Surveys

Management of non-timber forestry products extraction: Local institutions, ecological knowledge and market structure in South-Eastern Zimbabwe

M.J. Mutenje *, G.F. Ortmann, S.R.D. Ferrer

School of Agricultural Sciences and Agribusiness, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg 3209, South Africa

A R T I C L E   I N F O

A B S T R A C T

Common-pool resources (CPRs), such as forests, water resources and rangelands, provide a wide variety of economic benefits to forest-fringe dwellers in semi-arid areas of southern Africa. However, the public nature and competition involved in the use of these goods, and weak enforcement of institutional arrangements governing their use may lead to resource degradation. Using survey data from four communities in south-eastern Zimbabwe for 2008 and 2009, this paper examines the extent to which forest degradation is driven by existing common property management regimes resource and user characteristics, ecological knowledge and marketing structure. A Principal Component Analysis indicates that the existence of agreed-upon rules governing usage (including costs of usage), enforcement of these rules, sanctions for rule violations that are proportional to the severity of rule violation, social homogeneity, and strong beliefs in ancestral spirits were the most important attributes determining effectiveness of local institutions in the management of CPRs. Empirical results from a regression analysis showed that resource scarcity, market integration, and infrastructural development lead to greater resource degradation, while livestock income, high ecological knowledge, older households, and effective local institutional management of the commons reduce resource degradation. The results suggest that there is need for adaptive local management systems that enhance ecological knowledge of users and regulates market structure to favour long-term livelihood securities of these forest-fringe communities.

1. Introduction

Natural resources are the most accessible source of products and incomes for many economically marginalised people, and are consequently under considerable pressure to provide both production and environmental benefits (Darlong and Barik, 2005). In principle, people can contribute to their economic well-being by harvesting non-timber forest products (NTFPs) (Shaanker et al., 2004). Typically, forest resources accessible to poor people in less developed regions are common-pool resources (CPRs). Because CPRs are often considered to have an inelastic supply, and because their sustainable utilization may be threatened by externalities associated with individual actions in the appropriation of such resources, their sustainable management is an important issue facing both development planners and policy makers (FAO, 2003). Following Hall and Bawa (1993), sustainable utilization of NTFPs can be defined as the level of harvest that does not impair the ability of the harvested population to replace itself. Ticktin (2004) cautions that ignoring the potential variation in harvest strategies and their drivers can lead to incorrect conclusions about resource use sustainability.

Research on CPRs management has shown that local community level resources management is the most viable option of CPR management (Agrawal and Gibson, 1999). The emphasis on the community-based approach arises from the assumptions that local communities not only understand their problems but also have greater incentive to find workable solutions to problems because their livelihoods depend on the natural resource (Belcher and Schreckenberg, 2007). Further, as economic opportunities from utilizing the resource grow, so the community will have greater incentive to conserve the resource base and manage it sustainably over time (FAO, 2003). The IUCN's (2005) contention that indigenous knowledge and the equitable participation of local people are crucial in the management and conservation of medicinal plants in southern Africa is consistent with these arguments.

Although local control over natural resources is commonly regarded as a win–win solution for environmental preservation and local development, the empirical evidence is rather mixed (Malla, 2000; Agrawal, 2001). Community-based approaches in Asia have shown that local institutional arrangements, including customs and social conventions designed to induce cooperative solutions, can overcome collective action problems and help achieve efficiency in the use of such resources (Agrawal, 2007). Other studies, however, have shown that factors such as increasing market integration, high population pressure, lack of economic incentives and the breakdown

* Corresponding author.
E-mail addresses: mmutenje@yahoo.co.uk (M.J. Mutenje), ortmann@ukzn.ac.za (G.F. Ortmann), stuart.ferrer@canegrowers.co.za (S.R.D. Ferrer).

of traditional knowledge and beliefs increase the likelihood of degradation of CPRs under local control (Godoy, 2001; Belcher and Schreckenberg, 2007).

Poverty, low incomes, and immediate survival needs often drive local people to overharvest, at the expense of sustainability. As resources become degraded so people's livelihoods become increasingly vulnerable (FAO, 1996). In rural areas of Zimbabwe, for example, many people lack employment opportunities, due in part to their poor education and limited awareness (FAO, 1996). Moreover, in the face of the current uncertain economic environment in Zimbabwe, their poverty and marginalisation is expected to deepen and continue to the next generation, to the detriment of society as a whole (Saxena, 2003). The indifference of local people, combined with increased demand for NTFPs, has accelerated the degradation of many valuable NTFP resources.

The main objective of this study is to examine the extent to which forest degradation in south-eastern Zimbabwe is driven by existing local community management approaches, resource and user characteristics, ecological knowledge and marketing systems. The rest of the paper is organised as follows: Section 2 reviews literature on common-pool resource management NTFPs and their importance in rural livelihoods, market system, traditional knowledge and local institutional management effects on NTFP extraction. Section 3 describes the conceptual framework, study site and research methodology, while section 4 presents the results. The paper ends with conclusions and some policy implications of the study.

