Policies and Governance Structures in Woodlands of Southern Africa

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Printed by SMK Grafika Desa Putera, Indonesia
Cover photo by Godwin Kowero

ISBN 979-3361-22-0

National Library of Indonesia Cataloging –in-Publication Data

Policies and Governance Structures in Woodlands of Southern Africa/
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p. cm.
ISBN 979-3361-22-0

1. Forest Policy 2. Governance 3. Southern Africa 4. Rural Development
5. Community Involvement 6. Structural Adjustment 7. Woodlands 8. Forest Management

Published by
Center for International Forestry Research
Mailing address: P.O. Box 6596 JKPWB, Jakarta 10065, Indonesia
Office address: Jl. CIFOR, Situ Gede, Sindang Barang,
Bogor Barat 16680, Indonesia
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E-mail: cifor@cgiar.org
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Contents

Modelling multi-stakeholder interests in the Southern African woodlands

Planning woodland management with weighted goal programming

System dynamics approach to woodland management

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Acknowledgements

We would like to thank numerous persons who were contacted either as individuals or within their official capacity during the course of the research that culminated into this book. The households living around the various forest reserves deserve special appreciation because without their co-operation in field surveys, the research on which the models are based would not have been possible. Funding for the study was provided by a grant from the European Union Actions in Favour of the Tropical Forests in Developing Countries (B7-6201) to CIFOR for a research project "Management of the Miombo Woodlands" implemented in Malawi, Mozambique, Tanzania, Zambia and Zimbabwe in 1998-2002. The opinions expressed in this paper are the sole responsibility of the authors and do not necessarily reflect those of the European Union and CIFOR. We are grateful to Sally Wellesley for editorial support, Gideon Suharyanto, Cyprianus Jaya Napiun and Eko Prianto for cover design and layout and Feby Litamahuputty for secretarial assistance.

Foreword

For many decades Southern African governments invested heavily in expanding their forest estates through plantations of exotic tree species, building a wood processing industry for both plantation and natural forest roundwood, providing the supporting infrastructure for this through training, research, management and administration. Research and training at all levels was dominated by plantation forestry. The focus in management was trees or forests, their industry and markets. This focus diminished attention of forestry institutions to non-industrial forestry, with the exception of managing water catchment forests.

This state of affairs was disturbed by the awareness campaigns for an impending fuelwood crisis in Africa in the 1960s and 70s. This shifted the attention of foresters from industrial forestry to local communities. We saw increased investments in improved charcoal and cooking stoves as well as in local community initiatives in tree planting known by such names as village forestry, local community forests, village woodlots, and urban fuelwood plantations. However, no significant progress was made in getting rural communities to adopt more efficient fuelwood stoves. Worse still many of the tree planting initiatives at both the local community and central government levels failed. Gradually the focus returned to industrial roundwood production, processing and trade.

In the recent past, international initiatives related to increased democracy, property rights and good governance alongside economic reforms to revamp ailing economies in most of Sub-Sahara African countries have seen another shift in forestry towards local communities. This time the focus is on devolving, from central government, the management of the natural forests to the local communities and that of the plantation forests to the private sector. The aim is to decrease central government involvement in primary forest production, wood processing and trade. However, central government remains the custodian of national forestry policy and legislation.

The incorporation of local communities in managing natural forests is very challenging. Firstly, we do not have sufficient information to guide management of these resources to meet not only the myriad of the needs of these communities, but also those of other national stakeholders and the international community. Secondly, the natural forests have to be managed and used in the overall context of rural development. The implication is that whereas in government the focus was geared towards forestry sector goals, at the rural community level an approach that integrates forestry with other rural livelihood options is essential. The local communities are primarily engaged in agriculture and livestock husbandry. The forests supply key basic needs such as those related to energy, habitat construction, pasture for domestic animals and wild foods. There are other sources of livelihood including off-farm employment and small businesses. The challenge

facing rural development planners is that of planning natural forest management in the context of all these livelihood options.

Thirdly, the countries in the region have been implementing economic reforms known as structural adjustment programmes (SAPs) and largely backed by foreign financial institutions. These reforms started to be implemented in Malawi, Tanzania, Mozambique and Zimbabwe in respectively 1980, 1986, 1987 and 1991. These reforms are ongoing but in the form of Poverty Reduction Strategy Programmes (PRSPs). The latter aims to correct shortcomings of the SAPs, specifically in the provision of social services and ensuring community involvement in the development process. The PRSPs then define the environment for natural forest management.

The above three observations dictate a shift in both thinking and conduct of forestry business. More attention has to be given to the management of the more abundant forest resources in our countries—the natural forests, and not the plantations—and in the context of integrated rural development. This is a serious challenge since forests in this region have not been managed this way.

This book is very timely because there is increasing desire by central governments to devolve ownership and management of natural forests to local communities as well as to use these resources as one of the measures to alleviate rural poverty. The book is a compilation of results of research that attempts to shed light on these issues, specifically providing information and tools that have potential to guide planning and sustainable management of the vast woodlands in Southern Africa. By first taking stock of the way the communities are 'managing' this resource, the problems they are facing, and other relevant issues, the book provides insights on what we can build on. Further, the book provides us with a good account on how the forestry sector has evolved and how it can evolve in the present socio-economic environment. This provides us with potentially useful scenarios for planning as well as alternative forest management options.

However, as one of the initial efforts in this direction, the book opens up challenges to scientists and practitioners to repackage some of the information for immediate use as well as to do more to bridge the gaps identified by this research.

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1.
The challenge to natural forest management in Sub-Saharan Africa rural development: Experiences from the miombo woodlands of Southern Africa

G. Kowero

1. A BRIEF OVERVIEW OF NATURAL FOREST ESTATE AND MANAGEMENT IN SUB-SAHARAN AFRICA

Forest resources have significantly contributed to the economic development of many developed countries, like Finland, that are richly endowed with them. One would therefore expect the vast forest resources in many Sub-Sahara African (SSA) countries to present opportunities to further economic development on the sub-continent. According to FAO (2001) Africa has about 650 million hectares of forests (almost all of it located in the tropics) or 0.85 hectares per capita (very close to the world average). This represents about 17% of the world forest resources. About one percent of the forest estate is plantation forest. These forests are distributed as follows: Central Africa (56.5%), Southern Africa (30.0%), East Africa (23.0%), Africa- Small Islands (20.1%), West Africa (11.6%) and North Africa (1.0%). The net change in forest area is the highest in the world, estimated at -0.78% annually or a loss of 5.3 million hectares per year.

However, as noted by FAO (2001), most of the natural forest estate is not under any known management plan. National level information on the forest area covered by a formal nationally approved management plan continues to be scanty on the sub-continent. While undertaking the "Global Forest Resources Assessment 2000", FAO (2001) reports that only 3 out of 16 countries in West Africa could supply such information. Virtually none of the countries in Central, East and Southern Africa supplied full information; several had partial information. However, many countries have management plans for some of their natural forest reserves and wildlife management areas. The picture is that of large unmanaged tracts of natural forest resource in SSA that we do not know much about, but which support the bulk of the SSA human and

animal population as well as economic growth. In other words, SSA continues to face a daunting challenge of how to manage and conserve about a quarter of its land area that is wooded or forested in the face of increasing demands for land for agriculture and livestock production, infrastructure development and specific demands on these forest resources for energy, construction material and other livelihood needs.

More than 70% of the population in Africa lives in rural areas and depend very much on these resources. The urban population is directly and indirectly linked to these resources in terms of water and hydroelectricity supplies, fuelwood, food, medicines, construction timber and furniture. Of the 28 countries in the world in which forestry contributes at least 10% towards the national gross domestic product, 18 are in Africa (Kowero *et al.* 2001). Sub-Saharan Africa has 47 countries, 46 classified as developing, of which nineteen feature among the 25 poorest countries in the world. Only the Republic of South Africa is industrial (TAC Secretariat 2001). Of the 626 million inhabitants of SSA, 61% depend on agriculture and 34% are undernourished (FAO 2000a). In the period 1977-97 agricultural production grew at an average of 2.7% per year while annual population growth in the last three decades has been at between 2.4 and 2.9 % (FAO 2000b). Population growth has in most cases outpaced growth in agricultural production. This has increased hunger, poverty and environmental degradation. The increasing human population pressure has led to overexploitation of the forests for both commercial and household products, and excising the forests for cropland. Further, increasing livestock pressure has led to overgrazing in forests, woodlands and grasslands. The human and animal population pressure continues to drain nutrients from forest soils, exacerbate soil erosion, accelerate water run-off, and increase siltation of rivers and dams, among many other adverse effects. Apart from human and animal population growth, other factors that contribute to the deforestation of African forests include fires, urbanization, mining, road infrastructure, droughts, floods, settlements for migrating people, and conflicts. Commercial timber logging generally leads to forest degradation when it is selective, but its supporting infrastructure often leads to deforestation. There is growing and undeniable evidence of the negative impact of natural forest degradation on the livelihoods of the rural poor and the environment at large.

The forests are therefore an integral part of the economic, social, cultural and spiritual life of many Africans. This realization has ushered in new approaches and challenges to economic development with forest resources being an integral part of rural development. However, the links between sustainable use of natural forest resources and poverty reduction are not always well understood among development professionals and policy makers. While forest conditions affect opportunities for national development, the development process shapes what these forest conditions are, and what they will become. The use, development, and conditions of forests are fundamental consequences of the wider configuration of national policy and economic development. National development is constantly creating incentives and capacities to exploit and enhance forest resources. Economic growth and social conditions tend to shift the location and composition of forest resources. Understanding how national policies affect forests provides the basis for achieving desired types of forest conditions, including the aggregate contributions they provide, and the required trade-off with other national objectives.

Another development in SSA is the increasing shift away from the centralised and state-driven forest and woodland management of the colonial and post-independence

periods towards decentralised, and mainly community-based regimes. This move is part of the very much externally driven democratization process on the sub-continent that, among other things, encourages peoples' participation in decision-making. We see more involvement of local communities and private sector in natural forest issues, although on the ground SSA has a long way to go in getting these two stakeholders to manage a significant part of its natural forests. Forestry is gradually shifting from a practice with trees or forests at the center to a people-centered practice. This has therefore introduced a new challenge to the conventional way of managing forests, with the trees and industry at the center.

2. THE MIOMBO WOODLANDS OF SOUTHERN AFRICA

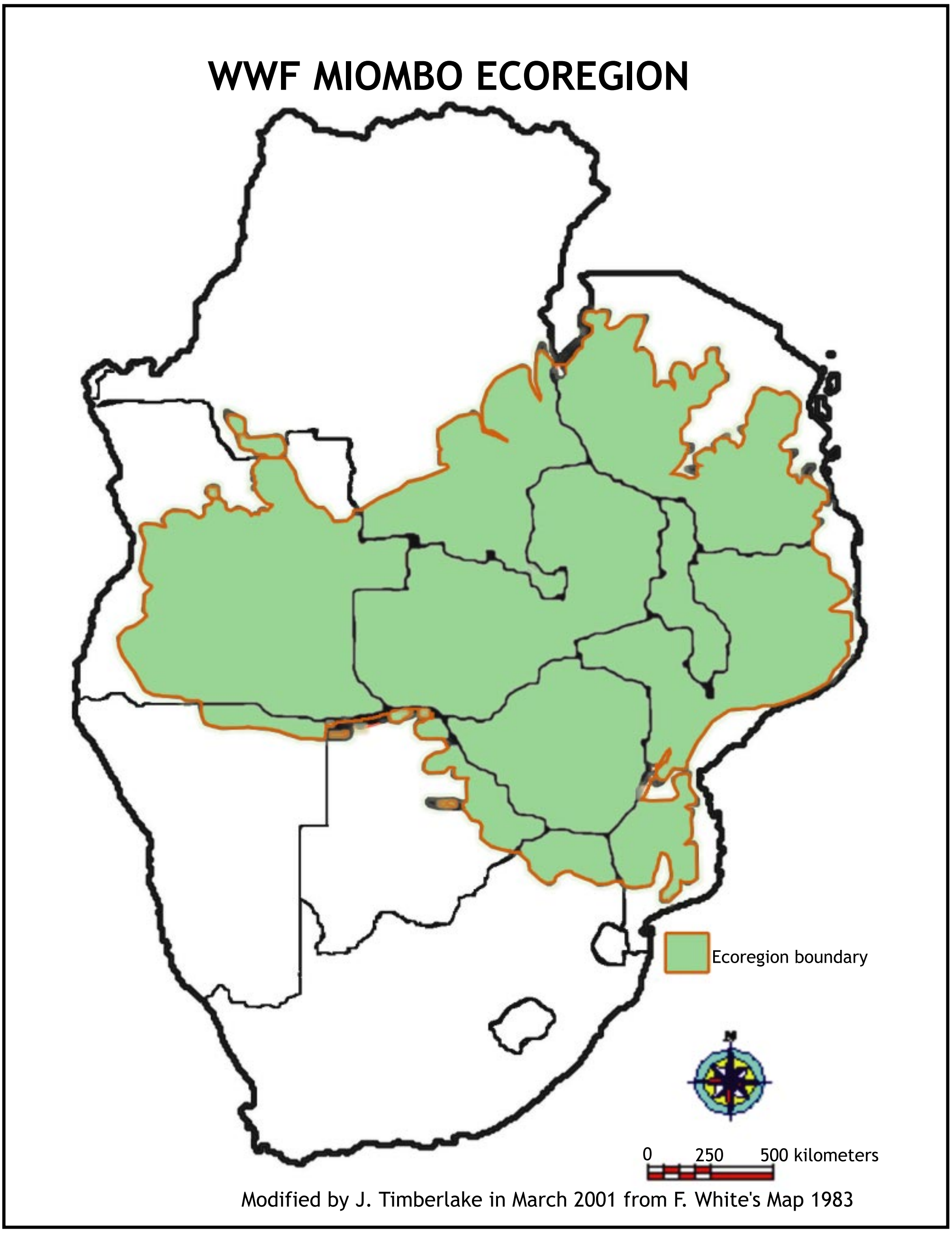
This book is based on research on the miombo woodlands of Southern Africa that evaluated local community participation in natural forest management as well as how macroeconomic policies and sectoral government policies have shaped forestry and their potential for guiding forestry interventions in rural development. The lessons learnt from the miombo woodlands could be of use in guiding the management of other natural forests. Miombo woodland is one of the most extensive dry forest vegetation types in Africa occurring in seven countries in eastern, central and southern Africa; namely Angola, Malawi, Mozambique, Tanzania, Zaire, Zambia and Zimbabwe (White 1983). They occupy an area of about 2.7 million square kilometres, almost equal to the combined land area of Mozambique, Malawi, Zimbabwe, Tanzania and Zambia. Miombo woodland is dominated by the legume family Caesalpiniaceae with the most important tree species being those of *Brachystegia*, either alone or with *Julbernardia*, and *Isoberlinia* (Celander 1983; Lind & Morrison 1974 ; White 1983). The miombo *sensu stricto* is therefore dominated by tree species in the sub-family Caesalpinoidea of the Leguminosea family.

In a recent treatise commissioned by The World Wide Fund for Nature (WWF) (WWF-SARPO, 2001), the miombo has been defined as an ecoregion complex (see Figs. 1 and 2) dominated by the miombo *sensu stricto* and related dry woodlands, namely the *Baikiae* and *Colophospermum* woodlands which are slightly less dense but function similarly in an ecological sense to the miombo *sensu stricto*. Interestingly enough, the two genera *Baikiea* and *Colophospermum* are also in the sub-family *Ceasalpinoidea*. Taken together, the ecoregion is home to the largest remaining 'herds of large mammals valuable for tourism', protects the catchments of Southern Africa's great rivers, and play a significant role in the hydrological functioning of the region and by extension a major component of the life support system to the 120 million people of Southern Africa of which some 70 million interact with and influence the miombo ecoregion. Its grass and herb dominated under-story is the bedrock of the livestock industry and its nutrient cycling function has underpinned traditional shifting cultivation agriculture which has been rendered ecologically unsustainable in a number of places within the ecoregion, by population pressure, lack of land for shifting cultivation and therefore much shorter fallow periods than before.

The potential for these woodlands in socio-economic development of the miombo eco-region has scarcely been exploited and yet the woodlands are rapidly being lost through:

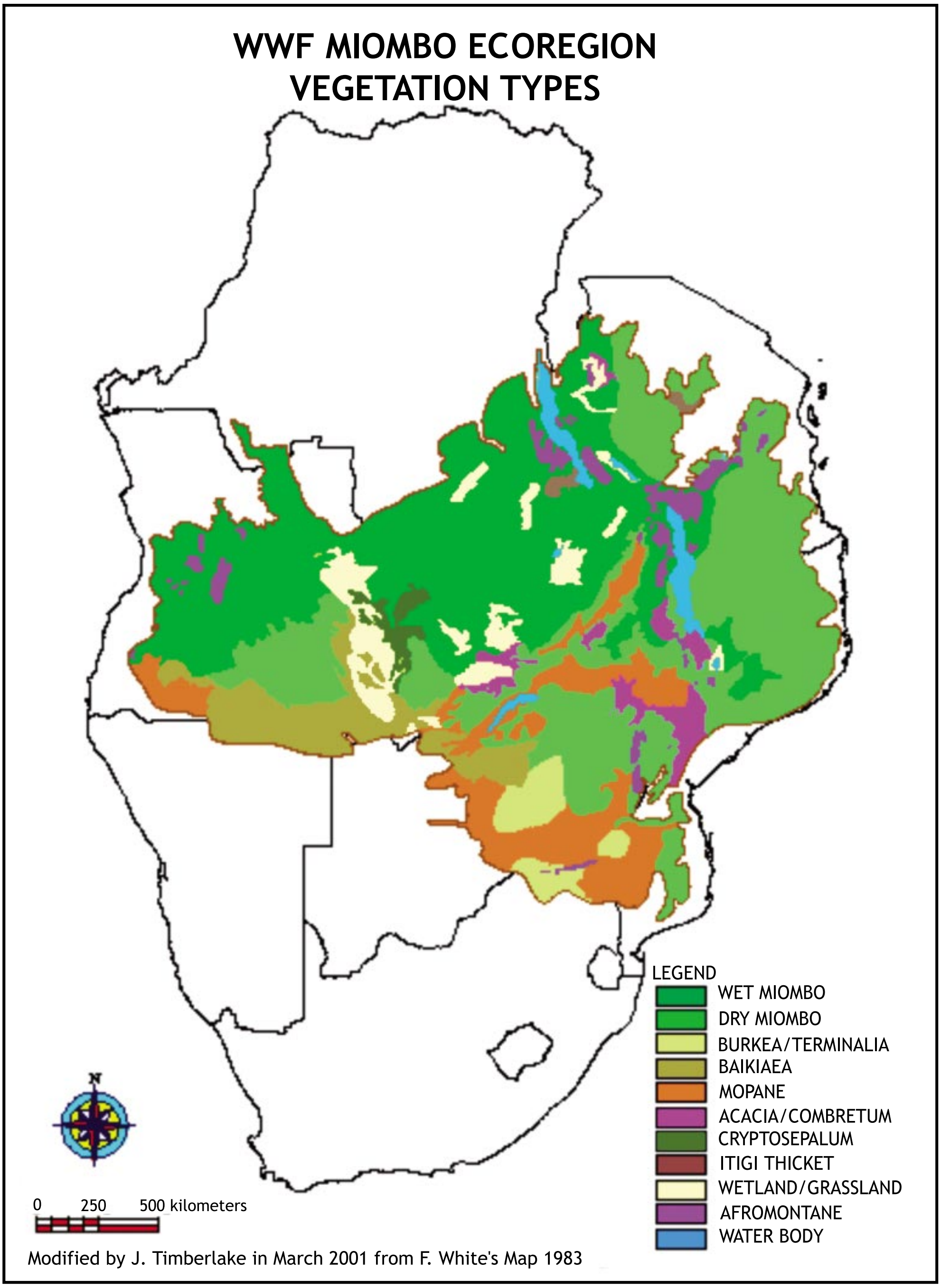
- agriculture expansion, the leading cause for deforestation,
- overgrazing that reduces the quality of the woodlands,

Figure 1. Miombo Ecoregion Boundaries



Source: WWF-SARPO (2001)

Figure 2. Miombo Ecoregion Vegetation Types



Source: WWF-SARPO (2001)

- fuelwood collection that impairs the quality of the woodlands and has resulted into massive deforestation especially in areas where charcoal production is prevalent,
- over-exploitation of important tree and animal species and
- uncontrolled burning that is increasingly becoming a feature of the woodlands.

All these combine to rapidly diminish the quantity and quality of the woodlands.

The critical factors that shape socio-economic developments based on the woodlands include:
- poor soils that limit nutrient availability,
- low and erratic rainfall,
- low value woodland products,
- inadequate knowledge on the functioning of the woodland,
- increasing human and animal populations,
- declining agricultural potential,
- high incidences of HIV/AIDS, malaria and other diseases in the ecoregion, and
- increasing poverty.

The implication of these features is that even if the woodlands were to give way to agriculture, as they might eventually do, crop production shall be constrained by inadequate and unreliable rains, as well as inadequate agricultural inputs to the poor soils due to extensive poverty. The low value of woodland products could constrain woodland conservation. The high incidences of HIV/AIDS and related pandemics hold potential to drastically alter the demography of the region, reduce agricultural production and increase poverty. Since human interventions in the woodlands are gender specific, changes in the demographics of the region might impact on the woodlands in ways that mirror the roles of men, women and children in these resources.

All these factors present tremendous challenges to rural development that could lift the rural communities in the miombo ecoregion out of poverty.

3. ORGANISATION OF THE BOOK

The first part of the book presents papers that summarise experiences with community based management of woodlands, and provides case studies of different facets of local governance related to woodlands. It considers how institutional arrangements change, the factors influencing change, the factors that lead to successful management of natural resources and conflict issues. Local community involvement in forest management has not been part of mainstream forestry - it is an important departure in terms of natural forest management, away from the allowable cut goal in management (largely targeted at the industry) to a goal that seeks to satisfy a myriad demands on of needs on these resources by many stakeholders.

The second and third parts of the book deal with the policy environment in which forestry business is conducted. This environment has changed substantially over the years. Most SSA countries have, in the framework of Tropical Forests Action Plans (TFAP), National Forests Action Plans (NFAP), Natioanl Environmental Action Plans (NEAP), Forestry Master Plans, National Forest Plans (NFPs) etc., revised their forest policies and/or forest laws and regulatory instruments that guide forestry development.

Further, due to declining economic development nearly all SSA countries embarked on economic reforms aimed at turning their economies around. These started in the 1980s as Structural Adjustment Programmes (SAPs), which have now been reformulated as Poverty Reduction Strategy Papers (PRSPs). The latter take into account society wide issues that SAPs neglected and therefore contributed to the failure of these policies in terms of containing deforestation and poverty, among others.

The second part of the book provides a review of key land based sectoral policies, namely, land, agriculture and forestry, their evolution and how this shaped developments in forestry. This also explores gender relationships and roles in use of woodlands, and investigates how policies guiding economic development have differential impacts on men and women at the local level. The third part of the book takes this a step further by examining the potential impacts, on rural livelihoods and forest condition, of selected policy instruments in the sectoral policies as well as in the macroeconomic policies (i.e., in the PRSPs). This is done through modeling. The aim of both parts two and three of the book is to facilitate natural forest planning by provide tools for both natural forest planning and management.

We are comfortable with planning and managing forest plantations. There are standard texts, guidelines, and experiences that have guided this practice for decades in southern Africa. We have fewer problems with planning and managing industrial natural forests guided by the allowable cut principle. The forest industry has since the colonial times thrived on valuable hardwoods from the natural forests. The cutting cycle has guided management where these resources were and continue to be harvested legally. However, we have serious problems with managing natural forests for non-industrial purposes and with local communities as the main client.

The woodlands, unlike industrial plantations and forests, have numerous local users. Their demands and behaviour are quite different from that of industry. While the industry might demand a certain volume of wood per day or week, communities have varying demands on the woodlands and some are not on a daily basis like firewood, but are seasonal, like wild fruits. Also their dependence on the woodlands is partial while some industries depend fully on the resources for their survival. Further, many rural communities are agricultural, with both crops and livestock that take most of their labour and other resources.

This book provides insights on the compatibility, at the household level, of agriculture, livestock husbandry and woodland exploitation, the main household activities in the ecoregion. This way the book provides guidance on how to reconcile the demands of the three key stakeholders on the woodlands (the local communities, government and private sector) and guided by the three prominent rural development goals of food security, increased rural incomes and biodiversity or forest conservation. This way the book provides information and tools that could be used in planning rural development, by for example identifying the tradeoffs between the three goals and the potential implications of serious health problems like HIV/AIDS and malaria that constrain rural labour supply and impair agricultural production and other undertakings.

Further, the increased involvement of local communities in natural forest ownership and management has apparently been more at the rhetoric level and less on how this can be done and in a scientific way. Each of the stakeholders could manage the resource alone taking into account its area of comparative advantage, for example the government managing water catchment forests. Alternatively the stakeholders can manage the resources jointly. Stakeholders might wish to give more priority in

management to some goals in management, like biodiversity conservation. In other cases the forests might have to continue as open access resources. All this creates scope for different forest management options. The book provides information on how to select the most appropriate woodland management regime and this is illustrated by case studies that have employed a system dynamics approach to the problem. In this way the book sheds light on the suitability or desirability of decentralization or devolution of ownership and management of the woodlands from central government to rural communities and private sector. It does so by highlighting the potential implications of each management regime on employment creation, woodland area converted to cropland, proportion of woodland that is eventually managed on a sustainable basis, and benefits to each stakeholder from the woodlands, agriculture and livestock production, and off-farm employment, among others.

As a whole the book is written for various audiences. Those interested in local institutions and governance issues can be contented with Part I, while those interested in policy analysis will find Part II and Part III more appealing. Academicians and researchers shall find the models exciting, while policy makers shall find the summaries for Part I, II and III and the text in general useful. The lay reader will find most of the text easy to follow.

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2.
Overview[1]: Institutional arrangements for managing woodlands

B.M. Campbell, S. Shackleton and E. Wollenberg

1. HOW IS DEVOLUTION FARING?

This section touches on how natural forest resources are being managed at the local community level, in what is popularly known as community based natural resources management (CBNRM). Case studies were made on CBRM projects in Malawi, Tanzania and Zimbabwe, with additional material derived from another five countries. There are undoubtedly some notable successes in CBNRM. Emerging results from Babati in Tanzania, suggest that the shift of control from central government to local communities has seen a turn around in the resource base, from degraded and overused woodland to regenerating woodland with a set of rules governing use (Chapter 3).[2] CBNRM in Tanzania builds on the rather unique and favourable local situation in that decentralized government allows the village to own property in its own right as a corporate entity. For Malawi, success in the regulation of uses and users is not universally associated with any particular type of property rights regime.[3] Communal property, private property and government property have all been associated both with success and failure – a simple one-to-one relationship between property regimes and outcomes is not apparent.

Despite the successes, we suggest that there is a fair degree of misplaced optimism about common property resource (CPR) systems.[4] In investigating common property issues for woodlands in communal areas in Zimbabwe, where people rely heavily on woodland resources, we are struck by the numerous case studies showing a breakdown of local institutions for CPR management (Chapter 4), and the lack of any emerging alternative institutions for such management. Weak or weakening local institutions is a theme running throughout the research papers. There are a number of contributing factors to this phenomenon, including the lack of an enabling policy environment, household strategies of poor people with few alternatives but to exploit woodlands unsustainably, marked and increasing differentiation of households within communities

which places pressures on CPR institutions, lack of legitimate local institutions, and various features of the resources. There is not much evidence to suggest that moving the locus of governance closer to the people means that resource management is more cost-effective. Communities will need similar levels of inputs to those required by other stakeholders in order to effectively manage natural resources, and there will be considerable transaction costs.

We argue that the formal rule-based systems which form the cornerstones of proposed CPR systems are far removed from the current institutional systems, which are based on a complex of norm-based controls, the formulation and enforcement of which are steeped in subtle and elaborate processes. For example, resource use boundaries for local management remain a thorny question – while the literature espouses clear boundaries and clear user groups, in reality this is often impossible to achieve. We suggest that advocacy of CPR and CBNRM systems has to be tempered with critical analysis.

2. DEVOLUTION AND THE ROLE OF CENTRAL STATE

Devolution involves the transfer of authority over natural resource decision-making and benefits from central state to local actors. The state, however, has a number of important roles (e.g. including protecting wider 'public goods' {watersheds, biodiversity, carbon sinks and other ecological services}, facilitating and regulating private activity, mediating conflict). We recognise these roles but question whether in practice a balance has been achieved between local and 'wider' interests and objectives in implementation. Too often the notion of conservation as a 'public interest' area or the need to achieve national economic development goals have been manipulated to serve the interests of NR departments and to legitimise their actions, usually to the detriment of local livelihood systems and the real choices available to people. Overall, the case studies showed that, despite rhetoric to the contrary, central authorities continued to drive the NRM agenda.

3. HAS DEVOLUTION WORKED FOR LOCAL PEOPLE?

In many cases, local people's views were that devolution policies had yielded only limited benefit for them. However, in addition to the material benefits, devolution also indirectly provided other benefits. Local people previously considered poachers, criminals and squatters were now seen as legitimate resource users in a number of sites. Donors, NGOs, government service providers and, in some countries, the private sector consequently took more notice of these users and provided assistance to them including technical, managerial and community capacity building, small enterprise development (e.g. bee keeping in Malawi, tourism ventures in Namibia). Devolution opened channels for rural dwellers to communicate their priorities to government decision-makers and in some places improved community-government relations (although in many sites suspicion continued to exist).

Can sustainable forest management succeed without linking it to improvement in agricultural productivity and to the constraints and opportunities offered by the wider economy? This is a thorny issue – as researchers and development practitioners interested in forests we may be moving in a limited direction – forest-based activities are only a small part of a wide livelihood portfolio.

4. THE ORGANISATIONAL FOUNDATIONS OF DEVOLUTION

The types of organisations that exercised 'local' authority (through devolution) and the direction and degree of their accountability had a strong influence on whether the outcomes of devolution policies were favourable for local people or not.[5] One organisational model that proved favourable was that involving corporate, legal organisations composed of all rights holders/residents, e.g. Trusts (Botswana), Conservancies (Namibia), Communal Property Associations (Makuleke, South Africa), Villages (Tanzania), and Range Management Associations (Lesotho). Since the foundation and legitimacy of these organisations were derived from the community itself, interference by the state was less pervasive (than in other arrangements), but the state still retained ultimate authority and continued to make decisions with negative impacts on local interests.

5. HOW HAVE DIFFERENT ACTORS INFLUENCED OUTCOMES?

At many study sites, parallel hierarchies of traditional leadership, local government and line department-sponsored committees existed. Often these had unclear or overlapping jurisdictions and mandates in NRM that led to institutional conflict and struggles for power (Chapter 5). In other cases, the influence of government and local elites over joint committees was strong and community representation and input severely diluted. NGOs, donors and the private sector further shaped outcomes by allying themselves with particular local groups or government officials. The "communities" in "community-based natural resource management" seldom exist in any simplistic sense. Internal differentiation in resource endowment within communities is the rule; thus it is necessary from the outset to use tools to identify the various groupings within communities. There are also numerous overlaps in membership of interest groups, often with conflicting and competing interests. Considerable effort needs to be made to understand the institutional context of CBNRM schemes, as context is likely to determine the success or failure of particular schemes.

5.1 National policy makers

The degree of policy support for CBNRM varies widely amongst southern African countries. In addition, within a country some policies may be supportive of local control while others may not (e.g. compare the wildlife and forestry policies in Zimbabwe). For effective CBNRM, it is believed that most rights should be devolved to the lowest level.

5.2 Traditional leaders

In almost all the sites, traditional authorities continued to play a role in NRM with varying degrees of legitimacy and control. In some countries, chiefs asserted disproportionate power as chairpersons of sub-district NRM structures and diverted some CBNRM benefits to building their own power base. On the other hand, the exclusion of traditional leaders from committees in other sites was counter productive resulting in conflict and delays, until these leaders were co-opted onto the committees (Chapter 5). In several cases, traditional leaders were provided an ex-officio or non-executive role (e.g. as patrons) on committees (e.g. Namibia). In others, such as

Malawi, the NRM committees reported to traditional leaders who remained external to the committee. Another model was to leave communities to decide whether or not to elect hereditary leaders onto local committees. Where traditional leadership was strong and legitimate it had positive impacts in promoting local people's priorities. Where it was weak or biased towards certain ethnic groupings, lineage leaders had little support or role in new NRM structures.

While local traditional structures have been important in regulating resource use in many countries, the fabric of rural society is undergoing rapid change, much of which is impinging negatively on traditional structures (Chapter 4). The rapid changes have also seen a rise in individualism and reduced community-related activities (reciprocity, communal work parties). There is a history of empowerment and disempowerment of these institutions. Despite their weakening role, they generally remain as a crucial component of CBNRM.

5.3 Local government

Like traditional leaders, local government had a mixed role in promoting positive outcomes for local people from devolved NRM. Some cases showed that local councils often served as a source of competition with users for control of resources and revenues (e.g. CAMPFIRE in Zimbabwe), and challenged institutional arrangements devised by communities, compromising local priorities. On the other hand, where district or local councils had little involvement in devolved NRM, community-based organisations came to operate in isolation of broader district level planning processes often to their detriment (e.g. Botswana). In these cases, to ensure local and district political support of NRM committees and the integration of CBNRM into regional and district development plans, it is necessary that community-based organisations mesh within local government structures and development processes.

