists were asked a range of questions to determine their opinions regarding the relationship between rural development and conservation as well as their willingness to purchase ecotourism related goods and services from surrounding rural communities. The resulting responses for domestic and international tourists are shown in Tables 5.6 and 5.7. Table 5.6 shows that there were differences in the interest of international tourists to purchase certain ecotourism goods and services compared to domestic tourists. The Cramer's V statistic which tests the null hypothesis of no association between the row variable and the column variable for categorical data (Agresti, 1984) shows association between nationality grouping of respondents and their interest in purchasing domestic goods and services (see Table 5.6). International tourists seem to have a higher interest to purchase the goods and services that villages can offer than domestic tourists. For instance, only 48% of domestic tourists would purchase a village tour compared to 63% of the international tourists. This reluctance of domestic tourists to purchase goods and services from the local communities has also been highlighted by Kepe (2001) who noted the reluctance of domestic tourists to visit and share cultural experiences of communities adjacent to a nature reserve in the Eastern Cape province.

Similarly, Cramer's V statistics in Table 5.7 show that there exists a significant difference between the nationality grouping of tourists with respect to their responses to

key statements pertaining to the relationship between conservation and rural development. Whereas none of the international tourists disagreed with the statement that tourism should contribute to the development of local villages, 10% of domestic tourists disagreed with this statement. Similarly, 20% of domestic tourists disagreed with the statement that the KNP should contribute towards rural development in the surrounding communities, compared to only 3% of the international tourists. Expectedly the statement that rural development is more important than conservation was met with high levels (> 50%) of disagreement in both groups of tourists, whilst almost 40% of the respondents in both groups also disagreed with the statement that the KNP should only focus on conservation and leave rural development efforts to other stakeholders. This could indicate that tourists are indeed aware of the need for integrated efforts in both conservation and rural development.

Table 5.6 Tourist interest in purchasing ecotourism related goods and services from rural communities grouped by nationality

	IND %	NP %	P %	χ^2 df (2)	Cramer's V
I would purchase from surrounding villages…					
Accommodation with KNP standards and prices					
• International	20	30	50	3.16	0.1
• Domestic	23	37	40		
Accommodation with KNP standards but lower prices	26	23	51	5.2**	0.1**
• International	22	35	43		
• Domestic					
3-4 hour village tour at R150 ($19)					
• International	16	21	63	6.5**	0.1**
• Domestic	25	27	48		
Crafts from a village craft market					
• International	17	10	73	9.1***	0.2***
• Domestic	22	22	56		
Traditional meal sold prices similar to KNP meals					
• International	35	12	53	8.1**	0.2**
• Domestic	28	26	46		
Traditional meal sold at higher than KNP prices					
• International	41	27	32	17.9***	0.2***
• Domestic	24	52	24		

IND- Indifferent, NP- Not Purchase, P-Purchase
Significant at * 10%, ** 5% and ***1%

Table 5.7 Tourist opinions on rural development and conservation grouped by nationality

	IND	Agree	Disagree	χ2 df (2)	Cramer's V
Visiting KNP, my only interest is wildlife					
• International	11	70	19	3.2	0.1
• Domestic	8	79	13		
I'm also interested in surrounding villages					
• International	25	64	11	11.3***	0.2***
• Domestic	25	48	27		
Tourism should contribute to development of surrounding communities					
• International	10	90	0		
• Domestic	8	80	12	10.5***	0.2***
Rural development is more important than conservation					
• International	32	14	54		
• Domestic	29	18	53	0.8	0.1
Conservation won't be sustainable without development in nearby communities					
• International	26	64	10	10.4***	0.2***
• Domestic	18	57	25		
KNP should only focus on nature conservation and not rural development					
• International	38	27	37		
• Domestic	21	36	43	10.1***	0.2***
KNP should support rural development in surrounding villages					
• International	15	82	3	13.7***	0.3***
• Domestic	15	65	20		
I would pay more for village tourism activities than current KNP entrance fees					
• International	26	56	18	5.2**	0.2**
• Domestic	20	49	31		

Significant at * 10%, ** 5% and ***1%

5.5 Discussion

This study is based on analyses of tourists preferences for ecotourism attributes which were identified jointly with the Mhinga local community through a consultation process. Results of the analysis suggest that there is interest in village tours and crafts markets for domestic and international tourist groups as well as across all income groups of tourists, but there is no interest in staying in village based accommodation in all tourist groups. The fee attribute was only significant for the low income groups. When tourists are grouped according to origin, the fees were most significant for domestic tourist groups. This is to be expected given that domestic tourists on average have lower income than international tourists. Likelihood ratio tests justified modeling tourists separately in two groups based on origin, as well as in four groups based on income.

The MWTP estimates derived suggest that tourists are willing to pay fees that are within or higher than the set bid values of $0, $20 and $40. The results also suggest that the second and third income groups as well as domestic tourist groups are willing to pay more for tours than the bids included in the surveys. This finding could be interpreted in two ways. First, tourists may indeed be willing to pay more than what is being charged for similar tours elsewhere and prices indicated by the communities because they value the service. Second, since these are hypothetical packages tourists might state that they are willing to commit themselves to pay more than they would actually pay should a market for these services arise. It is thus worthwhile for decision makers in communities intending to offer these services to look further into pricing of these services. In Guatemala, Hearne & Santos (2005) found that tourists had a preference for higher entrance fees than lower fees into the park and partly attributed this to the possibility that tourists might indeed realize the benefits of higher fees, or low bid values in the design of the choice experiment.

Our findings that tourists were generally reluctant to stay outside the park concurred with studies conducted in other countries. Hearne & Santos (2005) found that tourists in Guatemala had a preference for eco-lodges inside the park compared to rural cabins outside the park. Mackoy and Osland (2004), found that preferences of ecotourists for lodging requirements were constant over time and across destinations. Proximity to a natural area was one of the attributes that tourists considered in selecting accommodation.

The reluctance of tourists to stay in village accommodation might be due to a number of reasons. First, concerns about crime and personal safety in South Africa might account for the unwillingness of both domestic and international tourists to stay outside the KNP. This was expressed in informal discussions with some of the tourists during and after the interviews. Security concerns of tourists can impact on the feasibility of ecotourism. This was also noted by Hearne & Santos (2005) in Guatemala where there was a reluctance amongst tourists to stay in rural cabins compared to lodgings in the park. The second plausible explanation might be the inconvenience that is associated with staying outside KNP if the main reason for visiting the area is to view wildlife and participate in related activities inside KNP. This concurs with findings by Wight (1997) that tourists choose accommodation that enables them to experience a place i.e. choice of the environment and activities is what motivates the accommodation selected not vice versa. Indeed some of the domestic tourists indicated in informal discussions that they viewed KNP as a place where they could get away from their busy schedules in the city and spend some quiet time with their families. Such tourists would thus not be prepared to go and stay in villages where they were likely to come across and interact with more people than in KNP. Thirdly, the abundance of alternative accommodation and ease of access through online booking of KNP accommodation might act as a disincentive for tourists to seek lodgings elsewhere. The KNP itself often has below maximum occupancy rates for accommodation in most of its camps (South Africa National Parks, 2007; South Africa National Parks, 2008).

A possible solution to the lack of interest in village based accommodation might be for community lodges to be located inside KNP to alleviate possible concerns around security and logistical inconvenience. The KNP currently has concessions for investment in accommodation facilities to private companies inside the park. Such an arrangement for local communities would however, have to be more carefully considered given that most of the existing concessionaires in the KNP had not performed as well as expected due to various reasons, such as low occupancy rates and over investment (Spenceley, 2006). Stronger efforts to market the surrounding villages as part of the KNP experience would influence the choice of village accommodation by tourists. As long as the KNP remains the only attraction to the area, then tourists are likely to continue selecting accommodation inside the KNP and not outside. It is possible that expansion of cultural and social tourism aspects of surrounding rural communities could lead to a shift in the focus on environmental areas as the main determinant of accommodation choice as suggested by Wight (1997). Furthermore it might

be necessary to conduct detailed market studies to determine the types of tourists who are likely to be interested in staying in villages, rather than targeting all tourists coming to KNP.

5.6 Conclusion

This paper analyzes the preferences of tourists to engage in ecotourism related activities as well as their MWTP for three specific ecotourism attributes, namely village accommodation, village tours and visits to crafts markets in villages adjacent to the Kruger National Park (KNP). These attributes had been identified through a consultation process with local communities. Choice experiments were applied to determine tourists' preferences and their MWTP. Conditional probit models were used to analyse tourist preferences by origin and by income groups.

The results of our analysis suggest that there is potential for the development of ecotourism in the surrounding areas close to KNP. It is, however, necessary to consider the pricing and the nature of the services provided if ecotourism is to be practiced successfully. The benefits from developing accommodation facilities mainly targeted at KNP visitors might be limited, but rural communities can still target KNP visitors who intend to stay in the park for village tours and other cultural activities. Ecotourism activities should complement existing activities inside the KNP and target specific groups of tourists, particularly international tourists who have an interest in cultural related tourism activities and low income groups of tourists who might be attracted by cheaper accommodation outside the park. The finding that domestic and international tourists had similar preferences but different magnitude of the willingness to pay are similar to findings by Hearne and Salinas, (2002) for Costa Rica and Hearne & Santos (2005) for Guatemala towards development of ecotourism. It might thus be worthwhile to charge different rates for the village tours for domestic and international tourists.

This study can aid decision making for development of ecotourism by rural communities. Plans to invest in tourism accommodation in communities adjacent to the KNP should consider these findings and explore ways to address tourists' reluctance to stay outside the park, or even consider situating village owned accommodation facilities within the KNP itself. For the KNP and GLTFCA management, this study suggests the possibility for including cultural specific tourism activities within the tourism plans for the transfrontier park and also closer collaboration in developing ecotourism with rural communities in the GLTFCA. This would not only promote rural development but also provide a bridge for the

type of tourism that encompasses the principles laid out in the 2002 Quebec Declaration on Ecotourism. The principles include active contribution to visitor familiarization with cultural and natural heritage of places they visit and inclusion of local and native communities in the planning of ecotourism and better organized tours of small sized groups. Capacity should also be developed in local communities to harness the opportunities for income generation through village tours and craft markets and other aspects of ecotourism. The insights into tourist attitudes towards some ecotourism services highlighted in this study can help planners or project managers to understand the extent to which tourists would support efforts to bridge the divide between conservation and development.

The intention of this study was to keep the design simple given that choice experiments are a relatively new data collection method in developing countries. Future studies of ecotourism in or around KNP could consider increasing the number of attribute levels to increase efficiency (Johnson et al., 2007) and detail in terms of specific ecotourism packages to enable development of tailor-made tour packages. A weakness of the study is that in consulting communities in terms of the possible ecotourism attributes, the resultant ecotourism packages investigated ended up biased towards cultural tourism. Although this was not the intention of the study, the results of the study still bear relevance for the development of ecotourism in these communities. According to Weaver and Lawton (2007), there is a growing tendency in literature to see culture as a core component of the ecotourism attraction. In addition, although some distinction might be made between ecotourism and cultural tourism, there is growing recognition that all 'natural' environments are affected in a number of ways by human activity, so culture is implicit in natural tourism venues, and the two cannot be divorced. Future studies following a similar methodology could try to avoid this limitation, by specifying the attributes of ecotourism in advance and then asking communities to select from the range of options available.

Another possible limitation in this approach might have resulted from the reluctance of tourists to use accommodation out of the park. This could have resulted in respondents employing a lexicographic strategy[6] (Hensher, 2007) in terms of attribute processing. Hence future studies can also investigate lexicographic choices in ecotourism survey results.

[6] This involves a respondent selecting the most important attribute, and subsequently deciding on the choices only on the basis of the levels of that attribute, disregarding all others.

The case specific nature of this study makes it difficult to generalize the findings to other areas in South Africa, but even more so to other protected areas in developing countries. The study, however, illustrates the importance of choice experiments as a useful tool through which tourist preferences can be analyzed in the development of new tourism sites or in enhancing existing ones in other developing countries. Such analyses can also guide investment and provide information on the possibilities for involving rural communities in tourism. Furthermore, the study contributes to the growing body of literature on application on choice experiments in developing countries, and illustrates the usefulness of this approach in ecotourism studies where most of the goods and services provided cannot be valued through market based techniques.

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CHAPTER SIX: Exploring Options for Land Based Development at the Wildlife/Livestock Interface

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Abstract

Conservation approaches that promote wildlife conservation and stimulate local economic development in rural communities near protected areas are increasing in Southern African. Facilitating attainment of these multiple goals requires land use decisions that consider the complex interactions between wildlife and livestock, local socio-cultural concerns, and environmental and economic aspects. Spatial land use modeling, provides a method to explore alternative configurations of land based development, and the tradeoffs between different income sources associated with scenarios of land use. Such land use modeling can consider factors not previously integrated in land use planning and analysis in Southern Africa. We analyse the effects of a number of land use scenarios, explicitly including nuisance effects of wildlife to agriculture, plot connectivity, fencing constraints, land carrying capacity and water resources. Result show that in principle it is possible to achieve increase in income of more than 100% compared to the status quo land use allocation when all these factors are considered in land use planning. Based on these results we argue that rural development adjacent to protected areas can be enhanced by further exploring the potential of the prevalent natural resources and allocating land to the most promising uses.

***Keywords*: Spatial land use, conservation, wildlife, livestock, rural development**

6.1 Introduction

The relation between biodiversity conservation and developmental goals of poverty alleviation and improvement of human welfare is a key element for sustainable development. There are increasing efforts to explore 'win-win' solutions to these important but sometimes conflicting goals, especially in terms of land allocation (Adams and Hutton, 2007; Munthali, 2007). Although it has been argued that linking conservation and developmental goals is difficult, even at conceptual levels (Brandon and Wells, 1992; Sanderson and Redford, 2003; Roe et al., 2011), there is increasing pressure on protected areas and surrounding rural communities in Southern Africa to deliver a well balanced mix of environmental, social and economic benefits. Conservation approaches that promote wildlife conservation and tourism whilst simultaneously improving socio-economic conditions of rural communities living at the periphery of protected areas are gaining support from both public authorities and non-governmental organisations in Southern African (Weaver and Skyer, 2005; Munthali, 2007; Venter et al., 2008; AHEAD-GLTFCA, 2010; Wilhelm-Rechmann and Cowling, 2011). Advances in local development alternatives and land multi-functionality can provide solutions for reconciling development oriented biodiversity conservation and natural resource management goals (Torquebiau and Taylor, 2009).

The Great Limpopo Transfrontier Conservation Area (GLTFCA), which links conservation areas in South-Africa, Zimbabwe and Mozambique, aims to integrate rural development, tourism and wildlife conservation through sustainable land uses in and around protected areas. Although there is a general consensus that the concept of Transfrontier Conservation Areas (TFCAs) increases economic opportunities and fosters partnership between countries and amongst different interest groups (Munthali, 2007), there is limited information on how multiple conservation and development objectives can be achieved. Furthermore, there is uncertainty on the likely implications of promoting wildlife and tourism-based land uses on existing agricultural land uses and livelihood activities in rural communities (Wolmer, 2003; Cumming et al., 2007; AHEAD-GLTFCA, 2010; Cumming, 2011).

From the perspective of rural communities adjacent to the protected areas, the challenges include zoning of land, the main resource available, to reduce poverty through revenue generation and employment creation, and livelihoods diversification based on multiple land uses (Munthali, 2007). Other concerns focus on reducing the negative effects of wildlife on

agricultural activities, hereafter referred to as 'nuisance effects' of wildlife (Anthony, 2006; Chaminuka, 2011). Two important questions arise for communities integrating wildlife and agricultural land uses. The first question is how much of the available land should be allocated to each of the different land uses (Munthali, 2007), and how zoning of different land uses can be done, considering interactions with wildlife, the prevailing characteristics of the land and available resources. The second question is what are the tradeoffs in terms of income that are associated with the different spatial land use allocations.

Previous studies explicitly modeling land use options in Africa have largely focussed on the issue of land allocation and benefit sharing in community wildlife programmes (see e.g. Schulz and Skonhoft, (1996), Bulte and Horan (2003), and (Fischer et al., 2011)). Schulz and Skonhoft, (1996) analyse land use conflict between wildlife conservation and agro-pastoralism in East Africa and determine the optimal land allocation for different scenarios, considering the nuisance effects of wildlife. Their analysis, however does not consider spatial location of alternative land uses. Bulte and Horan (2003), analyse alternative patterns of land allocation under different institutional arrangements and related policy scenarios where there is competition for land between agriculture and wildlife hunting in a non-spatial model. They show that it is possible for different patterns of conservation and agricultural development to emerge in developing countries. The authors acknowledge the shortcoming of their analysis regarding the simplifying assumption that all parcels of land are homogenous and suitable for wildlife and agriculture. They also indicate that the fact that some land is more suitable for wildlife than agriculture for example, would affect the incentives for different spatial land use arrangements. When the heterogeneous characteristics of the parcels such as distance from the park, existing human settlements, rivers and roads are considered, spatial land use modelling thus becomes more useful. Furthermore from a practical point of view, it is not sufficient to indicate only the optimal amount land allocated to wildlife, but also the spatial location of different land uses in relation to each other, and in relation to the bio-physical and existing landscape features.

A different approach to analysing the competition between wildlife and livestock which has been used by several studies is bio-economic modelling approach. The bio-economic modelling approach has been used in the past (Skonhoft and Solstad, 1998; Kinyua et al., 2000) and recently by Fisher et al. (2011). The approach generally considers the incentive mechanisms by which single or multiple agents make decisions to support conservation or

alternative land uses. For example, Fisher et al. (2011), analyse the welfare implications of alternative forms of revenue sharing where wildlife and agriculture are competing land uses in Zimbabwe. Their model is not based on the assumption of a social planner, but considers three agencies mainly the communities, poachers and the park managers. They model two possible land uses, and depict the effects of wildlife as a function of declining rents from agriculture. They conclude that results depend on the extent of losses to agriculture in relation to benefits, hunting quotas and the design of revenue sharing regime.

In this paper we demonstrate how spatial land use modeling can assist in evaluating the consequences of alternative land use configurations. We apply the land use model that we specifically developed to study competing claims on land use and natural resources at the interface of wildlife and livestock (Chapter 2). Our model focuses on alternative land uses and includes the nuisance effects and damage of wildlife to agriculture, plot connectivity and fencing constraints. We analyse how income will be affected under various land use scenarios. As an illustration, the analysis is applied to the case of rural communities on the north-western borders of the Kruger National Park (KNP) in South Africa. We show how land can be allocated to the main potential sources of income in the region: livestock, irrigated agriculture, tourism and wildlife. We pay particular attention to factors that have previously not been explicitly considered by other studies, such as distance to the roads and rivers, interactions between livestock and wildlife through predation and animal diseases, connectivity of wildlife plots and fencing constraints. Spatial allocation of wildlife, and its relation to other land uses are important as wildlife can impose costs on agricultural based land uses, through damage-causing animals, whilst tourism can enjoy positive externalities associated with having wildlife nearby. Integrating spatial, economic, ecological and sociological aspects where land use decisions are expected to satisfy multiple stakeholder interests is important and useful where there are competing land uses and interests (Giller et al., 2008).

The paper proceeds as follows. Section 2 describes the nature of competition for land at the periphery of protected areas regarding rural development and conservation objectives. We also describe the case study area. In section 3 the model applied in the analysis is presented. Section 4 outlines the scenarios considered, presents the results of the scenario analysis and shows the effects of sensitivity analysis of key parameters in the model. In section 5 we discuss the implications of the results, and suggest some scenarios for land based

development in areas where wildlife conservation and rural development objectives are competing for land and natural resources.

6.2 Competing claims on land in Southern Africa

6.2.1 Poverty, agriculture, rural development and wildlife

Most people in sub-Saharan Africa reside in rural areas, which are characterized by high poverty, high unemployment, low levels of investment and inadequate infrastructure. Subsistence agriculture, which is the main activity of the rural economy, is characterised by low land and labour productivity due to bio-physical constraints such as erratic weather, poor soil fertility, and socio-economic constraints that include limited access to markets, poor infrastructure and lack of capital (Scoones et al., 2005). Although most efforts in developing the rural economy have focussed on agriculture, this sector alone is insufficient as a driver of the rural economy, with most households combining agriculture with a range of off-farm income sources (Ashley and Elliott, 2003; Scoones et al., 2005; Banchirigah and Hilson, 2010). Diversification of rural livelihoods can reduce the vulnerability of rural communities, and create new opportunities for developing rural economies (Assan et al., 2009). The major challenge, however, lies in identifying and implementing effective diversification strategies (Ashley and Elliott, 2003; Banchirigah and Hilson, 2010). Effective and sustainable utilisation of locally available livelihood assets such as human resources, land, water, wildlife and forestry resources can create pathways for rural income diversification (Boyd et al., 1999; Barnes et al., 2002; Scoones et al., 2005; Assan et al., 2009; Roe et al., 2011).

Wildlife conservation and tourism provide options for developing land with limited agricultural potential, and stimulating growth of the local economy in some areas in sub-Saharan Africa (Ashley and Elliott, 2003; Munthali, 2007). The linkage between conservation and rural development goals, especially poverty alleviation, is however, debated (Barrett and Arcese, 1995; Kepe et al., 2004; Adams and Hutton, 2007; Venter et al., 2008; Fisher et al., 2011). Depending on the institutional environment, wildlife can either present opportunities for realising local economic development, or be a threat towards rural livelihoods in wildlife rich areas. An important first step in reconciling conservation and rural development goals, is to ensure that rural communities secure rights to land and locally available natural resources such as wildlife, so that these resources are not viewed only as international public goods to

be protected but also as livelihood assets to be used sustainably to ensure local development (Barnes et al., 2002; Ashley and Elliott, 2003).

Transfrontier Conservation Areas (TFCAs) in Southern Africa, represent multi-national cooperation by governments to facilitate multi-sectoral policies that promote integration of wildlife conservation, tourism, and rural development (Munthali, 2007; Metcalfe and Kepe, 2008). For rural communities living within the GLTFCA in southern Africa, the emergence of new livelihood opportunities to diversify sources of income, is accompanied by increased demand for land and sometimes competing land uses (Munthali, 2007; Cumming et al., 2007; Cumming, 2011). Most people regard a TFCA as an area in which wildlife based tourism is the pre-dominant land use, and several questions have been raised about the effects of such changes in land use, on people's livelihoods, and existing agricultural based land uses (Bengis, 2005; Cumming et al., 2007; Cumming, 2011). It is also not clear how land use planning can be done considering the likely increase in human/wildlife/livestock interactions in the TFCA. Apart from the study by Munthali (2007) , who suggested a non-spatial method for evaluating how much land should be set aside for different land uses, we are not aware of any other studies on this topic in the GLTFCA. In Maputaland, a biodiversity hotspot in the Lubombo TFCA, Smith et al. (2008), conducted a study which utilized a systematic conservation planning approach to facilitate conservation of land cover types, species, and ecological processes. They proposed a conservation landscape which could provide substantial revenues from game ranching whilst meeting specific conservation targets. Analysing alternative spatial patterns of land use and their effects on income and local socio-cultural concerns can assist in decision making at local and national levels in the TFCA. It is essential to find good solutions for rural development and biodiversity conservation. If these sometimes conflicting objectives are not balanced, there is considerable risk that either wildlife conservation becomes impossible or that rural development will be frustrated by restrictions imposed on other livelihood activities by wildlife conservation.

6.2.2 The case of rural communities adjacent to the Kruger National Park

The rural areas near the north-western border of KNP are facing multiple challenges with regard to economic development and wildlife conservation. On its north-western borders the KNP is mainly surrounded by rural areas, with unemployment levels of more than 50% and poverty head count ratios of more than 60%. Social grants, remittances, and infrequent

informal activity are the main sources of income (PROVIDE, 2009; Chaminuka et al., 2011). The area has limited economic potential, is situated far from major towns and markets, and infrastructure services are generally poor (Thulamela Local Municipality, 2009). Rainfall is low (400 to 600 mm per year) with long drought periods (CGIAR, 2003). The area is not suitable for dryland crop production, and subsistence livestock production, the main land use activity is riddled with problems of overstocking, frequent droughts and stock theft. Furthermore, the proximity of wildlife has a nuisance effect on agriculture through damage causing animals destroying crops and livestock and risk of disease transmission between wildlife and livestock (Anthony, 2006; Chaminuka et al., 2011).

On the southern side of the KNP, the situation is quite different. The southern borders of the KNP comprise mainly private game reserves which together form the Associated Private Nature Reserves (APNR). The reserves form a buffer-zone between the KNP and livestock areas, and have a total size of about 185,000 hectares (Associated Private Nature Reserves, 2005). The reserves create employment for the local rural communities, and generate tourism and hunting revenues (Associated Private Nature Reserves, 2005). Plans are underway in the Thulamela Local Municipality under whose jurisdiction most of the rural communities on the north-western boundaries of the KNP fall, to invest in wildlife based tourism projects in rural communities next to the KNP. Such projects include game parks, tourism accommodation facilities, and cultural tourism (Mhinga, Undated; Thulamela Local Municipality, 2009).