2. Common-Pool Resource Management

An important distinction must be made between the CPRs and the resource management regimes under which they are held. Resource management regimes are often based on the basis of property rights held over the resources. There are essentially four types of property rights; open access, common property, private property and state ownership (Heltberg, 2001). Property rights regimes perform the function of limiting use, coordinating users and responding to changing resource condition. Thus regimes have two main functions, flow and stock management. They define and enforce rules of resource access (flow management) and limit aggregate output from the resource to ensure continued future flow of benefits (stock management). CPRs are natural resources for which it is difficult to exclude potential users and which can be depleted through over–use (McKean, 2000). Most CPRs in southern Africa (including Zimbabwe) are largely held under common property. *Common property* resources belong to the community, and access rules are defined with respect to community membership. It is a system of shared private property with clear boundaries, rights and management and use rules, yet potential free-rider problems have to be surmounted for communities to organise collective action (McKean, 2000). Hence, conservation rules may or may not be established resulting in regulated or unregulated common property regimes (Heltberg, 2001). Unregulated common property is where access is limited by community membership, but conservation rules are not enforced. Unregulated common property is prone to cause resource degradation if (1) the user population is large relative to the resource, and (2) the income from exploiting the resource is high relative to the opportunity cost of time; for example, due to easy access, good extraction technology, high value of the resource, or if users lack outside employment options. Regulated common property is when both access and conservation rules are in place (Baland and Platteau, 1996).

State protected areas in Zimbabwe are frequently surrounded by local common property systems and functionally creating systems in which some resources are managed under more than one management regime. It is important to examine whether common property regimes continue to function well and contribute to conservation. There has been limited research on common property regimes embedded with state property. Common property regimes in Sengwe communal, Chiredzi District, Zimbabwe are suitable for evaluation of such institutional overlap.

2.1. NTFPs and Their Role in Rural Livelihoods

NTFPs include all biological materials, except timber, extracted from the forest for human use. The term also encompasses service functions rendered by forestlands (Shiva, 2001; Saxena, 2003). NTFPs are generally most extensively used to supplement diets and household income, notably during particular seasons in the year, and to help meet medicinal needs. NTFPs are also widely important as a subsistence and economic buffer in hard times such as death of a bread winner. The importance of forest foods and incomes thus often lies more in its timing than in its magnitude as a share of total household contribution (FAO, 1995; Townson, 1995).

Millions of people in southern Africa depend on the harvest of NTFPs for their livelihoods, and the importance of understanding the complex relationships between NTFP harvest and conservation is increasingly recognized (Ticktin, 2004; Belcher and Schreckenberg, 2007). This is due to increased concern about overexploitation and interest in the promotion of NTFP harvest as a conservation and development strategy (Cunningham, 2001; SCBD, 2001). The sustainability of NTFPs extraction for the long-term ecological integrity of forests depends on a variety of considerations, including its importance to the local economy, possibility of alternative sources of income to the people, ecological impacts of NTFP extractions, and legal status of the forests (protected areas versus other categories) (Adhikari et al., 2004; Agrawal, 2007).

The current use of NTFPs in southern Africa has several problems: collection is rarely controlled or managed, leading to environmental damage if too many resources are taken (Darlong and Barik, 2005). The way people make use of NTFPs depends on the opportunities and constraints they face (FAO, 1996). When conditions are favourable, such as good market access, forest products with high demand and high value will be harvested more intensively, causing further declines in resources. NTFPs could play a greater role in supporting livelihoods if their extraction and sale were managed more carefully. It is important to know to what extent the local people depend on and what factors determine the dependence on forest. Well-defined property rights and local institutions that regulate the use of, and access to, resources are critical components of local management systems, and represent a key to ensuring sustainability (Berkes et al., 2000).

Scholars of the commons believe that the future of viable local institutional arrangements will depend greatly on how the different types of people–forest relationships respond to economic, social, and political changes which either reinforce or erode people's incentives and capabilities to practice local forest management (Berkes et al., 2000; Belcher and Schreckenberg, 2007). Forests can be managed in ways that minimise the ecological impact of harvesting. However, when dependence is high, as is the case in most developing countries such as Zimbabwe, the ecological impact will primarily be determined by the status of knowledge among the people, institutions that govern use and harvest of NTFPs, and the marketing system (Shaanker et al., 2004).