5.4 Non-governmental organizations (NGOs)

NGOs played an important facilitatory and capacity building role in many of the cases, helping to bridge divergent views between local people and government agencies and manage conflict within or among communities (Chapter 5).[6] In some countries government departments used NGOs as project implementers. NGOs generally displayed greater commitment to empowering communities than state agencies and worked better to integrate the development needs of local people with NRM concerns. The influence of NGOs was not, however, always positive for local people. NGOs sometimes sided with the state or created dependency rather than empowerment. Moreover, as local people's representatives and gatekeepers to the world, NGOs sometimes pushed communities into decisions they may have not necessarily taken.

5.5 Donors

Funding from donor agencies was critical in financing the development and facilitation of devolution. Donors often attached conditions to their funding, forcing governments to review their policies and practices to favour local needs. In most countries, donors, together with NGOs, were instrumental in driving the agenda towards greater local

control. In some places an unhealthy reliance on these external funds was created, resulting in the collapse of initiatives when funders withdrew.

5.6 Private sector

The private sector played a key role in income generation in some devolution initiatives. Private operators provided capital, expertise and market access. There were, however, many examples where local people benefited little from private sector involvement, particularly where the state continued to capture revenues or make decisions regarding private sector involvement. Another class of entrepreneurs included those who used local NRs but paid no resource rents (e.g. woodcarvers, firewood, charcoal and medicinal plant traders, and traditional healers). These powerful actors tended to ignore local regulations and controls, undermining the authority of community institutions and appropriating the resource base at the expense of local community members. Such entrepreneurs posed one of the greatest threats to local NRM in Malawi, where major conflicts existed between outside entrepreneurs and local people (Chapter 5). The government attempted to assist the community to control this illegal use through roadblocks, fines and seizure of products, but with little effect.

5.7 Within-community interests and power relations

In cases where significant authority was devolved, local politics and power relations often intervened to prevent more democratic control. At most sites problems occurred because of local elites seizing control. In some locations, checks and balances were in place to ensure committee accountability to the community at large. For example, in Malawi a mechanism exists to remove committee members with whom the community is unhappy.

6. LOCAL CAPACITY: THE KEY TO MAKING DEVOLUTION MORE RESPONSIVE TO LOCAL INTERESTS?

The degree of organisation amongst poor resource users and their knowledge of their rights was a critical factor influencing devolution outcomes. Where local people were well organized and had alliances with NGOs or other influential groups, they managed to secure greater control and benefits. In this context, to have capacity building include ways of improving representation, accountability and transparency is important. Assistance should allow for diverse constitutional forms to exist providing certain democratic standards are met. Promoting pluralistic processes that involve and protect disadvantaged groups will be especially important. Issues of day-to-day management can then be left to users, once democratic decision-making is assured.

7. HOW CAN THE STATE PLAY A MORE POSITIVE ROLE AND MOVE DEVOLUTION FORWARD?

As the cases show, devolution policies have often had disappointing impacts on local livelihoods and the ‘space’ that communities enjoy to make their own management decisions. Though the explanations for failures varied from country to country, one consistent pattern was that state officials and local people had different expectations

of what devolution was supposed to achieve and how. The state's use of contractual agreements, regulations and organisations accountable to it as instruments of devolution allowed officials to impose their own constructs and modes of action on villagers at the cost of local self-determination. In its extreme, devolution has been abused by governments to cheaply extend control where it was previously absent, and to shift the locus of state control from NRM and production to the extraction of revenues.

8. CONCLUSIONS

- Most devolved NRM reflects some continuation of central government control and management over natural resources rather than a genuine shift in authority to local people.
- The ways in which local people realise the benefits of devolution differ widely and negative trade-offs, most felt by the poor, are common.
- States, communities and other stakeholders have different visions of devolution and its mode of implementation. A shared framework, more accountable to local livelihood needs and people's rights to self-determination, is required. Redefining issues of wider 'public interest' forms part of this process.
- Organisational models that devolve authority directly to disadvantaged resource users are more embracing of local interests and priorities than those that allocate control to higher levels of social organisation.
- More powerful actors in communities tend to manipulate devolution outcomes to suit themselves. Checks and balances need to be in place to ensure that benefits and decision-making do not become controlled by elites.
- Strong local organisational capacity and political capital enhance outcomes for local people by enabling them to mobilize resources and negotiate for better benefits. NGOs, donors, federations and other external actors have a key role in moving devolution policy and practice towards local interests.
- Different measures will be needed in different contexts. Most fundamentally, governments need to enable a situation where resource users have the rights and power to bring about a fair division of control, responsibility and benefits between government and themselves.
- There is much commercialisation of resources and the successful institutional models are generally those where the resource has high value. The subsistence, sacred etc values of resources are equally important in the miombo woodlands – how does one move forward in terms of the management of low value resources?

Successful cases are generally those that are somehow embedded within government structures – the cases where the management largely occurs outside the influence of the state can be very vulnerable to outside pressures. However, a balance needs to be achieved, because in state-facilitated cases there are many examples where NRM becomes top-down or is usurped by the elite.

ENDNOTES

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3.
Making community-based forest management work: A case study of Duru-Haitemba village forest reserve, Babati, Tanzania

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ABSTRACT
Tanzania, like most other developing countries in Africa, has in recent years been fighting a losing battle in trying to protect vast areas of woodlands and natural forests scattered around the country. Consequently, forest resources in the country have been subjected to increasing pressure of exploitation. The government capacity to protect forests and woodlands has progressively declined with reduction in budgets and retrenchment of workers, making forests and woodlands even more vulnerable and open to degradation than before. A question emerged in recent years as to whether the main model of natural resource management, involving protection by policing, is the appropriate way forward. These and other developments have led to a paradigm shift regarding natural resource management, where local communities living adjacent to woodlands and forests are required to protect and manage those resources. One model that has emerged and gained ground is Community Based Forest Management (CBFM) through which local communities are ultimately empowered to manage natural resources. The guiding principle is that local communities have the right to control and manage natural resources on their land. This builds on the rather unique and favorable situation in Tanzania where decentralized government allows the village to own property in its own right as a corporate entity. Thus communities in Duru-Haitemba adopted CBFM as a result of local discontent regarding the way the 9000 ha forests remaining in Duru-Hatemba was being managed by the government. This forest represents the only remaining tract of non-reserved dry miombo forest of any significance in an otherwise well settled and cultivated Babati District.

The Tanzania government had a long standing idea to gazette the area. Before that, the District Council had put the area under the District Soil and Water

Conservation Bylaw, which meant that any use of the woodland had to be with consent of district officials; a situation which led to restricted local use of the forest. This made local communities lose confidence in their own district administration. Through this discontent, an entirely different process emerged which allowed local communities in Duru-Haitemba to conserve and manage the woodlands adjacent to them. This is the basis of the present situation where eight villages are managing the woodland resources. The forest, which was in a state of acute decline, now has boundaries that are intact, and incursion is limited; flora and fauna are recovering; and the forest is managed and protected effectively at minimum cost. The key factor that has led to the observed success is community participation, in which there has been a marked degree of power sharing to the extent that communities have taken full responsibility and control of the resource. Furthermore, the government, as former manager, has become a technical advisor and watchdog. Ultimately, villages now legally own the forest reserve. Thus there is a clear definition of woodland resource boundaries, village bylaws valid in a court of law have been established, and there is security of tenure and sense of ownership. Empowerment has resulted in full control, access and use rights for the community and obvious benefits have been reaped by local people. A similar model could be adopted in other areas facing related problems.

Key words: Local community, sustainable forest management, empowerment, devolution, rules

1. INTRODUCTION

In most developing countries, substantial efforts have been directed towards putting natural resources under sustainable use and management. Unfortunately, this aim has been difficult to achieve through conventional approaches to natural resource management. Consequently, an entirely new paradigm emerged in recent years termed Community Based Forest Management (CBFM) where the ultimate goal is to improve forest management, to provide empowerment of local people and to contribute to rural development. Through this, forest management is expected to evolve out of the many difficulties that have often embraced the protection and management of forest resources in most developing countries like Tanzania.

Different actors in Community Based Forest Management have portrayed different perspectives, motives and interests which have led to varying construction of the meaning of CBFM. According to (Jeanrenaud 1997), arguments regarding CBFM can be drawn from several disciplines and regional experiences, such as biology, conservation, anthropology, ethnobotany, indigenous knowledge and human rights. The debate is dynamic and actors have tended to be eclectic in their rationale, hence weaving various arguments in sometimes ambiguous and problematic ways.

Some arguments focus on CBFM as a means to resolving the injustices of protected forest areas where local people were excluded from the land they had traditionally occupied and depended on for their livelihood. Generally, protection of forests through gazettement has several negative impacts. Communities occupying lands adjacent to protected forests frequently bear substantial costs as a result of loss of access while receiving few benefits in return. People in these communities have been noted to be poor, they lack political influence and they receive few government services (Mvena and Kajembe 1997). Also a large part of costs concerning the protection of biological

diversity are borne by those least able to pay for them, even though the benefits are increasingly being recognized as global (Wells 1992).

In Tanzania, the central tenet of forest management has inevitably come to focus on protection with a key actor being a forester who is expected to protect the forest. However, expecting that low paid forest guards, mostly recruited from rural areas, to effectively protect the forest resource from fellow villagers in need of forest products for basic subsistence is unrealistic (Kajembe and Malimbwi 1996). Furthermore, in the wake of declining budgets and retrenchment of workers, the capacity of government to protect forests based on this model has progressively declined (Wily 1995). More importantly, foresters in recent years have begun to question whether or not the "policing model" of forest management is the right way forward. These and other developments have led into a paradigm shift where the only viable alternative to forest protection is to make the local people living adjacent to forests, the guardians of the forest resource.

Due to this paradigm shift, most foresters have realized that solutions to problems of forest management lie in the very section of society which has traditionally been regarded as the "problem": the local people who use forest resources. More effective, cheaper and lasting approaches are essential to sustainably managing the forest resources.

Under the right conditions, such as an appropriate legal framework, right motivation, bottom up interventions and clear definitions of property and tenurial rights, the local people have much potential to become the strongest and most cost effective guardians of forest resources. In the process, the government policing function has to cease, in order to allow officials a chance to serve as technical advisors or facilitators. It is fortunate that the government of Tanzania and many other governments have started to change their overall outlook. The purpose of this paper is to highlight what has made CBFM at Duru-Haitemba Forest Reserve a success.

2. PROFILE OF DURU-HAITEMBA VILLAGE FOREST RESERVE

The Duru-Haitemba forest is typical dry miombo woodlands located within the Rift valley, about 20 km South of Babati township. The woodlands, with an area of 9,000 ha or about 90 km^2, represent the only remaining tract of non-reserved forest of any significance in an otherwise well settled and cultivated Babati District. They consist of a series of small woodland patches named after the adjacent villages.

The woodlands occur along a series of related high ridges of up to 1850 metres above sea level. The ridges undulate, and the peaks along them give an impression of being distinct hills. About 145 species of trees and shrubs including climbers and creepers have been identified in the Duru-Haitemba woodlands. The dominant species include: *Brachystegia microphylla, Brachystegia spiciformis, Julbernardia globiflora, Albizia versicolor, Brachystegia boehmii, Combretum collinum, Acacia nigrescens* and *Tamarindus indica*. There are eight registered villages adjacent to Duru-Haitemba forest (Table 1). All the villages were included in the present study.

Table 1. Socio-economic characteristics of the study villages in Duru-Haitemba

No	Village	No of sub-villages	No of house-holds	Population **	Entitled* village area (ha)	% of village area still forested	Village forest reserve (ha)	Forest area per house-hold	No of sub-villages with forest	No of village forest guards
1	Gidas	5	694	3445	4250	21	875	2.6	4	12
2	Bubu	4	355	2430	4690	49	2300	8.8	3	14
3	Ayasanda	5	326	2931	1660	30	500	1.4	5	10
4	Endanachan	4	445	2503	2130	21	400	1.1	3	4
5	Riroda	9	705	4506	4610	38	1800	1.8	8	34
6	Endagwe	6	501	3112	4300	28	1220	2.6	6	12
7	Duru	5	308	2816	3720	35	1500	2.7	5	15
8	Hoshan	3	402	3520	2290	17	400	1.2	3	6
	All villages	41	3726	25253	27450	32	8995	2.4	37	108

* Entitled village area includes the forest.
** The population is for the year 2000.
Source: Field data and Wily 1996.

3. CBFM INITIATIVES IN DURU-HAITEMBA VILLAGE FOREST RESERVE

3.1 Establishment of local control and rules

As one of the few remaining tracts of miombo woodlands in Babati District, Duru-Haitemba forests had been targeted for gazettement into government forest reserve in 1990/91. In 1992 the Swedish-funded Regional Forestry Programme facilitated implementation of an inventory, survey and boundary demarcation process as a prerequisite for formal gazettement. However, the programme faced local discontent. Indeed the process and the attempt to withdraw the forest from public domain into the hands of government by gazettement was the catalyst to find a more acceptable, workable regime of management (Wily 1995). After a long process of dialogue, the decision was made to abandon gazettement in favour of assisting each of the eight villages to take full rights and responsibility for conservation of the forest. Today, a number of young men, serving as village forest guards are patrolling the forests against breach of the conservation rules each village has developed.

The rules for the forests include the following: First, there are rules banning various activities. Banned activities include:- Charcoal making; setting fire to the forests or grasses; felling any reserved tree species such as *Pterocarpus angolensis*; ring barking of trees for making beehives; house construction within the forest and farming and grazing within the forests. Second, certain activities may only be done with a permit from the village forest committee. These include entering the prohibited zone for any purpose other than passing through; cutting and collecting poles, rafters or withies for house construction; collection of stones for building; collection of herbs, roots or other plant parts for the purpose of producing and selling medicine; felling of unprotected species for the purpose of producing domestic tools or utensils such as hoe

and axe handles, pestles and mortars; and felling and pit sawing of trees for community service such as making school desks. Third, there are rules for freely permitted activities. These include:- collecting dry wood for fuelwood; cutting of sticks for making tooth brushes; collecting wild fruits and vegetables; collecting leaves or other plant parts for home medicine, provided the collection does not lead to mortality of the plant; seasonal grazing; collecting grinding stones; inspecting beehives; and entering the forest for recreational purposes.

These conservation rules were formally approved by the full Babati District Council (BDC) in mid 1995 under the District Authorities Act as village bylaws, thus formally recognizing the role of each village as the sole authority over the use and management of its Village Forest Reserve. This allowed the village to levy fines upon offenders. Each village is the legal authority and manager of that part of Duru-Haitemba forest which is adjacent to its own settled village area (Wily 1996).

3.2 Background to the success of CBFM at Duru-Haitemba

CBFM initiatives at Duru-Haitemba represent an exciting development within the forestry sector in Tanzania and have also served as inspiration for communities both within and beyond Tanzania. The CBFM initiatives at Duru-Haitemba are an example of devolution and democratisation, the desire being to give the local people a say in the governance of their natural resources. CBFM in Duru-Haitemba was prompted by local pressures.

Development experience has clearly indicated that centralized solutions to environment and development have not worked (Agrawal *et al.* 1999). Blueprint development strategies in the shape of standard technical solutions have been ineffective in meeting the needs of the poor, marginalized and less powerful groups. CBFM initiatives in Duru-Haitemba have shown that approaches that take people's aspirations more seriously can enjoy local success.

The observed success of CBFM in Duru-Haitemba can be attributed to the following factors: clearly defined boundaries; congruence between rules and local conditions; good collective choice arrangements; elaborate conflict resolution mechanisms; clearly defined resource property rights; the rights of villagers to devise their own institutions that are not challenged by external government authorities; and villagers' ability to develop a common pool resource institution where the benefits to be gained from collective action are greater than the opportunity costs.

3.2.1 Clearly defined boundaries

The study showed that all the villages in Duru-Haitemba have secure boundaries which give the villagers powers to take action against anybody who violates their rules. Duru-Haitemba forest had never been gazetted Forest Reserve. However, by the 1980s it was fully intended to be gazetted as forest reserve. To this end it had been surveyed and demarcated and all but the publication of Reservation document was complete. Thus beacons were on the ground. In most cases, boundaries had been marked by natural landmarks such as hills and rivers. In a few villages, boundaries were demarcated artificially. Since the Duru-Haitemba Forest is standing as the only remaining meaningful forest in a heavily depleted land, it has easily identifiable boundaries. Coupled with regular patrols by the village guards and application of strict village by-laws, the people in Duru-Haitemba uphold the boundary system.

Boundaries for common pool resources (CPRs) need to be clearly defined for the benefit of owners and to facilitate collective action. Owners of a CPR will have their confidence and security of tenure enhanced if limits of their jurisdiction are clearly defined. In this way they are not afraid to invest in the CPR due to the fear that their investment can be expropriated by others. Where security of tenure is not secure, outsiders can deplete the resource because they have nothing to lose (Ostrom 1996; Kajembe and Kessy 1999).

3.2.2 Congruence between rules and local conditions

Village governments in Duru-Haitemba have worked out rules that clearly define appropriation and provision and these rules have facilitated improvement in protection and management of the village forest reserve. The establishment of these rules is in accordance with the Village and *Ujamaa* villages Act of 1975 that gives powers to villages in Tanzania to make rules in the form of bylaws recognized in a court of law (Kihiyo and Kajembe 2000). Before rules were instituted, the village government organized an inventory of the forest reserve to assess and take stock of the resource. Thereafter rules were put in place to control exploitation. One main principle applied through these rules is that the volumes being harvested annually must not exceed the mean annual increment realized in the forest.

3.2.3 Collective choice arrangements

All eight villages around Duru-Haitemba Forest Reserve maintain strong and effective Forest Committees which are responsible for rule enforcement. The composition of Village Forest Committees has steadily shifted from village leaders to ordinary villagers representing their sub-villages. Most decisions concerning the forest are made through, or with the guidance of these committees. This is democratization at the local level which has arisen from a growing need for accountability as practical management gets underway (Wily 1996). The CBFM approach in most of the eight villages is to adopt a management strategy based upon geographical and political divisions in the village such that, each registered sub-village looks after that part of the forest to which it is adjacent. Also each village manages a part of the forest which had traditionally fallen within its village boundaries. To that effect, demarcation of the village areas has been undertaken, often with disputes resolved by arbitration. The forest has also been zoned in its entirety into sustainable use zones, grazing zones and protection zones all indicating precisely where cattle could be grazed, which areas could not be used at all by the villages, and which areas would be available for sustainable use (Wily 1996). With the exception of grazing, villagers use only the forest of their own village, which indeed is often the area of the forest that falls within their own sub-village.

The village is the obvious active manager of the local forest; it is engaged in preventing activities that have been declared illegal, issuing a limited number of permits for sustainable uses, patrolling and rehabilitating the degraded forest parts. It is crucial therefore that the villages have legal backing to support administrative decisions on collective choice arrangements through which leaders and ordinary villagers have decided to discontinue any uses which are considered damaging. Thus charcoal burning, tree felling and even grazing in some parts of the forest have been banned. Other forest uses are controlled through strict conservation and protection regimes in

order to ensure that individuals follow the rules. Enforcement by village forest guards is practised.

These village forest guards protect the forest against both non-villagers and offenders from within the village. These are duly selected by each sub-village and operate on a patrolling and reporting regime. Offenders who violate operational rules are subjected to graduated sanctions; the levels depending on the seriousness and context of the offence (Ostrom 1996). Offences such as encroachment for agriculture or settlement establishment, pit sawing, charcoal making and a range of destructive activities carry heavy punishment in the form of a heavy fine or confiscation of valuable property. Lesser destructive activities such as unauthorised firewood collection carry lighter punishment. Marrow and Hull (1996) also state that graduated sanctions are common in long enduring common pool resource institutions to allow flexibility in the system. Based on this it is prudent to treat with leniency a person who is normally a rule abider but due to dire need has committed an offence. The contrary applies to a frequent offender who has shown little allegiance to the rule structure of the institution. The planning and implementation of most of these forest-related activities in each of the eight villages is through Village Forest Committees.

These committees comprise men and women, with gender representation differing between villages (Table 2). The presence of village forest committees and patrolmen has led to a significant reduction in the number of offences in each village. The number of patrols conducted at sub-village level ranges from one to four per week. Most of the offences at Duru-Haitemba relate to grazing and encroachment for expansion of farmlands. Respondents also indicated improvement in the relations between forestry staff in the district and local communities as a result of paradigm shift where foresters have changed from *policemen* to facilitators or technical advisors.

CBFM has improved group cohesion and provided a platform for other development activities in the villages. It has also promoted local capacity by forging new social relationships and redefining old ones. Forest management by consent has proved to be effective and can serve as a model for other parts of Babati District and the country

Table 2. Membership in village forest committees in Duru-Haitemba villages

No	Village	Total number of members	Male	Female
1	Gidas	13	11	2
2	Bubu	9	6	3
3	Ayasanda	9	6	3
4	Endanachan	16	14	2
5	Riroda	12	8	4
6	Endagwe	8	5	3
7	Duru	8	8	0
8	Hoshan	9	6	3
	Total	84	64	20

Source: Field data.

at large. Indeed, policing the forest reserve by consent was observed in all the eight villages, where it has created better enforcement of rules. An example of management by consent was noted through the system of fines that does not spare both patrolmen and ordinary villagers. Patrol teams are exempted from other village communal activities such as local road maintenance and building local schools. However, failure to participate effectively in patrolling the forest, subjects the patrol staff to a fine just like any other villager who fails to participate in other development activities.

3.2.4 Conflict Resolution Mechanisms

It was observed that, at the village level, local conflicts are resolved through reconciliation committees. These are recognized by the formal village bylaw and are constituted at the village level through involvement of village elders who are perceived as the wise persons in the community. The village chairpersons serve as heads to these committees. In the event that traditional laws fall short in addressing certain conflicts, formal by-laws are applied. These bylaws must be approved by the Minister responsible for Local Governments before they can be operational as per Tanzania Local Government Act of 1982 (URT 1982). The resolution of conflicts in the village setting is in accordance with the principle that proprietors and their leaders must have rapid access to low cost local areas to solve conflicts among the proprietors or between proprietors and leaders (Ostrom 1996). In the study area the main conflicts were associated with competition for land use between farmland, grazing land and forest land. This involved villagers alone or with outsiders.

3.2.5 Resources users are clearly defined and are able to sustain legal claims as owners of the resource

Entitlement, the process of a community securing statutory ownership over their local land area, is a fundamental development policy within Tanzania (Wily 1996). The study found that all the eight villages in the vicinity of Duru-Haitemba had applied for ownership of their land that includes the traditional woodland areas. Title deeds have since been granted and therefore both through statutory local government regulation and through statutory entitlement, the eight villages of Duru-Haitemba are legal owners and managers of the Duru-Haitemba Forest Reserve. This has been made possible by the unique advantage Tanzania has over several other developing countries, in that villages in Tanzania possess the capacity to be registered as the grassroots' local level of government within the decentralized system. Consequently they exist as legal corporate entities with ability to sue and be sued and to own business and property as a local community (Wily 1996). Furthermore, a village in Tanzania is usually an integrated socio-spatial unit, with a defined group of households using land and resources only within a bounded, local area. The village has a formally recognized government that is a well-established mechanism of self-management and is a workable size for responsive and accountable decision making in the society.

Therefore villagers in Duru-Haitemba recognize themselves as a bounded local area, have clearly defined property rights over the resource and can exercise legal claims over the resource. Therefore they feel secure in their resource ownership and can protect their land from outsiders. In consequence they have been able to sustain long term objectives on the resource by investment through their labour and deferment

of current consumption in favour of long-term benefits by banning some consumptive uses. This is in accordance with Morrow and Hull (1996), who state that having legal title to the land is obviously a prerequisite for the villagers to define the boundaries of their forests as well as their legal rights to defend those forests. Also, security of tenure is necessary for development and survival of CPR institutions because proprietors have no incentive to invest in an institution to manage their resources if they believe those resources could be invaded by outsiders. If a CPR can be destroyed by the action of others, no matter what local proprietors do, even those who have constrained their harvesting from a CPR for many years will begin to heavily discount future returns (Ostrom 1996).

3.2.6 The right of proprietors to devise their own institutions is not challenged by external government authorities

Discontent began when the SIDA-funded Regional Forestry Programme introduced efforts to work with villages in and around the forest to encourage them to support gazettement and management of the then proposed forest reserve (Wily 1996). It was clear from the outset that the local people did not support the withdrawal of their forests into the hands of the government. Consequently they adopted a deliberate move to exploit the forests as fast as possible before its gazettement, such that by 1994 the forest was heavily degraded and encroached in many places.

Government tried to guarantee villagers some use rights but the local response did not suggest that gazettement would lead to effective conservation of the forest. Exploiting this potentially explosive situation, and with informal local support from the Babati District Council and the local Forest Officer, a consultant working for the SIDA-funded Regional Forestry Programme, started exploring if and how local communities could engage in conservation and management of the forests around them. No one envisaged that villagers would be enthusiastic and government officials were skeptical. The initial positive response from the local people convinced the government of suspending gazettement, pending assessment of whether villagers would cooperate and halt degradation of the forest. Eventually it was informally agreed that villagers could proceed, taking the responsibility of managing and conserving the forest.

Consequently the villagers became the ‘de facto’ controllers and managers of the Duru- Haitemba Forest Reserve. Based on these tentative and informal arrangements, the villagers launched a highly dynamic process of reviewing each and every aspect the forest management to determine just what was required to restore the forest and to keep it intact for future use. Simple but effective management plans were drawn up by each village, including “rules” for using the forest. Even forest uses that were considered indispensable before now became perceived as damaging and hence were completely banned. Village assemblies were convened in which all villagers debated and refined the plans. It was also agreed by the eight villages that the management strategy was to be based on geographical and political divisions in the village such that each registered sub-village was to look after that part of the forest to which it was adjacent. Demarcation of these areas was undertaken, sometimes with disputes. The forest was also zoned into use zones, defining core protected areas, and areas for controlled use.

Since then each village has maintained village forest guards to protect the forest from non-villagers and offenders from within the village. Today, encroachment, pit

sawing, charcoal burning and a range of less destructive activities have largely ceased and the main role of village forest guards is essentially preventing the forest being used by non-villager's cattle from adjacent villages. In order to run things smoothly, each village maintains a Village Forest Committee. It has motivated most villagers to participate in forest conservation and management. The membership to such committees has steadily shifted from village leaders to ordinary villagers, indicating a high level of democratization at the local level. The active involvement of all villagers in managing forests in the eight villages eventually led to the need for legal backing on the administrative rules.

Thus there was a need to review the management plan and rules and change them into village bylaws. In mid-1995, these plans and rules were formally approved by the full Babati District Council under the District Authorities Act. Today each village is officially the legal authority and manager of that part of the Duru-Haitemba Forest Reserve that is adjacent to its own settled village.

To a large extent, CBFM in Duru-Haitemba was initiated following local discontent. However, external players played a crucial role to kick-start, guide and facilitate the empowerment process. Imposition of rules by government officials was not possible, giving the community level of empowerment.

3.2.7 Clear asset structure

For a long time, villagers in the eight villages around Duru-Haitemba have depended on the forest for some basic subsistence needs. Due to this dependence and the benefits they reap, there are in close ties with the forest which they perceive as their asset. However, before the inception of the current CBFM, there was no meaningful asset structure to elicit community participation. Therefore, only very partial forms of local participation existed. The partial forms of community involvement included permitting local people some use rights to meet some basic needs, sharing revenue earned by the government or involving local people in some practical management activities. These measures did not guarantee sustainable conservation and management of the forest resources in the area because the fundamental matter that forms the core of the problem was not addressed. This relates to resource ownership and not participation. This situation calls for the need to clearly define the resource manager and the user in order to mitigate conflict between state and local community and reduce divergence in perception of rights. It also calls for the need to integrate the vested interests of forest users into responsible conservation by the users.

Thus the introduction of CBFM at Duru-Haitemba Forest Reserve addressed the issue of control and authority on the forest resource and also facilitated restructuring of these to provide the most fundamental of incentives for full and proper responsibility to conserve the forest. Therefore, the local people were empowered and motivated to make decisions and to take responsibility of these decisions as main guardians of the forest resource. It is this restructuring which re-defined the asset structure such that ownership of the forest was now in the hands of the local people and through this transformation the government itself secured a new relationship with the very people it earlier considered to be a threat to forest conservation.

This clearly demonstrates that a group of proprietors can develop a CPR institution if they are confident that the CPR is either theirs or they can exercise clear control

over it. But the benefits to be gained from collective action must be greater than the opportunity cost of organizing it (Marrow and Hull 1996). External agents can promote this process by reducing costs and increase the benefits of self-organization. With less control or clear benefits, the proprietors of the resource have less incentive to invest in communal management regimes (Ostrom 1992).

4. CONCLUSION

This study leads to the conclusion that it is the devolution, democratization, empowerment and sense of ownership that have induced the local communities surrounding the Duru-Haitemba Forest Reserve to invest their labour and time for sustainable conservation and management activities. This is the basis of the present situation where the villagers are managing the woodland resources such that a degraded forest has changed into one with boundaries that are intact, incursion is limited, flora and fauna are recovering and the forest is managed and protected effectively at minimum cost. The basis for the observed success is community participation and a marked degree of power sharing, to the extent that communities have taken full responsibility and control of the resource. Furthermore the government, as former manager, has become a technical advisor, facilitator and watchdog. Ultimately villagers actually now legally own the forest reserve. Thus there is clear definition of woodland resource boundaries, establishment of village bylaws, security of tenure and sense of ownership. A similar model could be adopted in other areas facing similar conditions.

To a large extent the CBFM approach in Duru-Haitemba represents a fundamental shift in forest management and conservation approaches and is a movement towards a more democratic civil society. It has potential to enhance the process of shifting from centralized to decentralized forest management; from unilateral, top-down decision making to a participatory, bottom-up decision making process; and from externally imposed rules to self-induced regulatory rules.

The study recommends minimal arbitrary intervention by the external agents in local management and tenure systems, while relocating responsibility and accountability of forest and other natural resources to individuals, user groups and local communities who best understand them and are better placed to manage and conserve them sustainably. More specifically, the role of CBFM need to be recognized; government should play the role of facilitator or technical advisor. Local people should be empowered to control resources around them through clear legally recognized rules.

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4.

Local organisations and natural resource management in the face of economic hardships: A case study from Zimbabwe

B.B. Mukamuri, B.M. Campbell and G. Kowero

ABSTRACT

In this study, participatory rural appraisal tools were employed in three smallholder farming areas of Zimbabwe to investigate perceptions about organisations, and the factors driving organisational change. In 1991 Zimbabwe embarked on the Economic Structural Adjustment Programme (ESAP) that encompassed wide-ranging economic reforms. Local people in the study areas linked many of the current hardships to ESAP and to the drought of 1991/92. The economic hardships were seen as the reason for the collapse of community endeavours and the increasing move away from the extended family. The reform measures have also negatively impacted on the state organisations operating in the rural areas, including those related to agriculture and natural resource management. Traditional institutions have eroded, but it is suggested that they still remain the focus for management of natural resources.

Key words: Institutions, organizations, woodland management, local values, economic reforms.

1. INTRODUCTION

Institutions can be defined broadly as 'regulatory systems of formal rules, regulations, informal agreements, norms of behaviour and organisations' (Harriss 1982). To understand natural resource use, a key entry point for enquiry is institutional analysis, as is indicated by the burgeoning of the literature on this topic in the 1990s (e.g. North 1990; Ostrom, 1990; Murphree, 1994; Richards, 1997; Arnold, 1998). Seidman (1992) argues that governance structures or organisations are critical to the study of natural resources as they define the context within which management is effected. The recognition that

institutions change, develop or evolve, and that such change affects the performance of society, is pervasive in the literature (e.g. Eggertsson 1990; North, 1990; Ostrom, 1990; Peluso, 1993; Angelsen, 1997). Given the promise of devolving rights and responsibilities for natural resources to local people (e.g. Chambers 1983; Christofferson et al., 1998; Western and Wright, 1994), an understanding of local institutions and how they change is pivotal to our ability to facilitate local empowerment.

In this case study we describe local organisations, including the arms of central government operating at the local level, in three sites in rural Zimbabwe. The focus in this study was on those organisations that play a role in the management of natural resources, in general, and woodlands, in particular. The effectiveness of those organisations in the 1990s was assessed, as perceived by rural communities. The factors influencing the current state were then elicited. In the context of rural areas in Zimbabwe, our hypothesis was that the economic reform policies of the 1990s have precipitated negative institutional change. Some of the possible driving forces of such change include increased unemployment (thereby reducing remittances to rural households), reduced government expenditure on social services and increased cost of living (Chipika and Kowero 2000, Oni, 1997; World Bank, 1996). We end the paper by looking at the potential of local organisations to manage natural resources.