Our analysis centres on four potential land uses, namely livestock, irrigation, tourism lodges and wildlife and is applied to an area of 84 640,72 ha (846,4 km sq) with a perimeter of 121,5km and stretching up to 58km along the KNP fence, and for 27km along the road from the Punda Maria gate of KNP (see Figure 6.1). The decision to extend this analysis beyond the Mhinga area was based on the realization that it is unlikely that should wildlife tourism be introduced in the area, it would only be confined to the Mhinga area as it is too small and other villages in the local municipality would also wish to benefit from it. We also considered that on the southern side of KNP, the APNR model which the community intends to emulate, is based on a much larger piece of land. We also found out during fieldwork, that some years ago the Mariyeta Initiative, a project proposal to participate in wildlife tourism on the western borders of KNP had been conceptualized on the basis of villages cooperating in terms of making land available for wildlife tourism use (Anthony, 2006). The land uses considered are described as follows;

Livestock: This is considered to be the same as the existing communal grazing livestock system.

Irrigated agriculture: This is considered to entail maize production under irrigation. It is possible that other crops can be considered in future analysis.

Tourism: In this land use, tourism mainly generates income from provision of accommodation and ecotourism and cultural tourism activities. Tourists also engage in game viewing or leisure tourism.

Wildlife land use: Income is generated through leasing of trophy hunting concessions, and wildlife viewing. Although it is also possible in the case of wildlife to get revenue from live animal sales, and venison sales, where animals are reared specifically for meat, we do not consider these as the area is situated within the buffer zone for foot and mouth disease control where there are restrictions to movement of animals and animal products (Bruckner et al., 2002). Furthermore, the production and marketing of venison, a low-cholesterol, low-fat protein in South Africa is very limited[7] (Tomlinson et al., 2002; ABSA, 2003).

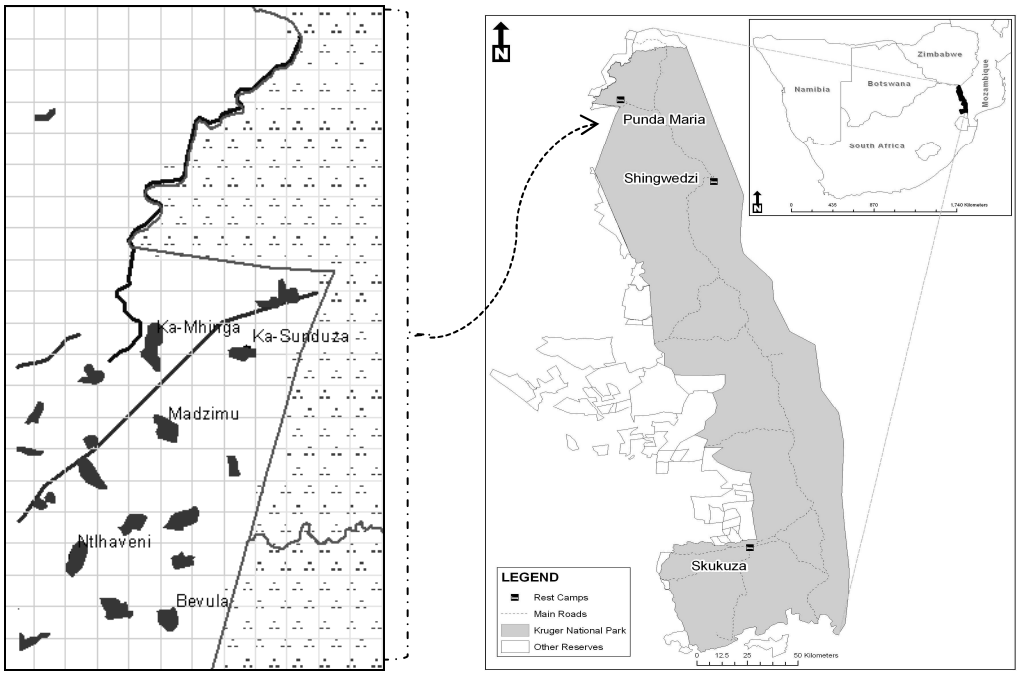


Figure 6.1 The case study area and its location in relation to KNP, Zimbabwe and Mozambique

[7] In Namibia, communities earn the equivalent of about 5% of total wildlife related income from sales and own use of game meat (Jones and Weaver, 2009).

6.3 The model

The model focuses on spatially explicit land use allocations and interactions between wildlife and livestock. The problem is formulated as a mixed integer problem, and includes key elements related to wildlife related damage, suitability of wildlife plots, fencing costs and endogenous effects of wildlife on other land uses and is described in detail in Chapter 2 of this thesis. The main land uses considered are livestock, irrigated agriculture, tourism lodges and wildlife ranches. Part of the area being modelled includes existing villages. The land occupied by these villages is not included in the analysis as there are no plans to resettle people. The objective function is to maximise total profits (Y) from all land use types (u) from all plots (g)[8]:

$$\max\left\{Y = \sum_{g}\sum_{u} P_{ug} - \sum_{k} \varpi F_{k}\right\}, \qquad (1)$$

where P_{ug} is the profit per land use per plot and ϖ denotes fencing costs in US$ for plots with wildlife, and $F_k \in \{0, 1\}$ denotes whether border k is fenced or not. The instrument variable in the model is A_{ug} which denotes the total area of land in hectares (ha) allocated to a specific land use per plot of total size a_g. In the model each plot is a 400 ha square. It is possible, however, to define the plots in different sizes based on different criteria such as land ownership or land cover characteristics. B_{ug} is a binary variable denoting whether plot g is covered by land use type u or not;

$$A_{ug} \leq a_g B_{ug} \qquad \forall u, g\,. \qquad (2)$$

Furthermore, any given plot can have only one land use type. Total output (Q_{ug}) is measured in tonnes for irrigated crops, large stock units (LSU) for wildlife or livestock and tourist bed nights for tourism lodges. Q_{ug} depends on the size of the plot A_{ug}, output that can be produced per ha if all land in the neighborhood is wildlife (β_u), and the additional output that can be gained from each land use if there is no wildlife in the surrounding plots. Wildlife has an endogenous effect on other land uses (i.e. the presence of wildlife on one plot can influence the productivity of adjacent plots for irrigation and livestock): In the second part equation (3) τ_{gh} denotes the extra productivity you gain in g from turning plot q (in the vicinity of g) into any land use type v other than wildlife, and A_{vh} is the size of the plots in the vicinity allocated to land use type v;

[8] Throughout the article variables are indicated by capital Latin symbols in italics; parameters are lower case Greek symbols or lower case Latin symbols; indices are lower case Latin symbols in italics.

$$Q_{ug} \le A_{ug}\beta_u + \sum_{h\in \mathbf{z}_q}\sum_{v\notin \mathbf{M}} \tau_{ugh} A_{vh} \qquad \forall u, g\,. \tag{3}$$

Gross benefits of land use type u in plot g (G_{ug}) in US$ are expressed as;

$$G_{ug} \le \rho_{ug} Q_{ug} \tag{4}$$

where ρ_{ug} indicates the net benefits per land use per unit of output per plot.

$$\rho_{ug} = \lfloor max\{0, \gamma_u(1-\delta_{ug} - \lambda_{ug} - \xi_u\eta_g - \varphi_u\chi_g) - c_{ug}\}\rfloor, \tag{5}$$

where ρ_{ug} depends on the price per unit of output (γ_u), a coefficient that reflects the effect of wildlife damage at different distances from the park (δ_{ug}), negative effects of being far from the park for some land uses (λ_{ug}), the slope extent (η_g), effects of the slope on output (ξ_u), distance from the road (χ_g) and effects of distance from the road on output (φ_u). For wildlife and tourism δ_{ug} is zero. Coefficient λ_{ug} indicates the change in willingness to pay for tourism services as one moves further from the park, and $0 \le \lambda_{ug} \le 1$ for tourism. Table 1 shows the values of these parameters. The operating costs per land use per plot are indicated as c_{ug}.

Profits per plot per land use (P_{ug}) are a function of the gross benefits and the annuitized capital costs for each land use (t_u).

$$P_{ug} = G_{ug} - \sum_u t_u B_{ug} \tag{6}$$

The park is the main source of wildlife stock, so migration of wildlife mainly occurs from the park to the communal land i.e. from east to west and from south to north. Following the approach of Williams *et al.* (2003), connectivity of the wildlife parcels is determined by the suitability of adjacent parcels to wildlife land use (for details see (Chaminuka et al., 2012)). The wildlife suitability (W_q) of a plot q is expressed as a function of wildlife suitability W_g of an adjacent plot g i.e. $W_q = f(W_g)$. $W_g \in \{0, 1\}$ where 1 indicates the presence of a wildlife ranch in plot g;

$$W_g \le \sum_{q\in \mathbf{V}_g} W_q \qquad \forall g \tag{7}$$

and

$$B_{ug} = W_g \qquad \forall u \in \mathbf{W}. \qquad (8)$$

W is wildlife land use, and $\mathbf{V}_g$ is a set that includes all plots q such that (i) $q \neq g$; (ii) border to border distance between g and q is zero (i.e. the plots share a border) and (iii) cartesian plane coordinates x and y are such that $x_g < x_q$ or $y_g < y_q$ or both, where x_g denotes the cartesian x-coordinate of plot g and similar notation for y and plot q. This formulation implies that a plot g is suitable as a wildlife ranch conditional upon sharing a border with a plot q that has wildlife, and g is located to the north, west or south-west of plot q, or sharing a border with a plot that meets the above requirements.

Fencing is important in the development of wildlife farms, and fencing costs are an important factor to consider in planning wildlife farms (ABSA, 2003). Because of the costs involved, and the role of fences in minimizing wildlife/livestock interactions at the interface (Ferguson, 2010), the fencing constraint is explicitly modeled in this paper. The perimeter of the wildlife farm is important as it bears directly on the costs of fencing and the extent of the wildlife/livestock interface. The fencing constraint is expressed as;

$$F_j \geq W_g - W_q \qquad \forall j \in \mathbf{K}_g \cap \mathbf{K}_q \text{ and } j \notin \mathbf{B} \qquad (9)$$

$$F_j = W_g \qquad \forall j \in \mathbf{K}_g \cap \mathbf{B} \qquad (10)$$

where $F_j \in \{0, 1\}$ is a binary variable indicating the presence of a fence j; g and q are indices of the plots as previously indicated; j and k are indices of the fences surrounding the plots with $j, k=1,\ldots,n$. **K** is the set of all the fences, $\mathbf{K}_g$ is the set of fences j surrounding plot g, and $\mathbf{K}_q$ contains the fences j surrounding plot q. **B** is the set of all outer boundary fences, i.e. belonging to only one plot. ϖ is the cost of fencing per fence length. Thus equation (9) holds for the combination of adjacent plots that share the same fence, but excludes outer boundary plots, whilst equation (10) holds for the outer boundary fences.

6.4 Data sources

The parameters used to calibrate the model are derived from secondary data, and from two surveys: one with local households, and another with tourists. An extensive review of literature and official documents and records relevant to the area and the topic was conducted. Key informant interviews and discussions with experts within the Animal Health

and Environment for Development (AHEAD) GLTFCA working group were also conducted. Information on the spatial characteristics of the land was obtained from the national land use and cover databases (NLC 2000), and the Universal Transverse Mercator (UTM) for area 36 South. Parameter values for output prices and costs for livestock and irrigated maize were obtained from the survey data and secondary sources. Wildlife and tourism lodges output prices and costs were obtained from estimates based on a study by the Amalgamated Banks of South Africa (ABSA) in 2003 on game ranching profitability in the lowveld ecological region, and adjusted for inflation. Carrying capacities were obtained from the ABSA study and from a national database called Agricultural Geo-Information System (AGIS, 2011), and other secondary studies conducted in the same ecological region. Parameter values for distance dependent damage coefficients were obtained from Chaminuka et al., (2011) and Anthony (2006).

Although there are more recent studies that have been conducted on matters related to economics of game ranching in South Africa, the data in ABSA report was considered more reliable and appropriate for use in this study for two main reasons. Firstly, the peer reviewed studies we could find on this subject in South Africa, were based on studies conducted in the Northern Cape Province (see Cloete and Taljaard, 2007; Saayman and Saayman, 2011) or Eastern Cape Province (see Sims-Castley et al., 2005). Of these studies, one was based on analysis of a single commercial farm, and in the other studies, the data was highly aggregated. Furthermore, the ecological and socio-economic characteristics of the Northern and Eastern Cape differ substantially from Limpopo Province. Second, the ABSA report is considered more comprehensive, reliable and relevant because it is based on a country wide study, and the data is presented according to ecological regions. In addition, we checked the programme of the 7th International Wildlife Ranching Symposium held in 2011 in South Africa (the 6th one was held in 2004), and found two presentations based on studies in Limpopo which could have potentially provided secondary data for this study. Of these two, one was based on questionnaire interviews and conducted in a specific location in a different district of Limpopo Province from where Mhinga is (see Musengezi and Child, 2011), and the other one has aggregated provincial level data (see van der Merwe et al., 2011).

Table 6.1 Key parameter values used in the base model

Symbol	Parameter	Value Livestock (L), Wildlife (W), Tourism (T), Irrigation (I)	Source
γ_u	Price per unit of output	L- $972/LSU; W- $1481/LSU; I-$203/tonne maize; T- $5082/tourist bed nights	Chaminuka et al., 2011 ABSA 2005 Tomlinson et al., 2002 http://www.senwes.co.za/apps/grain_data/daily/safex.asp, DoA 2008
β_u	Maximum units of output produced per hectare of land (land capacity)	L- 0.08LSU; W- 0.08LSU; I-5tonnes; T- 0.31tourist beds nights	ABSA 2005 Machete et al. 2004 AGIS 2011 Odhiambo 2010
ψ_u	Factor for adjusting capacity of land adjusted for wildlife vicinity effects	L- 0.8; I-0.7 ; W and T -1	Anthony 2006 Chaminuka et al., 2011
c_{ug}	Operating costs	L- $119/LSU; W- $377/LSU; I-$89/tonne; T- $1270/tourist bed nights	ABSA 2005 Chaminuka et al., 2011
t_u	Annuitised capital costs per 100 ha	L- $5; W- $1513; I-$316; T- $5082	ABSA 2005 annuitised over 20 years at a discount rate of 12.8%
ϖ	Annuitised fencing costs	$119/km	ABSA 2005 annuitised over 10 years at a discount rate of 12.8%
χ_g	Distance from the different land marks for each cell (park, river, road)	0- 24.47 km	
σ_{ug}	Coefficient for wildlife damage per parcel	Range of 0-0.25	Anthony 2006 Chaminuka, et al., 2011 Survey data
λ_{ug}	Coefficient for positive externalities from the park	Range of 0-0.168	Chaminuka, et al. 2012
φ_u	Factor for adjusting loss in revenue as distance from road increases	L- 0; W- 0; I-; T- 0.01	
η_g	Average slope of the parcel	Range of 0-10.8% rise	(UTM) 36 South GIS database
ξ_u	Factor for adjusting slope effects on parcel revenue	L- 0; W- 0; I--0.01; T- 0.01	
d_{gh}	Centre to centre distance between the parcels	Ranges from 0-45.7 km	Calculated in the model

6.5 Scenarios, results and sensitivity analysis

6.5.1 Scenarios

The scenarios considered in this paper were developed through a stakeholder engagement process which was conducted between June 2008 and May 2010[9]. This process included four workshops held in the community to discuss several issues pertaining to land use at the wildlife/human interface, discussions with experts in the AHEAD GLTFCA working groups, and review of the Thulamela Spatial Development Framework Document (2009) and the GLTFCA Joint Management Plan (2001). A study by Chaminuka et al. (2012) on tourist preferences for accommodation in the area, and occupancy rates in lodges inside the KNP (South Africa National Parks, 2008) provided information about the amount of land reasonable for tourism land in the area. The indications from the ecotourism preferences study and review of SANPARKS annual reports were that there was limited scope for land use based on investment in tourism accommodation and camping facilities. The different scenarios relate to the identified possible land uses and are outlined below:

- Scenario1 *(Status quo- 'Livestock oriented')*: This is similar to the current land use pattern where livestock production is the dominant land use in the area.
- Scenario 2 *('No land uses restricted')*: This is the best case under optimal conditions in the model, where there are no restrictions imposed on any land use.
- Scenario 3 *('Tourism land restricted')*: This is the second best case under optimal conditions in the model, where tourism land is restricted to two plots.
- Scenario 4 *('Irrigation and tourism land restricted')*: In this scenario the restriction on tourism land is maintained, and the amount of land for irrigation is restricted to parcels along the river on flat land.
- Scenario 5 *('No livestock')*: In this scenario, there is no land allocated for livestock, the tourism and irrigation restrictions are as in scenario 4. Such a scenario is close to what is envisaged in the TFCA where wildlife is the dominant or only form of land use.
- Scenario 6 *('No wildlife')*: This scenario has the restricted tourism and irrigation. An additional restriction is that there is no land allocated for wildlife.
- Scenario 7 *('Multiple land uses no wildlife damage')*: This scenario accommodates all land uses, as scenario 4 and includes the assumption that there are no wildlife damage to livestock and irrigation.

[9] An almost infinite number of alternative scenarios can be analysed. We have restricted the analysis to a limited set of scenarios that illustrate the main issues and that we consider most relevant.

- Scenario 8 *('Wildlife land capped at 25%')*: The total amount of land for wildlife is capped at 25% of land available after irrigation and tourism are restricted
- Scenario 9 *('Wildlife land capped at 50%')*: The total amount of land for wildlife is capped at 50% of land available after irrigation and tourism are restricted

6.5.2 Results

The main results of the different scenarios considered are shown in Table 6.2 and Figure 6.2. The results show that scenario one (the status quo) has the lowest income of all scenarios. Under the status quo, the land that is next to the park is best left unused rather than allocated to livestock farming (Figure 6.2a). This is because the costs of livestock farming too close to the park outweigh the benefits and these plots are thus left fallow. In scenario two, without restrictions on any land use type, all the land outside the park is allocated to tourism as it has the highest financial returns per hectare of land (Figure 6.2b). This is evidently not very realistic because the tourism demand is insufficient to cover the whole area. In scenario three, most of the land is allocated to the next profitable land use which is irrigation (Figure 6.2c). The two tourism plots are located in plots adjoining the park. Having most of the land under irrigation is also realistic, as not all the land in the area is suitable for irrigation. Scenario four is a predominantly wildlife land use scenario (Figure 6.2d), except for the land next to irrigation plots which is allocated to livestock. This suggests that livestock serves as a buffer around irrigated land to reduce the damage associated with wildlife damage which are higher for crops than livestock. This becomes apparent when the next scenario is considered. In scenario five (Figure 6.2e), which excludes livestock, some of the plots of land adjacent to irrigated plots are not allocated to anything, because allocating wildlife to these plots would result in huge wildlife damage to irrigated crops which would cause reduction of total income. Therefore, the plots remain fallow. One of the tourism plots is moved further from the park, to a plot close to the village which was allocated to livestock in the previous scenario. In scenario six (Figure 6.2f), when irrigation and tourism are considered with livestock, tourism is allocated very close to the park, and similar to the status quo spatial configuration, the plots next to the park are left fallow and not allocated to livestock.

In scenario seven, where there are no wildlife damage costs, livestock becomes a more favourable land use option, with a greater balance reached between the land allocated to livestock and wildlife (Figure 6.2g). The result is paradoxical, good fencing and disease

control can reduce the nuisance effects of wildlife, which would in this case make livestock more favourable. On the other hand, the higher the wildlife damage, the less attractive is livestock, so the more attractive becomes wildlife. The result, which is also cynical, stresses the need for good fencing, good disease control, in order to protect livestock farmers and minimize damage, whilst making wildlife land use a real possibility. When the total amount of land to be allocated to wildlife is capped at 25%, the resulting spatial allocation has wildlife mostly along the fence (Figure 6.2h). A 50% cap on wildlife land results in more land allocated to wildlife, in a more spread out manner rather than a compact one (Figure 6.2i).

Table 6.2 Effects of the different scenarios on total income (objective value)

Scenario	Income US$ *	% Change income compared to status quo	Resulting dominant land use
Sc. 1: Status quo	2,694	0	Livestock oriented
Sc. 2: No land use restricted	45,430	1586	Tourism oriented
Sc. 3: Tourism land restricted	16,845	525	Irrigation oriented
Sc. 4: Irrigation and tourism restricted	5,181	92	Wildlife oriented
Sc. 5: No livestock land	4,991	85	Wildlife oriented
Sc. 6: No wildlife land	4,625	72	Livestock oriented
Sc. 7: Multiple uses with no damage	5, 486	104	Multiple land use
Sc. 8: Wildlife land capped at 25%	5, 023	86	Multiple land use
Sc. 9: Wildlife land capped at 50%	5, 120	90	Multiple land use

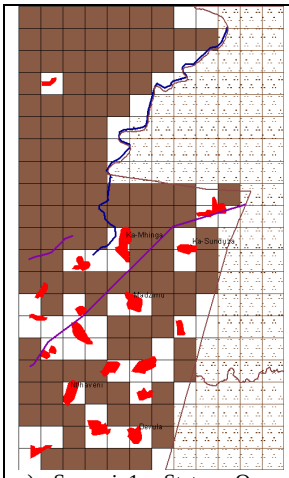
*Rounded off at 1000 US$

In Table 6.2 incomes of the different scenarios are compared to scenario one i.e. the status quo. The incomes associated with the different scenarios vary in order of magnitude from one to three when compared with the status quo. The unrestricted land use scenario yields up to 1500% more income than the status quo, whilst the least restricted option that includes all four land uses (scenario four) yields up to 92% more income than the status quo. Interestingly, the wildlife only scenario, similar to the TFCA ideal scenario represents less of a gain in income (85%) from the status quo than the multiple land use scenario with livestock. The scenario with all land uses (scenarios four and seven) can be considered the most realistic as it accommodates all land uses particularly livestock, whilst also giving the

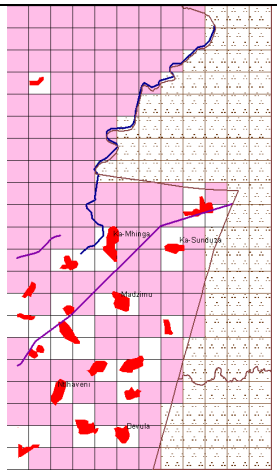
greatest increase in income from the status quo, with fewer restrictions. Interestingly, the scenarios where wildlife is capped (scenarios eight and nine) do not have a great difference in income from those where it is not (scenario four) suggesting that the margins in incomes between wildlife and livestock returns might not be very large.

6.5.3 Sensitivity analyses

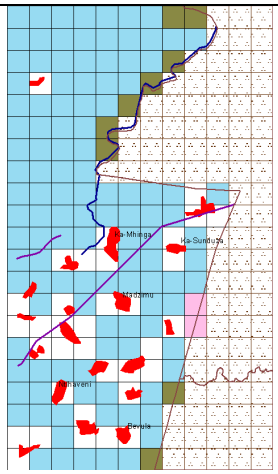
Sensitivity analysis was conducted on key parameters in the 'Irrigation and tourism restricted' (scenario four) as the reference scenario for the analysis. This is considered the most reasonable starting point of such analysis given the interests of the community who do not want livestock to be totally replaced by other land uses, and the advantages of livelihoods diversification. When fencing costs are doubled, this does not induce a change on land allocation between wildlife and livestock (Figure 6.3a). It is only when fencing costs are increased by tenfold that the amount of land allocated to livestock substantially increases (Figure 6.3b), and a compact block of wildlife results in the northern part of the area. Given that land allocation only changes when fencing costs are extremely increased, to an extent unlikely to happen in reality, indicates that fencing costs are not a major factor driving land allocation configuration in the model. Changes in commodity prices, however, seem to have an impact on the land allocation. Increasing livestock prices by 10% induces an increase in livestock land from 6% to 43% (Table 6.3). This indicates that a quality improvement in cattle to enable higher prices to be realized, or an improvement in marketing conditions could be very important in the area. The position of tourism plots also shifts closer to the park, and irrigation remains surrounded completely by either livestock or residential plots. Similarly a decrease in the price of wildlife by 10% has an even greater effect in making livestock land uses more favourable. This could indicate that investment in wildlife can be risky, especially where its prices are volatile.