2.2. The Impact of Market Forces on NTFP Extraction

Exposure to market pressures and opportunities is inescapably changing many subsistence-based use systems to market-oriented production systems, with clear losses of biodiversity (Lawrence, 1996; Bennett and Robinson, 2000). Moreover, as market prices seldom reflect the values of environmental and other 'external' costs and benefits, market demand may lead to short-term overexploitation and even to local extinction of some plants and animals that provide

highly desired products (Fa et al., 1995). This divergence between market and real economic and societal values casts doubt on the argument that the increased values attributable to tropical forests as a result of higher commercial demand for NTFPs necessarily encourage conservation of the resource.

Researchers have debated whether markets worsen the well-being of forest users by eroding their traditional collective action (Bennett and Robinson, 2000; Darlong and Barik, 2005). If collective action weakens with market expansion, then greater economic vulnerability among local people may be expected as they enter the market economy and increased forest resource degradation. Little is known about how integration into the market affects traditional uses of NTFPs (Bury, 2004). Additionally, high volatility of NTFP markets, seasonality of demand, poor infrastructure and irregular supplies hinder the successful marketing of NTFPs in remote semi-arid tropical areas (Bista and Webb, 2006). Exploitative extraction and trading relations are often the result. Studies in India have illustrated that increased demand tends to lead to more intense harvesting and overexploitation of NTFPs (Muraleedharan et al., 2005; Marshall et al., 2006).

2.3. Traditional Knowledge and Ecosystem Management

The indigenous knowledge and religious practices linked to the maintenance of biodiversity have already disappeared in some places as a result of government policies, market penetration, migration, external education, and integration (Cox, 1999; Sutherland, 2003). Government policies and regulations often assert state control over the forest resource, thereby further undermining the authority and effectiveness of community level institutions to control and manage forest use (Agrawal and Gibson, 1999). It is important to realise that local knowledge is not necessarily static, pristine, and culturally specific; it is dynamic and continuously evolving (Thomas et al., 2004). This change is influenced by cultural variation, rising populations, market opportunities, and policy shifts. If biodiversity is to be maintained in the forest ecosystems, there is need to recognize that these forests are present because of the actions of the local people who live in and around them (Berkes et al., 2000). Indigenous groups offer alternative management perspectives and knowledge based on their time-tested management practices (Thomas et al., 2004). Strengthening local-level social institutions is not by itself sufficient to institute effective co-management (Ticktins, 2004). The role of government should be to assist local people in their reconstruction of emerging knowledge systems and the adaptation of strategies for interacting with large- and global-scale political economic realities (Agrawal, 2007).

3. Methodology

3.1. Theoretical Framework of Analysis

Wade (1988), Ostrom (1990), and Baland and Platteau (1996) suggested favourable conditions for sustainable governance of the commons. Agrawal (2001) synthesised these factors, and identified four clusters that are crucial to the successful governance of CPRs: characteristic of the resource system, user group, the institutional arrangements, and the external environment. This paper draws on Agrawal's (2001) synthesis but also includes other factors that influence forest conditions. Additional factors were also drawn from Ostrom's (1999) design principles of long-lived management systems (Fig. 1). The design principles are enabling conditions that should be in place for successful CPR management institutions to occur (Agrawal, 2007).

Starting with resource characteristics, eight enabling (favourable) attributes for effective governance of forest commons include: size of the resource system, well-defined boundaries, resource mobility,
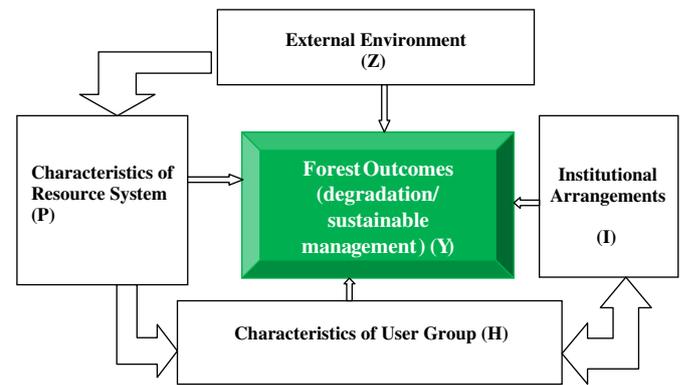

Fig. 1. Conceptual framework for analysing the impact of local management institutions on CPRs management. Source: Heltberg (2001).

possible storage benefits, predictability, feasibility of improving the resource, traceability of benefits to a management intervention, and ease of monitoring resource condition. Local institutions may help alter some of the features of the resource system but most of the attributes present problems because of the special features of NTFPs (Agrawal, 2007). For example, perishability, unpredictability, infeasibility of improvement, and lack of traceability pose challenges to many forest commons yielding multiple products (Heltberg, 2002).