The Government of Zimbabwe, assisted by the World Bank and the International Monetary Fund, introduced an economic structural adjustment programme (ESAP) in 1991. The emphasis of ESAP was on decontrolling the economy, reducing government deficits and creating incentives for the manufacturing sector. All these measures were expected to increase economic growth and alleviate unemployment (World Bank 1996; Oni 1997; Chipika and Kowero 2000). The economic reforms have had mixed results on the economy. For example, reforms have had negative impacts on those organisations that have traditionally relied on central government funding, as exemplified by the education and health sectors. The reduction, and in some cases, complete removal of subsidies, have led to increased costs of food, agricultural inputs and transportation, amongst others, a situation compounded by the devaluation of the Zimbabwean currency. The 1990s have also been marked by rising unemployment.

Economic reform policies which have been implemented in Africa have not necessarily improved the well-being of the local people, organisations and sustainable management of natural resources (Redclift 1984; Timberlake 1985; Anderson and Grove 1987; Reed 1993). Many studies have focused on the economic impacts of the reform measures on various aspects of livelihoods, but less attention has been directed towards assessing the effect of the reforms on organisations associated with natural resource management.

2. STUDY AREAS

The work was conducted in three communal areas in Zimbabwe, communal areas being the areas where the majority of smallholder farmers are concentrated. The study areas are Chivake Ward in Mangwende, Ward 18 (Tawanda Village) in Chivi and Mapirimira Ward in Hurungwe. The Hurungwe and Mangwende communal areas, with mean annual rainfall over 800 mm, are suited to intensive agricultural production, though, to achieve good crop yields, high inputs of fertiliser are required for the sandy granite-derived soils. Chivi has low agricultural potential because of low (650 mm) and variable rainfall, and is ideally suited to ranching and irrigated agriculture. The soils are also largely sandy

and of low fertility. The three sites differ in their proximity to Harare, the capital city of Zimbabwe. Mangwende is 80 km to the northeast of Harare, Hurungwe is 350 km to the northwest, and Chivi is 360 km to the south. Harare represents a source of employment and of inputs for farming, and a large market for agricultural produce.

The miombo woodland is the natural vegetation in these three communal areas. This woodland type is found throughout south central Africa (Campbell *et al.* 1996). In most communal areas in Zimbabwe, much woodland has been cleared for crop production, and the remaining woodlands are largely restricted to the grazing areas and to the more inaccessible and rocky areas, where crop production is not possible.

3. METHODS

Our research utilised participatory rural appraisal (PRA) techniques to elicit perceptions about effectiveness of organisations, changes in this effectiveness and drivers of such change. PRA groups based on age and gender were formed so as to limit the domination of certain groups during the group work.

We derived a measure of effectiveness of organisations in a ranking exercise, where the villagers ranked the organisations working in their areas according to their perceived contribution of the organisations to livelihoods, the mobility and presence of the organisations in the areas and the extent to which the organisations were involved in natural resource management. The scores were on a scale of 0 to 10. An organisation scoring zero is one whose presence is not felt in the area and is also doing minimal work in promoting natural resource management, while that scoring 10 has a strong presence and is doing work on natural resource management that is greatly appreciated by the local communities. Interviews were also conducted with representatives of all the relevant organisations.

4. THE ORGANISATIONS PRESENT AT THE LOCAL LEVEL

4.1 Agriculturally-oriented organisations

Agriculture is a central activity of most rural households in Zimbabwe. In addition, land clearance for agriculture is one of the prime determinants of woodland cover (Campbell *et al.* 1993), while livestock are central to the farming system and graze in the woodlands (Scoones and Wilson 1988). Cattle are important for draft power, cash, manure and other social goods. Thus, it was necessary to give attention to the Department of Agricultural, Technical and Extension Services (AGRITEX) and the Department of Veterinary Services, both state organisations in the Ministry of Lands and Agriculture. Of the parastatal institutions (owned by the state but with some degree of autonomy) the important ones for agriculture are the Agriculture and Finance Corporation and the Grain Marketing Board. In addition, there is the Zimbabwe Farmers Union, a non-governmental organisation (NGO).

AGRITEX has a mandate, in communal areas, to provide extension services to all farmers (Moyo *et al.* 1991). It has an extension worker in all the wards visited during the research activities. Each extension worker works with 800-1000 households.

The Department of Veterinary Services is tasked with undertaking livestock census, dipping and treating livestock, and mounting awareness campaigns for livestock diseases. At the local level, provincial and district officers, as well as a number of dipping attendants and their assistants, represent this organisation.

The Agricultural Finance Corporation provides credit to commercial and communal farmers. The Grain Marketing Board enjoyed a monopoly to handle, grade, transport, store and dispose of all maize up until 1991, when grain marketing was liberalised, as required by the ESAP policy. Numerous private crop buyers are now operating in all the study areas.

The Zimbabwe Farmers Union is a federation of market-oriented farmers in communal and resettlement areas. It has been involved in negotiating for land to resettle thousands of families, and for rights of squatters to live and graze their cattle on privately owned farmland. In recent years, the Union has been advocating the establishment of private tenure in communal areas. It also negotiates official grain-prices on behalf of smallholder farmers. The Zimbabwe Farmers Union has support from the government because of its national and political character.

4.2 Environmentally-orientated organisations

Two organisations are identified as having a focus on the environment, the Natural Resources Board (NRB) and the Forestry Commission, both under the Ministry of Mines, Environment and Tourism. The Natural Resources Board oversees conservation of the country's natural resources. Its mandate includes trees, soil erosion control, siltation, waterways, rivers, and dambos. The Board's approach to resource management has often conflicted with local needs and knowledge (Mukamuri 1995; Sithole and Bradley, 1995). In the areas studied, the Board is represented by officials based at the district offices.

The Forestry Commission is a parastatal organisation responsible for the nation's indigenous and exotic forests. In terms of extension, the Commission has been relying heavily on trained foresters. It often only has a single officer covering an entire district.

4.3 Community development organisations

There are a number of organisations that have broad community development mandates: the District Development Fund (DDF), Village Community Workers and Village Development Committees (VIDCOs). The District Development Fund is a local government organisation, responsible for rural infrastructure development, including district roads, dams and boreholes. The main funding for this organisation comes from the central government. Prior to 1990, the District Development Fund had been supporting forestry-related activities like tree planting. During the mid-1980s, it was praised for the well-maintained and fast expanding rural road network.

Village Community Workers fall under the Ministry of Community Development and Social Affairs. All villages in the three study areas had one Village Community Worker. Their duties include extension on primary health care, hygiene, and family planning, and organising rural women to form co-operatives and self-help groups.

Rural District Councils, under the Ministry of Local Government and Rural Development, administer all communal areas in Zimbabwe. At present there is a major programme to devolve power to these Councils. A number of wards make up a district, and the wards are subdivided into villages. The Village Development Committee (VIDCO) is the lowest development-planning unit in the district (Mukamuri 1995). In the 1980s, the Zimbabwe government introduced the concept of the VIDCO as the link between

government and local people. Representation on the VIDCO has been based on a democratic voting system. However, the structure has suffered from a prolonged legitimacy crisis, primarily because of the confusion between VIDCOs and political party structures. In addition, there have been conflicts between VIDCOs and traditional organisations. Ethnic divisions among households within the villages have compounded this crisis, with immigrants generally supporting the VIDCOs while 'locals' supported the traditional structures. Consequently, VIDCOs have failed to operate in many parts of the country.

4.4 Traditional institutions

The traditional institutions identified in the study areas are families and households, kraalheads (the lowest level of leadership within the traditional system) and chiefs. In addition there are traditional peasant groupings for community work, locally known as *nhimbe*.

Prior to modernisation and urbanisation, households largely depended on the broader extended family and the society at large for social protection and support for life-sustaining activities. Modernisation introduced and raised the significance of wage labour and this made peasants take up urban employment as a source of income. Remittances became part of the urban and rural sector's mutual existence. Remittances played key social roles, particularly in the education of family members as well as facilitating the accumulation of the vital livestock capital and facilitating investments in farming (Bourdillon 1985; Scoones and Wilson 1988). Individuals, households, families and clans lived in harmony with each other, as well as with the spirits and the environment at large.

In terms of natural resource management in rural Zimbabwe, traditional chiefs and kraalheads have for the past two decades been greatly marginalised. This has caused disharmony among traditionalists and 'modernists', as well as causing difficulties for local level resource management and development (Mukamuri 1989). At present, the government is planning to revert to some elements of the traditional structure, but that too may have problems, as the VIDCOs have become entrenched within some sections of the rural communities. This is particularly the case with immigrants that do not align themselves with the traditional structures and see the VIDCOs as a means for them to guide development.

Traditional chiefs played significant roles in keeping communities together. Their mandate included: protecting the communities from negative outside influences, ensuring that productivity and fertility of the land was maintained, co-ordinating rain-making ceremonies, and guarding and maintaining territorial sacred places and shrines, thereby ensuring harmony between ancestral spirits and territorial cult centres. Contrary to popular belief, the chiefs were not always dictatorial. They worked through a chain of deputies that included headmen and kraalheads. The headman often controlled a clan or lineage, with different clans making up a tribe. The kraalhead controlled what could be called an extended family or a village, comprising closely-related people. People from other areas that were not necessarily related to the ruling lineage also lived within the villages. However, outsiders were obliged to respect and pay allegiance to the institutional arrangements in the village.

4.5 Religious organisations

We categorised religious organisations into two main types: independent churches (like Zionists and Born Again Christians) and formal churches (like the Roman Catholic, Salvation Army and Methodist Churches). There were at least a dozen independent churches in the three study areas and seven formal churches.

The independent churches have dominated the African religious landscape from the early part of the twentieth century. Like their traditional religious counterparts, independent churches have developed, waxed and waned, and incorporated new beliefs and practices. They are charismatic and largely centralised in terms of leadership. Their focus is largely based on their perception of social, economic and material needs.

5. EFFECTIVENESS OF THE ORGANISATIONS

Of the organisations ranked for their effectiveness in the PRA exercise, the Zimbabwe Farmers Union, the Department of Veterinary Services and the Natural Resources Board were consistently ranked low (Table 1). At the other extreme, the organisations receiving high ratings were the District Development Fund, the Village Development Committees (VIDCOs) and the traditional organisations. The other organisations were generally rated low, often only being rated high by one gender group in one study area.

The low scores were mostly a result of the lack of presence of the organisations in the areas, which leads to ineffectiveness in carrying out their mandates. This applied to AGRITEX, the Natural Resources Board, Veterinary Services and Forestry Commission. Respondents decried the lack of co-ordination amongst government organisations.

The farmers argued that Veterinary Services was doing absolutely nothing to control livestock deaths, particularly those of cattle. In Mangwende and Chivi, farmers complained that they were being asked to pay cash for livestock treatment, and that the dipping tax for cattle has been increased. The Department of Veterinary Services lacks the resources to monitor all parts of the study areas, because of reduced budgets for transport and insufficient allowances for its staff.

Farmers claim that the Zimbabwe Farmers Union does not have local representation and that their money is being paid to an organisation which 'does nothing' to facilitate access to land and credit. The role that the Union plays in the national land policy debate is not apparent to the farmers in the communal areas.

Farmers in Mangwende complained about the lack of presence of the Natural Resources Board in the area, while those in Hurungwe complained that staff of the Board were hardly seen despite the depletion of woodlands in the area. In Chivi, the low scores given the Board were related to the ban by the Board on riverine and wetland cultivation. Such areas have been traditional farming areas for most households, with rice and vegetables grown on wetlands for centuries (Wilson 1990). The ban on wetland cultivation has been disparately enforced in different parts of the country.

In interviews with key staff of the Natural Resources Board, lack of transport, insufficient allowances and reduced funding for audio-visual services were cited as reasons for their reduced effectiveness. Field staff largely depend on transport provided by well wishers, friends and other government departments. Many parts of the study areas go without visits for long periods of time, and cases of environmental destruction receive inadequate investigation. Morale is very low among the Board staff operating at the district level.

AGRITEX generally scored very few points among most of the communities that were interviewed. Reasons given for this included the following.

- In recent years, the Extension Services appears to have abandoned its wide outreach mandate and opted for a group approach. The narrow group focus has earned AGRITEX animosity among large sections of the farmers who participated in the PRA activities.
- AGRITEX extension staff made very few visits to the majority of farmers.
- AGRITEX focused only on 'small groups of organised and rich farmers'.
- Farmers alleged that they are being forced to join group gardens rather than maintain individual gardens. The former are believed by the Extension Services and the Natural Resources Board to be environmentally friendly, to facilitate the dissemination of extension advice and visits, and to be more convenient to monitor and control. Local women complained that group gardens lack privacy and cause difficult pest control problems. The poor often find it difficult to make the necessary contributions for membership, fencing and pesticides.

Interviews with AGRITEX extension agents highlighted a big drop in the level of mileage allocated to the officers, from about 1000 km/month in 1985 to about 200 km/ month in 1996, due to reduced budgets. In the mid-eighties, all extension agents were provided with motorcycles on a hire-purchase scheme and this greatly facilitated transport, even to remote villages. However, during the 1990s no motorcycles were made available to newly-recruited extension agents, making them rely on bicycles that confine them to areas close to their homes.

AGRITEX has recently adopted a 'participatory extension approach'. The method views farmers as being informed and capable of making rational decisions about environmental and agricultural issues (Chambers 1983). However, participatory extension appears to have been adopted for different reasons. Extension agents saw the role for 'participatory development' as allowing the reduction of extension visits to individual farmers and the concentrating of efforts on groups of farmers. This implicitly abandons or marginalises farmers who are not willing or capable of joining organised farming groups. Reduced public funding for agriculture and conservation extension was mentioned as key reasons for the adoption of participatory extension methods. Very few extension agents and their officers who were interviewed believed in empowering farmers. The majority of the agents did not believe that farmers were capable of self-development.

The reasons advanced by farmers for the low ranking of the Grain Marketing Board included the following.

- The Board no longer provides guaranteed transport for crops from the farm gate.
- The Board does not buy the grain soon after harvesting.
- There is corruption within the Board, in terms of grading the crops it receives.
- There are serious delays in payments.
- There are now many other participants involved in grain marketing, some of whom out-compete the Board.

It would appear that the agriculturally-oriented organisations (AGRITEX, the Department of Veterinary Services and the Zimbabwe Farmers Union) and the environmentally-oriented organisations (the Forestry Commission and Natural Resources Board) are either very thin on the ground or completely not visible to the local

communities. The Village Community Workers were ranked very low on environmental issues (Table 1).

Table 1. Effectiveness of organisations as indicated by local people's ranking of the organisations in PRA exercises*

Organisations	Type	Mangwende		Chivi		Hurungwe	
		Male	Female	Male	Female	Male	Female
1. Agriculturally-related							
AGRITEX	State	0	9	2	2	0	2
Veterinary Services	State	0	0	0	0	-	0
Agricultural Finance Corporation	Parastatal	0	0	-	-	9	0
Grain Marketing Board	Parastatal	2	4	2	1	0	0
Zimbabwe Farmers Union	NGO	-	0	0	0	0	0
2. *Environmentally-related*							
Natural Resources Board	State	1	0	0	0	0	0
Forestry Commission	Parastatal	2	8	0	0	-	0
3. *Community Development*							
District Development Fund	State	7	0	10	-	8	4
Village Community Workers	State	3	-	-	-	3	-
VIDCO	State	7	6	5	6	1	0
4. *Traditional*							
Chief		9	10	-	8	-	7
Kraalheads[1]		10	8	8	7	-	5
5. *Religious*							
Independent		10	10	9	8	7	8
Mainstream		7	10	10	6	10	9

* The values are average values, each for male and female groups, where 0 indicates highly ineffective and 10 indicates highly effective.

[1] Leaders of clans (the lowest level within the traditional system).

If the Village Community Workers were given more training in social and environmental issues, they would probably be more effective, given their close association with villagers. Unfortunately, they are very poorly paid, and this reduces morale.

Overall, community development and traditional organisations appear to be more popular with the local communities than the sectoral government organisations. The high opinions of the District Development Fund were related to their widespread activity in infrastructure development.

VIDCOs appear to be highly regarded by the communities in two of the three study areas (Table 1). However, the VIDCOs do not appear to have been much involved with

environmental concerns. Furthermore, there does not appear to be a good linkage between these organisations and the various government officers in the areas.

The traditional leadership was generally ranked high, but some problems were raised during discussions. The slightly lower ranking in Hurungwe was because people were not happy with the kraalhead, whom they accused of 'selling grazing areas.' In Chivi and Zvishavane, the local chiefs were reported to be monopolising key resources at the disadvantage of immigrant groups (Mukamuri 1989). The interviews conducted seemed to suggest that, in the past, chiefs, headmen and kraalheads maintained and enforced social and environmental rules and that those who violated the regulations were tried and reprimanded. The dominating fear was that if society would break down, then the ancestral spirits would be angered and would retaliate by punishing individuals and the whole community. The ancestral punishment would come in the form of diseases, pestilence, poor harvests and drought. Local people still have respect for traditional structures, which are viewed as the link with the spirits of the land, and the traditional structures are probably the most important of all organisations in maintaining some degree of control over resource use. The nostalgic view that traditional leaders are guardians of land and local interests is, however, not always applicable, as can be seen in the examples whereby the leaders use the resources for their own gains.

Both independent and formal churches were ranked high, for their contribution to social aspects of rural life. However, it was noted that the churches did not cover many issues related to natural resources. This differs from other areas of Zimbabwe, where, for instance, the Lutheran and Catholic churches have made notable contributions to environmental issues. The capacity of the churches to assist local communities is largely dependent on the financial resources the particular churches have, most of which are derived from the communities themselves. Given the socio-economic hardships local communities are presently experiencing, churches have begun prioritising on the aspects and nature of assistance they can render.

6. DIFFERENCES IN PERCEPTIONS BETWEEN MEN AND WOMEN ABOUT ORGANISATIONS

For a number of organisations, men and women's rankings and perceptions differed substantially due to their different experiences with these organisations or due to their different roles in the household. For example, in Mangwende, women rated AGRITEX and Forestry Commission very highly, in contrast to men. The high score AGRITEX obtained is linked to the extension advice women obtain for market gardening, an activity which is a major source of income and livelihoods in the area. Women are less likely to get formal employment and they engage in market gardening in order to raise cash. The high score for the Forestry Commission is linked with the gum plantations which the Commission is actively involved in establishing. Women in the study area regard gum trees as a major source of firewood and fencing materials.

Some women alleged that there was a gender bias in the allocation of loans, consequently ranking the Agricultural Finance Corporation low. This was particularly noticeable in Hurungwe where women gave a score of zero to the Corporation while men gave it a score of nine. The explanation was that most of the loans provided by the Corporation have been directed to activities which males dominate, such as cotton,

maize and sunflower production, whereas women's agricultural activities, like gardening and groundnut production, have not been priorities for the Corporation.

In all sites women seemed to rank the activities carried out by the District Development Fund lowly (scores varying from 0 to 4) while men ranked the same organisation highly (scores ranging from 7 to 10). Men apparently give high value to good roads, which enable them to transport their agricultural products easily to the markets. Women found the organisation lacking because it did not do enough with respect to borehole provision for safe drinking water and watering vegetables.

The Village Community Workers were ranked low by men's groups in all the study areas because of their role in distributing contraceptive pills that are seen, by men, as being associated with promiscuity among women. It appears that the actual role of the Village Community Workers was not well understood.

7. INSTITUTIONAL CHANGE AND THE FACTORS DRIVING CHANGE

There have been definite changes in the organisations since the 1980s, and many of the local norms and informal rules have come under pressure. Many of these changes are believed by local people to have been brought on by the ESAP policies and the very serious drought in 1991/92.

From discussions with the staff of the agricultural organisations on the ground, it was noted that most state organisations have scaled down their activities since the mid 1980s, but this was more dramatic during the period of economic reform policies in the 1990s. These reforms have reduced government expenditure, in addition to encouraging privatisation (e.g. of grain marketing). Consequently, the central government and parastatal agricultural organisations have a very weak presence in the study areas and a lower image on the ground in the 1990s as compared to the 1980s. Some of the changes that have occurred as a result of budgetary cuts or reduced subsidies include late payment of farmers by the Grain Marketing Board, less farm gate collections of marketed products by the Grain Marketing Board, reduced loans available to communal farmers from the Agricultural Finance Corporation, reduced visits by AGRITEX staff to farmers and more group-based extension (under the guise of the 'participatory extension approach'). In general, the most affected components of the work of governmental and parastatal organisations are those related to interaction with local people, e.g. foot patrols, farmer visits and promotion of environmental awareness. Most of the extension and field agents who were interviewed highlighted increased use of informal means of transport. Extension staff increasingly schedule their meetings as part of meetings organised by other organisations. Under such circumstances extension work is becoming extremely difficult to plan and execute and the quality of work is drastically affected.

While government organisations have been collapsing, independent and formal churches have gained considerable prominence in the lives of the local people. Churches and traditional institutions have the advantage of a large and wide following, as opposed to the poorly-funded government organisations. Most of the churches were highly appreciated with respect to their social programmes, but the farmers rated them low in their contribution to environmental issues. In general, the churches introduce concepts which often are in contrast with those concepts embraced by traditional institutions, a serious situation for resource management as the traditional organisations often play a positive role in this regard. For instance, in their negative attitudes towards the belief

in spirits and the spirit world, churches undercut traditional conservation systems for specific trees and woodlands (see also Mandondo 1997). In Chivi, an NGO, the Zimbabwe Institute for Religious Research and Ecological Conservation (ZIRRCON), has incorporated traditional religious beliefs into an environment-religious management strategy or movement. At present ZIRRCON is running an impressive project whose extension programme on natural resource management is directed towards independent churches, traditional leaderships and other religious groups. If the ZIRRCON strategy succeeds, then it is important to evaluate how religious organisations can be mobilised to contribute to natural resource management.

All the informants in the study areas seemed to recognise the decline of the larger extended families and highlighted the nucleation of households. People have become increasingly concerned with producing and consuming within the nuclear households. Cultural values concerning the relationship between parents and newly married couples were also reported to be causing conflict, particularly in the 1990s. For example, in the past, daughters' in-law that were recently married could share the same kitchen with the husband's parents until they could sustain themselves. Informants mentioned that this practice had dramatically decreased because of the harsh economic conditions. Newly-established couples were given their 'kitchens' (i.e. made self-reliant) within a few months of marriage.

Old women believed that the emerging tensions within local communities and extended families were largely centred on scarce financial and food resources, which in turn are consequences related to the drought and ESAP. The picture these informants painted is that the extended African family, as well as close family ties, are gradually crumbling because of socio-economic pressures.

Respondents reported that differentiation amongst households was promoted by ESAP; many believed ESAP was 'for the rich to get richer'. Differentiation is particularly marked between those households that have cattle and farm implements and those that do not have these resources.

Clusters of households or the entire village used to form the basic labour or safety nets for households. Reciprocal work parties were often organised around clusters or families. Both rich and poor households participated in each other's labour parties. Money or goods did not form the basis for the labour or work parties; rather it was mutual help that was significant. Increased wage labour, greater socio-economic differentiation and heightened social disharmony have contributed to decline in reciprocal work parties in the study sites. It was reported that both rich and poor farmers were no longer prepared to work together if there were no direct material benefits. Most informants said that they started noticing the decline in reciprocal work parties around the turn of the decade. Extra labour for weeding is now largely organised through hired labour instead of being freely available through work parties. In Chivi, specific forms of reciprocal work parties remain during winnowing, but this is largely in areas where people still grow millet and 'if the farmer in question is lucky, socially respected or powerful.'

Community conservation work had been institutionalised in many local communities. However, like the reciprocal work parties, community-based conservation work was reported to have seriously declined in all study areas. The apparent reason is that rural people nowadays expect to be paid for whatever work they do. Interviews revealed that, during the past decades, local people used to do conservation work without direct payment. For example, between 1969 and 1973, people in Hurungwe

did conservation work that included damming a gully and planting trees in village woodlots. However, they now prefer to plant trees in individual home plots. The informants mentioned that, as a village, they no longer had time to do any conservation work. Other members of the community in Hurungwe also said that they were no longer interested in doing things whose benefits they were not sure of getting. It was also apparent that the style of local leadership also discouraged many people in joint conservation work.

In recent years, traditional regulations that seek to protect sacred trees and woodlands have been negatively affected by the difficult economic conditions. The decline in respect towards traditional regulations is largely due to the emergence of new livelihood strategies to cope with economic problems. For example, in some areas unemployment is causing many youths to turn to wood carving for tourists as a survival strategy. In the process the youths violate traditional rules by felling sacred trees. Sale of fruits from the natural forests was traditionally unacceptable. Interviews carried out in Mangwende indicated that, starting in 1993, local people noted the emergence of marketing of *Uapaca kirkiana* fruits. In nearby, Mutoko District, locals were marketing a cake and syrup derived from *Parinari curatellifolia*. In Hurungwe, discussion groups mentioned an increase in the marketing of *Syzygium cordatum* fruit. Children and women were identified as the key actors in the trade. In Chivi, local women were engaged in the marketing of an alcoholic product from *Sclerocarya birrea*. Some households were also reported to be exchanging the product for labour in the face of traditional rules that forbid the use of alcohol in any exchange relationship. Traditional rules and regulations with respect to woodlands appear to be under pressure from many angles, mostly as a result of the commercialisation of the resources.

In Mangwende and Hurungwe, most retrenched workers resorted to cultivating land formerly set aside for grazing, as well as farming in riverine areas. Group discussions highlighted that most of the people coming from towns do not have any choice but to cultivate any open piece of land they can get. In the study areas, there is a lot of sympathy for the returning retrenched workers and other unemployed people. The common expression was that ‘We can do nothing about the unlawful practices because the people doing it are our children and we would not want them to starve’. In Chivi, young families had not encroached on grazing land, but the newly married men said they would do so if the government did nothing to solve the acute land shortage. Some of the land pressure is linked to lack of employment opportunities. In all study areas, unemployed school leavers, whose option for a living is mainly based on the local woodland resource, were experiencing severe land shortage. Many of them became engaged in activities such as gardening, brick moulding, sale of building poles and building mud huts, all of which require clearance of land and/or the use of the woodland.

Economic hardships, land shortage and unemployment have rendered the traditional leadership with no choice but to turn a blind eye to some unacceptable and non-sustainable land-use practices. Some village elders were of the view that if they do not allow the young families to open any piece of land available, then they would have the burden of feeding them.

Land grabbing and unlawful expansion is not only affecting the traditional leaders in the study areas. Councillors and VIDCOs are even more powerless because they fear that if they interfere they might lose votes during elections. The traditional leaders would appear to be in a better position to control or reduce the unlawful practices,

given their popularity with and more knowledge of the communities. However, it would appear that traditional leaders put the immediate needs of their people first, rather than the conservation of natural resources.

Some consideration was also given to the increasing prominence in the society of AIDS. Many respondents reported increased deaths due to AIDS-related diseases. Illnesses and death are calling for more resources to be diverted towards health and funeral costs, as well as increasing pressures on an already stressed rural health sector. We believe that increases in illnesses and deaths are changing social relationships within communities and households. Traditions with respect to death and the attendance of funerals are also changing.

8. CONCLUSIONS

Little and Brokensha (1987) identify four factors that are likely to affect the nature of local resource management: (i) shifts in the formal locus of decision making; (ii) wealth distribution; (iii) market linkages, and (iv) demographic pressure. Their framework is highly applicable to the situation in our study areas, but we interpret 'demographic pressure' more broadly as 'resource scarcity' which could be due to reasons other than demographic pressure (e.g. increased commercialisation of resources and past land alienation policies).

Little and Brokensha's (1987) first point concerns the shift in the locus of power. Because of shifts in power between traditional structures and the new state-sponsored organisations (e.g. VIDCOs at the lowest level), considerable ambiguities have arisen over who has control of the commons. There has, however, been a positive shift in the locus of power, from the central government to more local arms of government. However, this has come at a time when the fiscal resources of the state are highly constrained, thus debilitating the functions of the state.

The second point of Little and Brokensha (1987) relates to differentiation. Where communities are highly differentiated, the visions about resource use between poor and rich may not be compatible, creating problems for local organisations and local institutional development (Uphoff, 1986; Hobley and Shah, 1996). Differentiation within communities appears to be increasing, apparently as a result of the recent changes in macro-economic policies. This has probably had impacts on community institutions, such as reciprocal work arrangements and community work parties.

Little and Brokensha's (1987) third point concerns market linkages. The emergence of market values for common property resources often leads to problems of over-exploitation, brought about either by the arrival of outsiders (with different values) to exploit the resource or the need by the very poor to exploit the resource for cash (see also McElwee 1994; Richards 1997). With the decline in the national economy, people are becoming more money sensitive and more orientated towards material benefits. Many households appear to have shifted their attention to woodland resources to raise cash, and thereby have gone against traditional institutions limiting such marketing of resources. At the family level the extended family concept and close family ties are also eroding fast, and children are being made self-reliant at an earlier age than in the past. While commercialisation pressures have sometimes promoted positive responses from communities or user groups, or have had minimal impacts on local controls (McElwee 1994; Richards 1997; Agrawal and Yadama 1997), such patterns have not been recorded in our study areas.

The fourth point relates to resource shortages. Such shortages create tensions and conflict that local organisations may not be able to resolve. In the study areas, this is seen in terms of land allocation and in-migration, and the use of woodland products for cash income. There are many studies that show similar patterns, though it is also possible that resource shortages stimulate the resurgence of local control (Agrawal and Yadama 1997). In Zimbabwe, resurgence has largely not occurred, though some Rural District Councils have implemented by-laws, the efficacy of which has not been investigated.

Overall, the findings of this study do not reject the hypothesis that the economic reform measures have initiated negative institutional change at the local level. However, this study must be seen as exploratory, given the perennial problems between governments and local people, problems that may be colouring the views expressed by the local people. We suggest that the economic decline has diluted traditional values within the local communities, values that are important for natural resource management. Furthermore, the reforms have eroded the efficiency of public organisations by constraining the availability of financial and other resources to them. These organisations have scaled down their operations and/or devised coping measures which compromise natural resource management. Many authors see the state and other external agents as important facilitators of local initiatives, by providing support and legitimacy to local institutions (Davis and Wall 1994; Hobley and Shah, 1996; Agrawal and Yadama 1997; Bebbington 1997). From this perspective, the reduced state presence at the local level is negative, though, in the southern African context, the state has more often not supported community initiatives (Murombedzi 1991; Matose and Wily 1996).

There is a multiplicity of organisations operating at the local level, many of which have some connection to natural resource management. This has been demonstrated elsewhere in Zimbabwe, and in other countries (Mbizvo and Mohammed 1992; Murombedzi 1991; Sithole 1995; Mandondo 1997; Bebbington 1997; Brown and Rosendo 1998). In this maze of organisations, in their interconnections and in their changing effectiveness, where is the hub for resource management initiatives? While there is talk of devolution of power to local governments, and there is much talk of participatory development, the capacity of government to facilitate the functioning and effectiveness of local organisations is extremely limited, given the budgetary constraints. The potential for an effective involvement of government organisations in joint woodland management activities with the local communities is presently very low. If the government wants partnership with local communities in managing these resources, then it will have to channel more resources to its organisations as well as improving co-ordination amongst state organisations on the ground. Furthermore, choice of organisations for partnership with local communities has to take into account the divergent expectations on those organisations from women and men.

For almost all organisations investigated, excluding the churches, the 1990s were seen as an era of reduced effectiveness. Traditional institutions are still well-respected by the people, but with the upsurge in individualism and the rising power of religious organisations, the traditional institutions are likely to experience reduced legitimacy. The richness of the stated local controls for woodland management is not in doubt (e.g. Mandondo 1997). Many of the woodland resources are common pool resources governed largely by informal rules and norms falling within the traditional ambient. It is less clear as to how effective the local controls are, and as to how the controls are

changing. The changes in local controls that we recorded do not, generally, forebode well for natural resource management.

The hub for development still appears to be the traditional institutions, and the networks linking to them, despite the problems identified above. While traditional institutions are eroding fast, the evidence is that they remain strong relative to other institutions, especially considering that they received almost no state support in the post-independence era (Matose and Wily 1996). Traditional institutions still have the best potential for mobilisation for natural resource management. This is evident from the values they espouse, record on past activities, and the esteem with which the institutions and their leaders are held.

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5.
Institutional arrangements governing natural resource management of the miombo woodland

Dennis Kayambazinthu, Frank Matose, George Kajembe and Nontokozo Nemarundwe

ABSTRACT
This study investigated the institutional arrangements governing the management of miombo woodlands by exploring factors resulting in institutional change and how institutions respond to change in the miombo woodland. It has demonstrated the existence of a multiplicity of institutions ranging from national to local and from formal to informal; each varying according to the particular socio-cultural and traditional context. Understanding institutions in the region and the processes involved in their origins, evolution and dynamics is observed as much more important than analysing and interpreting them according to the “design principles” approach under common property resource (CPR) systems. A historical analysis has also revealed that institutions have to some extent been affected by changing state and administrative frameworks, from colonial to post-colonial periods. While recognising, for various reasons, the general weaknesses of some institutions to effectively govern natural resources, this study also identified critical factors that make some institutions in the region stable and enduring. The analysis has shown that institutions that are better integrated in terms of traditional, socio-cultural traits and incentives, and are given moral and political legitimacy at the local level are more stable and enduring than those that are less so. In our study, these refer to institutions concerning traditional leaderships, different types of clans or households, and sacred areas. Recent developments of devolution and legislation to enable community-based resource management have been based on the recognition of the potential of these local institutions while at the same time calling into question the efficacy of state institutions to manage on their own without community institutions. As the region continues to recognise the legitimacy of traditional systems with their related structures and rules, these critical factors are important in shaping or

harnessing local institutions. This is of particular importance as policy makers try to develop institutional frameworks that integrate and accommodate formal legislation, e.g., the Forest Act, within the local by-laws for governing natural resource management of the miombo woodlands.

