SPECIAL SECTION: LAND USE OPTIONS IN DRY TROPICAL WOODLAND ECOSYSTEMS IN ZIMBABWE

Implications of co-management for benefits from natural resources for rural households in north-western Zimbabwe

Isla Grundy a,*, Jane Turpie b, Pamela Jagger c, Ed Witkowski d, Isabelle Guambe e, Daniel Semwayo f, Anastelle Solomon g

a Community Forestry, University of Stellenbosch, P. Bag XI, Matieland 7602, South Africa
b Percy FitzPatrick Institute, University of Cape Town, Cape Town, South Africa
c Department of Rural Economy, University of Alberta, Edmonton, AB, Canada
d Botany Department, University of the Witwatersrand, Johannesburg, South Africa
e Ministerio para Coordenacao da Acção Ambiental, Maputo, Mozambique
f Institute of Environmental Studies, University of Zimbabwe, Harare, Zimbabwe
g National Botanical Institute, Pretoria, South Africa

Abstract

Addressing issues of resource management in sub-Saharan Africa has prompted the consideration of joint management policies that incorporate the needs of several stakeholder groups. This study examines the short and long-term use of natural resources in north-western Zimbabwe in a complex ecological–economic setting using a simulation model. Land and resource ownership in the model is divided between communal lands, which are managed by local inhabitants, and State Forest, which is managed by the Forestry Commission. Three different resource users rely on the stock of resources that the woodlands and grasslands (dambos) produce: the Zimbabwe Forestry Commission, communal land residents and illegal occupants of the State Forest. Net benefits to each of the three user groups are estimated under four different management scenarios, two of which advocate for the expulsion of illegal forest dwellers from the State Forest, and two of which involve a degree of joint management of the State Forest by the Forestry Commission and inhabitants neighbouring the forest. If the status quo is maintained, or if access by local people to the forest is severely limited, forest quality will decline due to the impacts of increased fires (which are limited when livestock are in abundance). Eviction of the forest dwellers results in a serious loss of benefits for that stakeholder group, but does not result in a significant increase of benefits for other stakeholder groups. The economic impacts of the different management scenarios are not very different because of the low values of the forest resources. Compared to the status quo, co-management provides for slightly greater net benefits, but the transaction costs associated with the establishment of co-management may be too high to justify this option. © 2000 Elsevier Science B.V. All rights reserved.

* Corresponding author.

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1. Introduction

Rural households throughout Africa derive a wide range of products from the rich and diverse vegetation types that make up the ecosystems in which they live (Campbell et al., 1993). This fact, up until the last 20 years, was largely ignored by policy makers and woodland managers, who instead focused on merchantable timber resources from state-owned areas (Grundy, 1995). A number of studies have highlighted the essential nature of indigenous woodlands to the secure livelihoods of rural inhabitants (see Bradley and McNamara, 1993; Arnold, 1995, for examples). Many woodland-derived products are marketed in the informal sector, their revenue forming an important proportion of the household income (Brigham, et al., 1996).

With increasing population pressure and the move to greater reliance on natural resources for income generation, natural resource use, even if currently sustainable, may be pushed beyond sustainable levels (see Katerere et al., 1993). It is thus imperative that the importance of these resources to households and local economies be brought to the attention of policy and decision makers (Arnold, 1993). Most studies of natural resource use in this region are descriptive, however, and do not provide monetary values, a gap that Campbell et al. (1991, 1997) have attempted, in part, to fill. However, it is essential to take into account the dynamics of resource availability, use and values, if ecological and economic sustainability is to be ensured. Understanding these dynamic processes, which include natural ecosystem perturbations such as fire and drought, human disturbance, demographic and macro-economic changes and the conflicts that arise through social heterogeneity, is a major challenge. One way to unravel the complexity that characterises dynamic ecological-economic systems and to explore the implications of alternative management solutions is through simulation modelling (Costanza et al., 1993). Indeed, independent or reductionist analysis of individual components of natural resource management problems limits the opportunity to contribute to the long-term sustainability of both natural and human capital (Costanza et al., 1993).