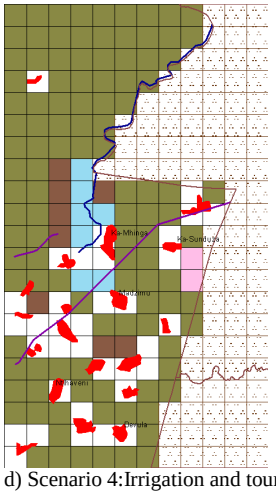
a) Scenario1: Status Quo- Livestock oriented



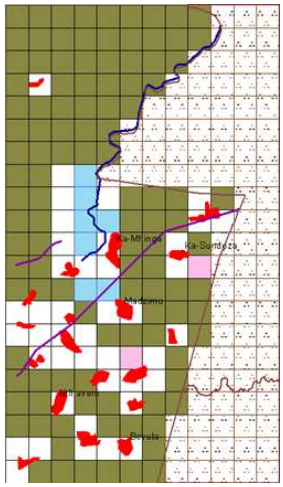
b) Scenario 2: No restrictions



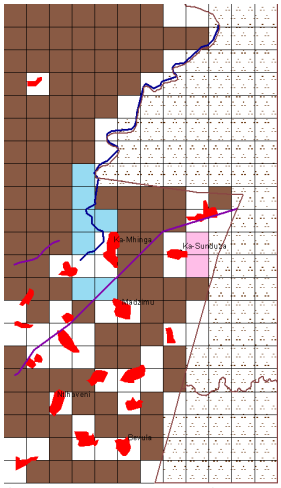
c) Scenario 3: Tourism restricted



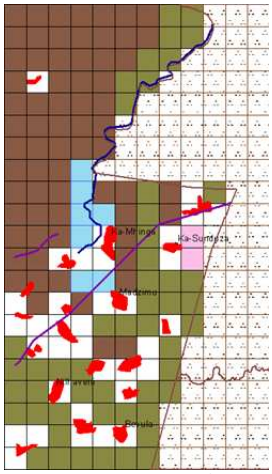
d) Scenario 4:Irrigation and tourism restricted



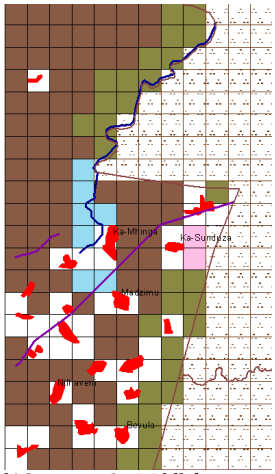
e) Scenario 5: No livestock



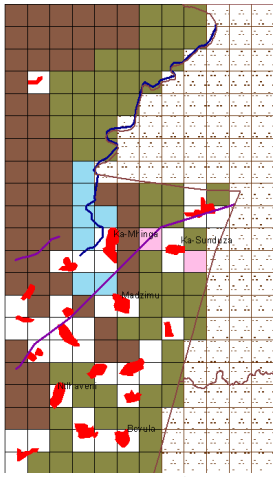
f) Scenario 6: No wildlife



g)Scenario 7: Wildlife damage costs eliminated



h)Scenario 8: Wildlife maximum land 25%

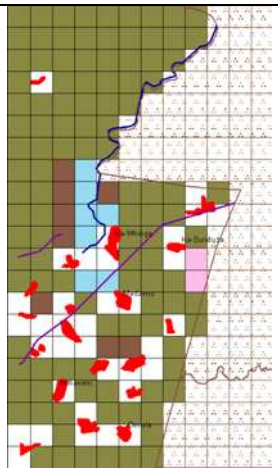


i)Scenario 9: Wildlife maximum land 50%

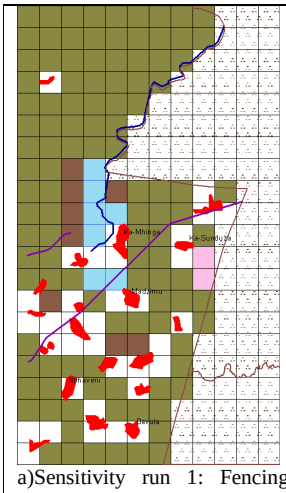
Figure 6.2a-i Alternative spatial land allocations associated with the different scenarios

Key: Park Wildlife Livestock Villages Fallow

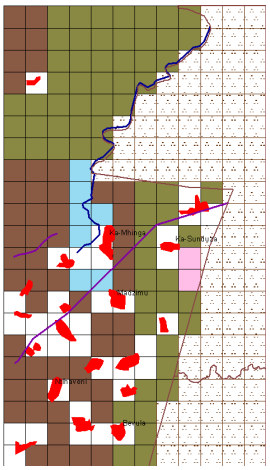
Irrigation Tourism Park fence River Road



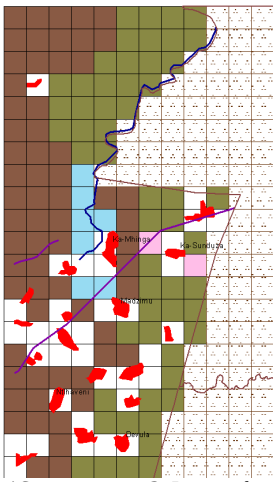
Base case: Scenario 4 in figure 2



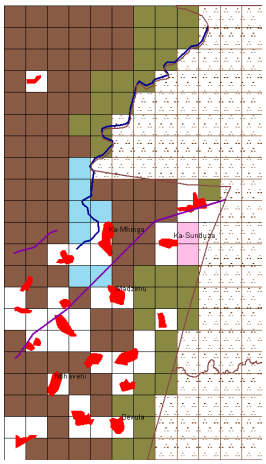
a)Sensitivity run 1: Fencing costs doubled



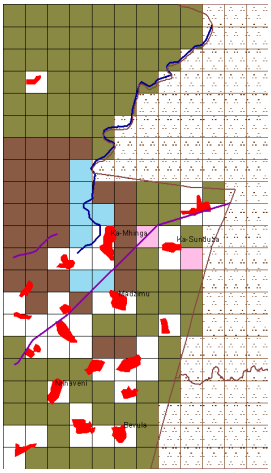
b)Sensitivity run 2: Fencing costs increased by 500%



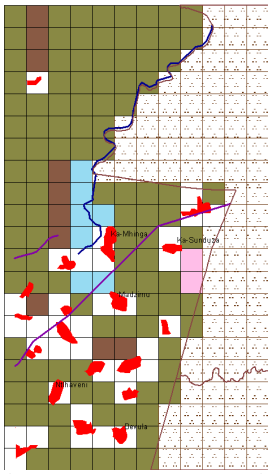
c)Sensitivity run 3: Livestock price increased by10%



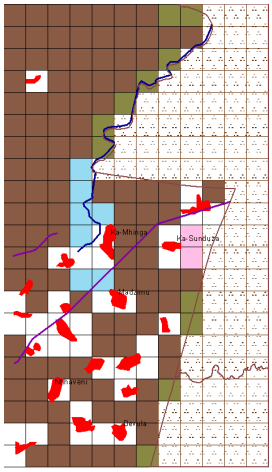
d)Sensitivity run 4: Game price reduced by10%



e)Sensitivity run 5: Wildlife damage reduced to 20%



f)Sensitivity run 6: Wildlife endogeneity effects disregarded



g)Sensitivity run 7: Equate carrying capacity to current stocking rate

Figure 6.3a-g Alternative spatial land allocations associated with the different scenarios

Key: Park Wildlife Livestock Villages Fallow

Irrigation Tourism Park fence River Road

When the wildlife damage effects on livestock are reduced, the resultant land allocations favour livestock but not to the same extent as the effects of price changes. Reduction in the probability of wildlife damage does not have much of an impact on land allocation. For example, halving the probability of wildlife damage, has no effect on the land allocation. A reduction in wildlife damage by 80% increases the amount of land allocated to livestock from 6% to about 24%. Disregarding the endogenous effects of wildlife on other land uses in the model almost has no impact on land allocated to livestock. Whilst in this case the land under livestock increases by about 1% only, wildlife remains the preferred land use. One of the livestock plots previously serving as a buffer to irrigation from wildlife, now gets allocated to wildlife. The percentage changes in income are much less than the corresponding percentage changes on each of the parameters considered (Table 6.3).

Table 6.3 Sensitivity analysis: Income and land allocation effects of change in key parameters

	% Change in income of the multiple land use option	% Land allocated livestock	% Land for allocated wildlife
Base- Sc 4: Irrigation and tourism restricted	-	6.3	86.7
Fencing costs			
• 100% increase	-0.7	6.3	86.7
• 500% increase	-5.2	42.2	50.8
Prices			
• 10% livestock price increase	2.1	43.0	50.0
• 10% wildlife price reduction	-5.6	66.4	26.6
Wildlife effects			
• Damage costs reduced by 80%	4.6	24.2	69.5
• Disregard wildlife endogeneity effects	2.0	7.8	85.9
Carrying capacity for livestock increased from 0.08 to 0.2 LSU/ha	48.1	84.4	8.6

The carrying capacity of the land is a key parameter in defining land uses. In the base model, the scientifically recommended carrying capacity is used for each of the land uses. In reality, however, the stocking rates of livestock in this area and other communal areas are much higher than those recommended by scientists. The effects of changing the carrying capacity in the model to be in line with current stocking rates of 5 ha/LSU in the area are considered in Table 6.3 and shown in Figure 6.3g. Livestock becomes more favourable as a land use, with only 8.6% of the land allocated for wildlife. Furthermore, there is an increase in income of up

to 48% that results from use of the current stocking rates as an indicator of the land's carrying capacity for livestock. Such a scenario is however not likely to be sustainable given the long run impacts of overgrazing on environmental sustainability.

6.6 Discussion

Analysis of possible land use options at the interface of livestock and wildlife in rural communities near KNP shows that the introduction of wildlife and tourism-based land uses can substantially increase the benefits derived from the land. There is potential for introducing wildlife and tourism based land uses in areas closer to the park, whilst maintaining livestock and irrigation in areas further from the park and closer to villages. Next we discuss the pros and cons of each of the possible scenarios considered in the analysis, which were derived through a community consultation process and discussions with other stakeholders in the GLTFCA.

Livestock only: This is the status quo, where communal cattle grazing is the predominant land use in the area. As shown, this scenario generates the lowest income compared to all the other ones. Land next to the park is not considered profitable for livestock because of the costs of wildlife depredation and diseases (Anthony, 2006; Chaminuka et al., 2011) and might better be left fallow if other land uses are not considered. Sensitivity analysis of the livestock carrying capacity also showed that if the current stocking capacities of 5 ha/LSU in the area were used as an indication of the carrying capacity, this would make livestock production seem more favourable than wildlife. It is thus important that land use decisions are based on the actual carrying capacity of the area which is environmentally sustainable and not the current stocking rates.

Tourism oriented land use: Although tourism generates the highest returns on a per hectare basis, it would not be possible to put all the land in the area under tourism lodges. The KNP experiences occupancy rates considerably below maximum in most of the camps for most of the year. A study by Chaminuka et al., (2012) revealed that given a choice, tourists would rather stay in the park than in lodges in the villages. The high investment costs associated with establishment of tourism lodges (ABSA, 2003) would also be a constraint on the extent to which communities can consider this land use. Tourism incomes are also erratic and seasonal, and open to shocks in the global economy. Similarly employment levels are also seasonal and local people are likely to get only unskilled low income jobs (Mbaiwa, 2003).

Moreover, the benefits associated with such projects are less likely to accrue to individual households than cattle farming.

Irrigation oriented land use: This scenario although returned by the model as a second best option, might not be practical due to several considerations. Not all of the land in South Africa is suitable for irrigation. A detailed study should be conducted to establish the suitability of the land in the study area for irrigation, and the availability of water for this purpose. We think that it is unlikely that this would be a suitable land use option given that only 1.2% of the land in the province is irrigable (Machethe et al., 2004).

Wildlife only land use: This kind of scenario is similar to what is envisaged in the TFCA, where wildlife and tourism become the predominant land uses. This scenario, where there is no livestock at all, yields less income than when there is some land under livestock. Having wildlife alone, with no livestock in the area, although possible, would cause problems in the area. Besides the problems of wildlife damage that arise when wildlife is too close to village settlements, ownership of wildlife is difficult to define (Murphree, 2005). Livestock has important cultural and livelihood roles in communal areas (Shackleton et al., 2005), and in the study area there is support for livestock farming from both livestock and non-livestock owning households (Chaminuka et al., 2010). Wildlife hunting is regulated and subject to quotas which are renewed annually by the Department of Economic Development, Environment and Tourism, hence it is difficult to predict with certainty the incomes that would be received from this land use. The seasonal demand of hunting trophies and problems of wildlife transmitted diseases causing restrictions in the marketing of game meat and game products in the area (Weaver and Skyer, 2005; Chaminuka et al., 2011) should be explicitly considered in further studies.

Multiple land uses: Scenario four is likely the most realistic and promising as it accommodates both existing land uses and emerging land use opportunities in the TFCA. It also allows diversification of livelihood opportunities, thereby shielding the community from external market related and environmental shocks. Multiple land uses would also promote both conservation and agriculture. Depending on community preferences, the spatial combinations for wildlife and livestock land uses can be altered, as in scenarios eight and nine. Several possibilities exist on how land use options based on combining livestock and wildlife could be implemented in the TFCA.

Integrated wildlife-livestock farming is possible and would entail cattle farming together with game such as antelope and zebra. Nevertheless, issues of competition for grazing and water, and disease transmission, would need to be dealt with. A possible advantage might be increased revenues from the land and the possibility of earning tourism incomes. For Kenya, Boyd et al. (1999), found that integrated wildlife and livestock management had positive household benefits in terms of food security, cash income generation, asset building, reduced household vulnerability and sustainable natural resource use. Furthermore, the timing of wildlife income complemented seasonal incomes from agriculture and expenditure patterns. For Zimbabwe Kreuter and Workman (1996), found that despite the problems associated with risk of disease transmission, integration of wildlife and cattle on commercial farmland allowed diversification and spread the risk for farmers, thus providing economic and ecological benefits.

Another possibility is to establish conservancies in these areas. ABSA (2003), broadly defines a conservancy as an area established by one or more people with the main intent of promoting a communal conservation goal. In these conservancies each community's right would be protected by a well-defined shareholding structure. This would promote conservation outside the park and also generate more income and employment for the communities than subsistence livestock production. It is also possible to combine farming activities and wildlife activities within a conservancy (ABSA, 2003). Conservancies have registered great success in enabling natural resource conservation, and sustainable natural use whilst bringing economic benefits to rural communities, and strengthening local governance systems in Namibia (Jones and Weaver, 2009). The first communal conservancy was established in 1998, and by 2009 there were 59 registered conservancies, covering about 16.1% of the country's surface area (NASCO, 2010). Most of the conservancies cover important habitats which fall outside state protected areas. The livelihood and income benefits for communities in the conservancies are many, and include benefits from trophy hunting, campsites, live game sales, joint venture tourism, grass harvesting and distribution of game meat (Jones and Weaver, 2009). In addition, rural communities living within these conservancies engage in several livelihood activities which include livestock and crop, wage employment and informal trade. Weaver and Skyer (2005), found that introducing tourism and wildlife land uses through conservancies in Namibia, increased the annual benefits for rural communities several fold, whilst promoting sustainability in the arid ecosystems. This

also changed the attitudes of local communities from viewing wildlife as a liability to considering it a local asset which should be conserved as it now contributed to household incomes, employment and food security. They noted that the long-term viability of the conservancies could be hampered, however, by risks associated with infectious diseases and associated regulatory controls in the marketing of wildlife products. Nevertheless, several sources of income can be realised in conservancies. For example, most of the income generated in conservancies in Namibia came from non-consumptive tourism, community-private sector investments in tourism accommodation, and trophy hunting (Barnes et al., 2002).

Communities also have an option of incorporating some of their land into the KNP and having this land operated as a concession, whilst earning concession fees on the land. A typical concession in the KNP allows a private operator to construct and operate tourism facilities on a 20-year contract. The private contractor is granted full commercial use rights to a defined area of land in return for payment of concession fees. The size of the land varies, and could be as small as 5000 ha. At the end of the contract term all facilities revert to the park. The concession contract gives rights of occupation and commercial use of the land together with a set of obligations on the part of the concessionaire regarding financial terms, environmental management, social objectives, empowerment and other factors. The KNP continues to perform functions of biodiversity management on the land. The Makuleke have a similar arrangement with KNP (Maluleke, undated).

Another possibility is the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) founded in Zimbabwe. CAMPFIRE enables conservation to be linked with sustainable livelihoods in rural areas, where there are few or no alternative sources of income apart from natural resources. Communities are granted rights to use wildlife, woodlands, water and grazing resources on their land and earn incomes through hunting and non-consumptive uses. Most of the income from such activities is retained at community level, whilst local, authorities and private partners that facilitate income generation activities get the rest (Bond and Frost, 2005; Murphree, 2009; Taylor, 2009). More than 1200 villages were part of the CAMPFIRE programme, with 83% of these villages were considered to be fully participating as they received benefits and were involved in sustainable natural resource management activities. Most of the income was earned from sport hunting and ecotourism (Taylor, 2009). One of the major problems faced in

CAMPFIRE concerned the distribution of benefits between various stakeholders. Although in the CAMPFIRE model, each ward was to receive up to 55% of the benefits, which would cover ward costs, and finance ward projects and household dividends, in most cases the wards received less than this. Most of the money was retained at rural district council levels (Taylor, 2009). Several factors which include benefits distribution, legislation of the authority status of different stakeholders, and legislation of land rights down to village levels (Taylor, 2009; Murphree, 2009), would need to be addressed should such a model be considered in South Africa.

Blignaut and Moolman (2006) studied the benefits of different land use options in a communal area on the southern borders of the KNP and explored the possibility of the area being declared as a conservation area with potential to generate income from payment for ecosystem services. They found that more value could be earned from conservation than under subsistence livestock systems. They also noted, however, that the success of such a scheme depends on the absence of availability of funding to pay for provision of the environmental services. Even with tourism and game ranching it is possible that insufficient income and employment is generated in the area. For example, the Makuleke envisaged that they could only generate up to 150 fulltime jobs on the 24,000 hectares of their land within the KNP (Maluleke, undated; Collins, 2003; Collins and Snel, 2008). In some cases, wildlife ranching can employ less unskilled labour than cattle farming (ABSA, 2003). However, where wildlife land use is considered jointly with ecotourism and related services, the employment benefits are much higher than for subsistence farming (Mbaiwa, 2003). In Namibia, employment from trophy hunting was mainly for persons trained as hunting guides, skinners and trackers, whereas the tourism sector created much more employment in more categories (NASCO, 2010). When the potential incomes from the multiple land use source are considered, given an estimated population of more than 15,000 in Mhinga and the adjoining areas, the income per person per day is less than the internationally considered minimum of $1.25/day (Ravallion et al., 2009).

Some inherent characteristics of the study area could limit the success of whatever land use option chosen in the area. The distant location of the area from major towns and markets, problems of diseases and the regulation pertaining movement of wildlife and livestock and their products from with the redline zone are all factors that could limit the competitiveness of land uses activities. There may be need to consider establishment of low capital agro-

processing industries or agricultural activities that do not necessarily require a lot of land. Alternatively non-land based options for poverty alleviation and development such as investment in education to enable people to seek employment outside the area could be considered.

6.7 Conclusion

In this study we analysed options for land-based development at the wildlife/livestock interface, using a spatial land allocation model that integrates nuisance effects of wildlife, the slope, carrying capacity and distance to water of the land and other constraints with the view to maximizing profit. Although the analysis is an appraisal of wildlife tourism-based development plans in the area, rather than an evaluation of performance of an existing project, it provides a useful insight into the potential future options for development in the GLTFCA, and a similar approach can be applied elsewhere. Land prices and detailed investment costs can be included in the analysis where applicable. Although the issue of benefits distribution within the communities is important, it has not been the primary aim of this study. A possible limitation of the analysis lies in difficulty in defining all possible ways in which plots can be connected for mixed integer linear programming models (Groeneveld, 2010). This could have resulted in some plots that could yield higher returns for wildlife, but are not connected to other wildlife plots being allocated towards other land uses, mainly livestock in this case. Another limitation of the study was the limited bio-physical characteristics considered. For example, Smith et al. (2008), considered land elevation, slope, habitat patch size and distance to coastline in their analysis of land use options in Maputaland, a biodiversity hotspot within the Lubombo TFCA. In addition, they classified land according to species distribution, land cover types and ecological processes.

The results suggest that although several scenarios for development at the interface are possible, when bio-physical constraints and market related constraints on tourism and irrigation are considered, the real competition for land is between wildlife and livestock. Depending on factors such as the objectives of the community vis-à-vis each land use, relative prices of livestock and wildlife outputs, and the extent to which losses from wildlife damage on other land uses can be minimized, a balance can be reached between the amount of land under livestock and wildlife. Spatial analysis can assist in planning for multiple land uses at the interface to satisfy competing claims for land and multiple stakeholder interests.

The study has some implications for land use planning at the interface. First, when all the factors are considered, it is not sufficient for decisions to be made just on the basis of how much land is best allocated to different land uses. Because of the interactions between wildlife and other land uses, spatial planning is important in land use decisions at the interface. Second, the analysis has also suggested that specialization in land use, although theoretically the most optimal, might not be feasible given the characteristics of the area and the specific stakeholder interests. Lastly, the idea put forward by proponents of the TFCA approach that local development can be achieved by shifting from agriculture to wildlife and tourism land uses needs to be revisited, for the key to development lies in diversification of options for generating income, not all of which are land based. Combining conservation and rural development objectives through land use planning can result in a very substantial improvement from the status quo in terms of income (up to 100% increase), whilst increasing the amount of land dedicated to wildlife conservation in rural areas.

We conclude on the basis of the case study that the current land use is not optimal. Given the price structure, it seems that wildlife exploitation offers some scope for improving incomes, provided that good spatial planning is applied. It also offers scope for attracting more tourists, and tourism provides on a per hectare basis very high revenues. There is, however, no panacea: rural development requires a long trajectory of investment and improvement in infrastructure. Spatial planning in an early stage can provide opportunities for long term sustainable solutions to reconciling rural development and conservation goals.

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CHAPTER SEVEN: General Discussion and Conclusions

Petronella Chaminuka

7.1 Introduction

Reconciling biodiversity conservation and rural development goals is a challenge that most African countries endowed with rich natural resources, particularly wildlife, have to contend with. The challenge is further exacerbated by the fact that high values placed on wildlife conservation internationally do not usually translate into local level benefits for communities that bear the day-to-day costs of living with wildlife (Emerton, 2001; Ashley and Elliott, 2003; Adams and Hutton, 2007; Dickman et al., 2011; Roe et al., 2011). Transfrontier Conservation Areas (TFCAs) in Southern Africa represent the most recent efforts to address jointly biodiversity conservation and poverty alleviation goals (Metcalfe and Kepe, 2008; Cumming, 2011). Part of the rationale behind TFCAs is that by creating large areas of land across national boundaries where wildlife can move freely, and the scale of tourism can be increased, it will be possible to achieve improved biodiversity conservation whilst generating employment and incomes from tourism revenues (Wolmer, 2003; Munthali, 2007). Furthermore, TFCAs are viewed as presenting opportunities for rural communities to participate in wildlife conservation, and benefit economically from tourism. These rural communities, mainly living at the periphery of protected areas, have in the past not been involved with or benefitted sufficiently from conservation initiatives. On the other hand, they have borne the costs of wildlife conservation in terms of being denied access to land and other resources, and suffering the consequences of damage-causing wildlife (Barrett and Arcese, 1995; Emerton, 2001; Adams et al., 2010; Dickman et al., 2011).

Most of the rural communities that lie within TFCAs are characterized by high poverty and unemployment levels, with subsistence agriculture and communal cattle grazing systems being the main land uses (Munthali, 2007; Metcalfe and Kepe, 2008). In the case of the Great Limpopo Transfrontier Conservation Area (GLTFCA), spanning Zimbabwe, South Africa and Mozambique, rural communities are expected to shift from agricultural based land uses towards wildlife tourism based land uses. However, little is known about how this can be implemented in these rural areas, or the extent to which wildlife and tourism are feasible land uses given existing livelihood activities and socio-economic circumstances and bio- physical characteristics of these rural areas (Munthali, 2007; Cumming, 2011). Furthermore, there exists no systematic method to evaluate the pathways for development within TFCAs, considering both rural development and conservation goals.

The general objective of this study was to develop a framework for evaluating land use options and tradeoffs for alternative development pathways to meet conservation and rural development goals in these communities that are at the wildlife/livestock/human interface (also called the interface). Using the case of a rural community in South Africa, that lies within the TFCA, I considered the following specific issues relevant to land use decisions at the interface in this study; (i) the risks and benefits associated with agriculture, specifically cattle farming next to wildlife; (ii) existing livelihood activities and benefits, especially cattle farming, and the potential impacts of wildlife land uses; (iii) the prospects for introducing new forms of livelihoods, particularly ecotourism and wildlife land use; (iv) the complementarities and tradeoffs between different land use scenarios in terms of income; and (v) spatial land use planning to accommodate the different land uses and the issues pertaining to introduction of wildlife land uses. These issues are important for decision making in the TFCA. They also contribute to the literature on reconciling development and conservation.