Key words: Community based management, change, devolution, institutional framework, degradation.

1. INTRODUCTION

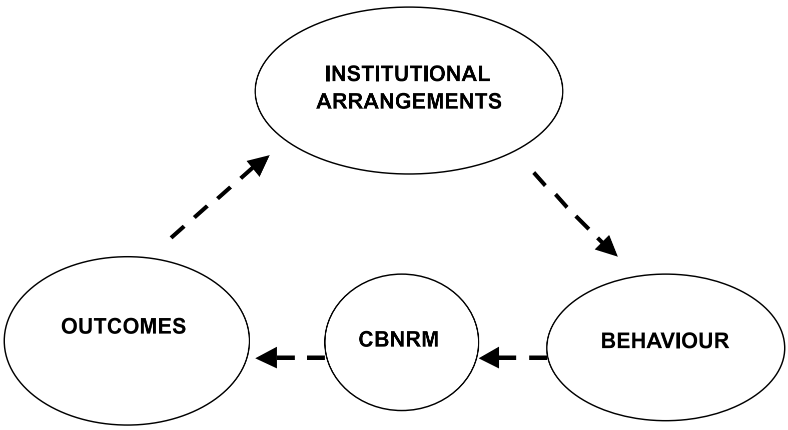
From the earliest human communities people throughout the world have had to decide who can use what resources when, where, and how. Such norms, rules and regulations that so govern behaviour are broadly defined as institutions. Under common property literature, these are taken as regulatory systems of formal laws, informal conventions and norms of behaviour, mainly designed to coordinate individual and collective actions for controlling and managing the resources (Harris 1982; Morris and Adelman 1988; North 1990; Bromley 1999; Cleaver 1999). This view of institutions has largely been developed by neo-structural institutionalists and economists, and the common property school against the backdrop of Hardin's (1968) 'tragedy of the commons'. Hardin's thesis is that resources held in common are subject to some degradation. The common property school has ever since tried to demonstrate that the tragedy of the commons cannot exist under common pool resources (CPR) where communities have regulatory systems to check against individual interests (Ostrom 1986; Bromley and Cernea 1989; Runge 1990). The aim of this paper is to analyse these 'regulatory systems' hereafter called institutional arrangements governing natural resource management of the miombo woodlands, in Malawi, Tanzania and Zimbabwe, by specifically examining institutional change and factors driving it.

Institutional analysis often requires that a distinction be drawn between institutions and organisations, mainly due to the difficulty of separating rules and regulations from the organisations that affect them. However, the analysis by Uphoff (1986) does not appear to separate institutions and organisations, mainly because of what the author terms as a close mileage between the two. Hence, Uphoff (1986) considers "institutions, whether organisations or not, as complexes of norms and behaviours that persist over time by serving collectively valued purposes". Thus, some kinds of institutions have an organisational form with roles and structures to implement social actions, whereas others exist as pervasive influences on behaviour. Mukamuri (2000) considers institutions and organisations as synonymous. The distinction between institutions and organisations is, however, summarised by Harriss (1982) and North (1990) by defining organisations as the key players, formed by groups of individuals, or the groups of actors bound together by a common purpose to achieve objectives. In this paper this distinction has been adopted in order to investigate what are the rules and organisations governing the management of miombo woodlands and how these have changed and responded to change over time.

People in all communities manipulate their institutions and that these evolve with time as political, social, economic, ecological and cultural needs and environment change and as communities come into conflict or contact with others. The institutional change that arises generates, in turn, a change in people's behaviour toward management of natural resources, often with either a positive or negative impact on the resource base. This theory implies that, depending on the impact generated,

there is a continued reworking process of the institutional arrangements to either liberate or constrain human behaviour towards management of natural resources (Bromley 1999) (Figure 1). However, among the socio-political commentators on transition of African institutions are those who believe that traditional institutions are static and resistant to change or modernity (Kajembe and Kessy 2000). Yet others, through a historical analysis of institutional change, have observed change and are trying to monitor the direction of the change or transition (Mukamuri *et al.* 1999). Either way and in an effort to examine institutional arrangements influencing the management of miombo woodlands, this paper further explores the critical set of factors that lead to enduring or changing woodland management institutions.

Figure 1. A conceptual framework showing changes in institutional arrangements towards community-based natural resource management (CBNRM) and control.



<u>Resulting outcomes</u>
Positive or Negative
Resource Management &
Social Well-being

<u>Characteristics influencing behaviour</u>
Rules
Resource
Political, Social, Economic &
Cultural Needs

2. BACKGROUND INFORMATION: HOW INSTITUTIONAL CHANGES AFFECT PEOPLE'S INTERACTION WITH THE ENVIRONMENT

One of the challenges facing policy-makers, local authorities, practitioners and groups working in natural resource management in the miombo region is to understand how institutions, and changes in institutions, affect people's interaction with their environment since these have consequences for the resource and people's well-being. Institutional factors are arguably the most important factors determining the success or failure of community-based natural resource management. The current drive, towards devolution of the control and management of resources to communities, may

not be enough if all that states are doing is to empower communities by changing policies and not try to understand how to strengthen local institutions. The understanding of institutions would afford the best opportunity to begin working with local communities and to generate policies that aim at promoting and supporting the appropriate governance structures and rule systems for resource management. At present, national policy support in the region is varied with some countries (e.g., Tanzania and Malawi in forestry and Zimbabwe in wildlife and water) having changed and created supportive legislations for community-based resource management. In other cases, such as forestry policies in Zimbabwe, there has been less support, although some experimentation with 'resource sharing' in the State Forests is being pursued (Campbell and Matose 2000). With the widely varying degrees of policy support and in the diversity of resources and communities, with complex and dynamic institutions that exist in the region, considerable effort is needed to draw parallels, disparities and common themes.

Bardhan (1989) recognises the fact that any socio-economic structure, consisting of property relations, corresponds to the level of development of the productive forces. The central force driving any change is therefore the force of production. Using Marxist theory, Bardham (1989) states that changes in the forces of production over time produces some tension between existing structure of property rights and the productive potential of the economy, and it is through class struggle that this tension is resolved in history, with the emergence of new institutions. This is said to have given way to neo-classical thinking on property rights and transaction costs, which trace changes in economic history to changes in the institutional rules. Further, it has also given way to the imperfect information theory of institutions which provides a framework for analysing institutions as substitutes for missing markets, in an environment of expensive risks, incomplete markets, information symmetry, and moral hazard. North (1981), however, brings out the theory of ideology and the state as also central to the institutional change. In this regard, social ideology may well induce individuals to behave in a way contrary to their own interests. Here the state, in propagation of ideology and socialisation process, as in defining and enforcing property rights, plays an authoritative role. North thus states the fact that the state, for reasons of maintaining its support structures, may even prolong socially inefficient property rights (Berthelot 1998).

Other important processes that may bring about institutional change are to do with collective action and free-rider actions that limit or enable groups of people to act together (Berthelot 1998). Ashton and Philpin (1985) look at the importance of specific historical processes of class capacity for resistance and struggle in directing change. In their analysis of neo-classical economic history, Ashton and Philpin, emphasise the fact that relative price changes fuel the main motivating force for institutional changes in history (primarily by inducing the development of property rights to the benefit of the owners of the expensive factor of production). In particular demographic changes altering the relative price of labour to land provide the incentive for redefinition of property rights on land and a rearrangement of labour relations. But according to Brenner's (1976) analysis of contrasting experiences of different parts of Europe on the transition from feudalism, it is known that changes in demography, market conditions and relative prices are not sufficient to explain the contrasts. Hence, changes in relative prices may at most, change the costs and benefits of collective action on the part of the different classes (creating new opportunities for political

entrepreneurs). However, such changes cannot predetermine the balance of class forces or the outcome of social conflicts that may result in given institutional change.

From a wide range of literature that focuses on institutions, two general approaches to institutional analysis are often described. One is the rational co-operation approach of reducing transaction costs among individuals with self-interest driven by new institutionalism (Ostrom 1990; North 1990). The common property theory encompasses this approach (Bromley 1992; McCay and Acheson 1987) by largely focusing on the set of variables that enhance the likelihood of users organising themselves to avoid the social costs associated with open-access (McKean 1998; Ostrom 1992). But as Campbell *et al.* (2001) observe, such 'literature and similar literature on community-based natural resource management (CBNRM) (especially that reaching the practitioners) is largely optimistic in outlook' for the miombo region. They go on to argue that such optimism stems from the simplification that somehow "it is possible for CPR appropriators to design, operate, monitor and enforce their own institutional arrangements" (Ostrom 1994). Also that "local communities can create and sustain institutions to manage their collectively owned resources quite successfully, often in the face of adverse pressures from the state, demographic changes and market forces" (Agarwal and Yadama 1997).

The other approach to institutional analysis places emphasis on the moral codes, traditions and value systems and draws from the Durkheimian tradition that an individual is largely a social being who is guided by the social norms (Scott 1976, 1985; Uphoff 1986). Hence, individuals make collective choices that favour some interests over others and some outcomes over others by using mental models. One's culture, knowledge, values and norms play a big role in the interpretation of one's environment and, may therefore vary according to different societies and environments. Studies from some parts of the miombo region indicate that institutions that are currently in place, are largely built on controls derived from traditions, culture and norms (Mandondo 2000). These controls are constantly contested, changeable and individually interpreted and, therefore, the analysis by the "design principles" approach is much more concerned with social engineering than with trying to have an in-depth understanding of the processes involved in the evolution and dynamics of institutions (Campbell *et al.* 2001). Faced with such social and cultural complexities of communities and natural resources found in the miombo region, we adopt this view in analysing the types of institutions, how they are formulated, structured and changed over time.

3. INSTITUTIONS, THEIR EVOLUTION AND FACTORS DRIVING CHANGE

The analysis of institutions and their evolution in this study is based on case studies done on communal and state-owned areas, in Malawi, Tanzania and Zimbabwe (Kajembe and Kessy 1999; Kajembe *et al.* 1999; Kayambazinthu *et al.* 2000; Mukamuri 2000; Campbell *et al.* 2001; Nemarundwe *et al.* 2001). It also draws from various sets of literature generated in other parts of the miombo region (Shackleton and Campbell 2001). The miombo invariably represent woodlands dominated by various *Brachystegia*, *Julbernadia* and *Isoberlinia* species and other associated species. The woodlands are largely used as grazing areas and as sources of wood and non-wood forest products, apart from providing cultural, social and other forest services.

3.1 Types of Institutions

Institutions governing land and resource management in the region can be broadly identified as ranging from national to local and from informal to formal, operating either independently or alongside each other (Table 1). The national legislation and guiding policies set the broader institutional framework, within which lower level government institutions, e.g., at district level, operate. At this lower level, they define governance structures, variously termed as local, community or village, to implement national legislation. A wide range of institutions and their supporting structures may fall within the state institutional framework or operate outside it as traditional institutions (Shackleton and Campbell 2001). The traditional institutions, which may fall within or outside of the state statutes, are the oldest and, depending on each case, may lie dormant, reformulate, reconstitute or may disappear completely over time (Mukamuri *et al*. 1999; Shackleton and Campbell 2001). Overall, the operating traditional institutional framework, as diverse as it is, is such that it does not wholly or easily fit into the CPR management systems. As suggested by Campbell *et al*. (2001), what is critical in understanding institutions in the region is to have an in-depth analysis of the processes involved in their evolution and dynamics.

In spite of the social and cultural complexities of communities and natural resources found in the miombo region, some key and parallel institutional features emerge from the case studies. At the local level, traditional chiefs are the encapsulation of all institutions, formal and informal, in the management of natural resources. All the case studies show that the traditional chief is at the centre of all user-group rules, sacred controls and civic controls in the area of jurisdiction. Several examples from the region show local institutions as potentially powerful, stable, valued and generate recurring patterns of behaviour in regulating forest resources. The local "Dgashiga" institution, in Bariadi, Tanzania, has since pre-colonial times been known to be very successful in communication and articulation of indigenous knowledge, attitudes and practices and in regulating access to natural resources within the community (Johannson and Mlenge 1993). Though largely ignored during the colonial and post-colonial period, Kajembe and Kessy (1999) state that there was little change in attitude towards this local institution. They also provide another example of a village or inter-village assembly, "Ngitili", (protectorate) with by-laws operating at the communal and private, household levels that have not changed over time and remain effective at the local level. These institutions date back to the 1940s arising out of the need to regulate pasture grazing, largely due to overstocking, with by-laws and associated penal codes as well as sanctions ("Masumule") instituted to effect resource conservation. A similarly effective and enduring local institution, "Lyabujije", meaning "forbidden", operate at the local level in a village and between villages with clear rules and by-laws for regulating and managing pasture and woodland resources.

The strength of tradition in both "Ngitili" and "Lyabujije" lies in a village elder called "ntale wa banamhala", who together with other elders form a ten-cell leadership to establish by-laws and associated penalties. The "ntale wa banamhala" remains incumbent for life unless some serious misconduct is committed by the elder which may warrant dismissal. Such types of institutions are common in many parts of the region with by-laws clearly understood and accepted by the community, stipulating what to do and what not to do. This may also refer to specific tree species and individual trees that are associated with some village taboos or traditional rules, as well as protected woodlands commonly mentioned as sacred because of their history, traditional rules and taboos associated with them.

Table 1. Types of institutions governing resource management of miombo woodlands in Malawi, Tanzania and Zimbabwe over time

Historical Period	Institutions: Malawi / Tanzania / Zimbabwe	Type of Rules
Pre-colonial		
• Local	*By-laws, customs, norms, taboos* (Traditional chiefs and councillors, clanheads, kraalheads, "Ngitili", "Lyabujije", "Dagashiga", Religious)	Informal
• User Group	*Resource use rules, regulations; Constitutions* (Craft associations)	Informal, Formal
• Sacred Controls	*Tree/woodland protection rules, customs, taboos*(traditional authorities)	Informal
• Pragmatic or norm-based/User specific	*Civic rules, norms, regulations*(NGOs)	Informal
Colonial		
• National	*Legal framework, Acts, Constitution* (state agents or parastatals: FD, FC, DNPW, DCs, etc.)	Informal
• Local	*By-laws, customs, norms, taboos* (local government administrative structures: RDCs, RMCs, VIDCOs, WADCOs, VFCs; traditional authority: chiefs and councillors, headmen, clanheads, kraalheads, traditional healers, "Ngitili", "Lyabujije", "Dagashiga", "Sabukus", Religious, etc.)	Informal, Formal
• User Group	*Resource use rules; Constitutions* (Craft associations, Garden Committees, etc.)	Informal, Formal
• Sacred Controls	*Tree/woodland protection rules, customs, taboos*(traditional authorities)	Informal
• Pragmatic or norm-based/User specific	*Civic rules, norms, regulations*	Informal
Post-Independence		
• National	*Legal framework, Acts, Constitution* (state agents or parastatals: FD, FC, DNPW, DCs, District Assemblies, etc.)	Informal
• Local	*By-laws, customs, norms, taboos* (local government administrative structures: RDCs, RMCs, VIDCOs, WADCOs, VFCs, VNRMCs, CAMPFIRE, ZINATHA, NGOs; traditional authority: traditional chiefs and councillors, headmen, clanheads, kraalheads, traditional healers, "Ngitili", "Lyabujije", "Dagashiga", "Sabukus", Religious, etc.)	Informal, Formal
• User Group	*Resource use rules; Constitutions* (Craft associations, Binga Craft Centre, Garden Committees, etc.)	Informal, Formal
• Sacred Controls	*Tree/woodland protection rules, customs, taboos*(traditional authority)	Informal
• Pragmatic or norm-based/User specific	*Civic rules, norms, regulations* (NGOs)	Informal

VFCs – Village Forestry Committees; VNRMCs – Village Natural Resource Management Committees; CAMPFIRE – Communal Areas Management Programme for Indigenous Resources; VIDCOs – Village Development Committees; WADCOs – Ward Development Committees; RMCs – Rural Management Committees; NGOs – Non-governmental Organisations; FD – Forestry Department; DNPW – Department of National Parks and Wildlife; DCs – District Councils; RDCs – Rural District Councils, ZINATHA - Zimbabwe National Traditional Healers Association.

However, there are also numerous examples from the region that show lack of continuity in effective (i.e., accepted, respected, adhered to and working) local institutions. These have, in one way or another, been undermined by several factors. In all the three case study countries, such institutions have been undermined at various stages of the colonial and post-colonial periods. With the influx of new institutions created within these periods, some functions and responsibilities of the traditional leadership, central in an African setting for effecting institutions, were either taken up by the new institutions or found to be irrelevant and therefore ignored. There is therefore considerable evidence that traditional leaders, apart from the case of sacred burial sites, are increasingly becoming weak and losing their legitimacy among the people in all the case study areas. In spite of the vacuum that this creates there is at the same time no alternative or forthcoming institution to replace them.

All the case studies and related literature point to the fact that sacred controls, in the management of sacred woodlands, clearly define woodland boundaries, and the rules on who has rights of access, use and at what times. These include graveyards and other woodlands of strong ritual significance. Here forests are protected for traditional purposes such as worshipping and sacrifice offering. Ordinarily, only dead wood can be collected from such areas and no cutting is allowed. Cutting of certain trees, the type of tree concerned varying between different areas, is strictly taboo. This includes, in some areas, certain fig trees, associated with rainfall as well as rain ghosts (especially for worshipping, sacrifice offering and rituals). Such rules are strictly embedded in the traditional spiritual, cultural, and local economical and ecological environment. Graduated sanctions are imposed by the elite, and there is little recourse to methods of conflict resolution if such conflicts arise. Morally and traditionally, such institutions are well accepted and respected by members of the community; who, in turn, are accepted and granted all traditional needs as forms of incentives. These institutions have hardly changed over time and not been affected by the colonial and pre-colonial era. They are therefore regarded as more enduring than other institutions in the region. It would appear then that reworking and invoking the CPR theory and design principles to explain the enduring nature of sacred woodlands would be rather inappropriate. Of necessity, sacred woodlands may be treated in relation to their spatial, temporal, economic, religious and political contexts. Elements of these contexts include the resource status, the power dynamics within the community; the commercialisation of some of the resources located in sacred woodlands, and the broader economic and climatic changes (Mukamuri *et al.* 1999).

However, the degree to which such institutions would be more enduring than in other sacred woodlands would differ depending on a number of factors. For example, where there are heterogeneous communities, mainly due to immigration from other ethnic groups, the survival of the sacred woodlands is less than in homogenous communities. In another example, when a trading class develops within a community,

the possibility arises that the traders seek out the resource irrespective of its politico-religious roles, and may therefore seek to compromise some of the sacred institutions.

The nature of institutions governing resource management by kraalheads (Zimbabwe) or clanheads (Malawi & Tanzania) in the region, though different from the sacred woodland institutions, generate similar attributes where these seem to be in full control of their resources. Some of these attributes include self-policing and enforcement, acceptance, respect, combined with fear for the resource, as it belongs to given families as private property. Throughout the region, the clanheads or kraalheads are traditionally empowered and therefore given legal authority to try cases concerning resource management and other cases such as witchcraft, adultery and theft. This only reinforces the strength and enduring nature of their institutions in the management of their natural resources. However, the national will at the legislative level has played an important role in influencing to what extent such legal authority can be exercised by such institutions. In Zimbabwe, the kraalheads did not have legal authority during the post-colonial period up until 1999 when the Traditional Leaders' Act was enacted. Even after then, implementation on the ground shows that, in some areas, the national will has yet to be fully realised to reinforce and strengthen these institutions.

The influx of alien religions to the region has also brought about changes in the local institutions. In the case of Zimbabwe, for example, the decline in traditional values and customs, i.e., respect for lion spirits (mhondoro), has been regarded as one of the major reasons why local values have become ineffective (Mukamuri 2000). "Mhondoro", was believed and known to safeguard ancestral rules and societal values through which people's lives were viewed as an integral part of the environment. However, these traditional rules have been interpreted and changed to suit new needs, as they have been affected by both Christian religion and strong inclination towards modernity. For example, Christians do not want to participate in traditional rain-making ceremonies known as *chipwa*. Even some of the kraalheads were known to be members of Ethiopian Orthodox and Methodist churches recently introduced to Zimbabwe.

The region shares a common legal framework in the establishment by governments of state institutions for the implementation of local level community developments. Such institutions—WADCOS, VIDCOs (Zimbabwe), VNRMCs, VFCs (Malawi), and VFCs (Tanzania)—have not only divided loyalties, between the committees and traditional leaders but they have also been politically marginalised. In some communities, for example in Zimbabwe and Malawi, people have tended to elect traditional leaders into these committees as a strategy of avoiding conflict and confused loyalties rather than because of their suitability as committee members. Although in some cases the committees have tended to weaken the traditional institutions, in general such committees are less powerful than the traditional leaders over the management of indigenous resources. Their institutions are therefore always having to adapt to the existing local institutions for effective application. To this end, both traditional and modern institutions, have been observed to work side by side, e.g., a number of institutions working in Mukarakate, Zimbabwe and Chimaliro in Malawi. This also indicates that the imposition of such structures and institutions on the people by a state of such structures and institutions for its political and hegemonic ambitions (Makumbe 1996) has led to the demise of many such institutions in the region.

The nature of the rule systems and organisations at the formal, national level has been the most dynamic for the region, with rule systems changing according to who is in power, right from the colonial to the post-colonial period. Accordingly, this has resulted in varying degrees of institutional change and arrangements for resource management, either enabling or inhibiting. All case studies show that this has, however, largely brought about negative impacts on local, traditional institutions and on the natural resource. A number of these formal, government institutions are referred to in Table 1. While recognising the nature of these government institutions and how they have evolved, it has become necessary in the region to strengthen existing traditional institutions and encourage the formation of new ones. This is, however, stemming from a few successful cases, such as the ones referred to above, which have encouraged effective resource management of miombo woodlands in the region.

Most of the user group institutions as well as norm-based civil institutions may be formal and informal but largely informal. They are based on working rules that achieve the purposes for which the groups have been established. The rules may be with regard to how individual committees should operate, how and when to use particular resources, and a range of other rules. In most cases these institutions are established by external agencies, for example, non-governmental organisations. In some cases, they are established by village committees, internally or externally sponsored, for controlling resource management. In general these institutions are temporal and change as situations and goals change and may be influenced by existing legal frameworks in each country. Though these can be replicated under similar circumstances, they have to be changed and modified to suit particular institutional arrangements governing resource management in other areas. Most important, particularly for the externally sponsored agencies in resource management, such institutions must be legitimised, compatible and in harmony with local institutions. While some examples illustrate this scenario, e.g., institutions established by the externally sponsored Hifadhi Ardhi Shinyanga (HASHI) in Tanzania, VNRMCs in Malawi and WADCOS or VIDCOs in Zimbabwe, for resource management, others have completely failed to fit into the local setting and therefore not contributed much to governing resource management.

4. EVOLUTION OF INSTITUTIONS AND FACTORS DRIVING CHANGE

Although there is wide diversity in the way traditional institutions have operated in the region, mainly due to historical, cultural and socio-political factors, there are commonalities that can be drawn from each country's experiences (Murphree 1993; Matose and Wily 1996). These include the fact that local communities, having a long history of association with forests and high degree of dependence on them, are assumed to have accumulated capabilities that enabled them to manage forests sustainably, particularly in the pre-colonial era. Cases from around the region (Matakala 1986; Makuku 1993; Campbell and Byron 1996; Madzudzo 1997) as well as from various parts of the world (Shiva 1988; Makela 1999) attest to this. Another commonality is the colonial legacy of state-created institutional structures that centralised control, regulation and management of woodlands away from traditional structures, resulting in various degrees of weakening and transformation of the latter. The socio-political transformation at independence did not bring much institutional change as the traditional institutional organisations, e.g., traditional authorities, became absorbed in the administrative, socio-political system of the state.

One of the earlier and most prominent initial factors that resulted in institutional change in the region was the intrusion of the colonial government into the existing traditional institutional structures. By introducing state structures to facilitate its own development and administrative agenda, the colonial government directly and indirectly undermined the traditional institutional organisations that had hitherto been effective in the management of woodlands. Traditional institutional constructs, giving clear rights of tenure by chiefs to their subjects, henceforth became part of the state's responsibility. This marked the beginning of the weakening and loss of authority of traditional organisations in the miombo region (Matose and Wily 1996). The colonial state agencies that were created to control, regulate and manage woodland resources, particularly through establishment of forest reserves as 'no go' zones to local communities, ensured that woodland resource management and land tenure was completely under state control, except for sacred groves and graveyards.

The literature on institutions in the region dating back to the pre-colonial period (e.g., More and Vaughan 1994; Richards 1940, 1950) show the key social and political institution of tribes as being centred on chieftainship (whether Paramount chief or any other tribal or clan leader among the Ngoni of Malawi, the Bemba of Zambia, the Lomwe of Mozambique, the Shona of Zimbabwe or the Sukuma of Tanzania). In this system, the subjects believed in the chief as having both political as well as religious or spiritual powers. This belief was the source of cohesion and adherence to governing institutions even as such powers got transferred from one generation to the other, including the legal rules of succession. However, in cases where there were constant wars such systems could not be maintained. For example, Ranger (1993), in giving a historical account of how communal tenure evolved from pre-colonial days onwards, points out that the Shona chieftainships, under constant factional wars in the nineteenth century could not provide security of natural resource tenure. In Ranger's view, there were few signs of 'traditions' of communal tenure transferred from the pre-colonial period to the early colonial Rhodesia (now Zimbabwe).

The coming in of Europeans in the region, whether as missionaries, traders and/or settlers in the late 1800s changed some of these institutions. The Europeans perceived for example, schisms, tribal practices and rituals, and general way of life among African tribes and clans, however organised and institutionalised, as uncivilised and backward. They therefore introduced Christian values and the state system. The role of traditional institutions was de-emphasized but the traditional chiefs and clan leaders were maintained with their role redefined as that of custodians of state system. All these dynamics contributed to the weakening of the traditional institutions and the group cohesion, which used to exist before.

The colonial period saw the establishment of legislative controls on woodland use in the region. These included the Native Reserve Forest Produce Act (1928), Natural Resources Act (1942) and the Forest Act (1948) in Zimbabwe; the District Administration (Native) Ordinance (1926) (for the Communal Forest Scheme) and the Forestry Ordinance (1931) in Malawi and, Forest Ordinance (1957) in Tanzania (Kajembe and Kessy 1999; Kayambazinthu 2000; Kajembe *et al.* 1999; Mukamuri 2000; Campbell *et al.* 2001; Nemarundwe *et al.* 2001). These Acts and Ordinances increased the state control over woodland resources, especially in the communal lands. Alongside these Acts and Ordinances, the colonial period also marked the beginning of major changes in woodland management in the region. This was through the introduction of state institutions and structures that were tasked with enforcement of rules and regulations and

management of forest resources were tasked with enforcement of regulations and management of forest resources. These included the Forestry Departments (FD), District Councils (DCs) and Village Forest Committees (VFCs) in Malawi and Tanzania; Department of National Parks and Wildlife (DNPW), Forestry Commission (FC), Rural District Councils (RDCs), Village Development Committees (VIDCOs) and Ward Development Committees (WADCOs) in Zimbabwe. These essentially aimed to facilitate the penetration and entrenchment of administrative structures in the control and management of natural resources by the colonial government and undermined the local people's initiatives and capacity for woodland management. This colonial legacy has, in some cases, left local communities with little rights over the resources they purportedly own, and with the hangover that everything should come from the top to the community (Mphepo 1998, Kajembe and Kessy 1999).

The coming of the post-colonial governments at independence further consolidated state powers and institutions in resource management as local communities were 'cultured' into a system of only receiving instructions from the top. In both colonial and post-colonial era, local communities were perceived as a destructive force and no attempts were therefore made to consider them in the management of miombo woodlands. Thus while independence marked the end of the colonial state in Tanzania in 1961 and, ushered in a new government in Zimbabwe in 1980 and in Malawi in 1964, there was little change in the attitude towards traditional institutions. In fact, local natural resource management institutions were further weakened as powers were shifted even further from the traditional authorities to the state under the District Councils Act (1980) and Communal Areas Act (1982) in Zimbabwe. Two other legislative instruments which contributed to changes in the institutional setting in Zimbabwe included the 1982 Prime Minister's Directive on Decentralisation and the Rural District Councils Act (1988). The District Councils Act removed the power to allocate land from traditional chiefs and headmen to District Councils, while the 1982 Prime Minister's Directive on decentralisation resulted in the establishment of local institutions known as the Village Development Committees (VIDCOs) and Ward Development Committees (WADCOs). The latter formed a parallel institution to the traditional authority in place at village level, creating friction between democratically elected leaders and the traditional leaders at community level, and further stripped chiefs and headmen of their land allocation powers (Mutizwa-Mangiza 1990). The government has now restored authority to the chiefs through enactment of the Chiefs and Traditional Leaders Act (1998). However, the existence of two legislations supporting two parallel power structures at the local level, without clarifying and distinguishing the various roles and responsibilities, creates potential problems of allegiance and legitimacy at the local level (Nemarundwe *et al*. 2001). Malawi has experienced similar institutional shifts with the creation of the Chiefs Act (1964) and the creation of Village Natural Resources Committees (VNRMCs) under the Forestry Act (1997) (Kayambazinthu 2000). For Tanzania, new institutions were imposed at the local level, from 1967, in line with the socialist ideology, modelled along Marxist-Leninist principles. In all these cases, the organisational structure was designed to represent a bottom-up approach to development, but was in essence a conduit for channeling propaganda and development ideas from the state to the local level. These government organisations and institutions have, however, failed in the region largely as a result of lack of local legitimacy, institutional overlap with the persisting traditional structures, and different interpretation by individuals and groups to suit their own ends (Kajembe and Kessy 1999).

One common institutional change that developed in the region from the mid-1980s was the introduction of the Structural Adjustment Programmes (SAPs), which were characterised by the emergence of commercialisation of forest products (Kajembe and Kessy 1999). SAPs have had a major impact on poverty among the rural poor especially as a result of removal of subsidies on major farm inputs, and market liberalisation. These have resulted in a big rise in input prices and hence affecting farmers' capability to access them and accordingly their capacity to produce (Carr 1998, Blackie 1998). The low productivity has resulted in increased poverty in rural communities. As a survival strategy some villagers have resorted to trade in forest products such as firewood and charcoal, thereby weakening the existing local institutions. As Mukamur.i *et al* (1999) argue, when a trading class develops within a community a possibility arises that the traders seek out the resource irrespective of its politico-religious roles, and this inevitably leads to breakdown of existing institutions. This has invariably posed new challenges to both government institutions as well as any remaining traditional institutions responsible for managing resources in the miombo woodlands. In areas with mixed social groups or tribes, what the forests and the forest products mean to the indigenous population is not necessarily the same to immigrants. For example, the indigenous Nyamwezi ethnic group of Tanzania, who live around the Urumwa Forest Reserve, see the forest in terms of timber, charcoal, firewood for tobacco curing or as a source of local medicine. At the same time, the Sukuma ethnic group who are immigrants to the area and pastoralists see the reserve as potential area for grazing (Kajembe and Kessy 1999). Such demands, under SAP and commercialisation, has led to the flouting, and subsequent weakening, of existing local institutions for the sustainable management of the resources. This particularly applies in the forest management cases in Malawi and Zimbabwe, where powerful entrepreneurs tend to ignore local regulations and controls, undermining the authority of community institutions. In general, this has also created highly stratified and differentiated communities with multiple interests, e.g., various resource user groups such as the Craft Associations and Garden Committees, and other pragmatic, norm-based and user specific groups (Table 1). This poses a particular challenge in that such situations create varying incentives and disincentives for respecting or accepting the local institutions and influences people's participation in community-based natural resource management (Shackleton and Campbell 2001).

Throughout the region, national and international non-governmental organisations have basically mushroomed in the later part of the post-colonial era. These, together with the old and well-established religious organisations, have had some impact on the management of miombo woodlands. As the early missionaries came into the region, during the pre-colonial as well as the post-colonial period, they acquired a lot of land from the local people and established their own institutions for governing resource management. The local communities did not have land nor resource use rights. Rights to forest products such as collection of dead twigs for firewood, fruits, caterpillars, mushrooms and honey varied from site to site but generally requiring permission. Donor agencies, forming another institutional set up, have had some influence on the general management of forests in the region. Their influence has basically been in terms of provision of financial resources and in some cases they have promoted certain policies which have a major impact on the sustainability of miombo woodlands. One example of such policies is the support given to the SAP.

5. INSTITUTIONAL CHARACTERISTICS

Using common institutional attributes, frequently referred to in the case studies and literature, a set of factors begin to emerge as critical in determining the resilience or susceptibility of institutions to change (Table 2). The likelihood of an institution to change or not to change is, in this case, qualitatively measured by the degree to which it can be characterised by these attributes; the higher the attributes the less likely for the institution to change. On the basis of this analysis, the first three categories of institutions are summed up (in the last column) as inherently having a low tendency to change. These include various institutions established at the local level by traditional leaderships, village institutions by village elders and clanheads or kraalheads, and those governing resource management of sacred areas. In all they appear to have better integrated traditional, socio-cultural traits and incentives that give them moral and political legitimacy than the externally sponsored and initiated institutions. These are also known to promote self-policing or enforcement of the institutions and social cohesion, necessary for implementation of rule systems.