Co-management, also called shared or joint forest management, is an emerging contemporary natural resource management regime. It has been defined by Nhira et al. (1998) as the management of reserved and protected forests by the forest owners with the active involvement of designated communities in terms of designing, planning and executing management plans. The communities receive benefits from such involvement, which are clearly spelt out at the beginning of the programme. The goal of managing natural resources in such a way as to maximise sustainable socio-economic benefits at the local and national scale is a challenging one in the face of conflicting development interests, institutional and regulatory problems, and rapid population growth (Arnold, 1993; Wily, 1997).

This study forms part of a broad collaborative study that attempts to model some of the dynamic ecological and socio-economic processes that affect the availability, use and economic value of natural resources in a case-study area in and around Mzola State Forest in western Zimbabwe. It is hypothesised that co-management between the State and the local people will result in an increase in benefits to both of the user groups (Wily, 1997).

The model developed in this study builds primarily upon an ecosystem-based model developed for the area (Gambiza et al., 2000). It focuses on the socio-economic aspect of resource use, based on a set of assumptions and within the limitations set by this model.

The main aims of the study are:
1. To develop an ecological-economic model describing the human use of natural resources;
2. To compare the costs and benefits of resource use between different user groups (legal users, illegal users and the State);
3. To investigate the implications of use patterns on the ecological sustainability of these resources; and
4. To explore the implications of alternative management options in terms of equity and sustainability of resource use.

2. Study area and socio-economic setting

The study area comprises 68,000 ha of state-owned land managed by the Zimbabwe Forestry Commission (Mzola State Forest) and adjacent communal land of an equivalent area. Mzola Forest falls into Binga District, while the communal lands are in Lupane District. The study area is situated on Kalahari sands and has a mean annual rainfall of 632 mm. It is characterised by dry deciduous woodland dominated by *Baikiaea plurijuga* (Zambezi teak), and interspersed with dambos (seasonally inundated grasslands), in the depressions between sand dune ridges. A substantial part of the woodland in the communal area has been cleared for agriculture and other uses. A more detailed description of the vegetation, geology and climate is given in Gwaai Working Group (1997).

The portion of the communal area studied contained approximately 2200 households in 1997, with a mean household size of 6.2 people (CSO, 1992). The rate of population growth in this district is 3.09% per annum (CSO, 1992). In 1997, about 525 households, with a mean size of eight people, were residing illegally within the state forest area.

The villages in the communal area were established around 1953 (Gwaai Working Group, 1997). Until independence in 1980, rules and regulations that govern rights of use to resources in communal woodland had been dominated by traditional institutional structures (chiefs and elders) working within the framework of the colonial land use systems (Bradley and McNamara, 1993). Following independence, throughout the 1980s and early 1990s, the new local government structures, through the district councils, became involved in the distribution and allocation of land and other resources. However in many instances traditional institutions have maintained or re-established their power (Moyo et al., 1991).

In the district, local persons appointed by the traditional leaders enforce rules regarding resource use. The role of these village policemen is to report offenders to local leaders (Gwaai Working Group, 1997). Recently this system of resource use regulation in the communal woodlands has been less effective, as non-community members have been able to acquire access to resources through bribery (Gwaai Working Group, 1997). In addition to the breakdown in the traditional system of resource use regulation, the issue is complicated by a rise in the influence exerted by a new institutional structure that involves a politically motivated hierarchy including the district council, the WADCO and VIDCO (Ward and Village Development Committee, respectively) (Bradley and McNamara, 1993). The position of the true apex of decision-making power is unclear.

Use of the natural woodland resources within the State Forest is governed by a permit system that allows for the grazing of three hundred cattle, and the harvest of finite quantities of selected resources such as thatching grass and wild foods (Gwaai Working Group, 1997). The Zimbabwe Forestry Commission is responsible for the regulation of this permit system and is obliged to fine transgressors. Mzola State Forest was fenced in the early 1980s to limit illegal access into the forest, with the result that relations between the communal area dwellers and the Forestry Commission have deteriorated (Gwaai Working Group, 1997).