The rest of this chapter is organized as follows. In Section 7.2, I discuss the general approach followed in the study, and the analytical approaches and data used to address the different research questions. Section 7.3 provides some insight into the main findings of the study and their relevance to the conservation development debate. In Section 7.4 I highlight what I consider to be additional issues pertinent to the future of the interface. In section 7.5 I discuss the implications of the study in for policy making. Lastly I reflect on the methodology used in the study, and suggest areas for further research.

7.2 Approach, implementation and data

This study broadly followed the Describe-Explain-Explore-Design research cycle proposed by Giller et al. (2008). The stages are not linear, there are feedback and feed-forwards mechanisms, and depending on the context it may be possible to identify opportunities to resolve competing claims by adapting the various phases of the methodology to suit a specific context (Giller et al., 2008). First I identified and described the competing claims for land in Mhinga in Chapter 1, and especially the main issues of concern for rural communities coexisting with wildlife in Chapters 1 and 3. In Chapters 3 and 4 the challenges of cattle farming at the interface are explained, and the relationships between cattle farming and other livelihood strategies. By analysing the cultural and socio-economic roles of cattle and other livelihood strategies it was possible to explore opportunities for future development regarding introduction of wildlife-based tourism. Chapters 4 and 5 explored with different stakeholders,

prospects for introducing wildlife-based land uses and ecotourism. In Chapters 2 and 6, a land use modelling framework to explore alternative scenarios of development based on stakeholder inputs given the objective of maximising net revenues from land use was developed and applied.

To address the research questions in the study, different analytical techniques were combined. The data comprised quantitative and qualitative primary data and secondary data sources. Chapter 2 was largely theoretical, mathematical modelling techniques were used to develop a land use model that allowed evaluation of alternative scenarios of land use. In Chapter 3, a partial budgeting framework suggested by Otte et al. (2004) was modified and used to analyse the costs and benefits for cattle farming at the interface. In Chapter 4 a livelihoods analysis framework considering different livelihood capitals, strategies and outcomes (DFID, 1999), was combined with economic techniques to estimate monetary values of marketed and non-marketed cattle products, modified after Moll (2005), and Dovie et al. (2006). The data for Chapters 3 and 4 were collected through several ways. A household survey using two structured questionnaires, one for households with cattle and another for those without cattle, was conducted in July-August 2008. Veterinary records and official reports of livestock depredation were inspected. Qualitative data collection techniques such as focus group discussions, key informant interviews, workshops and ranking and scoring exercises were employed between August 2008 and May 2010 to follow up on issues emanating from the survey.

For Chapter 5, choice modeling, a stated preference approach was used to determine how consumers' willingness to pay for a good depended on the attributes of that good. Tourists' preferences for village accommodation, village tours and crafts markets were considered as attributes of ecotourism. A survey was conducted in December to January of 2008/2009 and 2009/2010 and data were collected from 319 tourists visiting the KNP. Econometric estimation of relevant parameters was done using a multinomial probit model.

Options for land based development at the interface in Chapter 6 were explored by empirical application of the model developed in Chapter 2. A total of 163 plots each 400ha in size were included in the analysis. Data on the values of the parameters used in the model were derived from surveys described in Chapters 3 to 5, and from secondary data sources. In section 7.5 I reflect on the approach followed in this study and the lessons learnt.

7.3 Overview of findings

To achieve the overall aim of this study, the following research questions were addressed;
Research question 1: *How can alternative spatial land use options for improving incomes of local communities be evaluated taking into consideration biophysical and socioeconomic constraints?*

Research Question 2: *What are the risks and costs associated with livestock farming at the interface, and how do these affect the attitude of farmers towards wildlife and conservation?*

Research question 3: *What are the social and economic benefits of livestock production systems and how would an increase in the wildlife/livestock interactions impact the system?*

Research question 4: *What is the potential to develop ecotourism and what are the tourist preferences and community capabilities?*

Research question 5: *Given a set of bio-physical and socio-economic constraints, what spatial land use alternatives exist to improve net revenues from land use, and stimulate rural development and conservation in the GLTFCA?*

Research questions 2 and 3 addressed the current state of livelihoods at the interface and the specific issues relating to the impacts of wildlife on other livelihood activities from the local community perspective. Research questions 4 and 5 explored the potential for tourism and wildlife livelihood activities at the interface. Research question 1 was mainly aimed at developing a method for evaluating prospective and existing land use options considering specific interactions between wildlife and other land uses, requirements of wildlife as a land use, and socio-economic and biophysical constraints.

Cumming (2011) suggested some indicators for evaluating the success of TFCAs with references to the development and conservation objectives. He however pointed out that these indicators are not fully developed and are particularly complex for the human-wildlife-livestock interface. Nevertheless, I consider them particularly relevant and an important starting point for discussion regarding the current and future development of the interface. For the TFCA objective of ‘establishing policies and legal frameworks that provide incentives for local communities and landholders to benefit from wildlife- and natural resource-based enterprises’ (Cumming, 2011), I draw and discuss three main indicators that are relevant to this study. These are: (i) the extent to which capital assets of households are

enhanced; (ii) whether communities display positive attitudes towards wildlife; and (iii) the ability for land holders to invest and benefit from tourism and sustainable harvesting of natural resources. Although a post implementation evaluation is not possible at this stage, these issues are already being discussed and considered by local communities, local authorities, scientists, and rural development and conservation practitioners (Spenceley, 2006; Munthali, 2007; Thulamela Local Municipality, 2009; AHEAD-GLTFCA, 2010). I also summarise and discuss the specific options for implementing land based local development and conservation, mainly on the basis of land use modelling results.

7.3.1 Current state of livelihoods at the interface and potential of TFCA to enhance household capital assets

Although most of wildlife parks in Africa are surrounded by people who live in poverty and largely depend on land and other natural resources for their livelihood (Munthali, 2007), there are disparities in socio-cultural and economic conditions between the different countries and rural areas (Wolmer, 2003). In the GLTFCA, the absence of information on the spatial and temporal human welfare conditions has been indicated as a constraint to conservation and local level development planning efforts (Cumming, 2011). Poverty levels in Mhinga have been estimated to be as high as 60% (AGIS, 2009), and unemployment levels range from 60-80% (Anthony, 2006). The local economy is mainly driven by disbursements from the government's welfare programme, and remittances from urban areas, like most other rural areas in South Africa (Ainslie, 2005; Shackelton et al., 2001). In this study most of the households were engaged in multiple livelihood activities such as formal employment, cropping, small businesses and cattle farming. Although practiced by many households, the potential for dryland agriculture in the area is limited due to low rainfall levels and long drought periods (CGIAR, 2003; AGIS, 2009). This was reinforced during the community workshops, when dryland cropping was not classified as an important income source. Livestock farming particularly cattle farming was considered an important livelihood source for some households, although only 11% of the households in the area actually owned cattle.

There were differences in the livelihood activities and structure of household income for the cattle households (CH) and non-cattle households (NCH). The main source of income in NCH households was employment, whereas for CH it was social grants. Despite only a few households owning cattle, the benefits of cattle farming were derived by up to 95% of those

households who did not own cattle through dung, milk and during traditional ceremonies. This concurs with findings of Dovie et al. (2006), who found that cattle and goats yielded benefits mainly through gifts, milk and dung for non-cattle owning households. Cattle had, in order of importance, financial, physical, human, natural, and social livelihood roles. They contributed to both stock and flow of financial capital in the household, and accounted for about 29% of the total income in CH. The financial asset contribution was ranked as being the most significant followed by the physical and human asset contributions. Through sale of cattle and cattle products, households were able to fund other livelihood activities such as small businesses and cropping. The sale of cattle can provide a household with much needed capital to start a small business or to purchase inputs for cropping in the absence of alternative sources of credit. More importantly, we found in Mhinga that a number of households had sold cattle to meet the school fees needs of children. Dovie et al. (2006), reported similar findings elsewhere in South Africa. Cattle can also provide an outlet for investing cash generated through other livelihood strategies. For example, Ainslie (2005) reported that cattle provided a viable form of investment for lump sum pension payments or regular savings by migrant workers. Such investment and consumption decisions regarding cattle are made at household level, and at specific times that are unique to the household. Thus the presence of cattle in the household can give the household some form of financial independence and flexibility. This would not be the case when the household is dependent on communally owned wildlife resources. It is thus possible that for some cattle farmers, particularly the older ones who have limited chance of securing employment and those mainly dependent on cattle income, shifting to predominantly wildlife based livelihoods could represent a form of economic disempowerment and loss of autonomy.

One of the reasons why it has been argued that wildlife and rural development are irreconcilable goals, is that the presence of wildlife gives rise to costs by interfering with other livelihood activities in impoverished rural communities (Emerton, 2001; Anthony, 2007; Dickman et al., 2011). Naidoo et al. (2006), classify the costs of wildlife conservation into five components; wildlife acquisition, management, damage, transaction, and opportunity costs. For livestock farmers at the interface, wildlife was considered a risk to their main livelihood source, because of the damage costs and opportunity costs. In this study, livestock farmers identified wildlife depredation and disease as key issues of concern for them, particularly when the possibility of increased interaction between wildlife and livestock in the TFCA was considered. Some of the households without livestock indicated

that problems with wildlife in the community had also deterred them from considering livestock as a livelihood option.

Up to 25% of cattle households surveyed had suffered livestock depredation within three years prior to the survey. The problem of depredation was higher for villages closest to the park. Combined estimated annual losses to depredation and disease were 0.63 cattle per household. In monetary terms this amounted to US$351 per household per annum, but when the benefits of being close to the park were considered, the net amount lost to the household was US$34. By considering the benefits of being close to the park for households, and combined costs of livestock disease and depredation, it was possible to give a more balanced assessment compared to existing studies (for example Butler 2000). The main disadvantage with such an approach, however, is that whilst it avoids overestimating the damage, it can also trivialize the losses for some households. Although we found evidence of employment opportunities from the KNP, only a few households had benefitted from such opportunities. Most of the job opportunities from KNP were from the Working for Water Programme, hospitality services in different camps, from the wildlife ranger section and in the maintenance and construction services (Anthony, 2006). Some of the jobs were on three year contract basis, and there were reports of corruption and nepotism in the Hlanganani Forum which coordinated recruitment for the jobs. Another benefit received by the community from the park was subsidised fees for entering KNP. This benefit however was utilized by less than 10% of the households, mainly due to lack of motorized transport needed to enter the park (Anthony, 2006). Furthermore, the park benefits did not necessarily accrue to the specific households that had suffered livestock loss. Thus when it was considered that cattle had important livelihood roles for both owner and non-owner households, and the benefits were thin, the risks for households depending on cattle at the interface were considerable.

It appears that the TFCA could negatively affect livelihood capital assets through the following ways; (i) increased wildlife/livestock interaction could result in a reduction in the household financial assets, (ii) the social, cultural, and physical livelihood roles of cattle could also be impacted, (iii) other livelihood strategies such as small businesses and investment in education could also be negatively affected and (iv) the independence of households regarding cash flow and investment decisions from livestock would also be lost. Furthermore, non-livestock owning households could lose access to the benefits from cattle that they currently get.

On the other hand when the problems associated with cattle farming in the area are considered, it is possible that the TFCA could potentially enhance the livelihood capital asset base for some households. This area is prone to long droughts spells and this makes cattle households vulnerable. Although farmers received feed supplements from the government during drought years (see chapter 3), this was not sufficient to protect them from the effects of drought. It is also possible that in the future the government might not be able to continue providing such subsidies during drought years.

Tourism and wildlife incomes, could provide a safety net for households during drought years. For example, in Namibia, incomes from tourism contributed significantly to household incomes in times of drought (Weaver and Skyer, 2005). Another important issue to consider is that because only a few households had cattle, alternative sources of income are necessary for those households without cattle and not wishing to have cattle. In addition, this study found that cattle ownership is skewed with the top 10% of the cattle owning households, accounting for about 30% of the total cattle herd in Mhinga. It is possible that in future those households with few cattle, and the non-cattle households who are the majority, could consider wildlife tourism as an opportunity for greater and more equally distributed chances of benefiting from the land in Mhinga. In the future, when the negative environmental effects of cattle such as trampling, overgrazing and soil erosion are considered, it is possible that some members of the community would be less in support of cattle as a land use option. Such a scenario could arise if there was a mechanism through which the community could be paid for environmentally friendly land use options. For example, the COMACO project of Zambia (COMACO, 2011) discussed in chapter 4, rewards households for agricultural practices that are environmentally friendly, through cash bonuses and preferential market access, and punishes, by way of exclusion from markets and other services, those member households that do not comply.

Despite the current problems of cattle farming and its limited potential for expansion, I consider that cattle farming is too important to be dismissed as a livelihood and land use option in Mhinga. Furthermore, the livestock farmers were generally older and hence could be more vulnerable than younger members in the community. To manage the likely negative effects of increased livestock/wildlife interaction, it is necessary for the authorities to invest in both short term and long term disease management strategies, and control livestock

depredation through effective fences and devise an acceptable mechanism for compensation where necessary. Although farmers reported that there were no problems regarding the marketing of cattle in the area, further livestock expansion could result in saturation of the existing local market. The restrictions to cattle marketing outside the redline due to the Animal Diseases Act (NDA, 2000; Bruckner et al., 2002), could stifle efforts to increase beef production within this area, and in other FMD affected areas in the TFCA (Scoones et al., 2010). Calls for disease control have been made by other scientists working within the TFCA (Bengis, 2005; Kock, 2005). Lastly, although desirable from a community point of view, the role and impact of fencing in southern Africa is a widely contested issue. Ferguson (2010), provides an extensive review of the environmental, social and economic issues pertaining to fences and TFCAs in the region. The issue of compensation is discussed further in the next section.

7.3.2 Community attitudes towards wildlife

Findings suggested a generally negative attitude towards wildlife amongst people in Mhinga, particularly cattle farmers. Anthony (2007), also reported that despite attitudes of communities to wildlife being varied, households who experienced damage from wildlife had negative attitude towards the KNP. This was further compounded by the absence of a mechanism to compensate households who suffered wildlife damage. Problems of wildlife damage along the borders of KNP have been going on for a long time, and apart from crop and livestock damage, also involve a threat to human lives and property. During the time that this study was conducted, there were on-going efforts by local communities to try and resolve the compensation issue, but without success.

The underlying problem for failure to resolve the compensation issue can be attributed to several factors. Wildlife in South Africa is classified as *res nullius*, which means without a legal owner, or belonging to no one in general (Hopkinson et al., 2007). In the case of privately owned land, wildlife on such land is considered a natural resource to which the owner has rights to use. Once wildlife strays onto communal land, communities cannot enjoy the same rights to use wildlife as private owners because their land legally belongs to the state. The escape of wildlife from the KNP is largely attributed to the poor state of the fence (Anthony et al., 2010). The KNP however, does not own this fence. It is owned and maintained by the Animal Health section of The Department of Agriculture, who are mainly concerned with disease control and not issues of livestock depredation. When wildlife

escapes from the park, the mandate to capture such wildlife and return it to the park rests with the Department of Environmental Affairs. Thus there are several of institutions involved in the management and control of damage causing wildlife, and their roles are not clearly delineated, resulting in frustration within the communities (Hopkinson et al., 2007; Anthony et al., 2010). Anthony et al. (2010), argued that these problems indicate institutional failure caused by breakdown of trust between the community and different institutions, poor governance, and incapacity within government department and park authorities. Lack of coordination and limited or no local stakeholder consultation on options to solve the problem were also apparent in the area.

Although the Communal land Rights Act (CLaRA) 11 of 2004, aimed at restoring property rights over land to rural communities (Cousins and Kepe, 2004), which is yet to be implemented, could give communities rights similar to private owners regarding use of wildlife, more needs to be done to restore goodwill and positive attitudes in rural communities towards KNP. The KNP and the relevant government departments should consider options for compensating households for wildlife damage. Although farmers indicated that they preferred direct financial compensation, which they had been previously promised by both the KNP and the then Department of Environmental Affairs in Limpopo (Anthony, 2007), several problems have been documented regarding such schemes in other places. Some of these problems include the administration of such financial compensation schemes, particularly where corruption is a problem (Graham et al., 2005). Dickman et al. (2011), also discussed some of the problems of direct compensation schemes. In some cases farmers become careless with protecting their livestock knowing that they will receive compensation in the event that their cattle are killed. Furthermore, the procedures for reporting and proving cases of depredation are generally cumbersome, and even where it exists not all farmers are able to benefit from such direct compensation. Another problem has to do with availability for funding for compensation, particularly in the long run. Other options for compensation, can however be considered.

Lewis (2005) and Mizutani et al. (2005) suggested interventions to increase productivity of cattle farming such as veterinary care and better husbandry practices for households or communities suffering wildlife related damage as an incentive to encourage livestock farmers to tolerate wildlife, which could be considered in Mhinga. Other measures suggested include improved opportunities for livelihood diversification in this area through infrastructural

investment and support to small local and tourism based businesses and activities (Emerton, 2001). Dickman et al., (2011) discussed a range of instruments under the umbrella term of payment for coexistence, which can ensure that local communities receive incentives to co-exist with wildlife that are at least equivalent to the value that the international community places on the existence of such wildlife. Apart from direct compensation, insurance, revenue sharing, and conservation payments other instruments are possible. The TFCA provides an opportunity for revenue sharing with rural communities through tourism, trophy hunting, and sale of wildlife products. The Kenyan model provides another option. A Wildlife Conservation Lease Programme was developed to facilitate the migration of wildlife on communal land. Under this programme, households living next to Nairobi National Park were paid US$4/acre of land and in addition received compensation for any livestock that was lost to wildlife (Dawson, 2004). Although an assessment by the International Livestock Research Institute found US$4/acre to be fair payment in that area (Dawson, 2004), this might not necessarily be sufficient for other areas. Should such a programme be considered, it would be necessary to conduct an analysis to determine acceptable amounts for each context in the GLTFCA.

It is important that any mechanism for compensation, if established is set within a clear administrative and legal framework. Anthony et al. (2010) recommended active engagement of rural communities and all relevant stakeholder institutions in developing a system for managing conflict in the area. I further suggest that it is necessary to consider that the costs of co-existing with wildlife differs between households, as do the attitudes of different groups within the community towards wildlife. Thus the community should not be treated as a homogenous entity, but rather households who bear the greatest costs should receive more incentives and livestock farmers should specifically be engaged in any processes to seek a solution.

There were divergent views in the community regarding future prospects for introducing wildlife based land uses. Cattle farmers were generally against the idea of some of the land being turned to wildlife based tourism land uses. They argued that wildlife would compete for land with cattle, and also cause damage to crops and livestock thereby threatening these livelihood activities. In their view, cattle keeping was able to accommodate and enhance more livelihood activities than wildlife. On the other hand, the youth and small business entrepreneurs, were generally in support of wildlife land uses, despite acknowledging the

damage effects of wildlife on farming. They argued that because cattle incomes could only sustain a few households, wildlife and tourism presented opportunities to improve livelihoods and employment in the community. The mixed attitudes to KNP and wildlife by segments of the community were also reported by Anthony (2007), who found that the KNP was perceived by some as a potential source of income and by others as a source of anguish. It is noteworthy to state that although cattle farmers, constituted only 11% of the total households, predominantly used the grazing area, this did not seem to be a problem for participant groups comprising non-cattle owners in the workshop discussions. None of the discussions or suggestions by the other groups indicated that they felt disadvantaged in terms of land use by not having cattle. This could be explained by the fact that most of the NCH benefitted in several ways from cattle in the area as explained in chapter four. The fact that most households in communal areas seem to benefit from livestock, even without owning it has also been discussed by Ainslie (2005), Dovie et al. (2006) and in other studies, and is partially attributed to the social, economic and physical roles of cattle. In addition, there is no barrier imposed by CH which would prevent NCH from also acquiring cattle. With increasing population pressure and an increasing drive towards urbanisation of rural areas in South Africa (Roux, 2009), the situation might however change and the NCH could start pushing more for land uses that a greater segment of the rural population could benefit from.

Another factor to be considered regarding the attitudes of the community is that some of the communities next to the KNP were forcefully displaced from their land in the past to make way for the creation of the park, and submitted claims for land in the KNP under the restitution programme of the government (Venter et al. 2008). Prior to 1994, the approach to conservation was one of depriving local communities of access to resources in the park, and excluding them from participation in management of wildlife (Mabunda, 2004; Venter et al., 2008). Although this has since changed, and the KNP has made considerable efforts to involve local communities and ensure that they benefit mainly through employment and educational assistance there has not been further land lost by the communities for conservation. The introduction of wildlife on communal land within the TFCA might be construed by some community members as another form of displacement from their land. A lot of work remains to be done in communities such as Mhinga to address the perceptions of wildlife as a nuisance as well as reluctance of some members of the local communities towards investing land in wildlife. Finally, it is important to realize that although negotiated compromise solutions can be found, the problems of wildlife damage cannot be entirely

removed in areas where people reside with wildlife. What is important is that the value of the wildlife asset must be higher than the costs that it imposes on households (Torquebiau and Taylor, 2009).

7.3.3 Prospects for investment and benefits from tourism and sustainable harvesting of natural resources

Sustainable tourism that promotes employment, entrepreneurship and ecosystem services provision is one of the pillars through which communities are expected to benefit in TFCAs (Spenceley, 2006). Managers of protected areas are encouraged to work closely with the tourism industry to facilitate local community involvement in a broad array of activities that encourage cultural and ecotourism forms of tourism (Joint Management Board, 2001). To explore the possibilities for community investment in tourism in the TFCA, this study investigated prospects for development of ecotourism in Mhinga, and particularly the interest amongst tourists for goods and services provided by the communities. The study found that local communities were indeed interested in providing a range of tourism services to tourists visiting the KNP. The interest by local communities to share their cultural heritage with tourists was also reported by Mabunda (2004). In Mhinga there was interest in offering village accommodation, village cultural tours (including cultural entertainment, photography and interaction with locals), and crafts markets. Using stated choice modeling techniques it was determined which of these services tourists would prefer for ecotourism and how much tourists would be willing to pay for the services. Understanding the preferences of tourists, and their attitudes towards rural communities can provide useful information for rural communities, local municipalities, tourism managers in the TFCA and other stakeholders considering tourism investment in rural communities.

In their annual reports, the KNP generally classifies tourists into two groups; domestic and international tourists (South Africa National Parks, 2007; 2008). This study determined preferences for tourists disaggregated according to these two categories as well as into four different income categories. In general tourists were interested in the idea of engaging in ecotourism activities outside the KNP, as reflected by the fact that 69% of domestic and 78% of international tourists expressed a preference for one or all of the services presented. The village tours and crafts markets attracted the most interest, for both international and domestic tourists, and across all four income groups of tourists considered. There was,

however, general reluctance by all tourists groups considered, except the low income group, to use accommodation facilities outside the park. Marginal willingness to pay (MWTP) estimates were found to be generally higher than the bid values proposed for the village tours and crafts markets. For both tours and crafts international and the higher income groups, had higher MWTP values. In all cases, tourists had negative MWTP for the accommodation, indicating that they would need some discount to consider using village accommodation. This could be made possible by pricing the village lodges below the KNP rates.

The reluctance by tourists to stay in villages is similar to reports by Hearne and Santos, (2005) in Guatemala who found that tourists preferred to stay inside the park rather than outside. This has some important implications for development of tourism accommodation in rural villages. Part of the reasons that tourists were not willing to stay outside could be attributed to concerns about personal safety, given the high crime rate in South Africa. In the context of TFCA, security is an issue that would need to be considered to ensure that the idea of cultural tourism is well received by tourists. Failure to address these issues could result in limited business opportunities for tourism lodges built outside the protected area. An alternative option which could be considered is to have communities build their lodges inside the park, rather than outside, as is currently the case with concessions in the KNP. If built inside the park, however, the benefits from developing accommodation facilities mainly targeted at KNP visitors could be limited. The KNP often experienced below maximum occupancy rates (South Africa National Parks 2008), and between 2007-2008 the Punda Maria camp which is closest to Mhinga had average occupancy rates of 57-63% (South Africa National Parks, 2008). Furthermore, private lodges within the KNP also experienced low occupancy rates (Spenceley 2006). Although there were two privately owned lodges within Mhinga, less than 30 visitors could be accommodated at a time by both these lodges. I stayed for some time in one of the lodges and it appeared that tourists mostly stayed there when they had failed to secure accommodation in Punda Maria camp. Most of the visitors to these local lodges were government departments and other organisations having workshops. Such visitors could provide a potential market for community tourism lodges in Mhinga.