Research on the user group characteristics essential for successful CPRs management has uncovered many interesting findings, although there are substantial variations across time and space (Agrawal, 2001). User group attributes include small size, clearly defined boundaries, shared norms, trust, past successful experiences, appropriate leadership, interdependence among group members, nature of heterogeneity among them, their dependence on the resource, and resources available to initiate and maintain collective action (Agrawal, 2007). Although substantial research has been done on these issues, the way these attributes influence collective action is ambiguous and thus the impact on forest degradation is debatable. There is some evidence that smaller groups are more likely to manage CPRs successfully (Ostrom, 1999; Agrawal, 2007). But there are inconsistencies about group heterogeneity; different dimensions of heterogeneity have different impacts on forest outcomes. CPRs are managed by people of different ethnicity, religion, sex and wealth leading to different social, economic and political heterogeneity dimensions (Baland and Platteau, 1996). There is limited empirical evidence that clearly states the roles of heterogeneity dimensions in initiating and maintaining collective action (Agrawal, 2007).

This paper will focus more on social heterogeneity as it is crucial for enforcement and monitoring of rules (Heltberg, 2002). Social heterogeneity limits rule compliance amongst the resource users and render social sanctions less effective (Varughese and Ostrom, 2001). According to Heltberg (2002), successful CPR management is more likely if user groups depend on the resource for a substantial share of their income and potential loss from degradation are larger. This proponent is of great importance in semi-arid tropics such as Sengwe communal in south-eastern Zimbabwe, where people rely on NTFPs to a large extent (Dzingirai, 2004) because of large spatial variability of rainfall and missing insurance and credit markets. In summary, small, interdependent, and more homogenous groups that are more dependent on the resource for their livelihood are more likely to create institutions that help regulate forest commons more effectively (Agrawal, 2001).

Institutions are important enabling factors for effective governance of the forest commons. Institutions can more specifically be defined as a set of accepted social norms and rules for making decisions about resource use: these define who controls the resource, how conflicts are resolved, and how the resource is managed and

exploited (Richards, 1997). They shape the resource users' actions and expectations. Institutions provide a number of economic functions such as coordinating the formation of expectations, encouraging cooperation and collective action, and reducing transaction costs (Heltberg, 2002). For effective governance of CPRs, rules should be easy to understand and enforce, locally devised, take into account differences in types of violation, help deal with conflicts, and hold users and their local leaders accountable (Agrawal, 2001).

The final set of favourable conditions concerns the external environment: demographic, cultural, technological, market related factors, the nature of state agencies, and the level of external influence such as NGOs and international aid flows. Market pressures, demographic and economic shifts are considered important causal factors of forest degradation by scholars of the commons (Agrawal, 2007). There are substantial variations across time and space of how these factors impact on forest outcomes and they are often beyond local institutional management's control.

3.2. Study Sites

This study draws from surveys conducted in 2008 to 2009 among four communities of south-eastern Zimbabwe, Chiredzi district. These sites are within the proposed Great LimpopoTransfrontier Park (GLTP). The 99800 km^2 Gaza–Kruger–Gonarezhou Transfrontier Conservation Area (GLTFCA) was formally established in November 2000, when an agreement was signed by the governments of Zimbabwe, South Africa and Mozambique. In 2001 a smaller area containing the 'core protected areas' of Kruger National Park in South Africa, Gonarezhou National Park in Zimbabwe, and Limpopo National Park in Mozambique was recognized as GLTP (Wolmer, 2003). It is in Sengwe communal lands where the link (corridor) is proposed between Gonarezhou National Park and Kruger National Park in South Africa since these parks do not share boundaries. Gonarezhou National Park is surrounded by a number of communal lands, the main ones being Sangwe, Matibi 2 and Sengwe. Practically, in southern Africa, TFCAs have been pushed forward at a rapid pace without much time for consultation with communities and other stakeholders (Katerere et al., 2001).

Local institutional management of CPRs in Zimbabwe is based on customary rights to resources. Zimbabwe has a history of colonial rule where land was appropriated by the state (Dzingirai, 2004).Thus, common property regimes are nested within state property. The general setup in communal areas of Zimbabwe is that government authorities often create the general context in which resources are to be managed and then the local common property regimes carry out the on-site management (Mafaniso et al., 2009). Sengwe communal is an exceptional case where the government protected area is engulfed by the local communal property system; both communal and state property regimes are involved in the management of certain resources, in particular wildlife. Although government institutions are supposed to complement local institutional management regimes, there seems to be a conflict between customary and statutory rights in this area (Dzingirai, 2004). The contrasting human, ecological and institutional setup in Sengwe communal makes it suitable for evaluating institutions relevant to common property management, and to determine factors that drive forest degradation if common property institutions are robust.