The history and origin of the illegal settlement within Mzola State Forest is uncertain. Settlers have moved into the area and cleared the land required for their agricultural and settlement needs without acquiring permission from the Forestry Commission (Gwaai Working Group, 1997). They generally attempt to exercise usufructuary rights regardless of the Forestry Commission’s claim of ownership of the land and trees (Bradley and McNamara, 1993). The Commission has attempted to forcibly evict the forest dwellers a number of times, but the evolution of an institutional hierarchy within the forest dweller community and its allegiance to key political figures,
combined with a lack of enforcement power within the Forestry Commission, has allowed the settlers to remain on state land.

As the local population increases and resources in the area as a whole become increasingly scarce, there is the potential for conflict between the communal area dwellers and the settlers over the utilisation of the state-owned resources. However, no such competition appears to exist between the two user groups at present (Mushove, 1997, Forestry Commission, pers. comm.). State Forest dwellers harvest all of the wood and non-timber products required by their households from the State Forest. People living in the adjacent communal area utilise mainly the southern portion of the State Forest to obtain those resources that are not available from sources closer to their home sites.

Mzola State Forest is managed by the Forestry Commission primarily for timber production. Timber, mainly *Baikiaea plurijuga* (62%) and *Pterocarpus angolensis* (38%), is currently being harvested by concessionaires at a rate of about 5000 m³ per annum over a period of 8 years. For such a harvest to be sustainable, a forest regeneration period of about 40 years will be required before the next concession is granted (Mushove, 1997, Forestry Commission, pers. comm.).

### 3. Model description

A dynamic simulation model was developed using the programming language STELLA (High Performance Systems, 1993). This modelling tool is used for simulating complex ecological–economic systems, economic valuation and scenario analysis (as used in Higgins et al., 1997), and facilitates scoping and consensus building (van den Belt et al., 1998). Data were drawn from a number of published and unpublished sources pertaining to the study area and other similar areas in Zimbabwe (Grundy et al., 1993; Campbell, 1996; Campbell et al., 1997; Matose et al., 1997) as well as from local officials and other key informants. The model assesses resource use on an annual basis.

The resource use sub-model developed in this study builds upon an ecosystem sub-model (Gambiza et al., 2000) and is also reliant on a crop model (Campbell et al., 2000; Chivaura-Mususa et al., 2000) and an area and population model (Campbell et al., 2000) (Fig. 1). This paper concentrates on processes within the socio-economic system and their relationships with the ecological system. The resource use sub-model comprises a number of forest produce sectors (Fig. 1), each dealing with a major woodland product type used by any or all of the three user groups (communal area dwellers, State Forest dwellers and Forestry Commission).

The ecosystem sub-model provides the resource stocks for the resource use sub-model (Gambiza et al., 2000). When resources are utilised by any of the three user groups, they are deducted from the total stock in the ecosystem sub-model. Rates of ecosystem regeneration are built into the ecosystem sub-model, replenishing stocks and governed by fires and rainfall.

The area and population sub-model determines the amount of land under crops (and hence the total area of remaining woodland and grazing area). This sub-model has a simple model of population growth that increases the population annually, based on current growth rates in the area. Cropping area is a function of population density, with the initial areas cultivated being 9.8 and 4.5 ha per household in the State Forests and

![Fig. 1. Diagram of the resource use sub-model and its relation to other sub-models of the integrated model.](image-url)
the Communal Area, respectively. This area reduces to 2 ha per household at population densities of 50 persons km\(^{-2}\), as found elsewhere in Zimbabwe. The crop sub-model determines the stock of supplementary feed for cattle. The total land base is divided into four separate typologies, defined by land ownership and habitat type. These are woodlands and dambos within each of the communal land area and the State Forest area. The entire model is constructed in a four-tiered array in order to separate the populations, resource stocks and processes in these four areas, while allowing processes in one area to affect those in another.