Incentives do, of course, take many different forms and come from many different sources that it is difficult to figure out the multiple and diverse incentives that are at work in a community. For most of the externally initiated institutions, money seems to be the main incentive, e.g., an afforestation project which may pay people to plant trees. The traditional institutions, however, may be driven by fear, for example. This could be fear of the ancestors who may cause people to protect a sacred forest. In this case the community may have strong animistic beliefs and universally fear certain forest spirits that inhabit the region. Some families and some farmers hang amulets to the spirits in the trees to protect them as one would not dare approach a tree that might be inhabited by such a spirit. Another characteristic of the community, namely its shared religious beliefs, adds incentives that protect the rights of the owner. In some communities, for example, there is a powerful spirit of unity which generates pressure to conform to established norms. Group pressure may play a big role in getting people to engage in an activity or persuading them to protect a sacred grove. The community's ability to manage resources is its social cohesion and willingness to set and strive for common goals. In this case the community is able to establish common goals, establish strategies for accomplishing those goals, and then work together to follow the strategy that has been proposed. This is largely determined by history of the community (i.e., population and settlement history and conflict history) and its relations with others, its present social structure, its cultural values, and the way it governs itself. The population history reflects the ancestral origins of the community, whether descended from a common or single ancestor or family. The severity of the sanction is a factor in determining how much a rule affects behaviour. For example, a rule that when violated can result in one's expulsion from a community creates different incentives from one that results in nothing more than a token fine.

Unlike the national and externally influenced institutions of user groups and other norm based, specific user groups outlined in Table 1, the traditional institutions are more enduring and stable because of their strong foundation and deep-rooted, specific social stratification and structural organisations. Traditional societies, irrespective of their degree of centralisation or social fragmentation, use kinship or leadership as a moral framework of binding force and unity, which expresses itself in moral concepts or axioms. The moral order is therefore meant to be robustly collective with ensured checks and balances enabling group interests to be preserved and to guide local

government and politics, decision-making, and even religion. Everyone participates, is heard, and accepts his or her responsibilities to the group and to one another (Dia 1994; Kajembe and Kessy 2000). These attributes are key to institutional stability. Less effective and failed traditional institutions, mainly influenced by external forces throughout the colonial and post-colonial period, are a clear departure from the moral and political legitimacy of the ancestral, and strongly centralised, systems of African institutions.

Table 2. Institutional attributes as critical factors in determining change

Institution	Institutional attributes						Tendency to change
	Socio-culturally accepted/ respected	Moral/ political support/ legitimacy	Religious influence	Incentives	Self-policing/ enforcement	Promote social cohesion	
of Traditional chiefs and councillors	V. High	V. High	High	V. High	V. High	High	Low
of clanheads, kraalheads, "Ngitili", "Lyabujije", "Dagashiga"	V. High	V. High	High	High	V. High	V. High	Low
of Sacred Tree/ woodland protection rules, customs, taboos	V. High	V. High	V. High	V. High	V. High	V. High	Low
of externally instituted VFCs, Religious, VNRMCs, CAMPFIRE, VIDCOs, WARDCOs, ZINATHA, NGOs etc	High	High	Low	Moderate	Moderate to High	High to Moderate	Moderate
of Craft associations, Binga Craft Centre, Garden Committees, etc	High	High	Low	High	Moderate	Low	Moderate
of FD, DNPW, DCs, RDCs, etc	Moderate	High	Low	Moderate	High	Low	Moderate
of Civic rules, norms, regulations	V. High	V. High	Low	Moderate	High	High	Moderate

VFCs – Village Forestry Committees; VNRMCs – Village Natural Resource Management Committees; CAMPFIRE – Communal Areas Management Programme for Indigenous Resources; VIDCOs – Village Development Committees; WADCOs – Ward Development Committees; NGOs – Non-governmental Organisations; FD – Forestry Department; DNPW – Department of National Parks and Wildlife; DCs. -District Councils; RDCs – Rural District Councils, ZINATHA - Zimbabwe National Traditional Healers Association.

By the same reasoning, the lack of indigenous, traditional foundation and related political and moral legitimacy in national institutions, with origins from the colonial period and emphasis on control and centralised power, has tended to serve the laws of the countries of the region and not the indigenous population. As a result, these have not been given as much socio-cultural acceptance and respect, nor promoted social cohesion as well as the traditional institutions. These institutions, as well as those governing resource management by user groups and elected committees, have the tendency to change as their membership or conditions change.

6. DISCUSSION AND CONCLUSION

This study has demonstrated the existence in the mombo woodland region of a multiplicity of institutions ranging from national to local and from formal to informal; each varying according to the particular socio-cultural and traditional context. In this respect, understanding institutions in the region and the processes involved in their origins, evolution and dynamics is observed as much more important than analysing and interpreting them according to the "design principles" approach under CPR systems. Through a historical analysis it has also been revealed that all these institutions have also been affected by changing state and administrative frameworks, from colonial to post-colonial periods. From this analysis, it is clear that some traditional institutions have been largely weakened and considerably changed, from their inherent constitutional character, which saw them as the product of ancestral, ritual and spiritual power before colonial times (Dia 1992). As has been asserted elsewhere (Agarwal and Yadama 1997; Agarwal and Gibson 1998; Campbell *et al*. 2001), institutional analysis in the region should take account of spatial contexts, temporal contexts, including history, the micro-politics of resource use and transaction costs, and the actual condition of the commons.

The extent to which traditional institutions in the region have been affected in the past have made them to become more or less hybrid systems of institutions in which tradition and modernity co-exist. Recent developments of devolution and legislation to enable community-based resource management, however, come with the recognition of the potential of local institutions while at the same time calling into question the efficacy of state institutions to manage on their own without community institutions (Mandondo 2000). While recognising, for various reasons, the general weaknesses of some institutions to effectively govern natural resources, this study attempted to identify critical factors that make institutions in the region stable and enduring. The analysis has shown that institutions that have better integrated traditional, socio-cultural traits and incentives, and are given moral and political legitimacy at the local level are more stable and enduring than those that are less so. In our study, these refer to institutions concerning traditional leaderships, different types of clans or households, and sacred areas. As the region continues to recognise the legitimacy of traditional systems with their related structures and rules, these critical factors are important in shaping or harnessing local institutions. This is of particular importance as policy makers try to develop institutional frameworks that integrate and accommodate formal legislation, e.g., the Forest Act, within the local by-laws or to make provisions for the establishment of by-laws. The potential is there for existing traditional institutions to operate in harmony with externally sponsored institutions which is an indicator of the potential compatibility between

the two types of institutions (Kajembe and Kessy 2000). In recognition of internal differentiation of resource endowment with communities and overlaps of interest groups, often with conflicting and competing interests, governments must, however, reserve or retain the right to intervene in cases of conflicts at the local level, where such a higher level governance systems are required to provide protection to marginilsed groups and provide a forum for conflict resolution.

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6.
Conflicts over the miombo woodlands: The case of Blantyre, Lilongwe and Kasungu, in Malawi

C.M. Masangano, D. Kayambazinthu and L. Mwabumba

ABSTRACT
Malawi is currently promoting a policy of communal management of miombo woodlands. This is occurring at a time when the country has changed its political system to multiparty democracy and is decentralizing government and promoting community involvement in development efforts. There is, however, need to understand the factors likely to lead to success or failure of community participation in management of miombo woodlands.

Miombo woodlands contribute numerous resources to the livelihoods of rural households. Harvesting of miombo resources has most often led to conflicts among various parties. This paper discusses the major sources of conflict among communities living close to forests. It also discusses the approaches used to resolving and managing conflicts. The study revealed that conflicts centred on a range of land and forest issues. Land conflicts usually resulted when two parties both claimed rights of inheritance, or when one party failed to respect garden boundaries and encroached on the gardens of the other people. Land conflicts also occurred when there was failure to return borrowed land in the agreed period as well as when one's animals grazed in other people's gardens. Conflicts surrounding forest resources occurred when an individual was found harvesting resources such as poles and firewood from other people's gardens or from communal forests without permission. Conflicts also occurred when community members were caught harvesting resources from reserved woodlands.

The communities had some institutional structures which could be used for conflict resolution and management. Generally, conflict resolution started with the two parties discussing the issue. If they failed to resolve their conflict, they referred the matter to the village headman. The village headman discussed the issue with the two parties in the presence of other village elders. Conflicts not resolved at this level were referred

to the chief or group village headman where there was a similar process of discussion. These institutional mechanisms were, however, not very strong in resolving conflicts surrounding resources from forest reserves, because such forests were under state control and the state structures tended to be more powerful than local structures. Conflict resolution in these cases had to involve state structures. Any effort to promote local participation in the management of miombo woodlands must look into mechanisms for empowering local institutional structures.

Key words: Conflicts, woodlands, local institutions, management committees.

1. INTRODUCTION

Malawi is currently experiencing serious problems of natural resource degradation. Estimates show that the total national forest cover in Malawi is being depleted at 3.5 percent a year. The major causes of forest degradation are land clearing for agriculture, and tree felling for fuelwood and charcoal for domestic energy use and sale, fuelwood for tobacco curing and fuelwood for other uses such as brick making. Attempts by government to control deforestation of the natural woodlands have usually resulted in conflicts with communities. One serious type of conflicts is illustrated by Namatunu Forest where, with the advent of multiparty democracy in the early 1990s, local people went into the forest to harvest trees for fuelwood, charcoal, poles and even timber, without regard to Government rules. Attempts by Forest Department staff to control the situation were met with hostile resistance by local people.

Mwabumba et al (1999) categorized *miombo* woodlands in Malawi into two types: government protected woodlands which are on public land and village woodlands on customary land. The protected woodlands were, until the early 1990s, managed strictly by the government through its Department of Forestry and Department of National Parks and Wildlife. Staff of the Department of Forestry regulated the collection and utilization of forest products, and members of local communities were not allowed to collect these products unless they had a permit. Coote *et al* (1993) reported that these woodlands cover an area of about 1 million hectares.

On the other hand *miombo* woodlands on customary land consist of more than 2000 small areas of woodland covering a total area of 2.7 million hectares (Forestry Department 1985). These small woodlands are usually designated as village forest areas under the control of village headmen[1]. Community members living in areas close to these woodlands are normally allowed access to these areas to collect specified resources such as firewood and non-timber forest products like thatch grass, fruits, mushrooms and caterpillars. Cutting of trees is normally not allowed.

In an effort to promote good management of the government reserved *miombo* woodlands and in light of the democratization process, Malawi is pursuing a policy of community involvement in the management of such woodlands. Communities are being encouraged to participate in the management and utilization of forest resources. This is being done with the understanding that, in the past, communities co-existed with the forests which provided them with various livelihood benefits. They maintained certain cultural values and beliefs which ensured that the forests were not mismanaged.

This paper provides findings relating to the major sources of conflicts and the approaches used in conflict resolution and management among communities in the *miombo* woodlands. The existence of conflict resolution mechanisms is a precursor to successful community management. Robinson (1980) described conflict as a behavior

threat by one party at the territory of another party. Territory in this respect refers to a wider psychological dimension based on personal values and beliefs on individual privileges (Robinson and Clifford 1977). Group or individual behavior in conflict situations threatens the other party by trying to attain its goals or achieve its interests with enough behavioral intensity to limit the goal attainment of the other party.

One implication that can be drawn from this definition is that conflicts most often occur when resources are limited and people's needs and wants exceed the availability of resources. This causes behavior where by one party tries to block the other party from accessing the resources. One way by which parties, especially those in a position of power, try to block access to resources is through the types of policies they put in place. Policies represent the type of goals and values and in turn define the types of rights, interests and privileges that a society has.

The main objectives of the study were:

- To identify and document major sources of conflicts in the management and use of *miombo* woodlands and other resources in the vicinity of the woodlands.
- To identify and document the approaches used in conflict resolution among local communities.
- To draw lessons from this study for promoting more sustainable community management and usage of *miombo* woodlands.

2. METHODOLOGY

The study was conducted in four sites within three districts. The sites were Mdeka and Mangwero in Blantyre District, Dzalanyama in Lilongwe District and Chimaliro in Kasungu District. The study sites were identified by the researchers through a process of consultations with various stakeholders, including staff of the Forestry Department. Reconnaissance surveys were conducted to improve understanding of the sites chosen. This was followed by a series of focus group discussions of local communities in the study sites (Table 1).

Table 1. Villages/communities which were consulted during focus group discussions

District	Site	Names of villages/ communities consulted
Blantyre	M'deka	Chilipa
		M'mangeni
	Mangwero	Jamali
Lilongwe	Dzalanyama	Gowela
		Kapingiza
Kasungu	Chimaliro	Block 1 (Boni Chakuchanya)
		Block 2 (Boni Chakuchanya)
		Block 3 (Boni Chakuchanya)

These focus group discussions were conducted with various groups of people in each village. The groups consisted of a mixture of people (men, women and youth) as well as leaders in various categories, like chiefs and village natural resources management committees (VNRMC). Key informant interviews were also conducted as

a way of triangulation and to get additional information where possible. The key informant interviews were conducted with various individuals including:

(a) Village headmen
(b) Men
(c) Women
(d) Other local leaders such as members of parliament
(e) Non governmental organizations working in forestry and natural resource management in the areas of the study
(f) Staff of the Forestry Department and
(g) Staff of other relevant government departments such as Agriculture and Irrigation

Direct observations were also used in local court sessions in order to observe the process of conflict resolution, but these were few since local court sessions were rare during the period of the study. An attempt to review court records from formal courts failed as permission for such could not be obtained.

3. BACKGROUND TO THE STUDY SITES

M'deka and Mangwero were the two sites where the study was conducted in Blantyre District in Southern Malawi. They are in the North Western part of the District along the main Blantyre-Lilongwe road. The area experiences a continuous rainy season which starts in November and ends in March. Annual rainfall varies from less than 700 to 800mm with mean annual temperatures varying from 20 to 23^{o}C. The area was composed of mostly Yao people and they follow the matrilineal system of marriage. There were 1850 households in the three villages involved in the study in this area, (NSO 1987). Nearly half the population was less than 15 years old and the average population density was 200 persons /km^2. Communal management of natural forests in both Mdeka and Mangwero was implemented through village natural resources management committees (VNRMCs) which worked hand in hand with staff of the Forest Department in ensuring sustainable management and utilization of the forests. Both sites experienced major deforestation of their indigenous forests in the past 20 years. The main forces which influenced this deforestation were:

The opening of a main road which created markets for wood products such as firewood and charcoal. The focus group discussions revealed that the area has low agricultural potential because it generally received low rainfall which was often poorly distributed. Secondly the cost of agricultural inputs such as fertilizers and chemicals were very high and most of the farmers could not access them. These problems frequently resulted in low agricultural production and often people could not produce enough for their subsistence needs. On the other hand, people in the area did not have reliable alternative economic activities. The opening of the road opened market opportunities for forest products such as firewood and charcoal and to many people, this provided a good economic alternative. This led to the degradation of *the* woodlands.

Change of government from one party rule to multiparty democracy was another factor which influenced the rate of deforestation in the area. To most community members, democracy came to mean deregulation of state control. People went into the forests to get firewood, charcoal and other products without permission and this led to complete deforestation of state reserved forests. Namatunu Forest

which was about 10 kilometers away from Mangwero is an example of this deforestation.

Each of the villages which participated in the focus group discussions in Mdeka area, had a VNRMC involved in re-afforesting Chilipa hill. They were engaged in planting indigenous trees, protecting the trees from bush fires, controlled grazing systems amongst other things. Their efforts were supported with funding by the Malawi Social Action Fund (MASAF). There were a number of non governmental organizations working in forest management in the area including World Vision International and Nkhomano Centre for Development.

Mangwero is a hill in Jamali village. This hill was fully covered by a forest, which was established and protected by people in the village. The village had a VNRMC whose duty was to oversee the protection of the forest from bush fires, tree cutting, and pole and firewood collection, amongst other activities. There were no NGOs operating in this area. The VNRMCs played a major role of mobilizing the communities to participate in forest activities in both Mdeka and Mangwero. They reported to their village headmen.

Dzalanyama Forest is about 60 km to the south of Lilongwe City in Lilongwe District. It lies along the boundary between Malawi and Mozambique covering parts of Dedza, Lilongwe and Nchinji Districts. The forest was composed of two parts that included a government plantation and reserved natural woodland. The plantation forest surrounded the natural woodlands providing a wide boundary between local communities and the natural woodlands. The forest served as a water catchment area for Lilongwe City while the Ministry of Agriculture and Irrigation also used it as a cattle ranch. Dzalanyama area received annual rainfall ranging from 800 to 1600 mm and mean annual temperatures ranged from 17.5 to 20 ^{o}C. The topography consists of moderately sloping plains and hills with shallow stony lithosols.

The communities around the forest were predominantly composed of the Chewa tribe and followed the matrilineal system of marriage. Results of this study showed that most of these local communities had co-existed with the forest from before the time of colonization in the mid 1800s. Members of the community had been collecting forest products such as fruits, mushrooms, caterpillars, grass and firewood. At the time of the study the communities were organized into village natural resources committees, which were assisting in the management of the forest. These VNRMCs assisted both the village headmen and forestry staff in promoting the establishment of both individual as well as communal woodlots in their villages. The VNRMCs also assisted the village headmen and forestry staff by organizing people in their villages to participate in fighting bush fires and patrolling the forest. They also assisted in settling disputes on issues relating to the forest.

Chimaliro Forest is a miombo woodland 60km north of Kasungu Town in Central Malawi. It forms the northern boundary of Lilongwe-Kasungu plain. The forest covers about 160km^2, lying along the Malawi/Zambia boarder. Part of the forest is in Zambia and the management approaches of the forest vary in the two countries. Kayambazinthu, et al (2000) has provided more details about the forest. The annual rainfall in Chimaliro hills ranges from 800 to 1600mm with mean annual temperatures ranging from 22 to 24^{o}C. The topography consists of moderately sloping plains and hills with shallow stony lithosols.

The communities around the forest speak Tumbuka and follow a patrilineal marriage system. Their major economic activity is farming and their main crops include maize,

tobacco and groundnuts. Population density in the area is lower than most parts of Malawi with an average of 74 people per km^2 (NSO 1987). Chimaliro is a government reserved forest under the management of the Forestry Department. Community involvement in natural resource management is, however, done under a co-management arrangement where communities around the forest have organized themselves into co-management blocks. There are three co-management blocks, each comprising three of the nine villages, of group village headman Boni Chakuchanya. These co-management blocks had block committees, which worked hand in hand with staff of the Forestry Department in the management of Chimaliro Forest. The block committees assisted the village headmen and forestry staff by organizing people in their communities to participate in forestry activities such as fighting bush fires, patrolling the forest and clearing fire breaks. The committees also assisted the village headmen and forestry staff in settling disputes on issues relating to the forest. In addition to the blocks, each of the nine villages had their own village forest areas (VFAs) which had natural woodlots and in some cases planted exotic woodlots as well. These village forest areas were managed by village natural resources management committees (VNRMCs).

4. TYPES OF CONFLICTS

This study revealed that communities living in the study sites experienced numerous conflicts surrounding natural resources. The major sources of conflicts were those centred on land and forest resources.

4.1 Land conflicts

Land conflicts revolved around a number of areas, including land ownership and inheritance, boundaries, grazing animals in other people's gardens, failure to return borrowed land and land titling efforts. Cases where two or more people felt that they had a right to inheritance and ownership of one piece of land frequently caused conflicts. These conflicts most often occurred among people who were closely related and they usually pointed at one common ancestor from whom each claimed to be a descendent.

Two types of boundaries that were sources of conflicts were garden boundaries and village boundaries. In both cases, the conflicts started with one party accusing the other for not respecting the boundaries and therefore encroaching into the other party's land. Conflicts on garden boundaries usually involved members of the same village while those of village boundaries occurred between neighboring villages. One example of conflicts on village boundaries occurred in Dzalanyama where a village neighboring Kapingiza village established a village woodlot on a parcel of land that lay along the village boundary. It was claimed that trees were planted on land that belonged to Kapingiza village.

Another form of conflict that was common in the sites involved grazing livestock in other people's gardens and damaging crops. These conflicts were becoming more common as pressure on land was increasing with the rapid population growth. People were being forced to open grazing lands for cultivation and this was forcing livestock farmers to graze their animals in non traditional grazing lands such as land very close to cropped areas. Grazing in these types of land is risky as animals can easily go into the gardens and damage crops.

Another source of conflicts cited involved people who borrowed other people's land for cultivation for an agreed period of time but did not want to return it to the owner at the end of the agreed period. This caused conflicts when the owner tried to claim the land back. The other issue, which the respondents in Dzalanyama recalled to have been a major source of conflicts in the 1970s, was the Government's efforts to register land. Gowela and Kapingiza villages are in an area where the Lilongwe Land Development Programme (LLDP) was implemented through the Ministry of Agriculture from the late 1960s to the early 1980s. One of the Lilongwe Land Development Programme objectives was to undertake land registration. This was done in order to improve land information systems and increase productivity by ensuring more secure rights of land ownership. It was assumed that farmers would increase their capital and labour investment. It was also assumed that land registration would promote high value crop production, an example being tobacco. Implementation of the land registration programme implied that the land tenure system would change from customary to some form of freehold. The parcels of land were being registered in the name of the person cultivating it. People of Lilongwe District are mostly of the Chewa tribe, following a matrilineal marriage system where the man follows and settles at the wife's home. This means that the man cultivates on land belonging to the wife's kin. By registering the land in the name of the person cultivating it, the land was being registered in the names of people who only came to marry in the community and were not, by custom, legitimate owners of the land. This has been a major cause for numerous conflicts. Key informant interviews with staff of the Ministry of Agriculture and Irrigation revealed that these conflicts had continued up to the time of the study. In fact, with the expansion of Lilongwe City, most members of the community living close to the city have found it easy to sell their land to other people who are interested in developing it into suburbs. Conflicts have also been experienced in such transactions. These conflicts have usually occurred when the title holder of the land sells it without consulting other members who felt that they had legitimate claim of ownership to the land. In some cases the one trying to buy the land has ended up losing his or her money in such conflicts.

Literature shows that another type of land conflict commonly experienced in Malawi has been occurring between government and local communities regarding land gazetted for protected natural woodlands, national parks and wild life reserves. A number of forest reserves, national parks and wild life reserves were unilaterally declared public land for purposes of protecting the resources on them. This was done without making adequate consultations with the local communities who for a long time regarded these pieces of land as theirs. They were using pieces of such land for their subsistence needs. This alienation of land occurred during the colonial and one-party era. With populations increasing, there is much pressure on customary land and local communities are demanding that these alienated pieces of land be returned. The communities have reacted in several ways. In some cases they have encroached the forest reserves, and at other times, they have formally approached government to release some land for cultivation. One example of such a case is Matandwe Forest Reserve in Nsanje District, where Government has degazetted part of the forest and given it back to the community.

4.2 Conflicts around forest resources

The study revealed numerous conflicts around forest resources. Some of the conflicts were general to all the sites but others were specific to particular sites. These conflicts

took a number of forms including conflicts between individual members of the community which occurred as a result of cutting or collecting wood resources from other people's gardens, conflicts which developed as a result of cutting or collecting resources from communal woodlands without permission and conflicts which developed around forest resources from plantations and reserved natural woodlands

Most of the conflicts can be better understood in the context of power relations as well as rights to resources, which determined rights of access to the resources. Those people who had more power tended to have more access to the resources than others. Rights of access on the other hand tended to vary with the type of resource. There were those who had rights to land and all the forest resources on that land while others would have rights of access to some of the resources but not others. For example, while as the owner of land would have the right to cut down trees on his land other members of the community would only have rights to collect certain parts of the tree for such purposes as herbal medicines and natural fruit. Conflicts resulted when somebody who was considered not to have rights to certain resources was caught collecting such resources.

4.3 Conflicts around private and communal forest resources

While trees growing in people's gardens were considered as private property, some people considered such trees, especially indigenous ones, as open access and entered such gardens to cut and collect poles, firewood, handles for tools, etc. This was a major source of conflict. These types of conflicts occurred most frequently between the landless or those people who had very little land and those who had relatively more land. Private woodlands were only maintained by those people who had adequate land. Those who did not have adequate land could not afford to spare land for natural woodlots.

Another common source of conflicts was collecting and cutting wood resources from communal woodlands. These types of conflicts were more common in Mangwero, Dzalanyama and Chimaliro. These sites had substantial amounts of communal wood resources. Mangwero for example, is a hill with a fully established natural woodland maintained by the villagers from Jamaali Village. Many conflicts occurred between the villagers and members of the VNRMC. The members of the village felt that since they had participated in the management of the forest, they were free to collect resources such as firewood and poles from the forest any time they needed them. The VNRMC members who were charged with the duty to oversee the usage of resources from the forest restricted villagers from entering the forest. Members of the village disliked the VNRMC as a result.

These communal woodlands were, however, maintained for several purposes. Some were maintained as village woodlots, meant to provide various forest resources such as poles, fuelwood and thatch grass for the whole village. The forests were therefore governed by a set of rules mutually agreed upon by the whole village. In most cases, these rules specified procedures for harvesting and sharing resources. Conflicts normally occurred when some individual members breached such rules. For example, if an individual was caught cutting trees for poles or for making hand tools or collecting firewood without permission from the village headman, he was considered to have breached the rules and was subject to some penalties.

Graveyards were another type of communal woodlands, which existed in the villages. Graveyards were considered to be sacred places where extraction of resources

was considered as desecration and attracted various forms of punishment. The responsibility to monitor the usage of the resources in graveyards was loosely assumed by everyone in the village, since all members had the moral responsibility to report any illegal activities in the graveyard to the village headman or to other village elders (Masangano *et al*. 1999). Harvesting of resources such as cutting trees or collecting firewood from graveyards was only allowed during funerals and such resources were only to be used for the funeral. There were generally fewer cases of conflicts on trees from graveyards. The study revealed that generally people respected graveyards and that anybody found cutting trees or collecting firewood from the graveyards was given very punitive punishments. Such punishments ranged from loss of credibility, being ignored and being ostracized to some cases of being evicted from the village. Members of the community were essentially left on their own to devise rules governing the management of the graveyards and outsiders, including government, did not interfere.

Some of the graveyards were also used as places for conducting initiation activities for *gule wankulu*. All the secrets relating to the *nyau* cult were maintained in such graveyards. Harvesting of woodland resources from such graveyards was strictly prohibited and offenders, especially those not initiated, were heavily punished. In some cases punishments would result in death.

While outside interference on sacred woodlands was strictly not allowed, literature shows that there have been isolated incidents, especially in the colonial era, where government interfered in the name of development. Such violations ended up creating enormous conflicts with the communities. There are on the other hand, some myths relating to the magical resilience of these sites, and the fear associated with such myths have in most cases kept the woodlands undisturbed.

Some trees are left in the village to serve certain purposes. Some were left to provide shade in meeting places such as local courts (*bwalo la milandu*) and the grounds for traditional dances (*bwalo la gule wankulu*). Such trees were not supposed to be cut and people caught cutting them were subject to various forms of penalties. The focus group discussions revealed that there were some cases where individuals were caught either cutting branches of such trees or collecting firewood from them and this caused some conflicts.

4.4 Conflicts around forest resources from the plantation forest and reserved woodland

Forest resources from the government plantation forest as well as those from the reserved natural woodlands were a source of frequent conflicts. These conflicts have changed over time and can therefore be looked at in four time periods: the pre-colonial period, the colonial period, the one party era and the present period.

Management of natural woodlands in the pre-colonial period was basically in the hands of local communities. It seems that the local communities tended to maintain strong values regarding cutting down of trees and collection of natural resources from the woodlands. Coote *et al* (1993) studied local communities in the post-colonial era, and isolated some of the values which existed from the past. They observed that community members from Chemba village revered certain trees to the extent that they could not cut them nor do any harm to them. They gave an example where in one particular case people believed that when one villager set fire and burnt a certain tree to ashes, he developed swellings on his body that were similar to the swellings the tree

had. Members of the Chemba village believed that this person's death was a result of what he did. Other literature indicates that the chieftainship was the main political institution and chiefs were believed to have both political and religious power. The political and religious power that the chief had was a source of cohesion in the social system. Enforcement of the chief's orders was either through the territorial chiefs, councillors and clan leaders. There is not much recorded on conflicts experienced in this period

The coming of the European missionaries and settlers changed the institutional set up of local communities. The Europeans and settlers regarded the local institutions as uncivilized and backward. They therefore introduced Christian values and a central state system of government. The role of traditional institutions was de-emphasised but the traditional chiefs and clan leaders were maintained with their role redefined as that of custodians of the state system. This weakened the powers of traditional institutions in favor of the state institutions such as the police, judicial system as well as government ministries and departments. The coming of the post-colonial government did not change the situation; instead it further consolidated power to the government under the one-party system of government. Management of resources strictly followed a top-down approach and local communities were cultured into a system of simply receiving instructions from the top. Traditional institutions were moulded into a form of local government.

This is the time when most woodlands were unilaterally declared reserved forests and national parks. Management and use of resources from forest were strictly under government control. Local communities were not allowed access to forest resources. This was despite the fact that these forests provided many resources important to the survival of the communities. This caused many conflicts as members of the local communities were very often caught either cutting poles or collecting firewood and making charcoal in the forests. Those caught were either fined or the resources were confiscated from them; in some cases they had their tools confiscated. Staff of the Forest Department were even mounting road blocks to control the movement of charcoal from forests to the market. This action resulted in major conflicts not only with the charcoal makers, but also the transporter-traders. These conflicts became more overt at the time when the multiparty democracy was being introduced. This political change gave opportunity for people to express their views. This was coupled with the conception of democracy as a complete deregulation of government institutions. Experiences at Namatunu Forest Reserve provide a good case whereby abundant natural forest resources covering hundreds of hectares were cleared within days. Efforts by staff of the Forest Department to control the situation were violently challenged by the local people. In one case, it was reported that a staff member of the Forest Department was actually tied to a tree by a group of women who were caught collecting firewood from the forest.

Although efforts to promote communal management started towards the end of the one-party system of government, government started putting more effort to it when the multiparty system of democracy was introduced. With democracy, people were generally being encouraged to participate in various development programmes including management of reserved forest resources. Local communities were being encouraged to organize themselves into VNRMCs. These VNRMCs were working together with local leaders and forestry staff in the management of the forests. They also took a leading role in promoting the establishment of individual and communal village forests. These VNRMCs were very often found in conflict situations

with individual members of the community who were caught harvesting and collecting forest resources from the plantation forest and the reserved natural woodlands without permission. The study revealed that conflicts occurred between different groups of people such as conflicts between local communities and staff of the Forest Department, and conflicts between communities living close to the forests and those from distance places from the forest. The resources which, frequently caused these conflicts, included poles, firewood and charcoal, and sometimes wood for tools. Similar conflicts occurred when these individuals were caught by staff from the Forestry Department. Most of the entrances into the forest were guarded and nobody was allowed to go into the forest without a permit, but individuals used illegal entry points to the forest.

Sometimes conflicts developed between community leaders or the community as a whole and staff from the Department of Forestry. These conflicts usually developed because the local communities felt that they were not getting enough benefits for the efforts they put in the management of the plantation forest and reserved natural woodlands. The local communities were required to assist in policing the forest, making sure that individuals did not go into the forest to harvest or collect resources without permission. The communities were also required to assist in fighting bush fires in the forest. The community leaders were required to assist in settling disputes, which occurred when community members were caught in the forest. In return for this, the local communities were permitted to collect some resources such as grass, mushrooms and caterpillars. They were also allowed to collect a specified amount of firewood and poles at designated times. Outside the specified amounts, the community members were required to pay before they could collect firewood and poles. As members of communities living close to the forest, they were given a discount to collect these resources. However, the local communities expressed dissatisfaction when they compared these benefits with the efforts they put into the management of the forest. They argued, for example, that if a member of the local community was hurt when fighting bush fires, there was no insurance or medical scheme to take care of such a situation. They also argued that, while they fought the bush fires together with staff from the Forestry Department, they were not paid anything for their efforts while Forestry staff received a salary. They also argued that they expected to be given preferential treatment when it came to employment of labourers to work in the forest, but this was not happening.

In Dzalanyama, conflicts developed between communities living close to the forest and those from distant places. The communities living close to the forest were allowed to collect or harvest certain resources free or at discounted rates. This gave them a market advantage in that they could sell these resources at a higher price to people who were not living close to the forest. However, those people from distance places did not recognize the legitimacy of giving preferential treatment to those communities around the forest and tried to enter the forest through illegal entry points or by convincing forest guards that they were members of the communities close to the forest. This caused many conflicts when they were caught. Similar conflicts occurred in Chimaliro Forest between block members and non-block members. Non-block members did not recognize the legitimacy of giving preferential treatment to the block members.