Sengwe communal lands consist of five wards, of which four are communally owned. Malipati communal area (ward 15) to the south of the Gonarezhou National Park consists mainly of the Shangani and Ndebele ethnic people and operates Malipati Safari. Malipati Safari Area is 15400 hectares in size and falls under the Department of National Parks and Wildlife Management Authority of Zimbabwe but has been leased to the community. The Park allows people from this community formal rights to collect NTFPs through user permits. They market NTFPs through a local cooperative. The market organisation for the NTFPs involves various channels including local cross-border traders, private buyers and business operators from as far as Bulawayo and Harare. Also of economic importance in this area is the Manjinji bird sanctuary and irrigation scheme. Manjinji bird sanctuary is managed by the Park though it is outside the Park area. However, because of historical contingencies local people continue to extract NTFPs in the sanctuary, particularly fish and birds. There is conflict over ownership of the bird sanctuary as the local people claim control because it is outside the Park. Malipati community is ethnically relatively heterogeneous and there are no strong kinship ties among residents. The commercial activities, such as the Safari and irrigation projects, have created a tight-knit community. The close ties of the community are manifested in numerous joint cultural ceremonies such as kutseva.[1] These projects have unified the community to the extent that all community characteristics required to manage CPRs are found.

Sengwe communal area (ward 14), which is at the border with South Africa and Mozambique, is mainly composed of the Shangana ethnic people and survives on NTFP extraction from a dense thicket, called Pfungwe, and stream bank cultivation (Dzingirai, 2004). Hunting, fruit and herb gathering, and fishing are part of their culture. The community is ethnically relatively homogenous and there are strong kinship ties among residents. The long history and close ties of the community are manifested in numerous joint activities (such as community fish ceremonies) and extensive social networks. The community has most qualities and characteristics required for collective action to manage CPRs. At the third site, Chikombedzi communal (ward 11) to the north-east of the National Park, NTFPs are scarce. Due to its proximity to the district satellite growth point, it is a multi-ethnic community. NTFPs marketed through a local cooperative at the shopping centre are sourced from river banks, nearby commercial farms and the National Park through user permits. The market for NTFPs is highly organised through market shows and attracts buyers from Chiredzi, Harare and Bulawayo, and is held once every month. This community is ethnically relatively heterogeneous and there are no strong kinship ties among residents. Thus, they do not have the qualities and characteristics required for collective action to manage CPRs. In Pahlela, the fourth site (ward 13), NTFPs collection is mostly from the periphery and buffer zones of the Park. Though the Shangani ethnic people dominate in this community, there is a significant proportion of Karangas. Pahlela is ethnically relatively homogenous though there are no strong kinship ties among residents. A unique feature of this community is that NTFPs extraction is mainly done by the elderly and children. There is virtually no marketing of NTFPs; extraction is mainly for subsistence and recreation purposes. Though ethnically homogenous, no qualities of collective action are manifested in this community, either through extensive social networks or joint activities.

3.3. Data Collection

The sample frame consists of 20 villages surrounding Mabalauta Section of Gonarezhou National Park. Survey villages and households were selected through a multistage sampling procedure. First, 10 villages were selected from the sample frame through stratified random sampling. Stratification was based on population, number of households, distance to the Park, and village area. The village survey was carried out by conducting interviews with groups of key informants in the selected villages, gathering information on natural resource use, management institutions, and other village-level variables. Additional data on population, land use, and forest offences were collected from administrative records for the same villages.

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[1] Fishing and bird catching ceremony.

Household surveys were carried out in the respective villages. Twenty households per village were randomly selected to represent different conditions of access to the Park. Data on demographics, their farm production and natural resource use were collected.

3.4. Principal Component Analysis

To obtain quantitative measures for local management effectiveness, Principal Component Analysis (PCA), which seeks linear combinations of variables called principal components, was used (Nieuwoudt, 1977). The purpose of PCA is to translate a large set of variables highlighted in the theoretical framework as indicators of effectiveness of local institutional management into main choice variables. PCA was performed on the four clusters identified by Agrawal and Ostrom's design principles with the main aim of extracting dominant variables that influence the effectiveness of local institutional management in these rural communities. Thus, PCA was performed with the primary goal of data reduction and summarisation.

3.5. Econometric Model

A multiple regression approach was used to identify the main factors that determine forest degradation (Gujarati, 2003). Though Tobit analysis was the most appropriate for this bounded dependent variable, none of the observed values is close to the bounds of 3 and 15, hence the use of OLS regression. Estimation was based on the following relationship

$$Y = f(P, I, H, Z, \varepsilon) \qquad (1)$$

where Y is the forest outcome measured by a forest degradation index that ranges from 3 (not degraded) to 15 (degraded). P is a vector of resource system characteristics, I is a vector of institutional arrangements, H is a vector of characteristics of the user group, Z is a vector of the external environment such as market regime and technology progress, as recommended by Agrawal (2001), and ε is the error term.