While a full suite of natural resources is potentially available in woodlands, dambos are devoid of woody vegetation and, in this model, only supply grass for grazing or thatching. Resources used in the woodlands are dead and live wood for fuelwood, poles for construction, wild foods, and grass for grazing. Initially the model included wood for carving, but this section was removed as the levels of wood extracted are minimal in comparison to fuel and construction wood. The impact of harvesting for carving wood would have been more important had the specific tree species used for carving been modelled.

The model ensures that users harvest the resources closest to them before resorting to alternative areas. Thus, inhabitants of the communal area harvest as much as possible from the communal area habitats first and only resort to the resources found within State Forest in times of scarcity. State Forest dwellers are able to rely solely upon the less degraded Mzola Forest. Because of their larger households and closer proximity to abundant resources, forest dwellers were assumed to consume up to 50% more woodland produce per household than communal dwellers (see Campbell and Mangono, 1994, for an example).

Each of the resource types forms a sector of the resource-use sub-model (Fig. 1). In each sector, the ecosystem sub-model determines the abundance of a resource. The area of natural habitat that remains after the area under crops is subtracted from the total area determines the total available stock of each resource. Once the initial availability of resource stocks is determined, these stocks are affected over time by human utilisation as well as the growth components of the ecosystem sub-model. Human utilisation in the four areas is affected by both demographic and socio-economic factors. The utilisation rates of forest produce are determined by the combination of substitutability, costs and benefits associated with collection, which in turn are affected by the relative scarcity of the resource.

Benefits associated with collection of forest produce were based on current market prices of woodland products as far as possible. It was assumed that prices are affected by local changes in resource availability, i.e. prices increase as availability decreases, and this hypothesised relationship was incorporated into the model. Labour and transportation costs were assumed to be the only two costs associated with resource collection. Cost of labour is based on current rural wage rates, information or assumptions on time taken to harvest a full load of each type of output, and transportation costs such as the rural market rental rate for a scotch cart to carry produce. As for price, it was assumed that harvest costs would increase with decreasing resource availability, and hypothesised relationships between these factors were also incorporated in the model. The net benefit of resource use was estimated to be the difference between total value of the resource (price \(\times\) quantity) and the total cost of collection and transportation. No differentiation between the subsistence (rural) and commercial markets was built into the model as it is likely that commercial markets for the majority of forest products are absent in this region of Zimbabwe. Given the distance of the case study area from main roads and physical markets, this is a realistic assumption.

One of the sectors in the resource-use sub-model covers the use of the forest by the Forestry Commission. This sector allows for a portion of the State Forest to be reserved for grazing leases to large-scale producers (20% at present), and allows for the extraction of timber by concessionaires. The costs to the Forestry Commission are also incorporated as two components: administration and management costs (assumed to be cur-
rently Z$6.5 ha\(^{-1}\) year\(^{-1}\), and enforcement costs (Z$0.8 ha\(^{-1}\) year\(^{-1}\)). Management and enforcement costs were based on Zimbabwe Forestry Commission figures (Mushove, 1993).

Annual values accruing to the Forestry Commission, State Forest dwellers and communal area dwellers from cropping, grazing and the harvest of natural resources are aggregated and the net present value of all benefits is calculated using three different discount rates, 1, 6 and 15\%.

The model was run using two time horizons. Management scenarios were run over a shorter time horizon of 50 years. A longer time horizon of 100 years was used to explore the consequence of different scenarios on the sustainability of the natural resource base. All prices are for 1996:97 and are in Zimbabwe dollars, which at the time were Z$10.00 = US$1.00.

Specific factors controlling the availability, use and values of each of the different resources in the resource-use sub-model are described in more detail below.

3.1. Construction poles

Each household was assumed to demand a minimum number of poles for basic construction, namely, poles and thatching. Households contain an average of 2189 poles in their structures that are renewed approximately every 7 years (Grundy et al., 1993), and thus on average, annual household demand for poles was estimated to be 313 poles.

3.2. Fuelwood

The availability of fuelwood was taken to be 80\% of the deadwood biomass (assuming that a proportion of deadwood is unobtainable or unsuitable for fuelwood). Households in the communal area currently use about 5800 kg of fuelwood per year (McGregor, 1991).