Some additional factors could also affect the viability of tourism lodges in Mhinga. The Punda Maria entrance to KNP is one of the furthest gates from Johannesburg International Airport where most of the tourists arrive. The KNP receives more tourists on its southern parts where there are bigger camps like Skukuza and Pretoriuskop (South Africa National

Parks, 2008). There are also existing, well developed, craft markets on the southern side of the park, compared to the Mhinga side. Another issue which was however outside the scope of this study is the management of the village tourism facilities. Previous efforts to run a village lodge in Mhinga were stifled by management problems (Groenewald, 2010). Other overriding concerns for tourism investment could be the extent to which employment can be created, seasonality of tourism incomes and the distribution of revenues from community owned tourism businesses. In Botswana, Mbaiwa (2003), reported that tourism lodges created significant employment opportunities in the local community. However, most of the jobs held by local communities were unskilled, low paying jobs such as manual labourers, drivers, cleaners, night watchmen and cooks. Furthermore, wildlife based tourism reduced household livelihood activities as some households stopped cropping and keeping cattle to get employment in the tourism sector. Rural to urban migration also increased as households sought to counter the seasonality of tourism income (Mbaiwa, 2008). Such problems could arise in Mhinga. Lastly, the distribution of revenues from such community owned enterprises to the household is another matter that would also need to be discussed and agreed upon. I will return to this issue and the employment issue again in the next section.

Findings suggested the potential for development of certain forms of ecotourism in rural communities adjacent to the KNP, providing that the pricing and nature of the services offered were carefully considered. Tourism income generated through village tours and crafts markets targeted at tourists visiting the KNP, and low cost accommodation for low income categories of tourists could provide an opportunity for much needed diversification of income sources in rural communities. Understanding the attitudes of tourists and their perceptions regarding the relationship between development and conservation is important, given the importance of tourism for success of the TFCA.

7.3.4 Options for implementing land use based development and conservation in the TFCA

There seems to be limited studies on economic modelling of land use options within the GLTFCA. Apart from the work in progress by Musengezi and Child (2011), no other studies were identified. Outside of the GLTFCA, studies by Smith et al. (2008) in Lubombo TFCA, and work by (Cowling et al., 2004; Knight et al., 2008) and others on the STEP Project in the Cape Region in South Africa, and Tomlinson et al. (2002), Blignaut and Moolman (2006),

contribute to the literature on the subject and suggest methods for conservation assessment and economic evaluation which could be replicated in the GLTFCA. Other studies that address issues of economics in biodiversity conservation in South Africa include (Cloete and Taljaard, 2007; Sims-Castley et al., 2005; Saayman and Saayman, 2011). According to Naidoo et al. (2006), Polasky et al. (2008,) and Adams et al. (2010), the absence of spatially explicit economic information has limited the ability of conservation planners to fully incorporate the costs of conservation in a manner that is able to reduce the social conflict and opportunity costs of wildlife. Emphasis on biological and technical factors at the expense of social, political, and economic realities in conservation planning are other problems that can result in ineffective or failure of conservation strategies (Anthony, 2007; Polasky et al., 2008; Adams et al., 2010).

This study suggested a land use model that can be adapted and utilised by conservation planners, local development planners and other stakeholders to evaluate the effects of alternative land use scenarios on net revenues from the land. The mixed integer optimisation model, which was developed started simple and became more elaborate as more issues were considered. The objective function of the model was to maximise net revenues from land use under the assumption that a central planner made decisions on land use. The basic model formulation included factors such as output prices, land carrying capacity, production relationships, capital and variable costs, and wildlife damage from the park. To make to the land use model more relevant to the context, we included constraints to enable wildlife plots to be connected and considered interactions between wildlife and other land uses.

Results suggested that that the model could be used for zoning of land uses, whilst including socio-economic objectives and biophysical characteristics of land. The model enabled connectivity of wildlife land plots to be possible, and the nuisance effects of wildlife to be made endogenous to land use decisions. These are important factors to consider, given that within the TFCA there will be increased interaction between wildlife and livestock, and wildlife will also reside outside the protected areas (Cumming, 2011). Although the model put emphasis on the issues identified as being important from the perspective of local communities, it can be modified to emphasize ecological factors, or to include more bio-physical properties such as soil quality and nutrient availability. Depending on the objectives, it is also possible to reserve some plots for special flora and fauna protection, by fixing the land uses for such plots in the model.

Based on findings in Chapters 3, 4 and 5, options for land-based development at the interface are explored through the use of the model. Existing human settlements, irrigated agriculture, livestock, tourism lodges and wildlife land uses were considered in the analysis. Limits were imposed on the amount of tourism land allocated due to demand side constraints previously discussed in this chapter and in Chapter 5, and also indicated by Spenceley (2006) and South Africa National Parks (2007; 2008). Irrigation was also restricted considering that most of the land in the Province is not suitable for irrigation (Machethe et al., 2004). The competition for land was thus mainly between livestock and wildlife.

Results of the analysis showed that the status quo where most of the land was used for livestock, was not optimal. By introducing irrigation, tourism and wildlife land uses, whilst taking into consideration a range of stakeholder interests, income could be doubled. When tourism and irrigated agriculture, despite given the highest returns per ha, were restricted due to reasons explained above, the highest income from the land was only possible from having both livestock and wildlife. Excluding livestock and allocating all the remaining land uses to wildlife resulted in lower incomes due to the high damage costs of wildlife on irrigation. Similarly, having irrigation, tourism and livestock without wildlife resulted in lower income. Sensitivity analysis based on a scenario that included all land uses showed that spatial allocation of land and incomes were sensitive to change in wildlife and livestock prices, carrying capacity of the land and the extent of wildlife damage on other land uses. Increases in cost of fencing by up to 100%, did not have any effects on land allocation. This indicates the need to consider the macro-environment and changing factor prices and conditions in land use planning.

The possible ways in which wildlife and livestock could be integrated in the study area were discussed. The Namibian model of wildlife conservancies as described by (Barnes et al., 2002; Weaver and Skyer, 2005), where several communities combine land for wildlife purposes, under a well-defined shareholding structure could be considered in this area. Apart from increasing land-based income and employment opportunities, conservancies could also change the attitude of communities towards viewing wildlife as an economic asset, rather than a threat on other livelihood activities as illustrated in Chapters 3 and 4. Despite the findings in Chapter 4 that farmers were not very positive about the benefits of introducing wildlife in the area, mainly because of its high damage costs, the analysis in this chapter

showed that introducing other land uses has potential positive income benefits. Although I was able to consider in this model the effects of having wildlife and livestock or irrigation next to each other on land use revenues for example, this is not the only objective of the community. Other factors that would need to be considered are issues of human safety, and the type of wildlife that would cause minimal damage and be acceptable by the community.

Wildlife is a promising land use alternative, but it is not the only solution to poverty alleviation and rural development at the interface. Spatial land use planning that considers the nuisance effects of wildlife on other land uses, existing human settlements and a range of other factors are necessary to ensure that the benefits from the land are maximal. Success of conservation initiatives in TFCAs depends on the land use decisions that are made by rural communities. In addition to other factors, the potential benefits to be received from wildlife vis-à-vis alternative land uses will influence these decisions. This study makes a contribution by providing a framework through which income benefits of different land use options can be evaluated, considering community concerns, to assist decision making at local level. The factors considered in this analysis are however not exhaustive of all the issues that should be considered in land use planning and decision making. I highlight some of the issues to be considered in land use decisions at the interface in the next section.

7.4 What are the important issues for the future of the interface?

Based on the analysis in the different chapters of this study, I summarise in Table 7.1 some of the issues pertinent to future development wildlife and livestock land uses at the interface. The table shows the main arguments for and against wildlife and livestock or their integration, and some basic conditions to be considered in the future. I also discuss some important issues that were not directly addressed in the study but that I consider important in determining the future of the interface. Some of these issues are the subject of ongoing discussions at community level, in Hlanganani Forum meetings of the park authorities and the community attended by the researcher. Expert meetings such as the AHEAD-GLTFCA annual working group meetings and Competing Claims meetings of Wageningen University, were also attended during the study. The issues discussed below are not exhaustive, but I consider them most relevant to the discussion in this study, and they also indicate the complexity and diversity of issues to be addressed at the interface.

Employment creation: Next to maximizing net revenues from the land, employment creation is considered the most important socio-economic objective. Due to absence of reliable data it was not possible to analyse the employment levels related to the different land use scenarios in this study. I will however discuss the likely implications of different land use scenarios on employment creation. Opportunities for fulltime employment in Mhinga were few. Apart from the KNP, most employed people based locally worked in government departments mainly as teachers or clerks. Rural-urban migration provided the greatest prospect for employment for most young people. Cattle farming has limited capacity to provide full time employment, when it is considered that only few of the households have cattle and the average herd sizes were very small. Research findings elsewhere indicate that indirect economic effects of ecotourism such as hotel business and crafts markets can create more employment opportunities for local communities than subsistence farming (ABSA, 2003; Mbaiwa, 2008). I discussed previously that although tourism has high opportunities for employment creation, most of the jobs that local people qualify for are unskilled and low paying jobs. In the short run, this might not be problematic as mechanisms can be put in place to create capacity and train local people to be able to qualify for the high skilled jobs. For wildlife, it appears that the situation is different. According to ABSA (2003), game ranching is less dependent on unskilled labour than livestock farming. Another example can be drawn from the case of the Makuleke. According to Collins (2003), the Makuleke community expected to generate 150 jobs from the 22 000ha of land used for conservation, hunting and tourism inside the KNP. It is not clear whether this was realized or not. When combined with provision of accommodation facilities, it is however possible that the impacts on employment might be much higher. Another important point to consider is that employment benefits from wildlife and tourism are slow to realize (Mahony and Van Zyl, 2001), unlike in agriculture. Irrigation is a labour intensive agricultural practice with capacity to create substantial employment (Tapela, 2008), but with limited possibilities for irrigation in this area, the opportunities for employment are likely to be few.

Property rights and sharing of land use benefits- The successful reconciliation of conservation and development goals in Namibia has been attributed to the ability of the authorities to devolve rights to resource access, benefits, and management responsibilities to local communities (Weaver and Skyer, 2005). Past studies have shown that the success of conservation initiatives that include local communities depend on the ability of such initiatives to improve the welfare of humans and equitable and transparent distribution of

benefits (Barrett and Arcese, 1995; Songorwa, 1999; Emerton, 2001). In the absence of mechanisms to address these issues it could be difficult to get consensus for community engagement in wildlife, particularly from those households that currently depend on land for their livelihoods. Another important issue is that several communities would need to partner in making land available for creation of conservancies or any other form of wildlife land use. This means that several traditional leaders would be in charge of the conservancies. It would be necessary to define properly the rights and shareholding structure for such an enterprise to be successful (ABSA, 2003).

Human population expansion- A concern for rural development planning is the rising growing population and the demand on land for people to live on. This has potential to exacerbate poverty and unemployment and has been identified as a major shock and driver of change within the TFCA (Cumming et al., 2007; Munthali, 2007). If the human population density at the interface becomes too high, it might be impossible to sustain multiple land uses, particularly wildlife which needs vast amounts of land. Problems of poaching could also resurface. It is possible that the land in Mhinga could only support several wild antelope species that easily live close to humans, such as herds of impala, but would not support any of the larger wildlife which can bring in higher fees in trophy hunting. The large mammals could also pose high level of risk to the lives of humans if human population densities increase. The levels of income that are possible from the multiple land use scenario cannot guarantee more than $1.25 a day per person for the current human population in the area considered. This indicates that even where the population is able to earn income from all land uses considered, the poverty problem would not be solved. Institutional interventions to facilitate community benefits from natural resources such as land tenure security, and wildlife tourism investments are likely to be insufficient to resolve poverty and unemployment problems. Other problems related to population pressure and sustainability such as literacy levels, poverty and rural urban migration need to be tackled. In addition, the potential revenues earned from wildlife could decrease as population increase, as was the case in Zimbabwe where (Bond, 2001), observed that returns from wildlife related enterprises declined sharply where population densities exceeded 15people per square kilometer. Also related to the issue of population is the concept of scale mismatches in socio-ecological systems, which are described by Cumming et al. (2006). In addition to population pressure, a change in agriculture and food systems, changes in technology and governance systems can also contribute towards scale mismatches (Cumming et al., 2006). These are all relevant to

rural development and resource use. Lastly, within the GLTFCA countries, and within rural communities surrounding the KNP, there is variation in terms of population density (Munthali, 2007; Anthony, 2006), hence the possibilities for land based rural development will vary.

Wildlife harvesting quotas- Hunting quotas to communities on nature reserves within the Limpopo province are allocated annually by the Department of Economic Development, Environment and Tourism. The department allocates these quotas on the basis of decisions made regarding reduction of game on provincial nature reserves, informed by scientific considerations such as population growth rate, climatic conditions and carrying capacities. In 2009 quotas were allocated for lions (maximum 2 per community), buffalo, elephant, kudu, nyala, impala, zebra, wildebeest and warthog (Department of Economic Development 2009). The allocations varied between the communities, with some of them not receiving quotas for lions or elephants. The KNP is also involved in determining hunting quotas allocated to communities that share a border with it. This implies that communities do not have full control over the revenues that they can get from trophy hunting.

Water availability- All of the proposed land uses at the interface depend on water availability. The area falls within the Limpopo basin where water is considered a potential limiting effect on all future development in the region (CGIAR, 2003). Although the Luvuvhu river is perennial, the river has a large catchment area and Mhinga lies downstream. Water problems, particularly for livestock in drought years were indicated by farmers when I was in the area. Within the KNP, artificial water points are constructed to supplement natural water supplies, to support the existing populations and to distribute evenly the impact of herbivores on vegetation (Smit et al., 2007). This might be necessary should wildlife be introduced in the area. It is necessary that an analysis of the available water resources for any possible new land uses such as wildlife, irrigation or tourism be conducted and be used to inform land use decisions at the interface.

Non-consumptive options for benefitting from natural resources- The concept of payment for environmental services (PES) has gained prominence as a tool for biodiversity conservation (Bond and Frost, 2005; Dickman et al., 2011). Blignaut and Moolman (2006), suggested for communal areas on the southern part of KNP an alternative to livestock grazing. They argued that the area could generate more income through payment for environmental services

if it was declared a conservation area, than the values derived from the land through communal grazing and natural resource harvesting. They however did not answer the critical question of where the money to pay for the environmental services should come from. For areas with low potential to earn income from payment of environmental services, (Dickman et al., 2011) suggested an alternative payment scheme which they called payment for coexistence or PEC. This would allow these communities, that are not biodiversity rich and have limited capacity to generate ecosystem services, but still suffer wildlife costs to receive some incentive for co-existence with wildlife. Such payments should however be sufficient to outweigh the costs imposed on local people for co-existing with wildlife, whilst reflecting the value and benefits of wildlife to the international community. They suggested that funding for such a scheme could come from international governmental and non-governmental organisations, and a system of conservation credits paid for successful conservation, community contributions and consumptive and non-consumptive wildlife revenues. It is possible to explore the feasibility of such options within the context of the GLTFCA. For South Africa, the South African National Parks could afford to contribute towards such a scheme. For example in 2008, there were sales of ivory to the value of R60 million (approximately US$6.7 million) following the agreement reached at the 14th Conference of Parties (COP) to the Convention on International Trade in Endangered Species (CITES) held in 2007 (South Africa National Parks, 2009).

Infrastructural and market related issues-Most areas within the GLTFCA are far from major markets and have limited infrastructural services (Cumming, 2011). Although the situation is better for South Africa compared to other countries in the GLTFCA, Mhinga is almost 200km away from the provincial capital of Polokwane, and there is limited economic activity apart from that generated through the government welfare grants. The long distance from markets and limited local markets could have a bearing on the success of any of the land use options considered. As previously discussed, when compared to other rural areas, next to the KNP, Mhinga is disadvantaged due to distance and location. There are privately game reserves on the southern side, collectively referred to as Associated Private Nature Reserves (APNR) with well-developed infrastructure and more accessible, which rural communities in the TFCA would have to compete with. Within South Africa itself there is also an abundance of private game reserves which can provide competition. It is possible that even when wildlife, tourism and irrigation land uses are introduced the area would still not be able to generate sufficient employment and incomes for the local population. Migratory labour,

remittances and government welfare grants will likely continue to contribute towards livelihoods for most households for the foreseeable future, even with the successful implementation of the TFCA. For example in Namibia, where conservancies have been hailed for their success in reconciling nature conservation and bringing livelihood benefits to rural communities, there are some conservancies which still do not earn sufficient incomes to provide tangible benefits to households, and barely cover their operational costs. Households mainly derive their incomes from other off the land activities such as wage employment, trade and government pensions (NASCO, 2010).

Funding issues- Investment in tourism, wildlife ranching or conservancies requires substantial financial resources (ABSA, 2003; Spenceley, 2006). Most of such investments in South Africa have been funded through communities partnering with private partners. It is likely that this would be the same for rural communities such as Mhinga. To bring the greatest benefits to the community, it is necessary that such partnerships be stipulated in a manner that enables the community to be involved in key decisions made and be empowered in the long run (Spenceley, 2006). Commitment on the part of government and all stakeholders in the GLTFCA to make available financial resources is necessary for these rural communities to invest in wildlife land use.

Sustainability of the government social grant system: A matter of concern for the future of rural development in South Africa is sustainability of the government social grant system, which currently drives the rural economy and has been the subject of much debate (Bertrand et al., 2003; Triegaardt, 2005). This social-welfare system could be considered as an indirect subsidy to the current agricultural system. This study revealed that some of the CH had purchased their cattle from the old age grant. With such an indirect subsidy, it is possible that unsustainable and unprofitable land use practices can be promoted at the interface. Although the social grants, provide a safety net system for most households in the face of high unemployment, their sustainability has been questioned, especially in the face of an increasing population (Bertrand et al., 2003; Triegaardt, 2005). Analysis of rural development options at the interface should consider such policy distortions and the likely impacts on biodiversity conservation goals, should the social grants be unavailable.

Environmental effects: The effects of livestock production on the environment are multiple. The most critical issues include biodiversity loss through habitat destruction, deforestation,

soil erosion and loss of vegetation cover (Steinfeld, 2006). A weakness of this study is that it did not consider the environmental effects of the different land use options analysed. Evidence of environmental degradation in the study area includes soil erosion, overgrazing, gulleys caused by soil erosion, and timber extraction (Anthony, 2006). The current practice of steam-bank cultivation by the few households involved in crop production, also has negative environmental implications. It is likely that, should the status quo in land use continue, and the population also continues to expand, the damage to the environment will be exacerbated. Environmental management is not explicitly stated in the list of priorities for the Thulamela Local Municipality, and there is only one project related to environmental restoration in the list of projects needing funding (Thulamela Local Municipality, 2009). Integration of projects addressing environmental damage in the local municipality is important. The impacts of different land uses on the environment should be considered in decision making at the interface and integrated into future development plans in the local municipality. The KNP has however in the past years embarked on environmental awareness campaigns which have been considered successful (Anthony, 2006; South Africa National Parks, 2009).

Table 7.1 Summary comparison of livestock, wildlife and integrated land use and conditions for reconciliation of rural development and biodiversity objectives

	Livestock	Integrated approach	Wildlife and tourism
Pros	❖ Easily controlled and bred ❖ Ownership and tenure well defined. ❖ State support and subsidies offered. ❖ Easily traded for cash, goods, and services. ❖ Immediate benefits when sold and minimal transaction costs ❖ Can enhance other livelihood strategies ❖ Cultural values	❖ Fosters diversification of livelihoods and potential buffering of agricultural incomes ❖ More jobs can be created ❖ More land for wildlife conservation ❖ Can change community attitudes towards wildlife	❖ Cultural sentiment or religious significance ❖ Superior disease resistance and tolerance of local environmental change ❖ Generally (although not always) better use of and impact on habitat (excluding elephants) ❖ Has potential to earn more revenues per ha from trophy hunting and tourism ❖ Potential for zoonotic and livestock disease
Cons	❖ Can be an expensive investment for poor farmers in the event of loss ❖ Prone to disease, especially near wildlife ❖ Less resilient then wildlife to local environmental changes ❖ Environmental costs result if ranges are poorly managed.	❖ Increased incidence of disease ❖ Some households can become worse off if benefits not sufficient ❖ Might exert pressure on water resources ❖ Management expertise required ❖ High capital costs ❖ Wildlife prices volatile	❖ Mobile resource and difficult to control. ❖ Rarely individual ownership ❖ Tenure over wildlife rests with the State ❖ Requires collective management system ❖ Poses a threat to other livelihoods through direct competition or disease transmission. ❖ Direct consumptive use is often discouraged and sometimes illegal. ❖ Prices volatile
Conditions for fostering development and conservation at the interface	❖ Increased productivity ❖ Improved prospects for marketing ❖ Reduce stocking rates ❖ Disease control	❖ Restructure ownership of wildlife ❖ Shift emphasis from viewing wildlife as an object of conservation to legitimate component of rural livelihoods ❖ Reduce damage to agriculture ❖ Put in place mechanisms to compensate communities for co-existing with wildlife (institutional functions integrated and performed without corruption) ❖ Improve disease surveillance and control ❖ Establish sustainable and reasonable hunting quotas ❖ Facilitate capital investment for setting up wildlife reserves ❖ Develop market and infrastructure services ❖ Detailed feasibility studies required	

Table modified after (Murphree, 2005).

7.5 Policy implications

The long term plans of the GLTFCA focus on the development of wildlife-based tourism with freedom of movement for wildlife and tourists across international borders, which will likely increase interactions between wildlife, livestock and humans (Bengis, 2005). It is expected that these plans will promote both conservation and rural development goals, locally and across national boundaries. Based on the case study in this thesis, I identify several issues that should be considered from a policy perspective.

An underlying reason for competing claims on land and related conflict in the area is the lack of clearly defined property rights on land. The implementation of the Communal Land Rights Act (No. 11 of 2004) should be given priority at the interface to protect rights of communities and provide clarity on land administration before additional land uses are introduced. A clear definition of property rights would also address the issue of benefits distribution from wildlife land uses, should these be introduced. Under current legislation, ownership of land would also give the rural communities rights to the wildlife on their land. Furthermore, the rights of individual communities would also be safeguarded in the event that they combine land to form conservancies, or engage external partners to bring in funding for tourism investment. Without clearly defined property rights, it will be difficult to provide rural communities with incentives for wildlife conservation, such as those that exist for Associated Private Nature Reserves (APNR) on the southern side of the park. This is also echoed by Cumming (2011), who emphasizes the need for securing the rights of communities to resources as a step towards reconciling development and conservation in the TFCAs. Governance is relevant from household level, local community to national and international level in the TFCA. Creating better options for land use and for tailor-made wildlife tourism will be effective only when appropriate policies and institutions support these options.

Our findings in Chapters 3 and 4 showed that due to a lack of mechanisms for compensating wildlife damage, some segments of the rural communities, particularly livestock farmers did not welcome introduction of wildlife based land uses. The current situation where there are no clear channels to communicate problems of damage causing

animals, and both KNP and the government do not take responsibility for any damage caused by wildlife, should be addressed as a goodwill gesture of cooperation in wildlife conservation in the area. Compensation could be in the form of financial payments developed within a clear administrative and legal framework, or through non-financial incentives previously discussed. Chapter 6 showed that an increase in returns from livestock, or a reduction in wildlife related damage could have the effect of making livestock more favourable as a land use. Interventions to increase productivity of cattle farming through farmer training, and improved disease control could be introduced in the area. The processes to seek for a solution towards problems of wildlife damage should involve all stakeholders, and particularly not treat rural communities as a homogenous entity as this study has shown that the views regarding future prospects for development in the area are not unanimous. Failure to consider the heterogeneity of communities through broad based stakeholder consultation in the TFCA could derail both conservation and rural development objectives.

In addition, there should be a shift in emphasis from viewing wildlife as an object of conservation to legitimate component of rural livelihoods. This would enable rural communities to be involved in decision making regarding wildlife conservation, in the same manner they are involved in decisions regarding agricultural development. Similarly, policies that encourage capital investment by the private sector and infrastructural development in rural areas close to wildlife areas, are necessary to ensure that the potential of wildlife tourism to contribute towards rural development is harnessed in the long term.

The expectation that wildlife-based tourism will be the main land use within TFCAs should be closely examined. On the South African side of the TFCA, tourism infrastructure is already well developed within the KNP, by both SANPARKS and private concessionaires. The situation is different on the Mozambican and Zimbabwean side where tourism infrastructure is largely undeveloped (Spenceley, 2006). The prospects for rural communities on the SA side to effectively compete with KNP for accommodation offerings are very limited as shown in Chapter 5. Rural communities,

particularly local municipalities near the KNP should rather be encouraged to invest in activities that complement what KNP offers. I would recommend that the KNP be actively engaged in planning and marketing of tourism activities within rural communities adjacent to the park. Furthermore, these rural communities should also come together to promote conservation and tourism activities and be recognised in the same manner that the KNP recognises the APNR.