The forest degradation index, a composite measure, is constructed as the sum of ecological condition, forest condition relative to earlier times (10–20 years back), and forest use penetration (the depth into the forest from the village boundary where use pressure was evident) (Heltberg, 2001). Data on forest degradation were obtained from village and household surveys from three different variables: vegetation analysis with the help of the resident senior ecologist for the Park, by asking households and key informants to compare the condition of the forest today with earlier times (10–20 years back), and determination of forest use penetration. Vegetation was sampled along transects of 10 000 metres radiating from the settlement in five directions. The vegetation structure, several vegetation attributes such tree diameter at breast height, tree height, abundance, and number of cut and broken stems were recorded in each transect, along with attributes such as GPS location and distance from the settlement. At each site, the percentage of cut and broken stems of the total stems was computed for regions near to (0–4999 m) and distant from (5000–10 000 m) the human settlements. Sites with a greater percentage of cut and broken stems were assumed to bear higher forest damage than those with less damage, which was mainly attributable to the destructive means of harvest of NTFPs and to indirect pressures on the forest such as increased competition between people and wildlife.

As a measure of the effect of human disturbance, the frequency distribution of size and class of stems of NTFP species was computed. Across the four sites, the percentage of respondents that adopted ecologically friendly (non-destructive) methods for harvesting fruits and herb collection were determined (Shaanker et al., 2004). Based on vegetation analysis data, the ecological condition of the sites was described using a five-point interval scale (1 representing pristine and 5 high degradation). Forest condition relative to earlier times and forest use penetration were also coded on the same scale so that higher values show higher levels of forest degradation. The model adopted key explanatory variables whose importance has been highlighted in the theoretical framework. Table 1 below provides a summary of the key variables included in the regression model and their expected signs.

4. Results and Discussion

4.1. Key Characteristics of Research Communities

Table 2 summarises key features of the four communities selected for the study. Sengwe and Pahlela had the highest proportion of de facto female-headed households, 33.3% and 26.8% respectively. Due to their proximity to Mozambique and South Africa, temporary and permanent migration activities are part of the livelihoods strategies.

Table 1
Description of explanatory variables, forest degradation model, south-eastern Zimbabwe.

Variable		Explanation	Expected sign
Dependent Y	Forest degradation Index	Sum of ecological condition, forest condition relative to earlier times, and use penetration	
Characteristics of resource system P	Resource scarcity	Population size (forest + commons area)	+
Characteristics of user group H	Household education	Average education of household members in years	−
	Household head age	Age of household head in years	+
	Ecological knowledge	Ecological knowledge score[a]	−
	Wealth index	Household wealth index as determined by the PCA (excluding livestock)	−
	Distance to the forest from the household	Average distance to the forest from the household in kilometres	−
	Number of livestock owned	Number of livestock owned	±
	Tradition	Dummy variable equal to one if parents of household head and/or spouse have a history of NTFPs extraction, 0 otherwise	+
	Household formed	Number of years ago the household was formed	±
	Livestock income	Average livestock income in US$	±
	Off-farm income	Average annual income from non-farm income including remittances	−
Resource regime and institutional arrangements I	Local institution effective	Dummy variable equal to one if management is active (extracted from PCA), 0 otherwise	−
External environment Z	Infrastructure development	Measured by a development index[b]	−
	Market integration	Dummy variable equal to one if there is an organised market for NTFPs, 0 otherwise	+

[a] $KS = \sum_{i=1}^{n} Ai$ where KS is the knowledge score in (%); Ai (0;1). If the answer to a statement i is correct/wrong, one/zero point is attributed (Ai).
[b] Development index is the sum of schools (at various levels), banks, shops, irrigation facility, health centres, etc. existing in the village.

Chikombedzi communal differed significantly from their counterparts in terms of household types and income sources. This community, had a significantly higher proportion of child and dejure female-headed households. Focus group discussion results with key informants attributed these demographic discrepancies to high HIV/ADIS prevalence in the area. Monthly reports from the local hospital revealed that this community had the highest HIV/AIDS incidences compared to other communities in Sengwe communal. More than a third are *dejure* female-headed households, deriving most of their income from NTFPs and beer brewing.

The major NTFP activities (Table 2) in these communities are *Hyphaene benguellensis* (ilala) and *Sclerocarya birrea* harvesting, hunting, fishing and mopane worm gathering. *H. benguellensis* has multiple uses, which include weaving mats, baskets, hats and brooms, and fruits and wine. This has led to increases in social conflicts among households prompting local traditional leaders in Malipati and Sengwe communal area to privately allocate the *H. benguellensis* plots among households. Malipati community hires private hunters to operate the Safari and the meat and income are shared proportionally among all the households. In contrast, Sengwe community survives on traditional hunting of stray wildlife from the Kruger National Park and adult men of the community are part of the hunting team. Meat is shared according to household size in the community. Fishing ceremonies are common in this area. NTFPs are commonly marketed locally but traditional leaders do not allow people to sell fruits, for seed viability maintenance.