3.3. Food and other non-timber products

Very little is known about the availability and use of wild foods and other non-timber products in the woodlands of the study area. This sector of the model is thus somewhat hypothetical, but was included as an important sector in identifying the total benefit of the natural ecosystems to the inhabitants of the area. A hypothetical relationship was drawn between the biomass of large (harvestable) trees and the biomass of wild foods, including honey, fruit, vegetables, mushrooms, insects, small birds and mammals, so that available food biomass ranges between 0 and 100 kg ha\(^{-1}\) year\(^{-1}\).

Communal area dwellers will have less access to wild foods, and therefore consume a smaller quantity per person than State Forest dwellers. In the communal area, wild food consumption per household per year was assumed to be 300 kg (Wilson, 1990; McGregor, 1991). In the State Forest annual consumption per household was assumed to be 450 kg. The price of wild foods and other non-timber forest produce was set at Z$1 per kg, which is roughly equivalent to that for wild foods elsewhere in Zimbabwe (Campbell et al., 1997).

3.4. Thatching

Thatching grass availability is determined by grass biomass per ha and the total area of natural vegetation minus the amount grazed by cattle or consumed by fire. Grazing affects the availability of thatching, and not vice versa. Demand for thatching grass was estimated to be approximately 60 bundles for each house, and houses are re-thatched at 7-year intervals (Grundy et al., 1993). Thatching quantities are measured as 5-kg bundles. Each household in the communal area has approximately four roofs to be thatched. Forest dweller households, which are larger and generally wealthier than communal area households, have an average of five dwellings to thatch.

3.5. Grazing

Grazing is an indirect use of natural resources by the area’s inhabitants. Nevertheless, it provides an important component of the natural resource benefits that accrue to households while at the same time affecting ecosystem dynamics (see Gambiza et al., 2000) and the availability of
Table 1
Summary of the scenarios used in the analysis

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Communal land residents</th>
<th>State Forest dwellers</th>
<th>Zimbabwe Forestry Commission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status quo</td>
<td>Uncontrolled except for grazing</td>
<td>Uncontrolled except for grazing</td>
<td>Own controls</td>
</tr>
<tr>
<td>No community access to State Forest resources</td>
<td>Uncontrolled use in surrounding Communal land, no access to SF</td>
<td>Evicted</td>
<td>Own controls</td>
</tr>
<tr>
<td>Co-management with forest dwellers included</td>
<td>Controlled*</td>
<td>Legalised and controlled</td>
<td>Joint control*</td>
</tr>
<tr>
<td>Co-management with forest dwellers excluded</td>
<td>Controlled</td>
<td>Evicted</td>
<td>Joint control</td>
</tr>
</tbody>
</table>

* Controlled access scenarios are those in which stakeholders are limited to sustainable offtake levels.

thatch. In this sector, cattle numbers are determined by natural recruitment and mortality (influenced by the carrying capacity of each season) on the one hand, and by purchases and sales (influenced by cash availability and herd size) on the other. Both of these processes are influenced by drought cycles, which affect carrying capacity and crop yields, and hence cash flows. In this model, cattle provide measurable household benefits in terms of non-cash products such as milk and meat, as well as from sales.

4. The management scenarios

One of the overall objectives of this paper is to assess the impact of different management scenarios on the total benefits that accrue to households in communal lands and in Mzola State Forest. Four scenarios were defined for analysis, (i) the status quo, (ii) a scenario not permitting any access to the forest, (iii) a political solution characterised by co-management with all the current stakeholders, and (iv) a co-management scenario with the State Forest dwellers excluded (Table 1). A scenario that includes a buffer utilisation zone around a central exclusion zone in the forest was not included in this model, as the sustainability of this practice is debatable (Howard, 1991).

Each of the management scenarios was evaluated in terms of the resultant net present value of the area’s resources to each of the three stakeholder groups. Scenario analysis allows the modeller and forest manager to find the optimum levels for sustainable utilisation of the forest resources, while simultaneously recognising the socio-economic needs of the populations reliant on the forest resource base. The scenarios investigated are described in more detail below.