On a gender perspective, women tended to be more concerned with forest resources which were required for domestic purposes while men needed the forest

resources for commercial purposes. In most cases, women went into the forest to collect firewood, mushrooms, caterpillars and thatch grass for domestic purposes. Men on the other hand were more interested with resources they could sell for cash such as firewood, charcoal and wood for hand tools. The male-favoured resources caused conflicts because their harvesting had a major impact on sustainability. Charcoal making, for example, involves cutting live trees and often causes bush fires. Despite the fact that the resources collected by women had less impact on the forests, women tended to experience more conflicts with forest staff. This was because they needed to collect firewood often for domestic purposes. Failure to collect the firewood meant that they would be unable to prepare food requiring lengthy cooking.

5. CONFLICT RESOLUTION AND MANAGEMENT

Conflict resolution and management in Malawi can best be understood in the context of the four political eras previously described. Management of natural resources in the pre-colonial period was basically in the hands of the local communities. Literature on Malawi as well as other neighboring countries shows that local communities in the pre-colonial era had institutional structures which assisted in the sustainable management of natural resources. Moore and Vaughan (1994) have provided a good historical description of the Bemba people of Northern Zambia. The key social and political institution of this tribe was the chieftainship. The chieftainship centred on the paramount chief (Chitimukulu) who was believed by his subjects to have religious powers. The belief in his religious as well as political powers was a source of social cohesion throughout his chieftainship. Similar institutional arrangements existed among the Ngoni of Central and Northern Malawi, Nkhonde of Karonga. Enforcement of the chief's orders was through a system of territorial and other lower chiefs. Below the paramount chief were the territorial chiefs who ruled on behalf of the paramount chief. The paramount chief had powers to remove and replace the territorial chief if he felt it necessary, on grounds of poor leadership.

Similar cases have been recorded in the Shire Highlands localities of Southern Malawi. People of the Nyanja and Lomwe tribes used to live in clans/villages composed of clan members (members of close kin). Clan leaders used to have a team of village councillors who used to assist the clan leader on issues such as presiding over cases or trials between clan members. The clan leaders were under tribal chiefs who led the whole tribe living in an area. The chief had councillors who assisted him during trials. Enforcement of the chiefs order was through the councillors and the clan leaders. This was also true for the Chewa and Tonga people who settled along the shores of Lake Malawi.

As discussed above, this institutional set up changed with the coming of the European missionaries and settlers. They weakened the power of local institutions in favour of the state institutions. The situation worsened with the introduction of the one party system of government.

The role of local institutions as well as local governments is now being recognized. Active participation of the local communities is being emphasized now. In addition there is now a decentralization policy in place and the Department of Forestry is promoting communal involvement in the management of forest resources. It should

be noted however that the local institutions are still in a weakened state and it will take sometime before they can effectively manage the natural resources, as well as the associated conflicts.

Conflict resolution in the different study sites was similar. Conflict resolution generally started with the complainant approaching the defendant. The case was referred to the village headman if the two parties failed to resolve their conflict. The village headman brought the two parties in conflict together in the presence of other elders people to discuss the issue at a local court (*bwalo la milandu*). If the source of conflict was land, or garden boundaries, then the discussions were held at the site of garden. If the defendant was indeed found guilty he or she was either issued a warning by the village headman or asked to pay a fine, which was usually in the form of money or livestock such as chickens or goats. The fine was usually in two parts; one part to compensate the one who was offended and the other part was paid to the village headman as court charges. Conflicts that failed to be resolved at village headman's level were referred to the group village headman or the chief at a traditional authority level. Criminal cases such as those where conflicts resulted in a fight causing injury or those which, involved theft of peoples' property were directly referred to the police and were resolved in magistrate courts.

Conflicts around communal forest resources such as village woodlots, graveyards and trees in local courts and grounds for traditional dances were resolved slightly differently from others. Offenders in these types of conflicts were brought to the village headman who in consultation with the village natural resources committees (VNRMCs) decided on a fine for the offender. Unlike in other cases, the fine here was paid only to the village headman as court charges or to be used for village development activities. Cutting trees or collecting firewood from graveyards was considered a more serious offence than others, because graveyards were considered to be resting places for the spirits of ancestors and were not to be disturbed. As such, nobody was supposed to enter a graveyard alone. Anybody found in a graveyard was considered to be a magician or a witch and was usually ostracized by the rest of the villagers. Anybody cutting trees or collecting firewood in a graveyard suffered much heavier punishments. Apart from being ostracized, the offenders were asked to pay much heavier fines and the money realized from such fines was used to purchase utensils and tools to be used for funerals. Offenders who failed to pay such fines, as well as repeat offenders, were either evicted from the village or not allowed to bury their close relatives in graveyards in the village. The offenders themselves were also not allowed to be buried in the village. The only time people were allowed to cut trees or collect firewood from a graveyard was when a funeral occurred in the village and the firewood or tree was only to be used for the funeral activities.

Conflicts around forest resources from the plantation forest or reserved natural woodlands were resolved in a different manner. Offenders caught illegally harvesting or collecting resources from the plantation or reserved natural woodlands were taken to the Department of Forestry offices where forestry staff together with local leaders, including village headmen and representatives of the VNRMCs or block committees reviewed the case. Punishments varied depending on the type of offence. Small fines in monetary terms were imposed to those caught collecting firewood. Those caught harvesting resources that involved cutting trees had stiffer punishment, such as the confiscation of tools.

6. DISCUSSION AND CONCLUSIONS

In summary this study has revealed that forest resources are a source of many conflicts in the areas studied. These conflicts occurred among different groups of people depending on the type of resource. Some conflicts occurred between individual members of the communities. Other types of conflict occurred as a result of individuals who were caught harvesting resources from communal forests without permission, while others occurred as a result of resource poaching from the plantation and reserved natural woodlands.

Malawi is going through some major political changes as a result of the introduction of a multiparty system of government. The Malawian society is now opening up and people are more proactive. People should be and are demanding to be allowed to participate more actively in the development process. They should be allowed to participate in decision-making, implementation as well as in benefit-sharing. This development is occurring at a time that the country is experiencing major reductions in levels of public resources. This means that government cannot run most of its development programmes without the active involvement of local people. One way that government is responding to this is by promoting the process of decentralization. Currently the country has a decentralization policy, with an act of parliament already passed. As such local communities have to be organized into structures that can adequately represent them in various development activities. The promotion of VNRMCs is one way of promoting local participation in the management and utilization of natural resources. One problem, however, is that this is a new institutional structure. One has to ask whether the introduction of the new structures is not going to create a new set of conflicts or create confusion among institutional structures. One needs to note that the decentralization policy is also promoting another set of institutional structures: village development committees, area development committees and district assemblies. We recommend that the institutional structures be streamlined, with an introduction of sub-committees so that conflicts and confusions are minimized.

Local communities need to be empowered with clearly defined rules on rights to resources and the boundaries of those resources if local participation in the management of natural resources is to be sustainable. The role and authority of the local communities needs to be clearly established. The case of Mangwero provides a lesson where village members disliked the VNRMCs. VNRMCs need to have clearly defined roles and responsibilities.

There should also be congruence between the rules that assign rights and the rules that assign costs. Local communities should not be expected to invest their energies to the management of natural woodlands if they don't receive adequate benefits. The case in Dzalanyama where the local communities felt that their efforts in fighting bush fires and patrolling the forest were not being adequately compensated provides a good example. Government policies need to be reviewed in the interest of promoting more community involvement in the management of the resources.

ENDNOTES

1. A village headman looked after a village, which usually comprised of a grouping of households made up of people belonging to the same clan or kinship, and were, therefore closely related people. Several villages in one area were grouped together and looked after by a group village headman. A chief on the other hand, looked after an area with several group village headmen. The chief normally reported to the district commissioner of the particular district.

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7.
An overview[1]: The influence of major policies on forestry

G. Kowero

1. AGRICULTURAL POLICIES AND LEGISLATION AND FORESTRY DEVELOPMENT IN SOUTHERN AFRICA

Agriculture is critically dependent on environmental resources such as land, water, forest, and air. However, the use of these resources can affect, directly or indirectly, other natural resources through dynamic and complex interrelationships existing in the natural systems. This implies that wrong use of land, water, and forest in the production of crops and livestock can have far-reaching effects on environmental integrity. To avoid any adverse consequences, agricultural sector policies must fit in the overall environmental policy. This is critical in guiding proper and balanced use of natural resources and in defining sectoral responsibilities for environmental management. Agricultural policies, besides being internally consistent, must provide for a mechanism to link the sector with other sectors in protecting and enhancing environment.

In the pre-colonial period agricultural production was based on traditional technology with shifting cultivation or fallow systems as the means to maintain labour productivity and to regenerate soil fertility. Low population density in most areas permitted long periods of fallow, which contributed not only to soil fertility regeneration but also allowed forest regeneration. Although shifting cultivation was one of the major agricultural production practices, this was not carried out indiscriminately. Some areas were reserved for other functions such as water catchment protection, livestock grazing as well as religious rituals and ceremonies. Traditions and/or customs prevailing at that time in the clan or tribe governed the ownership of the means of production and assets, i.e. land, labour, livestock and the few farm implements. Thus, the problems related to or arising from the “haves and have-nots” never arose in most societies. Production and

distribution systems were organized such that whatever was being produced or gathered was geared first to family needs, second to the clan, third to the tribe and only finally to inter- and intra-tribe trade. Thus, local resources were mobilized and utilized to produce commodities or products that were needed locally by the community.

There is little evidence to show that during the era most close to the colonial period crop production strained land/forest resources in most areas. The exception would be areas with high population densities and easy access by international traders. However, there is evidence to show that growing land scarcity in some areas necessitated movement of people to other parts to open land for agriculture. Low population densities in most areas, existence of customary rules governing the use of natural resources and local knowledge about the environment explain the limited degradation of land and forest resources during this period.

The colonial period saw the creation of a dual agriculture-led economy characterised by peasant/smallholder and commercial sectors. The commercial sector, referred to as the estate sector in some countries like Malawi, had access to the most productive land while the smallholder sector was mainly relegated to marginal lands. There was massive forest clearing in both sectors for crop production and supporting infrastructure following the strategies employed in agricultural production that favoured the commercial sector. The low prices of agricultural products to smallholders as well as restricted access to markets, credit and extension services did not promote an increase in marketed surplus. On the contrary, non-farm activities and off farm employment were promoted as alternative sources of income, thereby reducing the labour available for crop production and possibly constraining deforestation. However, some of these activities were conducted in the forests, which resulted in deforestation and forest quality deterioration. Further, with low incomes investments in agriculture were negligible, leading to land exhaustion and need for ‘new’ land which was excised from forested areas.

Post-independence governments in Southern Africa have not managed to change this asymmetry in agricultural development. We continue to have on the one hand poor smallholder farmers on small, shrinking plots of land with limited capacity to make meaningful responses to economic production incentives as these would require them to make minimal investments in agriculture (e.g. buying fertilizers, pesticides, and other inputs), or to expand agricultural land so as to take advantage of economies of scale. On the other hand we continue to have relatively rich estate/commercial farmers with big farms, which are rarely fully cultivated. These farmers can respond to economic policies by expanding the area under crops and making investments to improve productivity. This imbalance has contributed to increased rural poverty and created incentives for rural communities to encroach on any land available in order to increase agricultural production. Increasing poverty is promoting a drastic surge in informal businesses, which largely involve forest products like firewood, charcoal, woodcarvings, and non-timber products. The sustained supply of such products cannot be ascertained, let alone the extent of deforestation or degradation of the forest estate.

Increasing privatisation and individualism and the onset of property rights imply that the smallholder farmers will continue to be confined to small plots for their agricultural and forestry related needs. Increasing populations on the shrinking cropland combined with increasing poverty will rapidly deplete these areas of their forest resources as local communities expand cropland.

The development process, either at individual or government level, requires resources. Governments as well as individuals still continue to rely mainly on agriculture

for this. Like in the colonial period, post-independence governments continued to give emphasis to export crops with cropland expansion very significant in this period, and accompanied by increased rates of deforestation.

Many countries continued for many years after independence without a comprehensive agricultural policy. The agricultural sector was guided by a number of policy statements and strategies which were part of larger programmes known by various names like rural development plans, integrated rural development programmes, five year development plans, etc. Otherwise they were part of major political pronouncements, like the development strategy for Mozambique that was formulated in the third FRELIMO party congress of 1977. This was the period preceding economic reforms or pre-economic structural adjustment programme period (pre-ESAP period). During this period the main agricultural strategy mostly remained the one inherited at independence, with the estate farmers largely producing for both domestic and export markets, while smallholder farmers produced mainly for subsistence and the domestic market. The latter saw increased production through agricultural extensification, while the estate sector realized good productivity growth through agricultural intensification. Further, governments continued with the institutional, technological, and pricing differentials between estate/commercial farmers, state monopolies, and cooperatives on one hand, and smallholder farmers on the other. This discouraged the latter from making any meaningful investments in agriculture, encouraging peasants to continue to mine the land and the few forests and trees left.

The ESAP period is characterised by rapid erosion of some of the pre-ESAP agriculture related policies and legislation. These included a gradual to complete elimination of subsidies on agricultural inputs; the increasing role of the private sector in agricultural production, distribution of inputs, and marketing of agricultural output; and the increasing role of market forces in the pricing of agricultural inputs and outputs.

The implications of the individual ESAP policies on agriculture and eventually on forest cover in this region have not been sufficiently studied and therefore need further scrutiny. However, the potential of these policies to increase land under agricultural crops in this region has been demonstrated in various studies. Expansion of cropped area and livestock grazing remain the major sources of deforestation and degradation of forests and woodlands. Further, apart from forests under government control, forests and trees are more abundant in estate/commercial farms as compared to smallholder farms. The estate/commercial farms face deforestation while smallholder farms are candidates for agroforestry.

2. LAND POLICIES AND LEGISLATION AND FORESTRY DEVELOPMENT IN SOUTHERN AFRICA

During the pre-colonial era forest and woodland resources were governed by customary rules and regulations that limited access to some areas such as sacred groves and graveyards, and controlled tree cutting through a series of taboos. Traditional leaders were responsible for exercising control over how land and associated resources were utilised in areas under their occupation. The traditional leaders were responsible for far much less land area compared with the land areas under present day central governments. Also at that time there were fewer stakeholders and with less demands on the forest estate. Their demands were mainly in terms of fruits, firewood and fodder for livestock, and simple building materials like poles and thatch grass. Forests

were also used for spiritual purposes. These demands shaped the objectives for administering the forest estate. The means or instruments employed for achieving desired objectives constituted management prescriptions on protecting and conserving trees and forests as well as on harvesting products from the same. Shifting cultivation was a characteristic feature of agricultural production. Due to the small human and animal populations characteristic of this era, land pressure was in many areas low and was not a threat to forest and woodland resources.

The colonial era policies are largely responsible for the present day land tenure systems. The major settlement thrust during this period was geared towards agriculture and therefore the land use patterns were influenced by the distribution of fertile land and segregation between settlers and indigenous people. The major effect of the alienation of land and other natural resources was the loss of control and ownership of traditional land rights. This translated into an erosion of traditional institutional capacity to manage natural resources, including forests. At the same time the colonial administration lacked the capacity to monitor, control and manage natural resources in publicly as well as in communally owned areas. This led to encroachment and destruction of forests in these areas, especially in native reserves where population pressure was high. Extensive destruction of forest and woodland resources also occurred due to the establishment and expansion of plantation agriculture and plantation forestry. However, large tracts of forest and woodland resources were protected during this era following the establishment of national parks and forest reserves. The exclusion policies under which these were managed were contested by displaced communities and those living adjacent to them, and both groups claimed the right of use by virtue of proximity and historical connections.

The post-independence era was characterised by attempts to redress the land imbalances inherited from the colonial era through land redistribution and resettlement programmes. This resulted in clearance of forests and woodlands for agriculture and settlement purposes. There were also very significant changes in the institutions given the responsibility to manage natural resources, including forests, with the responsibility for communally owned resources reverting to customary institutions (rural district councils in the case of Zimbabwe) or locally based elected structures. Despite these changes the land tenure categories inherited at independence, as well as the management regimes, were largely unchanged.

In addition, the following are noteworthy of this period:

(i) The restoration of traditional authority in land administration and local institutional capacity building this period were noted to have the potential for improved management and utilisation of natural resources including forests. Studies on community-based management of natural resources in Tanzania, Malawi and Zimbabwe have demonstrated the efficacy of a change in institutional structure in the productivity of wildlife and fisheries, for example, the Duru-Haitemba community-based forestry programme, CAMPFIRE, and Lake Chilwa Fishery, respectively.

(ii) The importance of boundaries for community land, their potential problems, the need for strong institutions, and sharing benefits from natural resources have been addressed in present land policies. However, for the latter it is necessary to establish a more detailed and perhaps procedural legal instrument to guide the sharing of benefits (for all involved stakeholders) generated out of common property regimes. In particular, the enforcement of such an instrument in order to guarantee that communities accrue such benefits is paramount for their engagement in the sustainable use of natural

resources. Such communities have, up to the present, not gained any significant and legally recognized returns from forest resources, except direct consumption of forest products.

(iii) One avenue for increasing access to land was observed to be through the creation of and improvements in land markets. This element is an integral part of the proposed land policies. Attaching value improves efficiency in resource allocation since scarcity determines the extent of resource utilization. Since there is a direct link between land and forests, logic would dictate that pricing of the former would directly affect the value of the latter and therefore the level of utilization, and hence incomes from such products, if the costs could be directly transferred to the consumer. The development of land markets through land policy reform would probably be indeterminate to national forest cover, in that estate farmers holding unused land under forests or woodlands will most likely give up such land to the state, increasing the proportion of protected forests. However, should the state reallocate such land to the landless, then the area under forests or woodlands will decrease.

(iv) Low investment on customary lands has often been associated with high levels of insecurity due to the absence of property rights to the individuals occupying them. It is also argued that the tight social structure and traditional norms in rural areas confer group security to members who possess use rights to customary land. To what extent the latter promotes investment is not certain. However, elements of the proposed policy reforms purport to secure individual as well as group security of customary land, thereby enabling these communities to use land as collateral for investment funds. Assuming that group security is likely to prevail in the new land policies, it follows that there is likely to be no change in tree tenure.

(v) Some of the proposed changes in land policy in Zimbabwe are likely to involve redistribution of about eleven million ha of land from the large-scale commercial farmers. Based on previous experience, the implication of this is that large areas of woodlands will be cleared for agriculture. Thus, some measures to mitigate the hazards of wanton destruction of vegetation need to be put in place.

(vi) Improvement in forest cover will be contingent on effective inter-sectoral harmonization and coordination of programs and activities dealing with common issues in natural resources management, such as increasing demands for energy, agricultural land and construction materials. Harmonization and coordination will require a review of sectoral policies, identifying areas of common interest and mapping out joint strategies. This can succeed if rural development actors adopt a consultative and holistic approach on the ground and not only at the development planning level, as is largely the case at present.

(vii) By and large the new resource tenure legal frameworks in the region establish the basis for ensuring access to the resources for all stakeholders, thereby enhancing common property regimes and sustainable use and management of natural forest resources. However, the challenge to the governments as well as to relevant non-governmental organisations is to devise ways to move towards a more stable system of secure property rights based on land tenure and market allocation, grounded in law, upheld by the courts of law, and observant of people’s needs and preferences.

3. SECTORAL FOREST POLICIES AND LEGISLATION AND THEIR INFLUENCE ON FORESTRY DEVELOPMENT IN SOUTHERN AFRICA

In the pre-colonial era, there was an unwritten sense of direction in some forestry matters of relevance to the local communities. In addition there were intentions/ objectives, regulations, knowledge and other means to guide related tree and forest activities, as well as recognised and respected authority over the resources. There was a parallel role with present day forestry management, in that forest reservation was practised on the basis of very localised interests which the communities subscribed to, while present day gazettement of forests takes on broader national and global considerations which local communities might not be aware of. Also there were restraints and guidelines on managing and harvesting tree and forest products much as we find today in forestry.

The colonial era brought many changes in the lives of local people and in the administration and management of natural resources. The broad colonial policy declared 'unoccupied' lands as state property, and this marked the beginnings of 'nationalisation' of property by the state. This period marked the beginning of the disruption of common property regimes. Apart from present day imbalances in access to land in some of these countries, the colonial administrations were largely responsible for shaping present day forest resources and their guiding policies and management practices. One of the most significant developments during this era was the introduction of the concept of a 'state' or 'nation', and formal national policies and legislation. Forestry matters began to be examined and governed in the context of district, province and nation; alien concepts. The colonial administration imposed restrictions on access to trees and forest resources, by gazzetting these as state property, and introduced administrative tools for the national forest estate. The colonial governments were preoccupied with gazettement, and harvesting commercially important natural forests mainly for export. The major players in forestry were governments and the private sector; there was minimal involvement of local communities, with the notable exception of Malawi, where 'village forest areas' were initiated. However, environmental concerns were given attention in light of noted adverse effects of deforestation, albeit with differing emphasis across countries. Forest administration was given little weight, despite the extensive coverage of the forests in the region, being initially placed under agricultural departments or as small departments/sections under the ministries responsible for agriculture. The absence of a clear vision in some countries, and commitment in virtually all countries, on how the sector should have developed resulted in haphazard or uncoordinated development of the sector, which continued even after these countries became independent.

The independence period is characterized by two economic regimes, the pre-economic reform period (also known as the pre-economic structural adjustment, or pre-ESAP, period) and the economic reform or ESAP period. The pre-ESAP period brought major changes as national governments tried to bring immediate positive changes in the lives of their people. In some cases this resulted in political ambitions overriding economic logic, political policies replacing sectoral policies, and sectoral policies from other sectors having preference over forestry sector policies in their own domain. The results were varying levels of encroachment into forest areas as well as constrained growth of the sector. Further, forestry policies were not revised immediately after political independence to take into account peacetime socio-economic orientations by the national governments. This was partly due to the fact that the economies of these

countries were largely non-monetised at the time of colonialisation. As time passed, the pace of monetisation increased and this pace was much faster for other sectors such as agriculture, which were mainstreamed in government planning. Forests remained insulated from the monetised economy for far longer and therefore were marginalized not only in economic terms but also in terms of policy attention. The lag in commercialisation of the forestry sector partly explains the apparent supremacy of political and other macroeconomic policies over written national forestry policies during this period.

Also during this period, the objectives of forestry policies were mainly determined by what national governments and the political machinery considered appropriate and were rarely based on what people wanted as reflected in the market place. Primary forestry production was wasteful as governments determined the prices of such produce administratively and not on basis of market forces. Secondary forestry production was more market oriented, though when governments were in charge this led to gross inefficiencies, massive financial losses, and bankruptcies. This gave way to the privatisation of wood processing during the ESAP period.

In the ESAP period there were extensive policy and legislation revisions in the forestry sector. It would appear that these revisions could largely be attributed to global shifts in environmental thinking and in the way forestry business is conducted, and less in response to internal or national political and socio-economic policies.

Current policies demonstrate a very clear shift in emphasis from previous ones. Significant shifts are from:

- An emphasis on management of plantations of exotic tree species to one on better management of natural forests.
- Centralised forest ownership and management to decentralised, devolved, and joint management and ownership.
- Forestry practice revolving around tree and forest management to forestry as rural development or as integrated land management.
- A heavily service-oriented forestry practice to sustainable profitable forestry.
- A heavy emphasis on exports of industrial round wood to increased emphasis on meeting a myriad of domestic socio-economic and ecological needs.
- Forestry as largely a male activity to one that effectively incorporates women as partners.
- A very localised or national focus to a much broader one that even considers sustained production of international public goods.
- Policies that were out of tune with political and socio-economic realities of the time to ones that are in tandem with prevailing circumstances.
- Intra-sector-oriented policies to ones involving or embracing many relevant sectors of the economy.
- A diffused or unclear environment for policy implementation to an enabling one that is very clear on the many strategies to employ. The strategies include financial incentives, legal provisions, empowerment, rights, roles and responsibilities for major stakeholders.

Many forestry sectors have and continue to accommodate various international agreements and conventions in their policies and plans. Donors and foreign lending institutions continue to support the sector, but they have different approaches to forestry. These developments have precipitated a situation whereby some forestry

departments/services have been caught in a loop of continued planning to suit these demands. The consequences include strain on both human and other resources for implementing forestry plans, the confusion these demands continue to create in the sector, and the loss of a long-term planning horizon in forestry.

4. ECONOMIC REFORMS HAVE BEEN ROUNDLY BLAMED FOR ACCELERATING DEFORESTATION AND WORSENING POVERTY. HOW HAVE THESE FEATURED IN THE MIOMBO REGION?[2]

We have used the experiences of Malawi, Mozambique, Tanzania and Zimbabwe to examine the likely consequences of ongoing macroeconomic policies on the economic development of these countries, and assess the implications for forestry development. Macroeconomic policies affect the main variables that make forest conversion, wood processing and trade attractive. We find that economic performance has marginally improved under ESAP macroeconomic policies compared to pre-ESAP macroeconomic policies. The four countries have done quite well in economic growth terms, growing at an average of 3.9% per annum over the SAP period. This is higher than economic growth in the pre-ESAP period. Comparatively, this growth performance surpasses the average for sub-Saharan Africa, Southern Africa and low-income countries.

4.1 On deforestation

We hypothesise that macroeconomic policies have mainly two effects on forestry development. First, by affecting the distribution of income and poverty, macroeconomic policies impact on the forestry sector because of poorly distributed national income (and rising poverty) that forces individuals to denude forests. As wild plant and animal resources provide a “green social security” which people fall back on during these hard times, this has a major negative impact on forestry development. The process is not driven by an increase in economic growth, but is rather a consequence of skewed income distribution changes and rising poverty from a given macroeconomic policy. We might call this *‘intensive deforestation’*[3].

Second, increased growth as a result of macroeconomic policies can dominate the process. This is a more ‘extensive’ form of deforestation. Extensive deforestation is in many cases closely associated with the macroeconomic and sectoral impacts that are growth inducing while intensive decline is linked to social impacts, through changing income distributions and poverty levels. Although in practice the actual movement in a forest mining economy will be a mix of the two, there will be different balances between them. Distinguishing between these two kinds of deforestation is useful, because the potential sources of growth in the two and thus the appropriate policy emphases are different.

In the ESAP period, the impact of macroeconomic policies on forest development also appears mixed, and difficult to disentangle. With the exception of Zimbabwe, there appears to have been some economic growth in the ESAP period, which suggests that they could have promoted the extensive form of deforestation in the other three countries. However, with state forest parastatals on sale and industrial activity low as property changed hands, the overall economic stagnation in Zimbabwe would suggest a reduced extensive form of deforestation. In all four countries there was a dramatic increase in exports during the ESAP period. Most of the growth came from exports that

are low-technology primary products (e.g. wood, cotton lint, tobacco, coffee and minerals). This raises the possibility of forest losses due to agriculture, mining and logging. The latter is especially true of Mozambique, which has become increasingly reliant on timber for export earnings while increased mining activities were recorded in Tanzania and Zimbabwe during the period. All these processes, unless forest protection policies are put in place, have potential to increase extensive degradation of forests.

Fiscal and monetary policies affect the underlying demand and supply conditions, with knock-on effects on the forestry industry. One of the main components of the post-ESAP macroeconomic policies included reduction in public expenditures through, *inter alia*, retrenchment of public-sector employees. Indirectly, worker retrenchments might occur in the private sector following reform, which raises international competition. In the ESAP period, stabilization policy has been characterised by austerity. In the short run at least, this has induced contraction of the domestic economy. This has potential for reducing the extensive decay process in forests. Where stabilization has been achieved, inflation has also come down, most probably reducing intensive decay processes in forests. With most Poverty Reduction Strategy Programs (PRSPs) emphasising poverty reduction, poverty may well fall, so that the resulting intensive decay process in forests might ameliorate the extensive decay process emanating from increased growth. In any case, it will be necessary to monitor and control the effects emanating from the extensive processes on forests of PSRP implementation.

The sequencing of economic reforms and environmental protection measures is an issue that has not received attention when structuring and implementing economic reforms. In principle, since environmental protection is concerned with longer run issues, there is no real need to delay them; the presumption would be that simultaneity is appropriate. If environmental activities are legislated but, because of the short-run economic consequences, are not implemented or enforced, then the credibility of economic reforms suffers.

4.2 On industry

The high interest rates of the ESAP period are likely to have discouraged spending and investment. However, forestry investment actually increased in Zimbabwe, much of it being long-term capital investment. This was despite the increase in real interest rates, which on its own should have reduced investments, including those for conservation. Overall, however, the consequence of high interest rates for the four countries was a decrease in credit availability and consequently economy-wide fixed capital investment. The overall level of capital investment in the four countries has yet to return to its pre-1990 levels. It has grown marginally, and certainly has been below GDP growth.

In industry, trade liberalisation is likely to (i) favour the export sector and labour intensive industries, (ii) increase foreign direct investment, and (iii) lead to the closure of less efficient industries. The impact of the switch to the export sector on forestry depends on whether industry is a major forestry products exporter, whether it uses forestry products intensively as its inputs and whether it has the potential to absorb a large pool of labourers. Trade policies that reduce protection of domestic manufacturing tend to speed up the process of deforestation as a result of the de-industrialisation of domestic manufacturing that ensues. The closure of inefficient industry raises the risk of unemployment and recession and therefore increased poverty, with negative consequences for forestry.

4.3 On trade

Major channels through which economic policies impact on forestry include large-scale commercial trade, for example in timber, woodcrafts and non-timber forest products. Southern Africa has widespread markets for such products. Seasonal markets exist for indigenous fruits, caterpillars, honey etc. Other commonly sold woodland-derived products include benches, chairs, stools, hoe handles, axe handles, mats, baskets, thatching grass, bricks (they require fuelwood for preparation), mice, termites and traditional medicines. This is a widespread means of earning income in many households in the region.

According to Braedt and Standa-Gunda (2000)[4], marketing of woodland-derived products has outstripped the importance of agricultural activities as an income source for some households in the craft industry along the major tourist routes of Zimbabwe. Using woodcraft markets as one of the indicators for growth in the informal forestry sub-sector, we note from Braedt and Standa-Gunda (2000) that growth of the woodcrafts market was modest between 1980 and 1989 (the pre-ESAP period). In their study of 111 craft markets in existence in 1997 on nine routes they surveyed, only four of them existed before independence (1980) and 16 emerged in the 1980-1989 period. Of these 111 craft markets, 97% were established during the ESAP period. They note that one of the reasons for this has been the steady rise in tourism since the late 1980s and the beginning of the 1990s. They also noted a remarkable increase in the export of woodcrafts from Tanzania in the ESAP period.

With respect to trade in industrial timber, we note that in Zimbabwe exports of forestry products rose following trade liberalization, while in Tanzania between 1992 and 2000 there was very little change in industrial wood production, despite the incentives offered by macroeconomic reforms. This was a period when the industry was changing hands from government parastatals to the private sector, in line with the ESAP requirement to increase private sector involvement in production and trade and to

Furniture from reeds in Malawi (Photo: G. Kowero)

reduce the central government's role. On the other hand, industrial wood production showed a steady decline over the period, except for a 1995 peak in Malawi. In Zimbabwe, the ESAP policies that initially had the greatest impact on industry and trade were trade liberalisation and domestic deregulation. These came at a time when world timber markets were strengthening and therefore provided the timber industry with the capacity to grow, develop a wide range of products and adopt an export focus. However, in terms of improving employees' real incomes of lower level employees' were eroded by high inflation to the extent that they were better off at the start of ESAP than during the ESAP period and even in the post-ESAP era. In the post-ESAP era the forest industry has been characterised by uncertainty of tenure for its plantations due to recent changes in land laws, high inflation that erodes profitability, local market shrinkage due to the prevailing stressed economy, loss of investor confidence and unrealistic exchange rates that make exporting unattractive. All these combine to form a very hostile environment for the industry.

5. POLICIES AND GENDER RELATIONSHIPS AND ROLES IN WOODLANDS IN SOUTHERN AFRICA

Men and women have different perspectives on woodland resource use and management issues. There is division of labour, responsibility and control over these along gender lines. In many rural areas women are mainly involved in non-cash agriculture and in ensuring primary human development. Men are more involved in cash cropping and non-agricultural activities, in addition to indulging in matters of personal pleasure.

Throughout the colonial, post-independence and economic reform periods of the countries in southern Africa, policies have in general pushed women to rely more on forests than men because of shrinking cropland per capita and the fact that women, in general, do not own land. Most of the policies do not have a gender bias, but instead treat men and women equally despite their different capacities to respond to such policies. A deliberate effort should be made to favour women in such policies because women are more directly linked to sustainable development as compared to men. Women would suffer more than men if the natural resources were to be damaged. They are likely to value these resources more than men.

The negative effects of economic policies in rural areas, especially economic structural adjustment policies, which place heavy emphasis on market forces, are being felt disproportionately by rural people. In general, structural adjustment, even in countries where it has been applauded as having had some positive effects, such as in Ghana, left out some important groups: those producing non-tradables and those who are net buyers of agricultural commodities. These are usually the very poor, the majority of whom are women. The weak links between the rural poor and the general economy also constrain poor farmers (the majority of whom are women) from participating fully in the monetised economy. Women are therefore ill equipped to benefit from agricultural production incentives and other economy wide policies. They have, in general, less capacity than men in terms of acquiring new technology, less time and land to devote to income generating agriculture and less command over some of the most important resources such as family land and capital. Since men often control most of the household income, women thus have less capacity and incentive to respond to economic signals. Women are, in general, risk averse and do not immediately venture into new projects

and thus tend to be left out. Therefore, rural development policies need to increase their focus on women with a view to facilitating their capacity to respond.