4.2. Dimensions of Local Institutional Management

The PCA indicated the most important attributes determining the effectiveness of local institutions in the management of CPRs. The results in Table 3 show that the first three principal components had eigen values greater than one (2.586, 2.341, and 1.342 respectively) using the Kaiser criterion and explained 75.1% of the total variation in the variables used. Variables with coefficients in absolute value above 0.5 are said to be dominating (Nieuwoudt, 1977), hence should be used in the analysis. The different factors extracted represent different dimensions of local institutional management of forests in communal areas of south-eastern Zimbabwe.

Component 1 explains 29.7% of the variation in the variables included in the model and represents strength of local institutional management of the commons. The results show that good rules, effective enforcement of rules and a high degree of cultural homogeneity, are associated with effective local governance of CPRs. These results are consistent with Agrawal (2001) and Adams et al. (2003) where clearly-specified use rules, monitoring and sanctions

are prerequisites for effective local governance of CPRs. The relatively high coefficient associated with strong beliefs in ancestral spirits reflects the importance of religious taboos and moral persuasions in monitoring and deterring community members from breaking rules (Heltberg, 2002).

The dominating variables in the second factor, which explains 24.1% of the variation in the variables, were clearly defined boundaries (0.551), suitable use and contributing rules (0.589), proper monitoring of the agreed-upon rules (−0.645), proportion of household income from CPRs (0.554), and sanctions are proportional to the kind of rule violation (−0.651). The negative signs on two of the variables suggest that having suitable rules does not guarantee effective governance of local resources. According to Ostrom (1990), local institutions become fragile whenever one or more principles are missing. This component represented strength of local enforcement of rules.

The third component, which explains 21.3% of the variation in the variables, represents conflict resolution strategy dominated by local courts for resolving conflicts (−0.901), household consumption and welfare (0.761), proportion of household income from NTFPs extraction (0.719), social heterogeneity (−0.621) and strong beliefs in ancestral spirits (−0.602). The negative signs suggest that lack of local courts for resolving conflicts and cultural diversity are associated with high extraction of NTFPs. Social and/or cultural heterogeneity is generally believed to lead to fragile local institutional management of the commons because of absence of shared values and norms, low level of trust, and lack of social cohesion, which make social sanctions less effective (Baland and Platteau, 2007; Varughese and Ostrom, 2001).

4.3. Forest Outcomes

Table 4 provides the econometric outputs of the impact of local institutions and other key variables on forest outcomes (degradation). The explanatory variables jointly significantly explain forest degradation, while the adjusted R^2 value is 0.58. Resource scarcity had a significant positive parameter. This suggests that the more the users relative to the forest area the greater the resource degradation. These results confirm Bardhan's (1993) proposition that at high levels of scarcity and ecological stress institutional arrangements break down as people scramble for survival and discount rates increase.

Market integration also had a highly significant positive parameter. This suggests that villages that had highly organised and exploitative markets were more likely to experience severe forest degradation, holding other factors constant. These results are in line with findings from India where increased demand led to more intense

Table 2
Key characteristics of the research communities, south-eastern Zimbabwe.

Characteristics	Malipati	Sengwe	Chikombedzi	Pahlela
Ethnic groups (%)	97% Shangana 3% Ndebele	100% Shangana	58% Shangana 41% Karanga 1 Ndebele	71% Shangana 29% Karanga
% Male-headed households	71%	48%	52%	63%
% of *de facto* female-headed households	19%	33.3%	9.7%	26.8%
% of *dejure* female-headed households	10%	18.6%	38.3%	10.2%
Forest management regime	Common property	Common property	Common property	Common property
Forest products available	Illala crafts & wine, fruits, nuts, fish, honey, game meat, tourism services	Illala crafts, wine & fruits, fish, fruits, nuts, honey, game meat	Mopane worms, crafts, fruits, nuts, fish	Fruits, honey, game meat, thatching grass
Main source of income	NTFPs, remittances & livestock	Remittances & livestock	NTFPS, beer brewing & daily wage labour	Remittances & cross-border trading
Important crops	Sorghum & millet	Maize	Sorghum, millet & maize	Sorghum & millet

Table 3
Dimensions of local institutional management, south-eastern Zimbabwe.