Lastly, the idea put forward by proponents of the TFCA approach that local development can be achieved by shifting from agriculture to wildlife and tourism land should not be used as a general basis for informing either conservation or rural development policy. Given the slow rate at which the GLTFCA has been implemented, and the limited number of studies so far conducted (Cumming, 2011), it is difficult to conclude whether the expectation that TFCAs will provide a forum through which conservation and rural development can both be efficiently addressed is realistic or not. What is clear from this study, and other recent analyses in the region (Cumming, 2011) and elsewhere (Roe et al., 2011) is that there is no panacea regarding reconciliation of conservation and development at the interface. Involvement of all stakeholders is critical, and much room remains for multidisciplinary studies to generate detailed information that feeds into policy processes and localized land use decisions. This would ensure that the TFCA approach does not end up just being another 'merely documented approach' at reconciling development and conservation goals.

7.6 Reflection on the methodological aspects of the study

The study entailed evaluating existing and prospective land uses, so what were considered the most appropriate approaches to tackle each research question were employed. The overall use of different methodologies had its advantages and disadvantages. I explain two advantages. Firstly, using different approaches made it possible to address the aim of the study from different angles. This resulted in a more complete picture of the issues considered. For example, when the benefits of cattle and attitudes of farmers were analysed in Chapter 4, it appeared that there were very limited

prospects for wildlife land use. Yet the results of the land use modelling in Chapters 2 and 5 showed that although in reality livestock used up all the land, even land next to the park, in the optimal solution such land was left fallow, even when there is no wildlife land use outside the park boundaries. The modelling approach revealed different spatial configurations for wildlife-livestock integration which could not have been identified through the use of livelihoods analysis. Second, by considering several techniques it was possible to match the research question with the most appropriate technique. For example, there was no existing market for ecotourism so it would not have been possible to use livelihoods analysis or cost benefit techniques to address the research question. Through employing stated preference methods which are more suitable for valuing non-market goods (Louviere, 2000; Hearne and Salinas, 2002) it was possible to answer the research question within the specific context of the study itself.

The main disadvantage of using different approaches to evaluate land use options was that it was not possible to directly compare the results. If cost-benefit analytical techniques had been used (with data from elsewhere of course) to evaluate the prospects for ecotourism development, for example, the results could have been different from those obtained through choice modelling. It would, however, have been possible to have estimates of costs and benefits of ecotourism which could be directly comparable with, for example, livestock land use. Another disadvantage was that there were some discrepancies in the results from the different approaches. For example, conclusions regarding wildlife were more promising from the land use modelling compared to conclusions reached in Chapter 3 which considered the risks and Chapter 4 which considered relationships between different existing and potential livelihood activities. If the results of the modelling can be considered a somewhat ideal situation and results based on empirical analysis in Chapter 3, 4 and 5 a realistic situation, then it becomes clear that there are discrepancies in what could be the ideal situation and what is possible within the existing socio-economic setting. This, however, is to be expected because it is not possible, neither is it the purpose in land use modelling to take into consideration all socio-economic factors (van Ittersum et al., 1998; Young et al., 2006).

Concerning a methodology for evaluating the livelihood roles of cattle, I conclude that the use of both economic estimation techniques and livelihoods analysis is essential in understanding the roles of livestock in rural communal grazing systems. The two approaches employed showed differences in the relative values of financing, security and cultural functions derived through economic estimation techniques, compared to farmer ranking of the importance of these functions. The high values that farmers placed on the non-monetary roles of livestock could partially explain their reluctance to shift from livestock based livelihoods towards wildlife. Such information, would not have been obtained by simple quantitative estimation techniques. A limitation of the livelihoods approach was that it was not possible to breakdown the analysis of cattle functions into specific capital assets.

The decision to simplify the choice experiments due to concerns of their limited applications to developing countries (Hearne and Salinas, 2002) resulted in highly aggregated attributes, which could have been further broken down for more meaningful results. The bid values proposed also turned out to be rather low, indicating the need for better design in future studies. Another possible limitation in this approach might have been caused by the reluctance of tourists to use accommodation out of the park. This could have resulted in respondents employing a lexicographical strategy (Hensher 2007) in terms of attribute processing and thereby biasing the results.

The land use modeling focused much on the socio-economic aspects, and less attention to the ecological aspects which are also important for conservation planning. The decision to specify the direction of wildlife movement in the model, which was primarily aimed at avoiding islands of unconnected wildlife plots which would not be practical in reality affected the results retained by the model. For example, some plots that could yield higher returns for wildlife, but not connected to other wildlife plots were allocated towards other land uses, mainly livestock. It was not possible, however, to address this due to the inherent inability of mixed integer linear programming models to allow definition of all possible ways in which plots can be connected or stepping stones (Groeneveld, 2010). Groeneveld (2010) suggested using a combination of mixed integer

linear programming approaches that can complement each other to address this problem in reserve design, and possibilities exist for more research in this area. There exists other extensive literature on conservation planning which can also be used to guide future research on land use in the GLTFCA. For example, Margules and Pressey (2000), discuss participatory driven conservation planning, and also discuss some of the critical factors that can influence whether or not an area might be selected for biodiversity preservation. The methodologies developed through years of extensive work by Knight, Cowling and others in the Cape Region could also be adapted and applied in the GLTFCA. The lessons learnt in the process of conservation planning as documented by Knight et al. (2006), would provide useful lessons for implementation. In addition, the study by Smith et al., (2008) in the Lubombo TFCA provides detailed, and useful bio-physical indicators that could be applied to identify the most appropriate places for biodiversity conservation in rural areas such as Mhinga considering a range of multiple criteria. The approach that we have taken in this study is not the only method that could have been used, and neither is it the best. As discussed by Sahotra et al. (2006), there are several approaches to analyzing conservation problems, and depending on the objectives and the context a range of tools can be applied. In addition, it might not be the case for some communities within the GLTFCA that the objective is to maximize net revenues from land use. As such there is much scope for future research on conservation and land use planning that considers specific stakeholder needs.

The Describe-Explain-Explore-Design (DEED) framework followed in the study was useful in guiding the depth of analysis at different stages, although there are no clear cut boundaries between the different phases of the cycle. It was not the intention in this study to follow all the stages of the cycle, and by adapting it to suit the research questions and the context, it was possible to analyse competing claims for land in Mhinga. In using this approach there were some challenges that were faced, which can provide lessons for other researchers. The nature of the study and the approach involved engaging several stakeholders, and often left the researcher in an awkward position, as some stakeholder groups tried to influence the objectivity of the researcher and also use the researcher as a medium for negotiating their position. As with all such research methods, the costs in

terms of money and time spent in the field were considerable as the process was not linear, but rather involved feedbacks and flexibility between the different stages, as is common for participatory modelling approaches (Voinov and Bousquet 2010). For a larger scale study, much more resources would thus be required.

7.7 Suggestions for further study

This study focussed on maximising benefits at community level, and did not consider the mechanisms for benefits distribution. This was necessitated by the fact that the nature of wildlife land use is such that there should be decisions at community level, and not household level. However, there still remains a need for research into the incentives for households to support wildlife versus livestock land uses. The land use model that we developed was static and did not consider the dynamic aspects of wildlife and livestock populations, or the time value of investment benefits. It has been noted that where spatial characteristics of land parcels are considered, as well as the relationships between the parcels themselves, such an analysis can become complicated, and for a dynamic analysis the data requirements are extensive (Polasky et al., 2008). Such analysis is however possible, and further research in the GLTFCA could focus on this, especially when actual data after implementation becomes available. We also did not consider ecological models in our analysis. These are important for biodiversity conservation and future studies could consider integrating spatial ecological models with economic analysis in this context. In addition other factors such as land elevation, habitat patch size, species distribution, land cover types and ecological processes such as those considered by Smith et al. (2008), could also be used to improve the model. In the model that we used in Chapter 6, we relied on secondary data from elsewhere for wildlife, tourism and irrigation revenues. As more data become available in the TFCA, there should be progressive analyses of the land use options. Future studies of ecotourism in or around KNP could consider increasing the number of attribute levels to increase efficiency (Johnson et al., 2007) and detail in terms of specific ecotourism packages to enable development of tailor-made tour packages. The impacts of lexicographic strategies in survey results can also be investigated.

Research opportunities exist in the field of institutional economics. Research on development and implementation of appropriate policies to optimize governance of land that is jointly used for livestock and wildlife to support poor communities in the TFCA could be conducted. Through research it could be possible to explore alternative forms of governance systems to address problems of poor coordination between different government agencies working in conservation. Other issues that need detailed research are divergent opinions in the community regarding promoting livestock and/or wildlife tourism activities, and options for payment of incentives to co-exist with wildlife in rural communities. Lastly, more calls have been made for research in TFCAs in Southern Africa (Cumming, 2011). These include issues of disease risk and related economic and livelihood impacts, scale and sustainability issues, and studies to evaluate progress made in terms of different indicators of conservation and development.

7.8 Major conclusions

The ability of Transfrontier Conservation Areas to reconcile rural development and biodiversity goals is not only dependent on political will and cooperation between different countries. It is a process that requires commitment, implementation and cooperation across multiple levels of governance and between multiple stakeholders. Although there is no single implementation approach, that can be recommended this study identified the following issues as being important for successful implementation of the TFCA and land use decision making;

1. Positive attitudes towards wildlife conservation and cooperation are necessary for rural communities to commit land towards wildlife land uses. The negative attitude towards the idea of increased wildlife/livestock interaction were mainly caused by the failure of relevant authorities to address problems of wildlife depredation and disease. It is imperative that sustainable solutions to address these problems be identified in consultation with rural communities, particularly those households that suffer the greatest costs of co-existing with wildlife.

2. The incentives from wildlife land use, especially in terms of household level incomes and capital assets, must be sufficient to justify households shifting from other land uses particularly livestock. There is a possibility that shifting towards wildlife land uses can result in some households, particularly those whose members are older and unemployed, losing autonomy and independence that comes from cattle farming.
3. For communities to be able to benefit from wildlife land uses, they should have ownership rights to the land and be involved in decisions concerning sustainable utilization of wildlife resources.
4. The potential for ecotourism as a source of income is limited by demand side constraints and the comparative disadvantage that the Mhinga area has in relation to other gates to the KNP and its remote location from major cities. There is however, scope for development of low value ecotourism services such as cultural and village tours and craft markets.
5. The expectation that households will shift towards predominantly wildlife tourism land uses in the TFCA is not realistic when the limitations of wildlife and tourism are considered. The interface should be considered as a multiple land use zone, where wildlife and tourism are some of the livelihood activities, and depending on the site specific conditions such as distance from the markets, tourism potential and agricultural potential, then emphasis can be put on the land uses that are likely to yield more benefits.
6. Spatial land use planning, and multidisciplinary methodologies can provide useful tools through which land use options can be evaluated in a manner that takes into consideration socio-economic, and bio-physical factors unique to each location.
7. It is important that other means to generate incomes and employment outside of the TFCA be considered, as it is unlikely that sufficient jobs and household incomes can be generated through wildlife tourism and agricultural land uses.
8. The future of the interface will not only be determined by the land use decisions that are made, but many other factors such as the rate of population growth, water availability, the hunting quotas issued to the rural communities, access to investment funding and markets and infrastructural provision.

9. From a policy perspective, it is important that there should be a shift from regarding wildlife not only as an object for conservation, but also a legitimate component of rural livelihoods, which if utilized sustainably can contribute towards poverty alleviation in the long term.
10. There is great diversity in the socio-economic conditions of communities that are living within the GLTFCA in the three countries. A case study such as this can play an important role in exploration of issues, but there are limitations regarding generalization of some of the findings. As with most social science studies of this nature, I can only highlight the important issues that are pertinent to future development within the GLTFCA, but the relevance and the importance attached to each of the issues varies widely between the countries, and within South Africa itself.

Finally, it is the implementation, the manner in which local communities and other stakeholders buy-in to the idea of TFCAs, and the institutional mechanisms and incentives which are in place that will determine whether this is indeed the long awaited solution to reconciling rural development and biodiversity conservation goals in the new millennium.

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Appendices

APPENDIX 1: Questionnaire FOR CATTLE OWNERS

TO BE FILLED IN BEFORE THE INTERVIEW COMMENCES

Name of Enumerator:…….

Village of household: ……

Date of Interview:……

Full name of respondent …….

Relationship to Household head……

Gender of respondent: **Male/Female**……

Is the respondent the head of the household **Yes/ No .....**

SECTION 1:This first section is about the people who live at this homestead and eat from the same pot as yourself and the general activities they engage in. This includes people who live away from the house during the week or month, but come back on a regular basis and contribute to the income of the household.)

1. What is the household head's full name:……
2. Gender of household head **Male/ Female(*circle right answer)***
3. What is the year of birth for the household head?:……
4. What is the main occupation of household head? (*one answer possible)*

1	2	3	4	5	6	7	8
Farmer fulltime	Part-time Farmer	Pensioner	Employed-Civil Servant	Employed-Kruger Park	Employed-Private Company	SMME (specify)	Unemployed

7: Specify type of SMME……..

5. Where is the household head based? (*Only 1 choice possible)*

1	2	3	4
Locally	In town comes weekend	In town comes monthly	Other (please specify)

4: Other……

6. What is the marital status of the household head? (*one answer possible)*

1	2	3	4
Married	Widowed	Divorced	Single

7. How many years did the household head go to school? (*one answer possible)*

1	2	3	4	5	6	7
0	1-4	5-7	8-10	11-12	Tertiary-Diploma/Certificate	Tertiary- Degree and above

8. Does the household own cattle? **Yes/No**

9. Are there any cattle that do not belong to the head of the household that are looked after here?

Yes/No ***If NO go to Q14***

The next set of question are about the owner of the cattle: If the owner of the cattle is only the household head, skip this section to Q14

10. Gender of the cattle owner **Male/ Female(*circle right answer)***

11. What is the year of birth for the cattle owner?:……

12. What is the main occupation of cattle owner? (*one answer possible)*

1	2	3	4	5	6	7
Farmer fulltime	Part-time Farmer	Pensioner	Employed- Civil Servant	Employed- Kruger Park	Employed- Private Company	SMME (specify)

7: Specify type of SMME……..

13. Where is the cattle owner based? (*Only 1 choice possible)*

1	2	3	4
Locally	In town comes weekend	In town comes monthly	Other (please specify)

4: Other……

Next we ask about all the people that live here

14. How many people are in your household, living together including the head ? (*answer all categories: fill in 0 if none)*

Persons	**Number**
Adult male (18 years and above)	
Adult female(18 years and above)	
Boys (10-17 years)	
Girls (10-17 years)	
Children (less than 10 years)	
TOTAL	

15. Which of the following activities do you have in the household? .

Activity	***(****Tick if Yes****)***
Growing crops	
Livestock farming	√
Formal employment	
Small and medium business enterprise	
Other activities (specify them)	

Other…….

16. Which of the following other sources of income do you have in the household?

Sources of Income	***(****Tick if Yes****)***	***Frequency***
Receiving grants		//
Remittance from non-household members		……per……..
Private Pension (not pension grant)		……per……..

(IF NO ONE RECEIVES A GRANT, GO TO QUESTION 18)

17. How many people in the household receive each of the following types of grant.

Grant type	**No. of members**
Pension	
Child	
Disability	
Foster	
Other Grant (specify)……..	

18. How much arable land do you have?……...ha (*if in other size, mention units*)
19. Did you have to pay any money to get arable land? **Yes / No** ***(circle correct answer)***

(IF THE HOUSEHOLD DOES NOT GROW CROPS IN QUESTION 15 SKIP TO QUESTION 34)

The following questions are about CROP PRODUCTION

20. Which crops where planted during the past year (2007/2008)

Crop	Area planted	Amount harvested in 2008 (e.g 50kg bags, 20 litre tins or 5 litre tins

21. Do you sell some of the crops you produce? **Yes / No** ***(circle right answer)***

Crop	**Amount sold** (e.g 50kg bags, 20 litre tins or 5 litre tins)	**Whom sold to? i.e. middle men from outside village or local villagers**

COMPLETE THE FOLLOWING TABLE ABOUT CROP INPUTS

Input	**(*cross right answer)***	**If yes, how much was spent? *(in Rand)***
22. Did you buy any seed for the crops	Yes/No	For how much? ……
23. Did you buy any fertiliser	Yes/No	For how much? ……
24. Did you buy any pesticides	Yes/No	For how much? ……
25. Did you pay for ploughing ?	Yes/No	How much? ……
26. Did you hire any labour	Yes/No	For how much? ……

27. What do you use to plough?

1	2	3	4	5
Hire tractor	Own tractor	Hire plough and livestock	Own plough and livestock	Hoe

28. Have you ever faced problems with wildlife destroying your crops? **Yes / No** , ***IF NO GO TO QUESTION 33***

29. If yes, explain……

……

30. How many times was your crop destroyed by wildlife this year?.**1. Once 2. twice 3. More that twice**

31. When was the last time this happened? **(Month and Year)** .....

32. How many times have you had this problem with wildlife in the last three years?.....

33. What other problems do you face growing crops in this area? (circle appropriate)

(DON'T READ OUT THE RESPONSES, MORE THAN ONE ANSWER POSSIBLE)

1	2	3	4	5	6	7
Drought	Difficult to get inputs	Pests	Soil fertility	Labour shortage	Theft	Other (specify)

7: Other……

SECTION 3: The next section is about animal production

34. Which of the following species of animals do you have?

Animal Type	Tick if YES	Number Now
Cattle		
Goats		
Donkeys		
Chickens		
Sheep		
Pigs		

THE NEXT SET OF QUESTIONS ARE SPECIFICALLY FOR CATTLE.

35. For the cattle the household keeps complete the following table

	How many do you have now	**How many 3 years ago (in 2005)**
Breeding Cows		
Breeding Bulls		
Heifers		
Oxen and bulls under 2 years		
Unweaned Calves		
Total		

Please check if the total corresponds with question 34 for cattle

36. Are there any cattle that are in your kraal that do not belong to a household member?

Yes/No

37. If yes how many are they? ……

38. If you look after the cattle of someone who is not staying here, is the household paid for it?

Yes/No ***IF NO GO TO Q 40***

39. If yes, what does the owner pay for the cattle to be looked after?

R…….per……or other payment specify)……

40. Who takes care of the animals? **(more than one answer possible)**

1	2	3	4
Household member	Paid herd boy	Other relative	Other (specify)

Other……

41. If the cattle are looked after by a herd boy how much is he paid a month?.....

42. For how long have you been keeping your own cattle?.....years

43. Have you been herding cattle for your parents before you had your own cattle? **Yes/No**

44. Where did you get the initial money to start keeping cattle?

…….....

.....

45. What are your reasons for keeping cattle **(*More than one answer possible*)**

1	2	3	4	5	6	7	8	9	10
Commercial/sale of cattle	Commercial /sale of products	Tradition / Culture	Milk	Meat	Security	Manure	Draught power	Hides	Other (specify)*

* Specify……

46. Can you give the most important **<u>three</u> (1 is the most important)** reasons for keeping cattle

1	2	3

47. Do you buy extra feed for the cattle? **Yes (1) / No (2)** ***If NO SKIP TO QUESTION 50***

48. If yes, what type of supplement do you buy?

Product bought	**Amount fed**	**Where do you buy the feed?**

49. When do you buy extra feed for your cattle?

1	2	3	4
Every winter	In drought years only	Always	Other (specify)

50. Do you dip your cattle? **Yes/No**…….

51. If **NO** how do you prevent diseases?.....

52. Complete the following table about Animal diseases

What are the common diseases here	**How many times in the last 3 years**	**What treatment do you give?**	**Who administer treatment?**

NOW WE ARE GOING TO TALK ABOUT THE PRODUCTS THAT YOU GET FROM THE CATTLE

First we talk about Cattle Milk

53. Do you milk your cows? **Yes (1) / No (2)** ***IF NO SKIP TO QUESTION 56***

54. How many cows do you milk? ……..…….cows

55. How much milk do you get from one cow on average per day? …….…..litre

The next questions are about Draught Power

56. Do you use cattle for draught power? **Yes (1) / No (2)** ***IF NO SKIP TO QUESTION 60***

57. Do you ever plough other people's land with your cattle? **Yes (1) / No (2)**

58. If yes, how much do you charge per hectare? R.....

59. In the last season how many hectares did you plough for other people?.....

The next questions are about cattle dung

60. Do you use the dung of your cattle? **Yes (1) / No (2)** ***IF NO SKIP TO QUESTION 65***

61. What do you use the dung for? (more than one answer possible)

1	2	3	4	5
Fertilization crop land	Cooking	Building	Sale	Other*

* Specify……

62. Do you sell cattle dung? **Yes (1) / No (2)** ***IF NO SKIP TO Q 65***

63. If yes how much (specify container) R……..

64. How much did you earn last year for sale of dung? R……..

The next questions are about Cattle Meat

65. Do you ever slaughter your own cattle? **Yes (1) / No (2)** ***IF NO SKIP TO QUESTION 69***

66. How many animals did you slaughter during the past three years?.....

TYPE	**Number**	**Reason slaughtered**
Breeding Cows		
Breeding Bulls		
Heifers		
Oxen and bulls under 2 years		
Unweaned Calves		
TOTAL		

67. How much of the meat did you sell the last time you slaughtered an animal ?

1	**2**	**3**	**4**	**5**
0	¼	½	¾	**1 =whole animal**

68. Where do you sell the meat for the cattle you slaughter?

1	2	3	4	5
People from this village	Local butcheries	People from other villages	Butcheries from far	Other (specify)

5.Specify……..

The next questions are about selling and buying of cattle

69. Have you ever sold any live cattle in the last three years **Yes (1) / No (2)** ***IF NO GO TO QUESTION 74***

70. How many animals were sold during the last three years?.....

	Number sold	Reason sold (**More than one answer possible)**	Price per head **More than one answer possible)**
Breeding Cows			
Breeding Bulls			
Heifers			
Oxen and bulls under 2 years			
Unweaned Calves			

71. To whom did you sell the cattle? (More than one answer possible)

1	2	3	4	5	6
People from this village	Local butcheries	People from other villages	Butcheries from far	Makhoma /Gaza Beef	Other (specify)

72. Have you ever bought any cattle in the last three years **Yes (1) / No (2)** ***IF NO GO TO QUESTION 77***

73. How many animals did you buy over the last three years?.....

74. Why did you buy the animals? (More than one answer possible)……

……

75. How much did you pay per head of cattle you bought? (More than one answer possible)…..

76. From whom did you buy the cattle? (More than one answer possible)

1	2	3	4
People from this village	People from other villages around Mhinga	People from other villages outside Mhinga	Other (specify)

4 Specify……

The next questions are about input or output of cattle in your herd

77. How many and which animals were used for the following purposes in the last **three years**;

Purpose	**No of animals**
78. How many cattle were given to relatives?	
79. How many cattle were received from relatives?	
80. How many cattle were stolen	
81. How many cattle were lost to wildlife?	
82. How many cattle were given away as payment for herding cattle ?	
83. How many cattle were received as payment for herding someone else's cattle?	
84. How many cattle died to disease?	
85. How many cattle died to drought ?	

86. If you lost cattle to diseases which specific diseases were they?(**I don't know is an ACCEPTABLE answer**) ……

……

87. What did you do with the cattle that was killed by wildlife?……

……

88. Did you report the loss from wildlife to anyone? **Yes (1)/ No (2)**

89. If yes, to whom? ……

SECTION 4: The next set of questions is about GRAZING AREA

90. What is the name of the grazing area (s) that your cattle use?.....

91. Are there any problems you face in using the grazing area? **Yes (1)/ No (2)** ***IF NO GO TO Q93***

92. If yes, explain…….....

……

93. Who manages the grazing area?.....

94. Are there other people from outside this village who graze their cattle in the same grazing area as you?

Yes (1)/ No (2) ***IF NO GO TO Q97***

95. If yes, which villages?.....

96. Why do they use your grazing area?.....

……

97. Is the grazing area used for any other purpose apart from grazing? **Yes (1) / No (2)**

98. If yes, explain……..

……

99. Is the grazing available sufficient for all the cattle there? **Yes (1) / No (2)** ***IF NO GO TO Q101***

100. If yes, do you think more cattle could be admitted into this grazing camp without causing shortage for your animals? **Yes (1) / No (2)**

101. Are there any rules that you have to follow in using the grazing camp? **Yes (1) / No (2)**

102. If yes, explain……

……

SECTION 5: Next we talk about the future of livestock farming in this area

103. Do your children have an interest in livestock farming? **Yes (1) / No (2)**

104. Do you think they would continue cattle farming after you quit farming? **Yes (1) / No (2)**

105. **ASK ONLY IF NOT RETIRED**: If you were to get a job in the city would you continue cattle farming? **Yes (1) / No (2)**

106. In what ways do you think people without cattle in this community benefit from your cattle farming?

……..……

……

107. Do you belong to any farmer's organisation? **Yes (1) / No (2)** ***IF NO GO TO Q111***

108. If yes, what is the name of the farmer's organisation?.....

109. When was it formed?.....

110. Why did you join?.....

111. What do you think are the problems that may limit livestock farming in the future in this village?……

……..