Women are also constrained from effectively deciding on issues of access to natural resources because in many societies women's ideas are either not forthcoming or, when available, are valued lightly or completely ignored, and their initiatives do not carry as much weight as those of men. Current thinking in natural resource management is towards giving communities the responsibility to decide on how to manage their natural resources, including forests and woodlands. Women are the majority of the poor in these communities; therefore their active participation in these endeavours should be facilitated.

ENDNOTES

1. This text is based on chapters 8 to 12.

2. Mabugu, R. and Kowero, G. 2002 Macroeconomic policies and forestry in Zimbabwe. Draft Working Paper, CIFOR, Harare.

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4. Braedt, O. and Standa Gunda, W. 2000 Woodcraft markets in Zimbabwe. International Tree Crops Journal 10 (4): 367-384.

8.
Evolution of land policies and legislation in Malawi and Zimbabwe: Implications for forestry development

C. Mataya, P. Gondo and G. Kowero

ABSTRACT
This paper sheds some light on the effects of the colonial and post-colonial land policies and legislations on the management and utilisation of natural woodlands in Malawi and Zimbabwe. The two countries share similar patterns of land ownership structure; customary or tribal trust land designated by colonial governments for settlement and cultivation by indigenous population; private land mostly alienated from local communities for commercial farming and ranching, initially by white settlers and later officially sanctioned by post-colonial governments; and public land appropriated by government for the purpose of establishing national parks and forest reserves. The first two forms of land tenure, private and public land, not only reduced the size of land available to indigenous communities for agricultural and non-agricultural activities, but also compromised the roles and power of traditional authorities in controlling and managing natural resources, including miombo woodlands.

With rising populations and demand for food in both countries, conflicts arose over access to land and natural resources between the heavily endowed and landless communities, as evidenced by increasing incidences of encroachment. Bush fires have had devastating effects on indigenous forest cover and some tree species. An increase in population pressure, poverty and failure by governments to urgently provide effective policy guidelines on land management and administration regarding the utilisation of forests and natural resources, appear to be the major factors which have contributed to rapid deforestation and land degradation.

Political pressure resulting from increasing levels of landlessness, unemployment, poverty and food insecurity convinced the two governments to begin seriously addressing the land problem in the 1990s, as evidenced by the appointment of land policy reform

commissions. The major observation in this paper is that the new land policies resulting from the nation-wide consultations of the land commissions cannot become effective in arresting deforestation and land degradation unless the problem of poverty is adequately addressed. Dependency on subsistence agriculture, common to both countries, as the main source of livelihood, exerts tremendous pressure on land resources and contributes to deforestation. Development of alternative sources of livelihood especially non-agricultural activities, would not only reduce this pressure but would also diversify the economic base, thereby improving household incomes and food security. Since the majority of both rural and urban communities depend on wood as their main source of energy, for land policies to contribute effectively to conservation of forests and natural resources, it is crucial that existing forestry and energy policies be reviewed and implemented.

Key words: Land policy, legislation, forest resources, traditional authorities, customary law, and public land.

1. INTRODUCTION

Land underpins the economic, social and political lives of the majority of the people of Malawi and Zimbabwe because of their strong dependence on agriculture and natural resources. Land is a fundamental resource in that it provides many things for supporting life. Its capacity to do so depends very much on its quality, adequacy, and the manner with which it is used, among others. In the southern African region land degradation has been an issue for many decades and a lot has been said and written about this. Further, land degradation is often cited as being due to poverty, unfair land allocation, and disruption of traditional land management systems. However, there is realization that policies and legislation influence the way people use land. The question is then what policies should be adopted and how they should be implemented in order to promote better land use practices as well as contain land related problems like deforestation.

This paper seeks to highlight policies and legislation that, over time, have influenced the manner in which land has been used and continues to be used in rural Malawi and Zimbabwe. These are neighbouring countries that shared the same colonial master, Britain, and later followed a capitalistic approach (though Zimbabwe initially started with a socialist policy) to economic development immediately after independence. These two common attributes have influenced their treatment together in this paper on the assumption that there could be similarities in the way land policy and practices have evolved in these two countries. The paper is based on an evaluation of past and present major land policies, legislation, and traditions in these countries, recognising very well that there are other factors like wars which have influenced access to land and other land related issues. While it is not possible to trace the evolution of all major land uses the paper is restricted to how forestry condition and practice in these two countries have evolved under the reviewed land policies and legislation. The hypothesis in this paper is that land policies and legislation have created conditions that have considerably shaped the development of the forest condition in these two countries. This of course does not ignore the influence of macro-economic policies on peoples' livelihoods and their corresponding responses, which often impact on forest resources.

In Malawi about 42.6% of the total land area is considered to be under forest cover (Nyasulu 1997). This comprises national parks and wildlife reserves, forest reserves,

protected hillsides, and natural woodland on customary land (GoM 1996). The corresponding proportion for Zimbabwe is estimated at 51% (Nyasulu 1997). The rates of deforestation are estimated at 61,000 ha per year for Zimbabwe and 53,000 ha per year for Malawi (*ibid.*). The exact rate of deforestation or extent of natural forest cover in many countries in sub-Saharan Africa are unknown; there are conflicting estimates on the natural forest area as well as rates of deforestation.

The paper is organised as follows. Sections 2, 3, 4, and 5 review the situation during the pre-colonial, colonial, post-independence, and present periods respectively. Section 6 presents a summary of major observations.

2. PRE-COLONIAL PERIOD EXPERIENCES

In the pre-colonial period, traditional leaders had authority over land and other natural resources in systems that were based on clan or tribal groupings (Chenje and Johnson 1994). Control and utilisation of land was determined by conquest or abandonment. According to Ranger (1993), chiefs controlled and distributed land to their people as long as they remained powerful. Land was free and belonged to a social group claiming descent from a common ancestor. The traditional leader or his representative allocated land and settled disputes. However, ownership was not vested in the chief or his subordinate, the chiefs were merely guardians or trustees (Phiri 1991). There were no land markets; access to land was guaranteed by individuals' allegiance to the chief or clan head. Once land had been granted, family members could inherit use rights. In Malawi, inheritance was governed by marital status along both matrilenial and patrilenial systems whilst in Zimbabwe it was along patrilenial lines only.

Tribes and other ethnic groups had different cultures and socio-economic demands that over time led to the development of land use patterns. The geographical distribution of ethnic groups in Malawi was a result of tribal wars amongst the Ngoni, Chewa and Yao tribes. In Zimbabwe, the Ndebele tribesmen settled in the southwest and western parts of the country following their conquest of the Shona tribes originally resident in these areas. Under the traditional system, land areas were divided into different use categories governed by different rules and regulations. Some areas (such as residential areas) were under individual control and could be inherited by members of the family or clan for several generations, whilst others were communally owned. In some cases different rules applied to the same piece of land at different times of the year or to different resources within the area. A typical example is agricultural land where control by the individual prevailed when there were crops in the fields but communal access was accepted after harvests.

With regard to forest resources, these were governed by similar customary rules and regulations that limited access to some areas such as sacred groves and grave yards and controlled tree cutting through a series of taboos (Matose 1992, Misana *et al.* 1996). Traditional leaders were responsible for exercising control over how land and associated resources were utilised in areas under their occupation (Abrahams 1967). Due to the small population characteristic of this era, demands on land were mostly for agriculture and grazing, and as such did not pose a great threat to natural resources status, including forests, except in areas with high population densities. Evidence from some countries in southern Africa suggests that the land use systems in this period were sustainable (Kaoneka *et al.* 1999). For example, shifting cultivation and nomadic livestock rotation systems were practised. The long fallow periods allowed the land to recover fully

before the next rotation, whereas low livestock densities were not a threat to grazing lands. This ensured sustainable productivity of land.

3. COLONIAL PERIOD

3.1 Land policies and laws

The process of colonisation in the region was varied. In Malawi the process was through the introduction of Christianity that was later followed by British settlers. As more British missionaries, planters and traders came into the country, the need to provide for their protection increased. This and a combination of other factors led to the proclamation of the British Protectorate in 1891.

In Zimbabwe, colonisation was predominantly through conquest of the major tribes (Shona and Ndebele) in 1896 by the British. The conquest was followed by declaration of all land as crown land and subsequent demarcation into native reserves and white (European) settlement land. The first native reserves were created by the British colonial powers as early as 1894. By 1911 native reserves comprised 8.5 million ha of largely marginal land. About 60% of the estimated 700 000 native population lived in these reserves and since the population was still low, degradation was not yet a problem (Whitlow 1988).

The major settlement thrust was largely geared towards agriculture and therefore the land use patterns in both Malawi and Zimbabwe were influenced by the distribution of agriculturally fertile land as well as segregation between the settlers and the indigenous people. Although formal land policies were non-existent, there were a series of acts governing the distribution, management and administration of land. For example in Zimbabwe, under the Land Apportionment Act of 1930, most of the fertile land was reserved for European settlers whilst the indigenous people were forced into African Reserves (Moyo 1995), though the settler land area declined slightly by 1953 (Table 1). This Act further marginalized the indigenous people by making tenancy illegal and reducing the supply of land to Africans by depriving them of the right to buy farms outside the African Purchase Areas. After World War II, the increased attractiveness of colonial agriculture led to the eviction of more Africans from land designated for settlers, resulting in a dramatic increase in both human and livestock population in the native reserves, which led increased rates of natural resource degradation. By 1950, 30% of the African population was already landless (Moyo 1995).

Whilst the overcrowded African reserves were being severely deforested, the land occupied by white settlers reverted to forests, as only 4% of the 14.9 million ha was under cultivation (Riddell 1979). Between 1930 and 1975 there were further land tenure changes when the state resettled more than 12,000 families from the overcrowded dry southern provinces to the northern and northwestern provinces after the northward movement of the tsetse-fly belt.

The Native Land Husbandry Act, characterised by intensive conservation measures (contour ridges, drain strips, rotational grazing and livestock de-stocking), was introduced in 1951. The Act also favoured individual tenure and sedentary agriculture that resulted in land being divided into small parcels arising from the demarcation into residential, grazing and individual arable plots. Imposed restrictions on land use rights led to feelings of tenure insecurity and resistance to land management programmes. The natives provided stiff resistance towards this Act as the pressure for even bare subsistence production

Table 1. Historical land distribution in Zimbabwe

Group	1931 (million ha)		1953 (million ha)	
European area	19.67	(51%)	18.96	(49.2)
African Reserves	8.64	(22.3%)	8.34	(21.7)
African Purchase Areas	2.98	(8%)	2.26	(5.9)
Special Native Areas	_	_	1.65	(4.3)
Unassigned land	7.12	(18%)	5.68	(14.7)
Wankie Game Reserve	_	_	1.19	(3.1)
Forest area	0.24	(0.6%)	0.39	(1%)
Undetermined	0.03	(0.1%)	0.02	(0.1%)
Total	38.68	(100%)	38.51	(100%)

Source: Chipika *et al.* (1998) citing Government of Zimbabwe (1982).

grew on the limited land (Cliffe 1986). The Act was eventually abandoned in the mid-1960s. However by 1966, some 49% of grazing land in the Tribal Trust Lands was described as bare to very overgrazed (i.e. 6.24 million ha out of 12.64 million ha) (Cleghorn 1966). The Land Tenure Act of 1969 was introduced under mounting pressure from the natives and the war of liberation. The 1969 land distribution is roughly the one that was inherited at independence in 1980.

In Malawi, alienation of land by settlers was initially effected through granting of concessions by chiefs to missionaries and European settlers. These were later converted to certificates of claim after the declaration of the Protectorate in 1893 under the provision of the Africa Order in Council of 1893 that resolved competing claims to African territories by European countries including Britain, Germany and Portugal. Through the use of certificates of claim, up to 1,499,464.8 ha of land were disposed of to private persons by 1894, of which 1,092,652.2 ha were owned by one company, the British South African Company. The protectorate, through subsequent clauses of the British Central Africa Order (1902 and 1907), established a system of control of land by the British administration. Under the provisions of these new clauses an additional 56,479.4 ha were granted as freehold and 49,977.3 ha as government leases.

The Nyasaland Protectorate (African Trust Land) Orders in Council were enacted between 1936 and 1949. They declared some lands as native trust, i.e., for native settlement. The present day land tenure system originates from the enactment by the local legislature of the Nyasaland Protectorate (African Trust Land) Order in Council 1950.

The enactment, which in 1951 became the Land Ordinance (currently the Land Act) defined for the first time three categories of land, namely public land, native trust land (now known as customary land) and land granted to any other interests by grant or lease (private land). Public land included all lands and interests in land acquired by, or on behalf of His Majesty, land in townships not in private ownership, land in forest reserves, lands and mines in the custody and bearing the signature of the Director of Surveys and the Survey Department and land declared as public land. Thus all the lands of the protectorate excluding public lands, lands under lease or grant and under certificate of claim were declared African Trust Land. However, powers to dispose of African Trust

Land or convert it into any tenure category were still vested in the Secretary of State. As observed by Msisha (1999), this implied that although the land was intended for the benefit of the natives, they had no legal right to protect their supposed interests in that land. At independence 87 % of the land was customary, 2% private and 11% was public land (*ibid.*).

3.2 Implications for forestry

a) Loss of ownership rights and erosion of traditional authority

Generally the effect of alienation of land by colonialists in both Malawi and Zimbabwe was loss of control and ownership of traditional land rights. In addition the loss of control translated into erosion of traditional institutional capacity to manage natural resources, including forests. At the same time the colonial administration lacked capacity to monitor, control and manage natural resources in these areas. This administrative vacuum promoted encroachment and destruction of forests by bush fires. In the case of Zimbabwe, the role of traditional leadership in managinge resources was continuously disturbed through a series of administrative policy reversals and eventually weakened. For example, in the 1930s traditional leaders were allowed to control and manage resources in the native reserves, whilst these powers were taken away in 1951 with the introduction of the National Land Husbandry Act in 1951. The powers were returned again in 1969 under the Land Tenure Act, following stiff resistance to the National Land Husbandry Act. Unfortunately the latter move was viewed with suspicion as the war of liberation was escalating.

b) Increase of pressure on limited land area

The confinement of indigenous people to relatively small and marginal lands (reserves) resulted in overcrowding and destruction of forest cover. For example, by the end of the 1920s there was evidence of degradation in the native areas as farmers increased land under cultivation in order to cope with taxes and falling grain prices. Livestock numbers were also increasing compounding the degradation problem.

c) Introduction of plantation agriculture and forestry

Destruction of indigenous forests and other natural resources, especially in Malawi, can also be attributed to the establishment and expansion of large scale agriculture, especially tea and tobacco, which demanded substantial amounts of wood as fuel and construction material. The weaknesses in the lease covenants facilitated over-exploitation of forest and other natural resources. However, in Zimbabwe, land on settler (large-scale commercial farms) farms was generally under-utilised, with less than 4% of the total land area cultivated. Over 30% of the forest cover in Zimbabwe is found in these areas (Forestry Commission 1997). In addition, the land laws facilitated the establishment of exotic plantations for industrial purposes mainly of pines, Mlanje cedar, eucalyptus and other tree species. This was associated with the clearance of natural forests.

With respect to public land (state land, national parks and forest reserves), all rights to forest produce were vested in the state or lessee. This was, however, contested by local communities living adjacent to these areas who claimed the right to use the land by virtue of proximity and historical connections. This resulted in conflicts between the state and local communities and was one of the primary triggers of the liberation struggles.

d) Emergence of land markets

Although market transactions were provided for on leased and freehold land, this did not apply to land in native reserves or Tribal Trust Lands where access was based on user rights. The lack of market value could have encouraged over-exploitation of forest resources, in that the land and the forest resources it supported were viewed as of low or no value, and in many cases was freely available.

In both countries the indigenous people were not allowed to purchase land from the freehold large-scale commercial farms. However, in order to accommodate increased demand for land by indigenous farmers in Zimbabwe, this restriction was eased through the creation of the African Purchase Areas. In Malawi, if natives wished to hold land, a distinction was made between land for agriculture and land for residential purposes. Through the Land Commission of 1920 recommendations were made that natives could hold land at the same rent as Europeans but were exempt from survey and registration fees. They could also be allowed to have smallholdings for their houses as a way of achieving transition from a communal system to individual land ownership (Msisha 1999).

4. POST INDEPENDENCE LAND POLICIES

Due to constitutional constraints, the first years of the post independence era in both Malawi and Zimbabwe were characterised by minor attempts to redress the land imbalances inherited from the colonial era. In Zimbabwe the Lancaster House agreement prevented compulsory acquisition of land from the commercial farming sector for ten years (1980-1990). These limitations together with costly land acquisition and a strong lobby against this by the settlers or their descendants, as well as the slow process of modifying legislation, combined to slow down the process of land redistribution.

4.1 Land policies and legislation in Malawi

At independence in 1964, the Malawi Government inherited the institutional and legal framework of land management and administration with minor modifications of the Land Ordinance passed in 1951. The land tenure categories are as summarized Table 2 from information in the preceding section.

Statutory reforms to the Land Act of 1965 that took place in 1967 led to the creation of three statutes, the Land Act, the Registered Land Act and the Customary Land Act. The Land Act merely redefined the three categories of land holding namely, public, private and customary. One of the provisions of the act stipulated the authority

Table 2. Land tenure categories in Malawi in 1964 and 1997

Tenure category	Percent of total land area in 1964	Percent of total land area in 1997*
Customary	87	66
Public	11	19
Private	2	12
Urban	-	3

*Source: Presidential Commission on Land Policy Reform (1998).

of the minister of the new government over the management and administration of customary land, some of which included making and executing grants, leases, or other dispositions of public or customary law for various purposes. For example, the minister was empowered to grant leases on customary land for estates for a period not exceeding 99 years. Although the act also declared all customary land to be the lawful and undoubted property of the people of Malawi, vested in perpetuity in the president, the declaration did not confer legal ownership and title to the land in question.

The Registered Land Act was created with the aim of simplifying the system of recording land holdings and methods of carrying out land transactions, i.e., charges, transfers, etc, and thus circumventing the problems of long and complex process required previously by the Deeds Act. This act also provided a basis for the development and implementation of the Customary Land Development Act which was an attempt to confer titles to individuals or groups on customary land and was partly motivated by a common view of many development agencies at that time, that customary tenure relations were an impediment to rapid agricultural development. This development was, in part, fuelled by the expansion of burley and flue-cured tobacco and other crops as were defined in the Special Crops Act.

A thorough examination of the process through which the Registered Land Act was implemented shows that it was the major mechanism through which large tracts of customary land were alienated for the purpose of expanding estate agriculture, especially tobacco and sugar. In fact the acquisition of land for the purpose of establishing large-scale farms translated into permanent loss of that land to society, since at the expiry of the lease agreement the land never reverted to the customary sector but became public land. The act was also the major avenue through which government acquired large areas of customary land for the purpose of establishing development projects under which rights of cultivation and the crops to be cultivated were controlled by Government itself, e.g., the Kasungu Flue Cured Tobacco Authority (KFCTA). For example, it is estimated that 64,000 ha of leasehold surrendered under the 1965 Land Act reverted to public land between 1964 and 1980 and were lost forever from the customary sub-sector since smallholders did not hold cultivation rights to public land. In addition, land alienated from the customary sector is estimated to have increased by 110,000 ha (46%) and customary land (family titled land in the Lilongwe Land Development Program, LLDP) is estimated to have declined by 640,000 ha (8%) (Phiri 1991) during the same period.

The Customary Land Development Act 1967 empowered the Minister to declare designated customary areas eligible for division into individual or group titles under the Registered Land Act. In support of this exercise, a Local Lands Board charged with the responsibility of authorising any transactions involving such lands, including selling, leasing, partitioning, subdivision or any other disposition, was instituted through the Local Lands Board Act 1967. Title registration implied cessation of traditional authority over the demarcated customary land. The latter saw the birth of the 'Ndunda[1]' system, which was enacted into law in the form of the Customary Land (Development) Act and the Registered Land Act 1967. Lilongwe West was under a Land Development Project that was designated as a pilot project area for land registration and titling. However, contrary to expectations, none of the benefits predicted by the policy planners, such as greater security of ownership, negotiability of title, a robust land market and improved agricultural productivity, have materialised under the Ndunda system.

The Adjudication of Title Act 1967 was passed to reduce the cost and simplify the process of land registration. In relation to the Deeds Registration system, the act was

deemed user-friendly as it permitted dealings in land even by lay persons (Msisha 1999). Although the act is equivalent to the Customary Land Development Act, it applies mainly to private land. This Act empowers the Minister to declare an area as an adjudication area, a process that allows demarcation and recording officers to undertake verification of all interests in land in the affected before registration is effected.

Agricultural leases have, in the post-independent era, carved an important niche in the economic development of Malawi. This is the mechanism that made the dramatic expansion of burley and flue cured tobacco possible between 1967 and 1994. Agricultural leases were expected to fulfil not only the development conditions for which the grant is made, but also to ensure that the land, the subject of the grant, is sustainably managed.

Since independence, a considerable proportion of customary land has been converted to leasehold for agricultural purposes. Table 3 provides some statistics from the Lands and Valuation Department on 104,434 ha of customary land lost between 1983 and 1990 to other land use sectors. The trend from 1964 to 1997 can also be discerned from Table 2.

Government policy began to change from the mid 1980s when the pace of creating new agricultural leases began to slacken. The Control of Land Order issued in 1989 partially formalised the directive that no more leasehold estates be opened. This directive, however, did not apply to customary land occupiers who wished to convert their land into leaseholds. The Order was amended in 1996 to prohibit the conversion of customary land to leaseholds except in very special cases.

Table 3. Customary land lost between 1983 and 1990 (hectares)

Year	Public land	Freehold land	Leasehold land	Customary land lost
1983	1,640,594	52,058	296,811	13,057
1984	1,639,931	52,065	301,555	13,057
1985	1,641,607	52,016	308,413	8,484
1986	1,641,993	52,016	327,603	19,577
1987	1,654,953	53,903	341,601	28,843
1988	1,655,113	53,903	351,209	9,768
1989	1,655,961	53,903	355,492	4,032
1990	1,654,903	53,901	363,067	7,615

Source: Department of Lands and Valuation (various reports).

As observed by the Presidential Commission of Inquiry on Land Policy Reform (Msisha 1999) with regard to leasehold title:

> Indiscriminate conversion of customary land into leasehold estates has contributed to artificial pressure on land and the resources upon it in many areas of the country. Most communities were ignorant of the fact that conversion of customary land into leaseholds would result in permanent loss of such land to estates.
>
> Many communities believe that the introduction of the leasehold tenure has been responsible for severe erosion of cultural values and solidarity and, in particular, of community rules for sustainable management of land and other resources.

The fact that agricultural leases are of varying periods, ranging from 7 to 99 years, suggests that there is some confusion as regards agricultural leasehold development policy.

Many of the development conditions contained in leases of all categories are often ignored by lessees since there is in sufficient machinery for their implementation and enforcement.

Informal and unregulated leasehold arrangements, especially under the guise of customary law, have become an important part of rural life.

Many land conflicts can be resolved or managed through comprehensive land policy development that addresses, among other things, existing settlement patterns, improvement in production technologies and the design of new laws and legislation.

4.2 Land policies and legislation in Zimbabwe

In Zimbabwe the immediate priority at independence was land redistribution to address the inequalities of the colonial era (Zinyama *et al*. 1990, Moyo 1995). Sustainable development within the densely populated communal areas was considered impossible without a reduction in population densities. Government policy was therefore aimed at achieving quantitative and qualitative redistribution of land. The specific policy objectives included the development of rural areas through acceptable and fair distribution of land guided by a land reform programme; rapid reduction of poverty through increased land productivity; and achievement of food self sufficiency (Republic of Zimbabwe 1981). This was imperative as, at independence, Zimbabwe inherited four major land tenure regimes, namely, Commercial Farm Lands, Communal Lands, Resettlement Areas and State Lands. Commercial Farm Lands constitute 36.2% of the country's total land area in the form of mainly large-scale commercial farms (LSCF) that average 3000 ha (Table 4).

Table 4. Land tenure types in Zimbabwe

Category	Total area (million ha)	Proportion of total area (%)	Proportion of arable land (%)
Non-agricultural			
State forests	0.9	2.3	_
Urban and other	0.2	0.6	_
Sub total	5.8	15.0	_
Agricultural			
Large-scale commercial farms (LSCF)	12.7	32.5	38.3
Small-scale commercial farms (SSCF)	1.4	3.7	4.3
Communal areas	16.4	42.0	49.5
Resettlement areas	2.6	6.8	8.0
Sub total	33.1	85.0	100.0
Total	38.9	100.0	100.0

Source: Moyo *et al*. (1993) citing Whitlow (1988)

There are also 10 600 small-scale commercial farms (SSCF) owned by Africans on freehold tenure. About 4000 LSCF are owned by whites, while 450 LSCF are owned by Africans. LSCF occupy 66% of the best land in natural regions I–III, whilst communal lands occupy 41.8% of the total land area, of which 75% is in the worst natural regions (IV and V) (Table 4). Land in Zimbabwe is classified into five natural or agro-ecological regions which are based on soil type, rainfall and other climatic factors with natural region 1 being the most productive and natural region V being the most marginal and least productive.

Table 5. Distribution of Natural Regions by land category (%)

Land category	Natural 1 Region	Natural 2 Region	Natural 3 Region	Natural 4 Region	Natural 5 Region
State	1.1	0.0	0.2	0.2	0.4
Communal	20.2	23.7	42.4	63.0	52.9
Large-scale communal farms	73.7	66.4	37.0	28.4	44.8
Small-scale communal farms	1.2	4.2	8.2	4.2	1.1
Model A resettlement*	1.2	5.2	11.9	4.2	0.8
Model B resettlement*	2.6	0.5	0.3	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

*Model A resettlement is a category whereby individual peasant holdings are created by subdivision whereas in Model B category the allocation is made to communal farming cooperatives.

Source: Moyo *et al.* (1993) citing Hosier (1988)

In communal areas (formerly Tribal Trust Lands) the community, represented by the chief, owns the land but allocates heritable rights to households to cultivate land and permits them to graze their livestock on unallocated grazing lands and natural woodlands that are communally managed (Fortman and Bruce 1993). However, communal land cannot be bought or sold. The Rural District Councils Act of 1981 set up elected councils as the key institutions for rural local governments. This was followed by the Communal Land Act of 1982 that vested ownership of communal land in the President and assigned administrative control to district councils rather than traditional leaders. This Act effectively gave the power to allocate and administer land to District Councils. It noted that existing land rights would be preserved but new permits to occupy land would be granted by District Councils. They would grant permits for residential and agricultural use, while taking into account customary law, and grant land only to those who had the customary right to it. Thus the Act regulated access to land according to customary law relating to allocation, occupation and use, but did not restate the customary laws. These had been transferred to the Customary Law and Primary Courts under the customary Law and Primary courts Act of 1981. This resulted in conflict between traditional leaders and district councils over control of land and other natural resources. In fact in most areas chiefs continued allocating land.

Under the Communal Land Act, a district council could pass by-laws relating to its duties and functions. The Act also has model conservation by-laws that provide for the preparation of land use plans for all land within a council area. Such plans may regulate

land holdings and use of pasture and arable land. These changes are very similar to attempts by the colonial government to assume control of land administration from traditional authorities under the Native Land Husbandry Act of 1951, except that local communities were now expected, through various committees, to take part in land use planning. The district councils are considered to be too far removed from the requirements of farmers with respect to land and trees to be able to make informed decisions on the use and allocation of land (Cliffe 1986). Whilst chiefs are council members, some local communities resolve conflicts between traditional leadership and the council by electing traditional leaders to positions of councillors or ward and village development committee chairpersons. This has resulted in confusion as to under what authority they continued to allocate land.

At independence the inherited dual, unequal and hierarchical system of land tenure that was also racially divided was reinforced by declaring land in LSCFs as freehold and entrenching the tenure structure in the constitution. State control over freehold land remains minimal. These lands have essentially been self and market regulated. Thus the relationship between the state and freehold and leased lands is governed by civil laws and is weighted in favour of the landowners. This is in contrast to communal lands where the relationship with the state is dominated by the granting of powers to state functionaries and criminalisation of non-compliance.

The initial plan was to resettle 162 000 families by 1985. However, by 1989, only 52300 families had been resettled on 2.6 million ha of land. Only 22% of the resettlement areas were in natural regions I and II. Several reasons were advanced for the slow pace of the resettlement programme. These included limited availability of land due to high costs of land and constitutional constraints during the first decade that prohibited land expropriation. Some flexibility was introduced under the Land Acquisition Act of 1985, which gave the government the right of first refusal in respect of sales of commercial farms, but land could only be acquired on a willing-seller willing-buyer basis. Inefficient implementation strategies were also cited. By 1990 the pattern of land distribution and land use still represented the situation during the colonial era (Moyo 1995 and Chipika 1998). The resettlement programme, with a predominantly state-dominated permit tenure system, enabled only 60 000 families to gain access to more land, mostly of poor quality. Resettlement areas occupy 8% of the country's land, whilst state lands in the form of National Parks and forest areas occupy 15% of the total land area (Moyo 1995). The area under resettlement (as well as that under LSCFs) has continued to change since the introduction of the 'fast track' resettlement programme that was introduced by the Government of Zimbabwe in 2000. This programme has yet to be completed. Under the Land Acquisition Act, the requirements for land distribution were clearly articulated. It was envisaged that a total of 11 million ha would be acquired and the farmers compensated.

The designation of land for resettlement purposes, however, sparked controversy both within and outside Zimbabwe as it has been interpreted as land grabbing in some quarters. The critics of this approach argued that this will undermine the agricultural sector and also expressed fear that the farmers whose land has been designated would not be adequately compensated by government. They further pointed that the first post-independence government did not provided adequate resources for infrastructure development to support productive use of the resettlement areas.

The ESAP period has also been characterised by increased illegal settlement on both commercial farms and state lands (reserved forest areas and National Parks) and

heightened conflicts over resources between communal areas and adjacent resettlement, commercial and state lands. This is partly due to growing resource scarcity and population pressure in communal areas following redundancies and growing unemployment partly due to the economic reform programmes.

4.3 Implications for forestry

This section attempts to describe the likely implications of the policies and legislation on forestry. These insights shall later be useful in discerning useful observations from these historical developments as well as conclusions that are less descriptive.

Malawi and Zimbabwe share a number of factors that have contributed to deforestation on different forms of landholding systems in this era. Appropriation of land by white settlers for the purpose of agricultural production and the state for the establishment of public amenities such as national parks and forest reserves physically reduced the size of the land available for agricultural and non-agricultural use by the rural communities, as well as access to the natural resources found on them. While clearing of indigenous woodlands for estate agricultural production inevitably resulted in deforestation of indigenous trees in both Malawi and Zimbabwe, the extent of deforestation between the two countries differs, being probably less in Zimbabwe.

(a) Leasehold and freehold lands

As opposed to Zimbabwe, leasehold and freehold lands appropriated for plantations in Malawi hardly have any indigenous trees. Some analysts argue that the notion that owners of such freehold lands have absolute immunity against government intervention in matters of land use is a major factor behind the destruction of indigenous forests. This also encourages freeholders to explain away the existence of unutilised or under-utilised land in terms of their freedom to decide how best to use such land.

Destruction of indigenous trees on leasehold lands in Malawi is also associated with failure by the relevant ministry to enforce the lease covenants, especially one requiring the lessee to plant trees on at least 10% of the total land. This is further complicated by the fact that land issues affect both the agricultural and the forestry sectors, and poor co-ordination of policies and strategies between the two has created uncertainty on the administration of agricultural land, and especially enforcement of lease covenants with respect to afforestation.

Although land appropriation is politically unpopular and was more excessive in Zimbabwe than in Malawi, barriers to access to resources on white-owned freehold or leasehold land have to some extent contributed towards the conservation of bio-diversity. Barriers to access to gazzetted forests, natural parks and reserves in Malawi and Zimbabwe have also partly contributed to the conservation of indigenous woodlands. However, there is a case for examining the effects of redistributing idle estate land, where natural vegetation, and especially indigenous woodlands, exists. The fact that growing high value crops such as burley tobacco required one to have title to land in the form of leasehold or freehold reduced demand for natural wood (outside the leaseholds and freeholds) used for tobacco curing and processing structures, and consequently contributed to the conservation of natural woodlands. The relaxation of this policy, especially in Malawi (Special Crops Act) in 1994, in which smallholder farmers were permitted to grow burley tobacco without requiring land ownership certificates, did exactly the opposite, i.e., increased demand for natural wood and accelerated deforestation.

Although deterrents against illegal occupation and use of leased, freehold and public land in the form of national parks and game reserves exist, these types of lands are often deliberate targets of encroachment by land hungry small scale operators. Encroachment and destruction of natural vegetation by wild-fire on public lands are difficult to control due to lack of capacity in enforcing rules and regulations governing land resources. Generally, due to laxity in enforcing regulations, the extent of loss of bio-diversity resulting from encroachment and wild-fire on public lands is likely to exceed that on freehold and leasehold lands. Local communities surrounding these lands argue that estates, in general, have far too much land for their needs, and that a good amount of this is not being put to productive use. The fact that the creation of these parks involved the displacement of entire villages, some of which were forced to settle into valleys of uncultivable gradients, is particularly a source of grievances in some communities. Communities in some of these areas complain that the government is more interested in protection of wild animals than in human welfare.