Variables	Principal component (eigen value)		
	1 (2.586)	2 (2.341)	3 (1.342)
Clearly defined boundaries	0.301	0.551	0.491
Suitable rules for contributing private benefits	0.654	0.589	0.421
Member contribution to decision making	0.473	0.413	0.076
Monitoring and enforcement of rules	0.855	−0.645	−0.464
Proportional sanction	0.557	−0.651	−0.322
Local court for resolving conflicts	0.200	−0.051	−0.901
Contribution to household consumption and welfare in crisis times	0.318	0.449	0.761
Proportion of household income from CPRs	−0. 098	0.554	0.719
Social homogeneity[a]	0.712	0. 069	−0.621
Strong beliefs in ancestral spirits	0.773	0.216	−0.602
Percent of Variance Explained	29.7	24.1	21.3
Institutional Performance	Strength of local institutions	Enforcement of rules	Conflict resolution

[a] The index was computed following Varughese and Ostrom (2001): $A = \sum_{i=1}^{n}(P)^2$ where, Pi is the proportion of total population in the ith social group. A varies from 0 to 1 and measures the probability that two randomly selected persons will not be in the same social group.

harvesting and overexploitation of NTFPs (Muraleedharan et al., 2005; Marshall et al., 2006). Infrastructure development had an unexpected highly significant (5% level) positive relationship with the forest degradation index. This was attributed to the prevailing harsh economic condition. This was also supported by results from semi-structured interviews where 75% of the key informants constantly lamented and blamed the prevailing socioeconomic conditions for forest degradation.

The wealth index and effective local institutions had the expected negative parameters. A higher wealth index is associated with less forest degradation. The results also suggest that effective local institutional management play a significant role in reducing forest degradation (Heltberg, 2001; Ostrom, 1990). A high ecological knowledge score was also associated with less forest degradation. According to Shaanker et al. (2004), high ecological knowledge compels people to adopt ecologically friendly and prudent methods of harvesting NTFPs. The number of years ago the household was formed (proxy of life cycle stage) had a highly significant negative parameter. Thus, older and well-established households impose less severe forest degradation compared to relatively young households. Livestock income had a significant negative effect on the forest degradation index. The importance of livestock in these communities provides an incentive to collectively invest and preserve the natural resource base. This is also supported by Heltberg's (2002) findings that if a community depends on the forest resource for a substantial share of income the more likely is the collective action for resource management. It was also noted during interviews with key informants

that burning of forest in grazing commons attracted a fine of one heifer to the traditional leaders in the area.

5. Conclusion

The main objective of this paper was to examine the extent to which forest degradation in the semi-arid Sengwe communal area of Zimbabwe is driven by existing common property management regimes, resource and user group characteristics, ecological knowledge and marketing system. In summary, the PCA revealed that social homogeneity, religious taboos, proportion of income from NTFPs and their contribution to household consumption and welfare in times of crisis, monitoring and enforcement of rules and suitable rules for contributing benefits were important variables in explaining the effectiveness of local institutions in governing forest commons. There seems to be a positive correlation between social homogeneity, monitoring and enforcement of rules, religious taboos, and effective local institutional governance of CPRs. Contrarily, high dependence on the resource in times of crisis and for income, and lack of local courts to resolve conflicts lead to fragile local institutional management of CPRs. The results suggest that strong suitable rules, enforcement of these rules and conflict resolution strategies are essential for an effective, local management system.

Multiple regression results revealed a positive relationship between resource scarcity, market integration, infrastructure development, and forest degradation. The significant negative relationship on household formation period and household head born in the area implies that households formed earlier and household heads born in the area were more likely to engage in prudent NTFPs extraction activities. The negative and significant relationship with livestock income showed the importance of livestock as a livelihood source. These results have important policy implications for development planners, conservationists and non-governmental organisations working in the region. There is a need for adaptive local management systems that enhance ecological knowledge of users and regulate market structures in favour of long-term livelihood securities of these forest-fringe communities. Though local context is very important to the construction of strong community forest resource management institutions, government should help communities to adopt marketing systems that are not exploitative and formulate resource regulations that are aligned with incentives for long-term sustainable use of resources.

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Table 4
Determinants of forest outcomes (degradation), south-eastern Zimbabwe (2009).

Variables	B coefficients	Std. error	t value
Constant	−0.421	0.083	1.071
Resource scarcity	0.514	0.002	2.659**
Ecological knowledge[a]	−1.724	0.045	−3.012***
Wealth index	−1.524	0.471	−1.874*
Livestock income	−2.431	0.203	−3.116***
Household head born	−0. 741	0.020	−1.826*
Household formed	−2.250	0.112	−3.223***
Local institution effective	−0.548	0.059	−2.562**
Market integration	3.212	0.401	3.072***
Infrastructure development	1.159	0.314	2.661**

$R^2 = 0.60$
Adjusted $R^2 = 0.58$
F test $= 13.502$***
$n = 200$

***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

[a] Ecological knowledge score $= \sum_{i=1}^{n} Ai, Ci$ where n is the number of questions/statements, Ai is the answer (dummy variable 1 if it is correct, 0 otherwise), and C is the certainty factor indicated on the seven-point scale of certainty, as recommended by Verdurme and Viaene (2003).

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