SECTION 5: Next we talk about the REDLINE Zone

112. Do you know about the redline? **Yes (1) /No(2)** ***IF FARMER DOES NOT KNOW HELP THEM BY EXPLAINING***

113. If yes, explain what it is?.....

……

114. Do you think it affects cattle production in this village? **Yes (1) /No(2)**

115. Do you think being close to the Kruger Park affects cattle production in this village? **Yes (1) /No(2)**

116. Explain your answer……

……

117. Do you sometimes have problems finding buyers when you want to sell your cattle because of the redline? **Yes (1) /No(2)**

118. Explain……

……

119. Are there any problems with complying with the redline zone regulations by people in this area?

Yes (1) /No(2)

120. Explain……

……

SECTION 6: The last thing we want to talk about is the activities that generate income for a living in this household

121. Is any member of the household employed in the Kruger National Park? **Yes (1)/ No (2)**

122. If yes, what are they doing there?

……..

123. Which of the following activities generate income or food in this household? *(USE INFORMATION FROM EARLIER ON IN THE INTERVIEW TO REACH AN AGREEMENT WITH RESPONDENT (MORE THAN ONE ANSWER POSSIBLE)*

Crop farming	Cattle farming	Other Livestock farming	Grants	Employment Income	Remittances	Private Pension	SMME Income	Other specify

124. How do you value livestock in relation to other sources of income

1	2	3	4	5
livestock 0% others 100%	livestock 25% others 75%	Livestock 50 % others 50 %	Livestock 75% others 25%	livestock 100% others 0%

In order of importance rank **with 1 being the most important**, the following income sources in the household pertaining to specific expenditures difference . **You must draw this table on the ground and explain to the respondent what they should do!**

125. Cattle Income vs Non-cattle income

	Purchasing fixed household implements	Paying school fees and uniforms	Groceries and Clothing	Funding funerals and weddings?
Cattle Income				
Other Income				

126. Grant income vs. Other Income

	Purchasing fixed household implements	Paying school fees and uniforms	Groceries and Clothing	Funding funerals and weddings?
Grant Income				
Other Income				

127. Which of the following implements do you have (ask each one individually and circle appropriate):

1	2	3	4	5
Tractor	Wheelbarrow	Plough	Cart	Car

128. Is there anything that you would like to say or ask ……

……

……

DO NOT ASK THIS QUESTION, JUST OBSERVE

129. Type of main house (for observation by enumerator, transfer to top)

1	**2**	**3**	**4**	**5**
Brick under tile	Brick under iron sheets	Brick under thatch	Mud under thatch	

No. of rooms in main house……..

WE HAVE COME TO THE END OF THE INTERVIEW , THANK YOU FOR YOUR TIME AND ASSISTANCE . Once again I would like to remind you that we will share with you the results of the study through workshops and pamphlets. All the information you gave in this study will be anonymous.

ASSESSMENT OF INTERVIEW: EASY / AVERAGE / DIFFICULT

APPENDIX 2: Questionnaire FOR NON-CATTLE OWNERS

TO BE FILLED IN BEFORE THE INTERVIEW COMMENCES

Name of Enumerator:…….

Village of household: ……

Date of Interview:……

Full name of respondent ……..

Relationship to Household head……

Gender of respondent:……

Is the respondent the head of the household **Yes/ No.....**

SECTION 1:This first section is about the people who live at this homestead and eat from the same pot as yourself and the general activities they engage in. This includes people who live away from the house during the week or month, but come back on a regular basis and contribute to the income of the household.)

1. What is the household head's full name:……
2. Gender of household head **Male/ Female(*circle right answer)***
3. What is the year of birth for the household head?:……
4. What is the main occupation of household head? (*one answer possible)*

1	2	3	4	5	6	7	8
Farmer fulltime	Part-time Farmer	Pensioner	Employed- Civil Servant	Employed-Kruger Park	Employed-Private Company	SMME (specify)	Unemployed

7: Specify type of SMME……..

5. Where is the household head based? (*Only 1 choice possible)*

1	2	3	4
Locally	In town comes weekend	In town comes monthly	Other (please specify)

4: Other……

6. What is the marital status of the household head? (*one answer possible)*

1	2	3	4
Married	Widowed	Divorced	Single

7. How many years did the household head go to school? (*one answer possible)*

1	2	3	4	5	6	7
0	1-4	5-7	8-10	11-12	Tertiary- Diploma/Certificate	Tertiary- Degree and above

Next we ask about all people that live here

8. How many people are in your household, living together including the head? (*answer all categories: fill in 0 if none)*

Persons	**Number**
Adult male (18 years and above)	
Adult female(18 years and above)	
Boys (10-17 years)	
Girls (10-17 years)	
Children (less than 10 years)	
TOTAL	

9. Which of the following activities do you have in the household? .

Activity	***(****Tick if Yes****)***
Growing crops	
Livestock farming	
Formal employment	
Small and medium business enterprise	
Other activities (specify them)	

10. Which of the following other sources of income do you have in the household?

Sources of Income	***(****Tick if Yes****)***	***Frequency***
Receiving grants		//
Remittance from non-household members		……per……..
Private Pension (not pension grant)		……per……..

(IF NO ONE RECEIVES A GRANT, GO TO QUESTION 12)

11. How many people in the household receive each of the following types of grant.

Grant type	**No. of members**
Pension	
Child	
Disability	
Foster	
Other Grant (specify)……..	

12. How much arable land do you have?……...ha (*if in other size, mention units*)
13. Did you have to pay any money to get arable land? **Yes / No** ***(circle correct answer)***

(IF THE HOUSEHOLD DOES NOT GROW CROPS IN QUESTION 9 SKIP TO QUESTION 28)

The following questions are about CROP PRODUCTION

14. Which crops where planted during the past year (2007/2008)

Crop	**Area planted**	**Amount harvested in 2008 (e.g 50kg bags, 20 litre tins or 5 litre tins**

15. Do you sell some of the crops you produce? **Yes / No** *(circle right answer)*

Crop	**Amount sold** (e.g 50kg bags, 20 litre tins or 5 litre tins)	**Whom sold to? i.e. middle men from outside village or local villagers**

COMPLETE THE FOLLOWING TABLE ABOUT CROP INPUTS

Input	**(*cross right answer)***	**If yes, how much was spent? *(in Rand)***
16. Did you buy any seed for the crops	Yes/No	For how much? ……
17. Did you buy any fertiliser	Yes/No	For how much? ……
18. Did you buy any pesticides	Yes/No	For how much? ……
19. Did you pay for ploughing ?	Yes/No	How much? ……
20. Did you hire any labour	Yes/No	For how much? ……

21. What do you use to plough?

1	2	3	4	5
Hire tractor	Own tractor	Hire plough and livestock	Own plough and livestock	Hoe

22. Have you ever faced problems with wildlife destroying your crops? **Yes / No** , ***IF NO GO TO QUESTION 27***

23. If yes, explain

……..

……

24. How many times was your crop destroyed by wildlife this year?. **1.Once 2.Twice 3. More that twice**

25. When was the last time this happened? **(Month and Year)**.....

26. How many times have you had this problem with wildlife in the last three years?

.....

27. What other problems do you face growing crops in this area? (circle appropriate)

(DON'T READ OUT THE RESPONSES, MORE THAN ONE ANSWER POSSIBLE)

1	2	3	4	5	6	7
Drought	Difficult to get inputs	Pests	Soil fertility	Labour shortage	Theft	Other (specify)

7: Other……

SECTION 3: The next section is about animal production

28. Which of the following species of animals do you have?

Animal Type	Tick if YES	Number Now
Goats		
Donkeys		
Chickens		
Sheep		
Pigs		

29. Have you at any time ever been involved in farming with your own cattle? **Yes/No** ***IF NO GO TO Q32***

30. If yes, when was the last time you kept cattle? **(Year)** .....

31. Why did you stop keeping cattle? .....

……

32. Are you interested in cattle farming? **Yes/No**

33. If **no**, explain why not? .....

34. If **yes,** explain why?.....

35. Do your children have an interest in livestock farming? **Yes / No**

36. Does any of your extended family in this area own cattle? **Yes/No**

37. Do you benefit from cattle production in this area? **Yes / No**

38. If yes, list **three (3) ways in order of importance**, in which you benefit from cattle farming in this area even if you do not have cattle yourself?

1	2	3

39. Which of the following cattle products do you get from people with cattle in this area?

	Milk	**Draught Power**	**Dung**	**Transport**
Yes/No				
Tick if you pay for the goods				
How much? Per month (specify units)				

40. Have you ever bought any cattle in the last three years **Yes (1) / No (2)** ***IF NO GO TO QUESTION 45***

41. How many animals did you buy over the **last three years**?.....

42. Why did you buy the animals? ***(More than one answer possible)***……

……

43. How much did you pay per head of cattle you bought? ***(More than one answer possible)***….

44. From whom did you buy the cattle? ***(More than one answer possible)***

1	2	3	4
People from this village	People from other villages in Mhinga TA	People from other villages outside Mhinga TA	Other (specify)

4 ***Specify***……

45. Do you use the grazing area in any way? **Yes (1)/ No (2)**

46. If yes, explain ……

……

47. If you had a chance to choose how grazing land could be used which of the following would you choose to have on the grazing land in order of preference ***(1 is most preferred to 5 least preferred)***

Cattle	Game Farms	Hotels and Lodges	Crop Farming	Houses	Shopping Centre	Other (specify)

Specify Other ……..

SECTION 6: The last thing we want to talk about is the activities that generate income for a living in this household

48. Is any member of the household employed in the Kruger National Park? **Yes (1)/ No (2)**
49. If yes, what are they doing there?

    ……..

50. Which of the following activities generate income or food in this household? *(USE INFORMATION FROM EARLIER ON IN THE INTERVIEW TO REACH AN AGREEMENT WITH RESPONDENT (MORE THAN ONE ANSWER POSSIBLE)*

Crop farming	Livestock farming (non cattle)	Grants	Employment Income	Remittances	Other (specify)

In order of importance rank **with 1 being the most important**, the following income sources in the household pertaining to specific expenditures difference . **You must draw this table on the ground and explain to the respondent what they should do!**

51. Salary Income vs Other income

	Purchasing fixed household implements	Paying school fees and uniforms	Groceries and Clothing	Funding funerals and weddings?
Salary Income				
Other Income				

52. Grant income vs. other incomes

	Purchasing fixed household implements	Paying school fees and uniforms	Groceries and Clothing	Funding funerals and weddings?
Grant Income				
Other Income				

53. Which of the following implements do you have (ask each one individually and circle appropriate):

1	2	3	4	5
Tractor	Wheelbarrow	Plough	Cart	Car

54. Is there anything that you would like to say or ask

…….

……

……

DO NOT ASK THIS QUESTION, JUST OBSERVE

55. Type of main house (for observation by enumerator, transfer to top)

1	**2**	**3**	**4**	**5**
Brick under tile	Brick under iron sheets	Brick under thatch	Mud under thatch	

No. of rooms in main house……..

WE HAVE COME TO THE END OF THE INTERVIEW , THANK YOU FOR YOUR TIME AND ASSISTANCE . Once again I would like to remind you that we will share with you the results of the study through workshops and pamphlets. All the information you gave in this study will be anonymous.

Assessment of Interview: Easy / Average / Difficult

APPENDIX 3

VISITORS' PREFERENCES FOR TOURISM ACTIVITIES IN THE SURROUNDING COMMUNITIES OF KNP FOR THE DEVELOPMENT OF ECOTOURISM IN THESE AREAS

The University of Limpopo (South Africa) and Wageningen University (the Netherlands) are conducting a study to understand whether tourists and other visitors to Kruger National Park (KNP) are interested in activities that could be offered by rural communities around the KNP to enhance rural development and create employment. For this study, we would like to ask you a few questions about yourself and your interest in ecotourism. The interview will take about 25 minutes

Firstly we will request that you provide us with some information about yourself. Please note that the information you give will be confidential and will only be used for the purpose of this study.

SECTION A

Identification

1. Gender male ☐ female ☐

2. Age…….

3. Nationality…….

4. Duration of stay in KNP……days……weeks……

5. Are you travelling alone? Yes ☐ No ☐

6. If no, how many other people are you travelling with……..

7. Have you visited the KNP before? .....

8. How many times have you been to KNP in the last 5 years? ……..

9. Do you plan on coming back to KNP in the next 5 years? Yes ☐ No ☐

10. Have you ever purchased any craft in the KNP or in the surrounding villages of KNP? Yes ☐ No ☐

11. Please indicate your annual income
    Less than R 96 000 ($12 000) ☐
    R 96 001 – 200 000 ($12 100- 25000) ☐
    R 200 001 – 400 000 ($ 25 000-50 000) ☐
    Above R 400 000 ($50 000) ☐

SECTION B

In the future it may be possible for you to combine wildlife viewing in the KNP with a range of activities in surrounding villages like village tours packages that include participating in rural craft activities, visiting a traditional healer and experiencing local cultural food or even spending the night in village lodges that are owned by rural communities with standards similar to those of KNP. These are additional activities to the traditional KNP experience of wildlife viewing, tracking and trails. We kindly ask you to choose from a range of additional activities that we specify. You are therefore requested to look at them closely, as they will make it easier for you to make choices in the subsequent parts.

Table1: This table contains information about the characteristics of the proposed alternatives

Characteristics of the tours	Description	Levels
 Accommodation	Besides KNP accommodation, visitors can also spend a night in lodges with similar standards in one or more of the surrounding villages of the KNP at the same price	▪ KNP accommodation ▪ Village lodges **same price and standards** as KNP accommodation plus cultural entertainment
 Arts and crafts market	In addition to wildlife viewing in the KNP, visitors can visit craft markets, to buy craft witness and learn the process of making them. Crafts include beading, pottery, crocheting and wood carving.,	▪ No craft market visits ▪ Visits to village craft markets in KNP
 Cultural experience	**Village tour package**. 3-4 hours long. Activities include interaction with locals, photography, cultural entertainment group, visit a traditional healer, the Tribal court house and visit cultural village.	▪ No village tours ▪ Village tours
 Additional fee	These activities would come at an additional cost above the KNP entrance fees*	• R 0 ($0) ▪ R 160 ($20) ▪ R 320 ($40)

**** Exchange rate fixed at $1=R8.00***

What would you choose if you were given the following two options? You also have an alternative to choose none of the two options by selecting the *Current situation*.

Choice Set I (2/3)

Characteristics	**Option 1**	**Option 2**	**Current situation**
Accommodation	Accommodation in the KNP	Village Accommodation similar to KNP standard and price plus cultural entertainment	I will not choose any of the two options
Craft markets	No visits to the craft market	 Visits to KNP craft markets	
Cultural experience	 Taking a village Tour	No village tour	
Additional Fees	 R 160 ($20)	 R 160 ($20)	☐
Please tick one box	☐	☐	

Which option would you choose, given the following?

Choice set II (7/2)

Characteristics	**Option 1**	**Option 2**	**Current situation**
Accommodation	KNP accommodation	KNP accommodation	I will not choose any of the two options
Craft markets	 Visits to craft markets in KNP	No visits to craft markets in the KNP	
Cultural experience	 Village tour	 Village tour	☐
Additional Fees	 R 160 ($20)	 R 160 ($20)	
Please tick one Box	☐	☐	

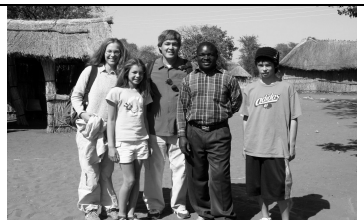
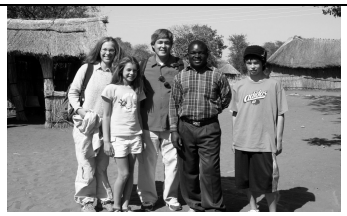
Which option would you choose, given the following?

Choice Set III (8/2)

Characteristics	**Option 1**	**Option 2**	**Current situation**
Accommodation	Village Accommodation similar to KNP standard and price plus cultural entertainment	Accommodation in the KNP	I will not choose any of the two options
Craft markets	No visits to the craft market in KNP	No visits to the craft market in KNP	
Cultural experience	No village Tour	 Taking a village tour	
Additional Fees	 R 160 ($20)	 R 160 ($20)	☐
Please tick one box	☐	☐	

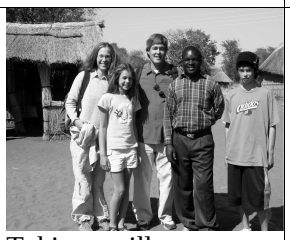
Which option would you choose, given the following?

Choice set IV (5/7)

Characteristics	**Option 1**	**Option 2**	**Current situation**
Accommodation	Village Accommodation similar to KNP standard and price plus cultural entertainment	Accommodation in the KNP	I will not choose any of the two options
Craft markets	 Visits to the craft market in KNP	 Visits to craft markets in KNP	
Cultural experience	 Taking a village tour	 Taking a village tour	
Additional Fees	 R 0 ($0)	 R 160 ($20)	☐
Please tick one box	☐	☐	

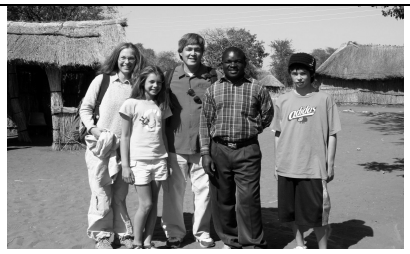
Which option would you choose, given the following?

Choice Set V (2/6)

Characteristics	**Option 1**	**Option 2**	**Current situation**
Accommodation	Accommodation in the KNP	Village Accommodation similar to KNP standard and price plus cultural entertainment	I will not choose any of the two options
Craft markets	No visits to the craft market in KNP	No visits to the craft market in KNP	
Cultural experience	 Taking a village Tour	 Taking a village tour	
Additional Fees	 R 160 ($20)	 R 320 ($40)	
Please tick one box	☐	☐	☐

Which option would you choose, given the following?

Set VI (6/8)

Characteristics	**Option 1**	**Option 2**	**Current situation**
Accommodation	Village Accommodation similar to KNP standard and price plus cultural entertainment	Village Accommodation similar to KNP standard and price plus cultural entertainment	I will not choose any of the two options
Craft markets	No visits to the craft market in KNP	No visits to the craft market in KNP	
Cultural experience	 Taking a village Tour	No village tour	
Additional Fees	 R 320 ($40)	 R 160 ($20)	
Please tick one box	☐	☐	☐

Which option would you choose, given the following?

Set VII (8/4)

Characteristics	**Option 1**	**Option 2**	**Current situation**
Accommodation	Village Accommodation similar to KNP standard and price <u>plus cultural entertainment</u>	KNP Accommodation	I will not choose any of the two options
Craft markets	No visits to the craft market in KNP	 Visits to craft markets in KNP	
Cultural experience	No village tour	No village tour	
Additional Fees	 R 160 ($20)	 R 320 ($40)	☐
Please tick one box	☐	☐	

SECTION C

Rural communities living near KNP can offer a range of services to tourists as a part of village tour packages. If these goods and services were available, would you be interested in them? Please rate, for each of the following goods and services, your willingness to purchase it on a scale of 1 to 5 as follows;

1- Definitely would not purchase 2- Probably would not purchase 3- Not sure 4- Probably would purchase 5-Definitely would purchase

	TICK THE APPROPRIATE BOX	**Definitely would not purchase (1)**	**Probably would not purchase (2)**	**May or may not purchase(3)**	**Probably would purchase (4)**	**Definitely would purchase (5)**
12.	I would consider using accommodation facilities with the **same standards and prices** as those in KNP **but located in surrounding villages**					
13.	I would stay in Accommodation facilities in surrounding villages with the same standards and **lower prices** than in KNP					
14.	I would take a 3-4 hour village tour as part of my visit to KNP at an additional R150 if it was available					
15.	I would purchase some crafts of interest from a craft market **in the KNP**					
16.	I would purchase some crafts of interest from a craft **market in the surrounding villages**					
17.	I would have a meal in the villages sold at the **same price** of a meal in the KNP					
18.	I would have a traditional meal in the village sold at a **higher price** than a meal in the park					
19.	I would purchase my food supplies outside KNP to support rural businesses if prices were the same as in KNP					

It has been argued that conservation efforts need to be more inclusive of rural communities that live close to national parks and often have high poverty and unemployment levels and sometimes have problems with wild animals that destroy their crops and livestock. Please indicate, for each of the following statements that relate to this debate whether you agree or disagree;

1- Strongly agree **2- Agree** **3. Do not agree or disagree**
4. Disagree **5. Strongly disagree**

Please indicate your strength of agreement or disagreement for each of the following statements from 1- 5	**Strongly agree (1)**	**Agree (2)**	**Do not agree or disagree (3)**	**Disagree (4)**	**Strongly disagree** (5)
20. When I come to the KNP I am only interested in wildlife					
21. When I come to the KNP I am also interested in surrounding rural villages					
22. Tourism should contribute to development of surrounding communities of KNP					
23. Rural development is more important than conservation					
24. Conservation efforts in the nature parks will **not** be sustainable if there is no rural development in surrounding communities					
25. The KNP should only focus on nature conservation and leave other stakeholders to focus on rural development					
26. For me, rural communities are part of 'the holiday experience'					
27. The KNP should support rural development in surrounding villages					
28.I would pay more to engage in village tourism activities such as tours and crafting than the current KNP entrance fees					

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!!! If you would like to receive results of this research or you have further questions please do not hesitate to contact the following;

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Summary

Rural areas adjacent to national parks in Southern Africa are considered to be areas with high potential to contribute towards biodiversity conservation, although they are faced with problems of high poverty, unemployment, and limited economic activity. Rural development is important to improve the livelihoods of people living in these areas. Land is central to livelihoods of most people living in these rural areas, and is considered the key to both biodiversity conservation and rural development goals of government. These goals, however, can sometimes conflict, particularly as both wildlife conservation and agriculture require land. In addition, wildlife imposes costs on agriculture through damage to crops and livestock and disease transmission. It can also threaten the security of human beings. Transfrontier conservation areas (TFCAs), which have recently been introduced in Southern Africa are viewed as having potential to address the goals of both biodiversity conservation and agriculture production simultaneously, through the involvement of rural communities in wildlife tourism land use activities.

It is however, not clear whether the involvement of rural communities in wildlife tourism will yield greater livelihoods benefits than current agricultural based land use practices, or how wildlife and agriculture can be combined as land use activities. A systematic approach for evaluating alternative land uses and development pathways, which is able to take into consideration a variety of socio-economic and environmental factors, and different stakeholder interests in these areas, is required. The main objective of this study is to develop a framework for evaluating land use options and trade-offs for alternative pathways towards improved livelihoods at the interface of conservation and rural development.

In this study, I present a spatial land use model for evaluating land use options at the interface wildlife/livestock/human interface (hereafter called the interface). The following issues are addressed; (i) socioeconomic risks associated with agriculture at the interface, and community attitudes towards wildlife tourism land uses (ii) contribution of existing livelihood strategies to household incomes, (iii) the potential for tourism development at the interface and (iv) trade-offs in net revenues between

different options for land use. The involvement of stakeholders in determining the main factors to be considered in evaluating different land use options and scenarios for future development at the interface is central to the study. This study considers the case of Mhinga, one of the rural areas within the Great Limpopo TFCA in South Africa. The area is on the north-western border of Kruger National Park (KNP), next to the Punda Maria park gate.

In Chapter 2, I develop a theoretical model that allows analysis of the effects of several land use scenarios on net revenues from land use. The model includes economic, biophysical and spatial considerations, including (i) the spatial effects of wildlife damage on agriculture; (ii) connectivity constraints to ensure that wildlife plots are not scattered over the study area; (iii) fences to minimize interaction between wildlife and other land uses; and (iv) endogenous nuisance effects of wildlife on other land uses. The mixed integer optimisation model developed, has the objective function to maximise net revenues, assuming the presence of a social planner. The model includes socioeconomic and ecological factors such as output prices, land carrying capacity, production relationships, capital and variable costs, water availability, fencing, connectivity, predation and disease costs, allowing for clarification of opportunities and tradeoffs in wildlife and livestock production. The model is illustrated using a hypothetical layout of plots of land in a 6x6 square grid. The results of the scenarios analysed show spatial patterns of land use that provide the best results in terms of income generation in the region under different constraints and illustrate potential tradeoffs in incomes between wildlife and livestock. This model can be applied in similar contexts and used to inform land use planning decisions at local and regional levels and stimulate rural development and conservation policy discussion.