4.1. The status quo

In this scenario, settlement and resource use, apart from grazing, is effectively unregulated in the State Forest area. The forest dwellers are allowed to remain in the State Forest, and the Communal Area residents experience few restrictions with respect to resource use in the State Forest, except that cattle numbers in the State Forest are severely limited. The Forestry Commission, which leases grazing concessions to large-scale cattle owners (usually commercial producers who are considered exogenous to this model), control access to portions of the State Forest for grazing and derive the benefits of the grazing leases.

4.2. No access to State Forest resources

In this scenario, the Forestry Commission enforces its rules concerning utilisation of the forest by local people. Settlers are evicted from the area
and communal land dwellers have no access to the resources in the State Forest. The model does not allow for forest dweller migration to the communal area upon eviction. They are assumed to move to other areas in Zimbabwe. The enforcement costs of the Forestry Commission are assumed to increase significantly in this scenario, due to the increase in numbers of guards employed (from six in the status quo to 25 in this scenario).

4.3. Co-management with forest dwellers included

In this scenario, a solution amenable to all groups is achieved through consensus. This scenario is thus characterised by the concept of co-management. Both forest and communal area dwellers participate in the management decision-making process for utilisation of State Forest resources. Co-management is defined as the rights of communities (or other units) to share management power and responsibility with the State. It is an attempt to formalise a de facto situation of co-dependence and interaction in resource management (McCay and Acheson, 1987), and necessarily involves reduced access to resources by one or more stakeholder groups. It is assumed here that the costs of enforcement borne by the Forestry Commission are significantly reduced (50% lower than the status quo). Use of forest resources by forest and communal area dwellers is assumed to be reduced to 80% of the status quo, but unlimited cattle numbers are permitted.

4.4. Co-management with the exclusion of forest dwellers

The Forestry Commission enforces its rules concerning inhabitants residing within the forest boundary, but enters into a co-management scenario with surrounding communal land dwellers. The resource use restrictions for the communal area dwellers remain as for the previous scenario. It is assumed that enforcement costs are intermediate between those for the status quo and those for the scenario with no access to the State Forest (set at 50% of the no access scenario).

5. Results

The outcome of the status quo scenario indicates that the outlook for the long run sustainability of the resource base in the Communal Areas surrounding the State Forest is not positive (Fig. 2). This is assuming resource use continues as predicted and that the population growth rate does not alter significantly. At year 85, around 2080, the forested area in the communal area has been completely removed. This is largely a function of increasing populations confined to a fixed land base, and the consequent rise in cultivated area. Given the lower population densities in the State Forest, total cropping area inside the State Forest increases slowly over time, causing the area of woodland to be reduced at the same rate. Scenarios that limit access to the forest by cattle reduce forest quality due to the resulting increase in fire frequency (Gambiza et al., 2000). The environmental situation is improved under the co-management scenario, largely because of the greater numbers of livestock, which reduce forest fires and therefore increase woody plant regeneration. Comparing the status quo scenario with the co-management scenario, hot fires are three times less frequent in the latter scenario and twice as many trees are present at the end of the 60-year simulation.
Fig. 3. Annual values (Z$) of the different woodland resources in Mzola State Forest and the adjacent Communal Area to communal area dwellers, under the ‘status quo’ scenario.

The model suggests that of the woodland products utilised, grazing is the most valuable (Fig. 3). Grazing values show much fluctuation, a consequence of the variability in livestock numbers as a result of rainfall patterns. At the start of the simulation the numbers of livestock rise with the human population. From about the year 2025, however, the cattle population has reached a ceiling with no reserve grazing available, following which wild fluctuations occur. Poles, fuelwood and wild foods are relatively more valuable to communal area dwellers than thatching grass, and provide substantial benefits. The net value of thatch is very low, reflecting lower prices and use of relatively small volumes.

For the full spectrum of woodland and grazing resources, using a 6% discount rate, the net present values for the communal area people are slightly higher under the co-management scenarios than for the status quo (Fig. 4). A greater difference occurs when people have no access to the forest. Under this scenario, the values go up slightly for the Forestry Commission, but decline significantly relative to co-management for the communal area dwellers, with no value for the expelled forest dwellers. Under the no access scenario, communal dwellers still have access to forest resources outside the State Forest, sufficient to fulfil most of their household demands during the first 50 years of the model’s time horizon. In the two scenarios in which forest dwellers are expelled (‘no access’ and ‘co-management without forest dwellers’), excluding people from the State Forest implies higher enforcement costs for the Forestry Commission. However, these higher costs do not make a big impact on the benefits derived by the Forestry Commission, as expelling
people puts greater areas of the resources under their control. The benefits derived from the forests are much lower for the Forestry Commission compared to those of local people.

When the benefits from use of the forest areas are combined across stakeholder groups, the scenario that generates the highest net present value, irrespective of discount rate, is the co-management scenario that includes forest dwellers, though the difference between the status quo and the co-management scenario with forest dwellers is not great (Table 2). On a 60-year simulation, discount rates of 15%, and even 6%, will mean that the net present value is largely determined by what happens in the first few years of the simulation. Equally, our conclusions hold for discount rates of 1%.

6. Discussion

6.1. Balancing stakeholder interests: can an optimal solution be reached?

Under the status quo scenario, the only official products from the forest are grass for grazing and merchantable timber species that are selectively harvested by the concessionaires. Thus the Forestry Commission recoups only a fraction of the total value of the forest. The benefits from the timber harvest, together with the revenue from commercial grazing leases, amount to a very small proportion of the value realised by the local inhabitants whose land borders on the State Forest.

The Forestry Commission is unable, for financial and political reasons, to enforce its restrictions on use of the forest resource (Mushove, 1997, Forestry Commission, pers. comm.). There is also no guarantee that the Forestry Commission will be able to maintain the status quo scenario in the future, in the face of increasing land shortages and natural resource use. Even with increased enforcement to keep local people from the forest, the resource base may not be secured (Matose, 1994, Forestry Commission, pers. comm.). Co-management, or at least the component that allows for high livestock numbers, also makes ecological sense in that fire frequency will be reduced. In this situation, there is a strong incentive for the Forestry Commission to buy into the co-management concept. When the four different scenarios are compared, it is clear that the economic benefits from the forest would not be the driving factor for this buy-in, but rather (i) the longer-term conservation of both the biodiversity of the forest and the water catchment areas, (ii) the development of strategic alliances with the community, and (iii) the longer-term maintenance of the forests for their livelihood contributions to poor people. The lack of major differences in economic value between different management scenarios is largely a result of the relatively low values that these forests have. The co-management scenarios offer the surrounding communities greater security of access to all of the woodland resources and a voice in management decision-making processes. The investment in management of the resource on the part of the local communities, and the reduced enforcement costs, will offset the potential resource losses, largely in terms of timber, to the Forestry Commission.

From the Communal Area dwellers’ present perspective, benefits are highest when the forest dwellers are removed because there is no competi-

<table>
<thead>
<tr>
<th>Discount rate (%)</th>
<th>Status quo</th>
<th>No community access to State Forest resources</th>
<th>Co-management with forest dwellers included</th>
<th>Co-management with forest dwellers excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>955</td>
<td>678</td>
<td>1035</td>
<td>834</td>
</tr>
<tr>
<td>6</td>
<td>329</td>
<td>251</td>
<td>349</td>
<td>291</td>
</tr>
<tr>
<td>15</td>
<td>142</td>
<td>113</td>
<td>148</td>
<td>129</td>
</tr>
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tion for resources, particularly for grazing. In the next 30 years or so Communal Area dwellers have sufficient woodland resources in their own areas for them not to rely heavily on the State Forest area, with the exception perhaps of wild foods. However, with the rising population and the consequent diminishing of wooded areas as a result of land clearance (in this model causing a complete clearance of wooded areas before 2095, Fig. 2.), woodland resources will become increasingly scarce. Communal Area dwellers will come to rely more heavily on the State Forest in order to meet their basic requirements. It is in their interest, therefore, to invest in the long-term sustainability of the State Forest resources by reducing their offtake and adhering to the mutually agreed management regulations.