In Chapter 3, a partial budgeting framework is used to analyse the risks costs and benefits for cattle farming at the interface. The attitudes of farmers towards wildlife are also investigated. This study differs from most existing studies by also considering the benefits of being close to the park for households. The data used is derived from a household survey, inspection of dip and livestock depredation records, and focus group discussions. Results show that livestock farmers consider livestock depredation and disease as key issues of concern for them, particularly when the possibility of

increased interaction between wildlife and livestock is discussed. The differences in the extent of wildlife damage between the villages, with households in villages close to the park reporting higher incidence of livestock depredation (32%) than those further from the park (13%), illustrate the potential problems that can arise when the impacts of wildlife on households are assumed to be homogenous. Livestock diseases resulted in more losses to the household than depredation, although farmers were more concerned about livestock depredation. The mean annual costs of wildlife/livestock interactions, taking into account benefits associated with proximity to the park, average US$S34 per household. Although there are benefits of being close to the park such as wage employment and veterinary subsidies, these benefits however, do not accrue to all households. Farmers displayed a negative attitude towards wildlife, and viewed it as an obstacle to cattle farming, and did not support the introduction of wildlife land use. The negative attitudes are mainly a result of the lack of compensation for wildlife damage in the area. Previous efforts by households to seek compensation from the government or KNP had been unsuccessful.

The contribution of cattle to livelihoods, and the relationship between different livelihood activities at the interface is investigated in Chapter 4. The approach used combines qualitative techniques (livelihoods analysis) and quantitative economic estimation techniques, to take into consideration those livestock roles and functions that cannot always be quantified. Most of the households in the study area engaged in multiple livelihood activities such as formal employment, cropping, small businesses and cattle farming. There were differences in the livelihood activities and structure of household income for the cattle households (CH) and non-cattle households (NCH). Cattle had important financial, social, cultural, human and physical livelihood roles for both CH and NCH. For CH, the income from cattle constituted about 29% of the total household income, although in both CH and NCH the income from the government social grants accounted for more than 50% of household incomes. Cattle farmers were not in support of introducing wildlife based land use activities as they considered them to impose costs on other livelihood activities, unlike cattle which in their opinions was complementary to other household activities. Some community members were however of the opinion that introducing wildlife tourism could create employment and improve household incomes, especially for those households not engaged in cattle farming.

Chapter 5, analyses the potential for development of ecotourism in rural communities adjacent to KNP, by determining the preferences of tourists, towards different forms of ecotourism. A choice experiment approach with three attributes of ecotourism i.e. village accommodation, craft markets, village tours and an additional price attribute is used. Data were collected from 319 tourists, using seven choice sets, each with three options and analysed using a conditional probit model. Preferences were determined according to tourist origin and income levels, and marginal willingness to pay for three ecotourism attributes were estimated. In general, tourists were interested in the idea of engaging in ecotourism activities outside the KNP, as reflected by the fact that 69% of domestic and 78% of international tourists expressed a preference for one or all of the services presented. The village tours and crafts markets attracted the most interest, for both international and domestic tourists, and across all four income groups of tourists considered. There was, however, general reluctance by all tourists groups considered, except the low income group, to use accommodation facilities outside the park. Marginal willingness to pay estimates were found to be generally higher than the bid values proposed for the village tours and crafts markets. I concluded that there was potential for development of certain forms of ecotourism in rural communities adjacent to the KNP, providing that the pricing and nature of the services offered were carefully considered.

The model developed in chapter two is applied to explore options for land based development at the interface in Chapter 6. Parameter values are derived from primary and secondary data sources. Four land uses are considered; irrigation, tourism lodges, wildlife and livestock together with the location of existing village settlements is also considered. The impacts of several scenarios developed in consultation with stakeholders, on land use revenues and spatial allocation of land are explored. Results show that the status quo where most of the land is used for livestock, is not optimal. By introducing irrigation, tourism and wildlife land uses, whilst taking into consideration a range of stakeholder interests, net revenues from land could be doubled. It is concluded that given the socio-economic and bio-physical constraints characteristic to the area, the most income can be obtained by having all four land uses in the area. Spatial land use modelling which considers the nuisance effects of

wildlife on other land uses, existing human settlements and a range of other factors is necessary to ensure that the benefits from the land are maximal.

In Chapter 7, I integrate the findings of the thesis and discuss them under three main headings pertaining to establishment of the TFCA; (i) the extent to which capital assets of households are enhanced; (ii) whether communities display positive attitudes towards wildlife; and (iii) the ability for land holders to invest and benefit from tourism and sustainable harvesting of natural resources. Based on the findings in chapter 3 and 4, I conclude that the increased interaction between wildlife and livestock in the TFCA could negatively affect livelihood capital assets through reduction in household financial assets, a negative impact on the social, cultural, and physical livelihood roles of cattle and other livelihood strategies related to cattle in the area. More importantly the independence of households regarding cash flow and investment decisions from livestock could also be lost, and some households, particularly the old and less educated could become more vulnerable to poverty. The reasons for negative attitudes towards wildlife by farmers in the area, which concur with findings of other previous studies, are discussed in this chapter. In addition, I also discuss the related implications for introduction of wildlife tourism in the area, given the negative attitude of farmers. I conclude that positive attitudes towards wildlife conservation and cooperation are necessary for rural communities to commit land towards wildlife land uses. Based on findings of Chapter 5 and 6, it appears that there are several factors that will influence the ability of rural communities to benefit from tourism land uses. Some of these factors discussed in Chapter 7, include the issue of property rights to land, availability of water, potential of tourism and other land uses to create employment, availability of capital investment, infrastructural development and decisions regarding distribution of benefits to the households. I also highlight the need for alternative ways to generate income and employment for people in the area, apart from wildlife tourism and agriculture.

The policy implications of the study are also discussed in Chapter 7. Of great importance is the need for property rights over land to be given to rural communities. Without such rights, and given the current problems of co-existing with wildlife, the incentives for rural communities to engage in wildlife tourism are minimal. The issue of compensation for wildlife damage should also be addressed, and rural communities

be engaged in seeking a sustainable solution to the problems of damage causing wildlife. In addition, the importance of existing land use alternatives should not be underestimated, but rather policies that promote development of both existing and new land uses should be considered. Wildlife should not only be viewed as an object of conservation, but a legitimate component of rural livelihoods, which contributes towards sustainable poverty alleviation.

It is not possible at this stage, to conclude whether the expectation that TFCAs will provide a forum through which conservation and rural development can both be efficiently addressed, is realistic or not. This study and other studies elsewhere, however, show that there is no panacea regarding reconciliation of conservation and development. There will be wide variation in the nature of the challenges faced by different countries, and within different communities, and this needs to be considered in any interventions planned. It is the implementation, and the manner in which local communities can benefit from wildlife tourism, whilst maintaining their current livelihood activities, that will determine whether this is indeed the long awaited solution to reconciling the goals of rural development and biodiversity goals in the new millennium.

Samenvatting

In het Zuiden van Afrika worden plattelandsgebieden naast nationale parken beschouwd als gebieden die een hoge potentie hebben om bij te dragen aan bescherming van biodiversiteit, hoewel deze te maken hebben met problemen zoals zware armoede, werkeloosheid, en beperkte economische activiteit. Plattelandsontwikkeling is belangrijk om de levensomstandigheden van mensen in deze gebieden te verbeteren. Land is de centrale factor in het levensonderhoud van deze mensen en wordt beschouwd als de sleutel voor zowel bescherming van biodiversiteit- als plattelandsontwikkelingsdoelen van de overheid. Deze doelen zijn echter soms conflicterend, vooral omdat voor zowel de bescherming van wild als voor de landbouw land nodig is. Bovendien veroorzaakt wild kosten in de landbouw door schade aan gewassen en vee, en besmettingen met ziektes. Dit kan ook de veiligheid van mensen in gevaar brengen. Recentelijk zijn grensoverschrijdende natuurgebieden (GNB) geïntroduceerd in Zuidelijk Afrika. Van deze natuurgebieden wordt gedacht dat ze de potentie hebben om tegelijkertijd agrarische productiedoelen en biodiversiteits beschermingsdoelen te realiseren, door het betrekken van lokale gemeenschappen bij het landgebruik door wild-toerisme.

Het is echter niet duidelijk of het betrekken van lokale gemeenschappen bij wild-toerisme meer zal opleveren voor het levensonderhoud dan het huidige agrarische grondgebruik, of hoe wild en landbouw gecombineerd kunnen worden in het landgebruik. Daar is een systematische benadering voor nodig die verschillende vormen van landgebruik en ontwikkelingsmanieren vergelijkt en die rekening houdt met een scala aan sociaal-economische en milieufactoren, alsmede de wensen van stakeholders in deze gebieden. Het hoofddoel van deze studie is het ontwikkelen van een kader voor het evalueren van de landgebruiksopties en trade-offs tussen verschillende ontwikkelingsmanieren om de levensstandaard op het snijvlak van bescherming en plattelandsontwikkeling te verbeteren.

In deze studie presenteer ik een landgebruiksmodel om verschillende landgebruiksopties op het snijvlak van wild, vee en mensen te vergelijken (hierna: het snijvlak). De volgende problemen worden onder de loep genomen: (i) sociaal-

economische risico's op het snijvlak, en de houding van de gemeenschap met betrekking tot landgebruik voor wild-toerisme; (ii) de bijdrage van bestaande levensonderhoud strategieën aan het inkomen van huishoudens; (iii) de potentie van het ontwikkelen van land voor toerisme op het snijvlak; (iv) trade-offs in netto opbrengsten tussen verschillende landgebruiksopties. Het betrekken van stakeholders staat centraal in deze studie bij het bepalen van de belangrijkste factoren die meegenomen moeten worden bij het evalueren van verschillende landgebruiksopties en scenario's op het snijvlak. Deze studie onderzoekt Mingha, een van de plattelandsgebieden binnen het Greater Limpopo GNB in Zuid-Afrika. Het gebied ligt aan de noordwest grens van Kruger National Park (KNP), naast de Punda Maria ingang.

In hoofdstuk 2 ontwikkel ik een theoretisch model waarmee de effecten van verschillende landgebruiksscenario's op de netto opbrengsten van landgebruik geëvalueerd kunnen worden. In het model worden economische, biofysische en ruimtelijke overwegingen meegenomen, zoals (i) het ruimtelijke effect van wildschade op landbouw; (ii) minimum aantallen verbindingen zodat wildgebieden niet verspreid liggen over het gehele studiegebied; (iii) hekken om de interactie tussen wild en andere landgebruiksvormen te minimaliseren; (iv) endogene overlast effecten van wild op andere vormen van landgebruik. Het ontwikkelde gemengde gehele getallen optimalisatie model, heeft een doelfunctie die de netto opbrengsten maximaliseert, zoals een sociale planner dat zou doen. In het model worden sociaal-economische en ecologische factoren meegenomen, zoals prijzen van eindproducten, de draagkracht van land, productieverhoudingen, kosten van kapitaal en variabele kosten, beschikbaarheid van water, hekken, verbindingen en kosten van predatie en ziektes. Hierdoor worden de mogelijkheden en trade-offs in wild- en veeproductie duidelijk. Het model wordt geïllustreerd met een hypothetische verdeling van gebieden over een vierkant grid van 6 bij 6. De resultaten van de geanalyseerde scenario's laten ruimtelijke landgebruikspatronen zien die de beste resultaten geven in termen van inkomen in de regio onder verschillende beperkingen en laten de mogelijke trade-offs zien tussen vee en wild. Dit model kan gebruikt worden in soortgelijke situaties, om informatie te genereren voor landgebruiksplanning op lokaal en regionaal niveau en als basis voor beleidsdiscussies over plattelandsontwikkeling en natuurbescherming.

In hoofdstuk 3 wordt een partieel budget raamwerk gebruikt om de risico's, kosten en baten te analyseren van veehouderij op het snijvlak. De houding van boeren ten opzichte van wild wordt ook onderzocht. Deze studie verschilt van de meeste bestaande studies omdat ook de baten van huishoudens, die aan het park grenzen, worden meegenomen. De gebruikte gegevens komen uit een enquête onder huishoudens, officiële gegevens van de overheid, en gesprekken met focusgroepen. De resultaten laten zien dat de belangrijkste zorgen van veehouders vernielingen door wild en ziektes zijn, vooral wanneer er gesproken wordt over meer interactie tussen wild en vee. De verschillen in de hoeveelheid wildschade tussen dorpen –huishoudens in dorpen dichtbij het park rapporteren meer vernielingen door wild (32%) dan in dorpen die verder weg liggen (13%) – laten zien tegen welke problemen men mogelijk aanloopt als aangenomen wordt dat de invloed van wild op huishoudens homogeen is. Veeziektes veroorzaken grotere verliezen voor huishoudens dan vernielingen door wild, maar boeren zijn bezorgder over vernielingen. De gemiddelde jaarlijkse kosten van wild/vee interacties, rekening houdend met de baten gegenereerd door het nabijgelegen park, zijn ongeveer US$34 per huishouden. Hoewel de nabijheid van het park baten genereert zoals betaald werk en veearts subsidies, profiteren niet alle huishoudens hiervan. Boeren hadden een negatieve houding ten opzichte van wild, zien het vooral als een obstakel voor de veehouderij en steunen de invoering van landgebruik voor wildbescherming niet. De negatieve houding is voornamelijk een resultaat van het uitblijven van compensatie voor wildschade in het gebied. Eerdere pogingen van huishoudens om compensatie te krijgen van de overheid of het KNP hadden geen succes.

De bijdrage van vee aan levensonderhoud, en de relatie tussen verschillende activiteiten op het snijvlak worden onderzocht in hoofdstuk 4. De gebruikte benadering combineert kwalitatieve technieken (levensonderhoud analyse) en kwantitatieve economische schattingstechnieken om de rollen en functies van vee mee te kunnen nemen, die niet altijd bepaald kunnen worden. De meeste huishoudens in het studiegebied maakten gebruik van meerdere activiteiten voor hun levensonderhoud zoals werk, akkerbouw, kleine ondernemingen en veehouderij. Er waren verschillen in deze activiteiten voor levensonderhoud tussen huishoudens met vee (HMV) en huishoudens zonder vee (HZV). Vee speelde een belangrijke financiële, sociale, culturele, menselijke en fysische rol voor het levensonderhoud van

zowel HMV als HZV. Voor HMV vormde het vee ongeveer 29% van het totale huishoudinkomen, hoewel voor zowel HMV als HZV de sociale steun van de overheid meer dan 50% bijdroeg aan het huishoudinkomen. Veehouders steunden de invoering van land voor wildbescherming niet omdat ze van mening waren dat dit extra kosten veroorzaakt bij andere activiteiten voor levensonderhoud, dit in tegenstelling tot vee dat, naar hun mening, aanvullend is bij de activiteiten van huishoudens. Sommige leden van de gemeenschap waren echter van mening dat wild-toerisme kan zorgen voor werk en het inkomen van huishoudens kan verbeteren, met name de huishoudens die geen vee houden.

Hoofdstuk 5 analyseert de mogelijkheden om ecotoerisme te ontwikkelen in plattelandsgemeenschappen grenzend aan het KNP, door de voorkeuren van toeristen voor verschillende soorten ecotoerisme te bepalen. Ik gebruik daarvoor een keuze-experiment met drie vormen van ecotoerisme, namelijk verblijfsaccomodatie in een dorp, ambachtsmarkten, en rondleidingen door dorpen, en een prijs. Er zijn gegevens verzameld van 319 toeristen, waarbij zeven keuzesets gebruikt werden, ieder met drie opties. Deze gegevens zijn geanalyseerd met een voorwaardelijk probit model. De voorkeuren werden bepaald naar herkomst en inkomensniveau en de marginale bereidheid tot betalen werd geschat voor de drie soorten ecotoerisme. Over het algemeen waren toeristen geïnteresseerd in het idee om deel te nemen aan ecotoerisme activiteiten buiten het KNP, zoals blijkt uit het feit dat 68% van de nationale en 78% van de internationale toeristen een voorkeur heeft voor één of alle aangeboden soorten diensten. De meeste interesse was er voor rondleidingen door dorpen en ambachtsmarkten, voor zowel nationale als internationale toeristen, en binnen alle vier inkomensgroepen. Alle toeristengroepen, met uitzondering van de groep met een laag inkomen, stonden echter afwijzend tegenover het gebruik van verblijfsaccommodaties in een dorp. De marginale bereidheid tot betalen was meestal hoger dan de voorgestelde prijs voor rondleidingen door dorpen en ambachtsmarkten. Ik concludeer dat er mogelijkheden zijn voor het ontwikkelen van bepaalde vormen van ecotoerisme in plattelandsgemeenschappen grenzend aan het KNP, als de prijzen en aangeboden diensten zorgvuldig overwogen worden.

Het in hoofdstuk 2 ontwikkelde model wordt gebruikt om opties te verkennen voor ontwikkeling op basis van land op het snijvlak in hoofdstuk 6. De waarden van

parameters zijn verkregen uit primaire en secundaire bronnen. Vier landgebruiksvormen zijn meegenomen: irrigatie, toeristenaccommodatie, wildbescherming en vee. De locatie van bestaande dorpen werd ook meegenomen. De gevolgen van verscheidene scenario's, die ontwikkeld zijn met stakeholders, op de opbrengsten van landgebruik en de ruimtelijke toewijzing van land werden verkend. De resultaten laten zien dat de status quo, waarbij het meeste land gebruikt wordt voor vee, niet optimaal is. Door het invoeren van irrigatie, toerisme en wildbescherming, rekening houdend met een scala aan stakeholderbelangen, kunnen de netto opbrengsten van land verdubbeld worden. De conclusie is dat, gegeven de sociaal-economische en biofysische karakteristieke beperkingen van het gebied, het meeste inkomen gegenereerd kan worden door alle vier de landgebruiksvormen in het gebied toe te passen. Ruimtelijke modelering van landgebruik dat rekening houdt met de overlast van wild op andere landgebruiksvormen, bestaande menselijke nederzettingen en een scala aan andere factoren, is noodzakelijk om te kunnen garanderen dat de opbrengsten van land maximaal zijn.

In hoofdstuk 7 integreer ik de bevindingen en bediscussieer ze met betrekking tot de belangrijkste punten die spelen bij het aanwijzen van het GNB: (i) in hoeverre de kapitaalgoederen van huishoudens worden verbeterd, (ii) of gemeenschappen positief staan ten opzichte van wild en (iii) de mogelijkheden voor landeigenaren om te investeren en te profiteren van toerisme en het duurzaam oogsten van natuurlijke hulpbronnen. Gebaseerd op de resultaten van hoofdstuk 3 en 4 concludeer ik dat de verhoogde interactie tussen wild en vee in het GNB de kapitaalgoederen voor levensonderhoud in het gebied negatief kan beïnvloeden door een afname in de financiële bezittingen van huishoudens, een negatieve invloed op de sociale, culturele en fysische rol van vee voor levensonderhoud en andere levensonderhoud strategieën die gebaseerd zijn op vee. Belangrijker nog is dat de onafhankelijkheid van huishoudens met betrekking tot liquiditeit- en investeringsbeslissingen verloren zou kunnen gaan en sommige huishoudens, met name de oudere en minder opgeleide, kwetsbaarder zouden kunnen worden voor armoede. De redenen voor de negatieve houding ten opzichte van wild in het gebied, die in overeenstemming zijn met eerdere studies, worden bediscussieerd. Ook bespreek ik de gerelateerde gevolgen voor landgebruik voor wild-toerisme in het gebied. Ik concludeer dat een positieve houding ten opzichte van wildbescherming en samenwerking noodzakelijk zijn voor

plattelandsgemeenschappen om zich te verbinden aan landgebruik ten behoeve van wildbescherming. Gebaseerd op de bevindingen van hoofdstuk 5 en 6 blijkt het dat er verschillende factoren zijn die van invloed zijn op de mogelijkheden van plattelandsgemeenschapen om te profiteren van landgebruik voor toerisme. Sommige van deze factoren, die besproken worden in hoofdstuk 7, zijn: de kwestie van eigendomsrechten, de beschikbaarheid van water, de mogelijkheden van toerisme en andere landgebruiksvormen die werk genereren, de beschikbaarheid van kapitaal om te investeren, ontwikkeling van infrastructuur en beslissing van huishoudens met betrekking tot de verdeling van de baten. Ik breng ook de noodzaak voor alternatieve mogelijkheden voor het genereren van inkomen en werk voor de mensen in het gebied onder de aandacht.

De beleidsimplicaties voor de studie worden ook besproken in hoofdstuk 7. Het is van het grootste belang dat de eigendomsrechten van land aan de plattelandsgemeenschappen gegeven worden. Zonder die rechten, en gegeven de huidige problemen van het naast elkaar leven met wild, zijn de prikkels voor plattelandsgemeenschappen om deel te nemen aan wild-toerisme minimaal. De kwestie van compensatie moet ook opgelost worden, waarbij plattelandsgemeenschappen betrokken zouden moeten worden bij het zoeken naar duurzame oplossingen voor de problemen van wildschade. Verder moet het belang van bestaande alternatieve landgebruiksvormen niet onderschat worden. In plaats daarvan zou beleid gemaakt moeten worden dat zowel bestaand landgebruik als nieuwe vormen verder ontwikkelt. Wild zou niet alleen gezien moeten worden als iets dat beschermd moet worden, maar als een legitieme component voor het levensonderhoud op het platteland, dat bijdraagt aan de duurzame opheffing van armoede.

Het is op dit punt onmogelijk om te concluderen of de verwachting dat GNBs een forum zullen vormen waardoor bescherming en plattelandsontwikkeling samen efficiënt opgelost kunnen worden, realistisch is of niet. Deze en andere studies laten echter wel zien dat er geen wondermiddel is om bescherming en ontwikkeling in overeenstemming te brengen. Het is de invoering en de manier waarop lokale gemeenschappen kunnen profiteren van wild-toerisme, terwijl ze tegelijkertijd hun huidige levensonderhoud activiteiten behouden, die zullen bepalen of dit inderdaad de

lang verwachte oplossing is voor het in overeenstemming brengen van plattelandsontwikkeling- en biodiversiteitsdoelen in het nieuwe millennium.

About the Author

Petronella Chaminuka (née Jeche) was born on March 20, 1974 in Harare, Zimbabwe. She attended high school at St Dominic's Secondary School and St Ignatius College. She earned a BSc. in Agricultural Economics from the University of Zimbabwe in 1995. She worked as a research assistant at the Institute of Development Studies (IDS) at the University of Zimbabwe from 1996-1997. In 1999 she graduated with an MSc. in Agricultural Economics, also from the University of Zimbabwe. From 2000 to 2003, she worked as a Junior Researcher in the Land Reform Programme of the then Southern Africa Regional Institute for Policy Studies (SARIPS) in Zimbabwe. In January 2003, she joined the University of Limpopo in South Africa, as a Lecturer in the Agricultural Economics Department. In 2006, she was awarded a sandwich PhD scholarship through the Competing Claims Project of Wageningen University. In 2009 she was awarded research grants by the International Foundation for Science (IFS), and the Wildlife Conservation Society (WCS) through the Animal and Human Health for the Environment and Development Great Limpopo Transfrontier Conservation Area (AHEAD-GLTFCA) seed grants programme. Results of her PhD research have been presented at three international conferences, and published as a book chapter, and journal articles. She is an active member of the AHEAD-GLTFCA Working Group. During her PhD studies she remained employed by the University of Limpopo as a lecturer.

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Completed Training and Supervision Plan

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Name of the activity	Department/Institute	Year	ECTS*
A) Project related competences			
Theories and Models in Environmental Economics	Wageningen University	2007	6
Advanced Econometrics	Wageningen University	2009	6
New Institutional Economics	WASS	2007	4
Bio-Economic Modelling	WASS		1.5
Advanced Bio-Economic Modelling	WASS		1.5
Analysing Farming Systems and Rural Livelihoods in a Changing World: Vulnerability and Adaptation	Wageningen Graduate Schools	2008	2.8
Land Science- Bringing Concepts and Theory Into Practice	Wageningen Graduate Schools	2007	4
Introduction to GIS and Remote Sensing	ITC, University of Twente	2007	1.4
Competing Claims for Natural Resources, South Africa	Wageningen Graduate Schools	2006	3
B) General research related competences			
MG3S Introduction Course	MG3S	2007	1.5
Techniques for Writing and Presenting a Scientific Paper	Wageningen Graduate Schools	2009	1.2
Introduction to Endnote	Wageningen Graduate Schools	2007	0.6
PhD Competence Assessment Test	Wageningen Graduate Schools	2007	0.3
Literature Review & Proposal Development	Wageningen	2007	3
C) Presentations			
10th World Conference on Animal Production, Cape town, South Africa		2008	1
12th BioEcon Conference, Venice, Italy		2010	1
Competing Claims Workshop, Mozambique		2008	1
Competing Claims Workshop, Zimbabwe		2010	
AHEAD-GLTFCA, Mozambique		2009	
AHEAD-GLTFCA, South Africa		2010	
World Veterinary Conference, Cape Town , South Africa		2011	
Total (minimum 30 ECTS)			**39.8**

*One ECTS on average is equivalent to 28 hours of course work