The State Forest dwellers would appear to be in the strongest position of all of the stakeholder groups. Whilst they live in the State Forest they are well-endowed with woodland resources, and because of the prevailing political (Mushove, 1997, Forestry Commission, pers. comm.) and economic situation, they are unlikely to be evicted from their land in the near future. If they see their residence in the forest to be short term, they have no economic incentive to invest in the long-term sustainability of the resource. If, however, they are convinced of their right to remain as land users in the Forest, it is in their interests to enter into a co-management arrangement with the Forestry Commission and to reduce their harvest of resources.

From the model, therefore, it is clear that an investment by communities in co-management of the woodland resources in the State Forest will result in benefits to all parties. Co-management is a relatively new concept that has been tested in India and Nepal over the past two decades, with varying degrees of success (Saxena, 1997; Ford Foundation, 1998). Whether these programmes achieve their objectives or not is dependent on the existence of pre-requisite factors for successful common property resource management regimes, a subject that has fueled much debate (see Arnold, 1998).

At the beginning of 1998, the Zimbabwe Forestry Commission, together with the UK Department for International Development (DFID) entered into negotiations to establish a joint forest management programme in the Kalahari sand Forests of Western Zimbabwe, of which Mzola State Forest forms a part. The model developed here depicts a realistic situation that is mirrored in many other parts of the world at the present time. Forest authorities throughout Africa and Asia find themselves in a similar situation of being forced by escalating costs and social opposition to enter into co-management situations with surrounding user communities (see Howard, 1991; Shepherd et al., 1991; Matose and Wily, 1996; Wild and Mutebi, 1996; Grundy, 1998, for some examples).

### 6.2. Long-term changes and potential trajectories that have not been modelled

The modelling of the next 100 years indicates that the current system cannot be sustained. Under the existing management regime and with the predicted population increases, by the turn of the next century, all the woodland will have been removed. This is a serious consequence considering that these woodlands play such a key role in sustaining livelihoods and spreading risk (Bradley and Dewees, 1993). The results beg the questions as to what total household incomes will be, and from where will they be derived at the end of the 21st century.

The model can never capture all the intricacies of change, and should not be interpreted too literally. The dangers of literal interpretation have been amply demonstrated in the case of the simple projection of fuelwood supply and demand into the future to forecast an impending ‘fuelwood crisis’ (Bradley and Campbell, 1998; Leach and Mearns, 1988). Households change their behaviour in ways that are difficult to predict, and hence difficult to model. From the model it is possible to predict that in 50 years time there will be major changes in the way people relate to land, and perhaps massive migration to urban centres.

Tourism is currently the highest growing industry in the southern African region, and areas such as Mzola State Forest are in close proximity to one of the world’s premier tourist sites: Victoria
Falls. The current model has not captured option values. The 68 000 ha of Mzola State Forests could potentially be of high value for tourism.

6.3. Implications of the model’s predictions for policy makers

The development of forest policy that provides balanced alternatives for all stakeholders has become increasingly complex. As the resource needs of households and local economies are more extensively researched, and the links between the environment and policy implications are better understood, co-management offers possible solutions to stakeholders at all levels. For policy makers co-management offers alternative management schemes that may address and equalise the competing needs of the stakeholders that rely on the resource base. In corroboration of the results from our model, Nhira et al. (1998) propose that the primary objective of co-management in the Zimbabwean context is the protection of forests from further degradation. In theory this will in turn lead to welfare improvement for rural communities in the long run. Government policy can be designed to create the appropriate incentives for co-management to result in a socially optimal outcome. The social optimum in this context centres on the principles of meeting household and local economy requirements, as well as sustainably managing the resource base over the long term.

Thorough negotiation of the rights and responsibilities of the communities as well as the Forestry Commission and local institutions must be undertaken if resource sharing is to be successful (Nhira et al., 1998). An open question remains: to what extent is the forest valuable enough to offset the high transaction costs that are required in setting up a co-management regime?

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