Claims made by displaced communities are not totally out of context. For example, the Presidential Land Reform Commission in Malawi observed that there are cases of leasehold grants that were made without verification as to the suitability of the demised premises for the purpose for which they were sought. The Commission further observed that many leasehold landowners sometimes embark on developments that are not approved under their terms of grant. Despite such developments, it should be noted that there is no law or practice in Malawi that would prevent the state, represented by the government, from enacting laws that create an environment for sustainable management of land tenure of all categories including freeholds.

(b) Public lands

Lack of property rights and the prevalence of open access to land have also being cited by many development economists as potential causes of mismanagement of natural resources, including forests. This line of thought draws its support from proponents of market liberalization, which advocates the use of market forces of supply and demand as a mechanism for efficient utilization of natural resources, including land. The absence of a pricing mechanism, it is argued, contributes to unsustainable consumption and eventually the extinction of resources (the tragedy of the commons). Individual right to ownership of land is expected to encourage the owner to invest in the land in such a manner that productivity would improve. The experience in Malawi does not appear to fully support this line of argument. A modified land registration in which right of ownership to land was conferred on a pilot basis to groups of individuals belonging to the same kinship did not improve investment in land and productivity (CLUS 1999). In fact, this experiment led to the development of informal land markets and loss of ownership to speculative buyers and urban dwellers for housing and agricultural production purposes. In some cases, the little forest cover available on these lands was lost due to increased dependence on natural wood as the main source of energy by both rural and urban low-income communities. Increased cultivation of burley tobacco after repealing the Special Crops Act in 1994 has also contributed to rapid deforestation on these lands.

The prevalence of open access facilitated the establishment of plantation forestry and estate agriculture. The early establishment of plantation areas was based on gazzettement of areas with suitable climatic conditions, (e.g. in the Eastern Highlands of Zimbabwe) as forest areas during the colonial era. This took place in areas where the natural forests were perceived to have low industrial potential and value at the time.

The establishment of industrial plantations replaced the natural forests with exotic tree species such as tropical pines and eucalyptus species that are grown as monocultures. The forestry industry in both countries is now almost entirely based on plantations. According to the Timber Producers Federation (2001), Zimbabwe has 119,130 ha under commercial forest plantations while the equivalent area for Malawi stands at 110,000 ha (Nyasulu 1997). Malawi's total land area is about 30% that of Zimbabwe.

In the late 1980s and early 1990s, the prospects for growth in the demand for short fibre pulp resulted in the increased establishment of eucalyptus plantations in many areas where the species could be grown successfully. The land policies are generally silent on the designation and conversion of natural forestland into forest plantations. This has seen the conversion of some prime agricultural areas into eucalyptus plantations as a means for increasing land values in Zimbabwean commercial farms that were likely to be designated for resettlement.

Fuelwood plantations were given prominence during the early 1980s when collection of firewood was considered to be a major cause of forest degradation. Whilst these were promoted by governments, donors and the World Bank, they have generally failed to address the fuelwood problem largely due to the unsuitability of the plantation species as fuelwood. In Zimbabwe the eucalyptus species used have found value as construction timber.

(c) Customary land

In communally owned land under customary management the impact on forests has been mixed. Customary land users are sometimes believed to be poor managers of land. The main reasons, apart from the paucity of good land and presence of high population densities in some areas, is their basic resource and technological poverty, the breakdown of community resource management systems, and the general marginalisation (as a matter of national policy) of the smallholder agriculture sector.

In areas where traditional systems were intact and values remained strong, customary forest resource management systems have been the basis for forest management. In these areas communally managed forest resources have continued to this day. Today they provide examples of community managed forests. In areas that experienced large influxes of immigrants, such as resettlement areas, traditional values and resource management systems have crumbled, resulting in an open access system and depletion of forest resources.

Appropriation of indigenous land, whether for commercial or public amenities such as national parks and forest reserves, reduced the geographical jurisdiction and powers of the traditional authorities and also alienated their traditional roles of guarding against wanton destruction of natural woodlands. Natural forests were protected from destruction because they served several important purposes. Apart from being a source of firewood, construction materials, herbs and medicines, natural forests were and still are important sources of food such as wild fruit and vegetables, honey, insects and meat. Natural woodlands also provided space for burying the dead and served as focal points for performing rituals and making special offerings to the ancestral spirits. Some tree species were considered so sacred that cutting them would provoke wrath from traditional authorities and the community. In recognition of the significant contribution traditional authorities played in natural resource conservation and also considering the lack of government capacity to enforce forest conservation, community-based natural resources management regimes have been

introduced in both Malawi and Zimbabwe (e.g., the Communal Area Management Programme For Indigenous Resources - CAMPFIRE). The new management regimes empower rural communities not only to manage these resources, but also ensure that part of the income generated from tourism and the sale of forest products including game contributes to improvement in social welfare through construction of schools and other amenities.

The disappearance of natural woodlands in marginal areas where the rural communities were forced to settle after land had been alienated from them is associated with increasing demand for food, energy and construction materials created by a rapid increase in population. In densely populated rural areas of Malawi, trees along watersheds and sloping areas including hills and mountains have been destroyed for the purpose of growing food crops. With little or no effort made to construct soil and water conservation structures, most of these lands are being degraded by gully erosion.

(d) Other factors

The implementation of the land reform and resettlement programme in Zimbabwe largely resulted in the clearance of forests and woodlands for agricultural purposes during the occupation period. As pointed out earlier, only a small percentage of settler-owned land was under cultivation, thus these areas were perceived to be under-utilised and were cleared to accommodate the new settlers. The land use plans in resettlement areas recognised the need to maintain forests and woodlands for grazing and other purposes. These were planned for and set aside. However, since these plans were on a farm basis they generally resulted in fragmentation of the forests. In resettlement areas adjacent to communal areas poorly endowed with forests, conflict has arisen over access to the forest resources.

The commercialisation of non-timber forest products has led to the depletion of forest resources, especially in areas where commercialisation of firewood and charcoal is possible. Production of woodcarvings has led to serious forest degradation as preferred species have been depleted. In some areas, commercialisation has resulted in access to forest resources being determined by village boundaries. For example, in Chipinge district in Zimbabwe, people from outside one village are no longer allowed to harvest palm leaves for crafts from another village without paying for the resource. Whilst this has helped curb over-exploitation of the resources, it has disrupted age-old coping strategies based on utilisation of resources in different areas at different times of the year and shared between villages. This has also disrupted traditional management institutions, as new institutions for managing the commercialised resources as well as new user rights have to be created or defined.

Rapid disappearance of natural forests is equally blamed on the lack of comprehensive policy in the energy sector. Although efforts have been made by national governments to develop alternative sources of energy for use by different sectors of the economy, very little progress has been made. Rising cost of petroleum products coupled with heavy taxation have continued to force poor urban and rural communities to depend on natural wood as their main source of energy, thus exerting more pressure on the limited natural forest reserves.

Dependence on land and land resources by the majority of the population is a coping mechanism against hunger, malnutrition and dire poverty. Unless alternative livelihood mechanisms are developed, it is unlikely that any new land policies will bring a lasting solution to landlessness, poverty and natural resource degradation.

5. CURRENT SITUATION (2002)

In both Malawi and Zimbabwe land bureaucracies have proliferated, jurisdictional conflicts intensified, and land users have been left to wonder as to what government policy really is. This has been recognised as a challenge to rational land development planning and management. Land policy development has, therefore, become an important item in the national development agenda of the two countries. In recent times, sectoral policies have been designed and approved for implementation by the government. These relate to agriculture, forestry, irrigation, environment, housing, and local government. An attempt to formulate a national land use management policy in each country has also been made. A quick review of these policies indicates that without a basic or referential policy framework on land, the physical framework on which all these sectoral activities operate, it is not possible to mobilise an internally coherent and coordinated scheme for the implementation and supervision of plans designed on the basis of the discrete sector requirements.

The process of land reform in both countries was initiated through the appointment of a land reform commission, first in Zimbabwe in 1994 and later in Malawi in 1996. The primary objective of the commissions' work was to develop and recommend the main principles of a new policy that would foster economic efficiency, environmental sustainability and social equity.

The commissions adopted a consultative policy development process that was aimed at involving all stakeholders. Oral hearings and consultations involving civil servants, politicians, civil organisations, NGOs, community leaders and selected members of the community were held at various locations in both countries. The commissions also received written submissions from special interest groups including women's groups and farmers unions. These submissions were supplemented with commissioned technical papers from selected experts. The commissions then wrote reports that will guide governments in land reforms.

With respect to Malawi the commission found that the main problems are associated with land scarcity, land management and land auditing (Msisha *et al.* 1999). They reviewed these problem areas in detail and their recommendations will form a basis for the government to review and develop a new land policy in Malawi. The commission recommended that the new policy should be fully integrated into the country's overall development policy, taking into account the Rio Declaration and Agenda 21 and the conventions arising from the Earth Summit negotiations.

With respect to Zimbabwe the Commission of Inquiry into Appropriate Land Tenure Systems (Land Tenure Commission 1994) recommended five land tenure categories, the provision of long land lease periods, introduction of a land tax based on farm size and potential productivity and that widows inherit and retain the land rights of their spouses.

The Commission therefore focussed on forms of land tenure and did not consider land distribution per se. The recommendations of the Commission have generally been well received. Some NGOs have noted that the proposals provide a framework conducive to improved decentralised woodland management. However, Government action has been slow despite endorsement of the recommendations by Cabinet.

Whilst there is general consensus amongst the key stakeholders that land redistribution is necessary, the current programme has been criticised for not having a recognisable policy framework or implementation plan (Moyo 1995, Nhira *et al.* 1999). There are no clear plans for the development and sustainable use of woodland resources in the resettlement plans, hence the criticism that the programme is environmentally insensitive.

Based on the experience from the early post-independence years, it is anticipated that there will be widespread deforestation in resettled areas unless there are deliberate measures to plan and clearly define institutional roles in resettlement areas. Such measures should recognise the role of woodlands in the agricultural production system and therefore plan for their incorporation in the land use of each resettlement area.

Although land redistribution in general received support from the donor conference held in 1998, the need for a clearly defined land redistribution programme in Zimbabwe was noted to be a prerequisite for donor support.

6. SOME OBSERVATIONS AND CONCLUSIONS

6.1 Pre-colonial period

During the pre-colonial era forest and woodland resources were governed by customary rules and regulations that limited access to some areas such as sacred groves and graveyards, and controlled tree cutting through a series of taboos. Traditional leaders were responsible for exercising control over how land and associated resources were utilised in areas under their occupation. Shifting cultivation was a characteristic feature of agricultural production. Due to the small human and animal populations characteristic of this era, land pressure was low and was not a threat to forest and woodland resources.

6.2 Colonial period

The colonial era policies are largely responsible for the present day land tenure systems. The major settlement thrust during this period was geared towards agriculture, and therefore the land use patterns were influenced by the distribution of fertile land and segregation between settlers and indigenous people. The major effect of the alienation of land and other natural resources was the loss of control and ownership of traditional land rights. This translated into an erosion of traditional institutional capacity to manage natural resources including forests. At the same time the colonial administration lacked the capacity to monitor, control and manage natural resources in publicly as well as in communally owned areas. This led to encroachment and destruction of forests in these areas, especially in native reserves where population pressure was high. Extensive destruction of forest and woodland resources also occurred due to the establishment and expansion of plantation agriculture and plantation forestry. However, large tracts of forest and woodland resources were protected during this era following the establishment of national parks and forest reserves. The exclusion policies under which these were managed were contested by displaced communities and those living adjacent to them and both groups claimed the right of use by virtue of proximity and historical connections.

6.3 Post -independence up to 2002

The post independence era was characterised by attempts to redress the land imbalances inherited from the colonial era through land redistribution and resettlement programmes. This resulted in clearance of forests and woodlands for agriculture and settlement purposes. There were also very significant changes in the institutions given the responsibility to manage natural resources, including forests with the responsibility for communally owned resources reverting to customary institutions (rural development

councils in the case of Zimbabwe) or locally based elected structures. Despite these changes the land tenure categories inherited at independence, as well as the management regimes, were largely unchanged.

In addition, the following are noteworthy of this period:

- Restoration of traditional authority in land administration and building local institutional capacity has the potential to improve management and utilisation of natural resources including forests. Studies on community-based management of natural resources in both Malawi and Zimbabwe have demonstrated the efficacy of a change in institutional structure in the productivity wildlife and fisheries for example CAMPFIRE and Lake Chilwa Fishery, respectively.
- One avenue for increasing access to land is through creation and improvements in land markets. In both Malawi and Zimbabwe, this element is an integral part of the proposed land policies. Attaching value improves efficiency in resource allocation since scarcity determines the extent of resource utilization. Since there is a direct link between land and forests, pricing of the former would directly affect the value of the latter and therefore the level of utilization, and hence incomes from such products, if the costs could be directly transferred to the consumer. The development of land markets through land policy reform would probably be indeterminate to the forest sector, in that estate farmers holding unused land under forests or woodlands will most likely give up such land to the state, increasing the proportion of protected forests. However, should the state reallocate such land to the landless, then the area under forests or woodlands will decrease.
- Low investment in customary land has often been associated with high levels of insecurity due to the absence of property rights to individuals occupying them. On the contrary, it is argued that the tight social structure and traditional norms in the rural areas confer group security to members who possess use rights to customary land. To what extent the latter promotes investment is not certain. However, elements of the proposed policy reforms in both Malawi and Zimbabwe purport to secure individual as well as group security of customary land, thereby enabling these communities to use land as collateral for investment funds. Assuming that group security is likely to prevail in the new land policies, it follows that there is likely to be no change in tree tenure.
- Some of the proposed changes in land policy in Zimbabwe are likely to involve the redistribution of 11 million ha of land from the large-scale commercial farmers. Based on previous experience, the implication of this is that large areas of forests will be cleared for cultivation. Thus, some measures to mitigate the hazards of wanton destruction of vegetation need to be put in place.
- Improvement in forest cover will be contingent on effective inter-sectoral harmonization and coordination of programs and activities dealing with common issues in natural resources management, such as increasing demand for energy, agricultural land and construction materials. Harmonization and coordination will require a review of sectoral policies, identifying areas of common interest and mapping out joint strategies. This can succeed if rural development actors adopt a consultative and holistic approach on the ground and not only at the development planning level, as is largely the case at present.

ENDNOTES

1. Land registered under the head of the family or clan, who in turn has the responsibility of allocating land to his kin.

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9.

Land policies in Mozambique and Tanzania: Implications for forestry development

I. Nhantumbo, G. Monela and G. Kowero

ABSTRACT

This paper traces the evolution of land policies in Tanzania and Mozambique in both pre- and post-independence periods, and implications for forestry development. In the pre-colonial period, the structure of land tenure in both countries was based on common and open access regimes, which were regulated by traditional law and culture. There were no land markets, and since land was perceived to be abundant shifting cultivation was practiced. This encouraged gradual clearance of forests and land degradation.

In the colonial period, traditional tenure systems were drastically altered, with unoccupied land or undeveloped land transferred into state ownership. Prime agricultural land was converted to freehold, mostly to settlers, creating a landlord-squatter relationship. This period was characterized by heavy exploitation of commercial timbers, clearing of forests to give way to cultivation of cash crops, and the indigenous population was forced to marginal land. This was the beginning of major land-related problems in the region.

Post-independence governments first substituted territorial systems (that regulated community access and control of natural resources) with radical title to land held by the sovereign. This led to a three-tier land tenure structure: state, communal, and individual ownership. In both countries the main feature was state ownership of all land, with governments maintaining the authority to grant rights of use and occupancy to different segments of society. However, much of the land in rural areas remained under customary land tenure. These complicated tenure arrangements gave rise to conflicts between local people (the “de facto” owners) and the state, which has “de jure” property rights. Existing land legislation and relevant institutions in land tenure were inadequate to deal with dynamic changes in land matters.

Both countries have since shifted from central to market economies as a result of economic reforms. Some of the objectives of the current land policies are to ensure rights of citizens over land and other natural resources, create an enabling environment for economic development, and encourage investments in natural resources. The paper discusses the current provisions of the land law in Mozambique and Tanzania and contrasts them in attempt to highlight the strong and weak provisions of both and how these impact on the use of forestry resources.

Key words: Land policy, land legislation, land tenure, forestry development, stakeholders, participation.

1. BACKGROUND: THE LAND TENURE FRAMEWORK

Southern African countries have been undertaking extensive resources tenure reforms with different degrees of achievement especially in terms of approved legal instruments. The major drive of the policy change appears to be the recognition by governments of their limited capacity and inefficient resource management system. Decentralization, empowerment of the local communities and strengthening of their institutions for better management of natural resources are recognized as crucial to sustainable use of such resources and improvement of livelihoods of the communities.

As a result several countries in the region have adopted community based natural resources management programs. Examples include Community Based Forest Management (CBFM) at Mgori and Duru-Haitemba in Tanzania, the Tchuma Tchatu and many more such initiatives in Mozambique, the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe, and conservancies in Namibia. The general feature of these initiatives is the assumption that common property regimes backed by rights to resources and some degree of local control over decision-making will result in a shift from an open access situation to one with resources in communal setting. In this case, group tenure would prevail, hence no individual would have defined and full rights. Further and no one would be excluded.

However, as noted by Nhantumbo (2000a) the reluctance of the national governments to give a full bundle of rights is noticeable. For example, in the case of CAMPFIRE the government not only sets quotas for harvests but also controls most of the benefits from resource use through the District Councils, the main managing institution at local level. Until recently (1999) land debates in Namibia included communities' claim for group tenure over the resources in the conservancies hence facilitating resource sharing by all the community members. The communities apply for registration as a conservancy in order to receive conditional use rights over wild resources, particularly wildlife. Nevertheless, the land continues to be owned by the state. Botswana represents a different model of tenure compared to other SADC countries, in that only a small percentage (6-7%) of the land is under a freehold ownership, while government land is 23% and community/tribal land is 70% of total (*ibid.*).

This paper gives an account of major developments in the evolution of land policies in Tanzania and Mozambique and their implications on forestry development in these two countries. The paper does not deal with details in legal and government documents on land but only those that are relevant to forestry development. Land use policies are some of a myriad of policies that influence forestry development. These policies played and continue to play a major role in shaping the extent and condition of forest resources.

The comparison between the two countries is important due to the fact that both have adopted similar policies especially regarding central planning, collective production and living systems, economic reforms (popularly known as structural adjustment programmes), that among other things facilitated the liberalization of markets as well as increased the role of the private sector in the economy. Currently, both are developing legislation aimed to promote involvement of various stakeholders in natural resources management with a view to grant them access to resources for their consumption as well as enabling them to derive more benefits from the resources in their vicinity.

The major assumption in this paper is that the present land policies and legislation shaping access and management of this resource are key determinants of forest use and sustainability. Consequently, the need for greater understanding of the land ownership and use context is paramount to understanding the potential for ensuring sustainable forest management. Such requirement is important for all stakeholders, be they community or private entities.

The paper starts with an account on pre-independence developments, followed by those in the post-independence period. The present land policies are then evaluated in terms of their potential for forestry advancement, and this is followed by a brief on the policy formulation process. A few general remarks and conclusions are given at the end.

2. PRINCIPAL MILESTONES IN ACCESS TO NATURAL FOREST RESOURCES

2.1 The pre-colonial and colonial periods

There are important milestones that have characterized access to natural forest resources in Africa, spanning different historic regimes. For Mozambique and Tanzania these are summarized in Table 1.

Table 1 shows that in the pre-colonial period in both countries access was either regulated by traditional law or unregulated in which case open access regimes prevailed. Ethnic groups had chiefs and headmen, who controlled and allocated land to members of the group. The individual as a member of a family, clan or tribe acquired rights of use in the arable land managed and used by that community.

Despite the wide prevalence of common or open access regimes, there was a clear individual ('private') ownership or control of land plots used for agriculture by individual households. Labor allocation to clear forestland gave value to land and provided tenure rights to those who cleared land and their heirs. Therefore, anyone with energy to clear forests could acquire private property rights on the land on which they stood (World Bank 1992, Fortman 1984). On the other hand, the equivalent of free access was practiced for livestock grazing and harvesting wood and non-wood forest products (MLHUD 1995; World Bank 1992; MAP 1997).

The social differentiations during the pre-colonial period promoted conflicts over use of resources, and led to tribal and clan wars. However, autochthonous land use systems, which prevailed during this period provided for flexible rules that reflected both the local conditions and adaptation to change.

During the colonial period, the traditional institutions were changed to suit the interests of the settlers (Table 1). These changes had serious implications on various

stakeholders with respect to rights of access, control and ownership of land and natural forest resources. The notion of land belonging to the state was introduced and reinforced with regulations, while simultaneously the settlers made treaties with local chiefs who were persuaded to accept gifts in form of manufactured commodities such as clothes and beads as well as spices in exchange for land (MLHUD 1995; Carvalho 1988). Immediately after acquiring the land, the colonialists introduced heavy exploitation of commercial timbers such as mahogany and also cleared forests to give way to cultivation of cash crops like coffee, tea, tobacco, cotton, coconut, sisal and cashew.

In Tanzania an Act of 1923 placed rights over land under the British governor. This was to be held, used, or disposed of as rights of occupancy[1] for the benefit of the indigenous people of Tanganyika (MLHUD 1995).

In Mozambique the legal provisions devised by the Portuguese Government (Table 1) defined three categories of land use. First, the state protected areas (national parks, forest and game reserves); second, the production forests, which supplied timber for export mainly to the mining industry in South Africa; and third, the free access areas where the development of plantation agriculture and other land uses took place (Nhantumbo and Soto 1999).

Generally, land tenure in these two countries reflected the interests of colonialists to get land, and thus it was a justification of force and not rights or justice. Like in the pre-colonial period, land markets did not exist in this period because under customary tenure, individuals were not allowed to transfer their land rights by selling (World Bank 1992). However, in Tanzania foreigners who then held more than half a million hectares of land could buy and sell it at will (*ibid.*).

During this period land allocation to indigenous people continued to be the responsibility of traditional chiefs. Therefore, the dichotomy of private agricultural land and common property forest and grazing land was still preponderant. Also the role of chiefs and family/clan headsman to allocate land continued to prevail in areas occupied by the indigenous communities.

The colonial governments maintained the traditional power basis as regards land allocation in order to sustain political stability in the territories. Also, they brought the notion of common access regime to all resources that could not apparently be allocated to an individual user. Furthermore, community boundaries were drawn, legislation created to regulate access and land user rights, and in certain cases all this led to land disputes, largely based on rights of access, control and ownership of land and natural forest resources (Bassett 1993).

2.2 Post-independence developments up to 1995

According to Okoth-Ogendo (1996), one of the main colonial legacies is the substitution of territorial systems (which regulated communities access and control of natural resources) with radical title to land that was held by the state. The state had power to allot rights of tenure to individuals, collectivities/groups and other agents. As a result, a three-tier land tenure structure was introduced and still prevails, viz., state or public ownership, communal ownership and the individual proprietorship. This situation is in fact what nearly all African countries inherited at independence, including Tanzania and Mozambique. However, for Mozambique one of the major differences is that the Portuguese government did not create tribal or communal areas (Negrão 1998).

Table 1. Timeline of important historic events in Mozambique and Tanzania

Historic Period	Country	Main features/milestones
Pre-historic	Mozambique	Common and open access to land Traditional/customary law No land markets Low population density Low human population density
	Tanzania	Same
Colonial	Mozambique (15th century commercial exchanges, but effective from 18th century) Portuguese	• Traditional tenure altered • Unoccupied or underdeveloped land becomes State's Land • State adjudicates land use rights (Münker, 1996) • Prime agricultural land becomes freehold (settlers)=> Landlord-squatter relationship initiated • reaties made by settlers with local chiefs (Carvalho, 1988)
	Until 1930's	• Chieftaincies replaced by '*Regulados*', under direct control by the Portuguese • Colonial presence strong in the South and '*Prazos*' (concessions to foreigners) dominate the north of Mozambique • *'Colonatos'* (white settlements) in fertile land • Cheap labor settled around *colonatos* (MAP 1997)[a]
	1960's	• The Land Law No 2001, 1944 and Protection of Soil, forest and Wildlife, Decree No 4040, 1955
	Tanzania (19th century – Germany) (20th century – British)	• Traditional tenure altered • Unoccupied or underdeveloped land becomes State's Land • State adjudicates land use rights (Münker, 1996) • Prime agricultural land becomes freehold (settlers)=> Landlord-squatter relationship • Treaties made by settlers with local chiefs (MLHUD, 1995)
	1895	• Tanganyika Crown Land vested in Germany Empire (Wiley, 1998)
	1923	• Land Tenure Ordinance No 3 => all land is Public Land, Rights of Occupancy introduced.

[a] One such case is the Limpopo Irrigation Scheme established in 1954 as a settlement of whites. Further, the so-called *assimilados*, black Mozambicans, who by virtue of education had adopted the Portuguese language and culture, also acquired (on probationary basis) 2 ha each of relatively inferior land (Bowen, 1993).

Another legacy of colonization is that the land tenure system was accompanied by regulated agricultural production with use of state subsidies and other government interventions. This meant that tenure and production decision-making were separated (Okoth-Ogendo 1996). This was particularly so in countries where cash crops (coffee, tea, cotton, sisal, etc.) were promoted. However, in Mozambique the colonial strategy was slightly different, in that local people were allocated marginal land close to large companies in order to supply these companies with cheap labour.

As Mozambique and Tanzania gained the independence, both adopted a socialist ideology (Table 2). The rationale was to ensure social justice, hence provision of equal opportunities for people and equitable distribution of resources by correcting the inequity in access to resources. However, state ownership of land was maintained and the motive was that the independence struggle aimed at giving the land back to the people, therefore, the state was the guardian and had power to decide on the conditions of its use.

In the case of Mozambique such provision is stated in the Constitution. This was the major thrust for nationalization of land in 1977. Article 8 No.2 of the Mozambique Land Use Law of 1987 states that users are required to have a state license for using their rights, the exception to this rule being the household sector, and this protected the family-farm sector. However, according to Nhantumbo (1997), the absence of a title or certificate for the household sector is one of the main shortfalls of this land law. The reason being that lack of certified rights made small-scale farmers the most vulnerable to displacement by large scale or commercial farmers, especially after the abolition of large-state farms in 1983. Further, the land law does not deter private investors from preventing local communities that want to use the land despite the fact that these investors (mainly companies) underutilize or do not use the land, as demonstrated by LOMACO, a multinational company engaged in cash crop farming (Nhantumbo 2000b).

The establishment of communal villages in both countries was meant to make people work together for what was understood to be a common goal. Therefore, the villages served as centres for economic development mainly through agriculture. The governments of Tanzania and Mozambique assumed that people would willingly relocate themselves to newly designed village areas. However, this was not the case. One school of thought is that people have strong cultural attachment to their land of origin bearing the tombs of their ancestors. As Kahama *et al.* (1986) states in Tanzania villagisation became compulsory and coercive in 1973. However, this phase was accompanied by a decentralisation policy aimed to bring the decision-making closer to the people, showing a theoretical will from the central government to encourage popular participation in decision-making processes. In practice, however, most decisions followed a top down approach as directives from higher authorities were issued (*ibid.*).

Concentration of people into the villages be them Ujamaa or Communal villages as they were known, respectively, in Tanzania and Mozambique meant abandonment of traditional agricultural and residence areas. This resulted into clearing forest areas for the new settlements and for their agricultural production. According to Kjell *et al.* (1988), the semiarid Tanzania suffered environmental degradation as a result of deforestation and soil erosion. The Ujamaa policy lacked the necessary incentives to increase production and investment while the forced movement of farmers made them reluctant to work efficiently. Farmers' locally adaptive agricultural knowledge accumulated during hundreds of years in old villages was rendered far less relevant.

Table 2. Sequence of important milestones

Historic Period	Country	Main features
Independence Nationalization of land	Mozambique (1975)	• Socialist ideology • Centrally planned economy • Land and natural resources on the surface and under the soil including water belong to the state[a] • Land was nationalized
	1977	• Land had to be allocated permanently and free of charge to large-scale state farms and co-operatives[b]
	Tanzania (1961)	• Socialist ideology • Centrally planned economy
	1963	• Freehold Titles Conversion and Government Lease Act No. 55
	1967	• Arusha Declaration => socialist aspiring state with a socialist mode of production ⇨ major means of production and exchange should be controlled publicly/communally ⇨ State as the custodian of peasant rights ⇨ Nationalization of industries, financial institutions and large estates ⇨ Ujamaa villages are established
Independence (Analysis of the land access and production system and its efficiency) => abolition of state farms	Mozambique 1975-	• Establishment of subsidized (equipment and inputs) for large-scale state farms • 'People farms or *machambas do povo* ' in communal villages[c]
	1981	• The Ministry of Agriculture recognizes inefficiencies of state farms as depicted by decline in the level of production
	1983	• Fourth FRELIMO[d] Congress => reforms (Bowen, 1993, MAP, 1997): • decentralization, • adoption of market-oriented • small-scale projects thus replacing centrally planned large-scale farming and capital-intensive development projects • allocation of the scarce inputs to relatively efficient sectors irrespective of them being state enterprises, cooperatives, private or peasant farmers
	1984	• Change on policy and role of family-farm and private sectors
	Tanzania	• *Ujamaa* policy enforced
	1969	• Government Leaseholds, Conversion of Rights of Occupancy Act, No. 44 => greater control of freehold land by government

[a] Article 8 of the Mozambican Constitution and Land Law No. 6/79
[b] Land Law and the Land Use Legislation of 1987 (RPM, 1987)
[c] Villagers joined to cultivate a common plot with inputs and equipment obtained through the state support
[d] FRELIMO is Frente de Libertação de Moçambique, the present ruling political party.

On the other hand, the planning of the villages was not done properly since some farmers were moved from fertile to less fertile areas on the pretext that the latter were closer to social and market infrastructures such as clinics, schools and roads. This arrangement was also coupled with government price control of agricultural produce, at times to the disadvantage of farmers.

The Act No 44 of 1969 (Table 2) compelled landowners to pay land rent to government and empowered the President of Tanzania to revoke any right of occupancy whenever it was considered appropriate. This move was aimed at avoiding the rights of exclusion in perpetuity held by the freeholders. The government came to acknowledge that because the owners could freely decide on the most appropriate way to use land, this led to indiscriminate clearing of forests and under/non utilization of land. Furthermore, the owners could sublease portions of their land. The improper use of land was exacerbated by lack of land development conditions or an approved land use plan by the government.

In another move aimed at containing customary land tenure system, the traditional functions of chiefs, that included land allocation, were rendered obsolete by The African Chiefs Ordinance (Repeal) Act. No. 13 of 1963 that officially abolished chieftaincy in Tanzania. In the case of Mozambique the traditional authority was suppressed immediately after independence as it was conceived to be against people's interests. For example, the chiefs were used by the colonial government to ensure the implementation of its policies, some of which involved into activities such as arresting of offenders, recruitment of people for military service, selling of people as slaves and tax collection from subjects.

In conclusion, during the first years after independence both Tanzania and Mozambique adopted socialist policies and nationalized land. Collective organization in production systems was enforced, and was viewed as an efficient equity mechanism for distribution of resources and wealth. To both governments 'state ownership' meant 'people's tenure rights'. For example, the government of Mozambique defined itself in the constitution as a guardian of resources, which belong to all people. The notion of 'people's rights' was the basis for creation of the 'People's or Peasants' farms' in which a group of people cultivated jointly the land and shared the benefits. This did not provide security in land tenure for the users, nor as collective or as individual entities with specific needs to meet. It however promoted open access (particularly in forests and woodlands) and mismanagement of public lands. Forest clearing by the community was all that was needed to ensure access to the land for agriculture and for grazing. On the other hand, a lease agreement was necessary for the private entities.

Some argue that the notion of 'people's tenure rights' is being reintroduced through the concept of communal land embedded in the new legislation governing land access. For example, in Mozambique a community is defined as a group of families within the locality, the smallest administrative unit. Therefore, smaller units can be defined by the community itself, delimit, demarcate in consultation with the neighbours and apply for a Land User Rights' Certificate. However, the new instrument is more progressive in that a legal instrument can be issued (up on request by the community representatives) in order to define the entity holding the recognized land rights. Hence, it can be inferred that having secure user rights, the community can engage in some form of natural resource management in the belief that secure tenure rights provide incentive for long term investment on land.

2.3 Land policy from pre-colonial to post-independence era: implications for land management and forestry development

Apparently during the pre-colonial period the resources were abundant due to low population pressure. Therefore, despite the practice of shifting cultivation, the system was deemed sustainable. In addition, local institutions were in place and had strong allocation powers, which may also have contributed to what appeared to be a sustainable resources use system.

The acquisition of land by colonial settlers that forced indigenous people to marginal land was the beginning of land-related problems in the region. Growing human and livestock populations caused overcrowding in smallholding areas leading to forest and land degradation, mainly because of clearing forests for subsistence agriculture, habitation and grazing. In an attempt to contain this trend colonial governments adopted policies that introduced compulsory conservation work and group resettlements and constrained livestock movement and development. These measures were common in the southern African region and people resented them. For example, by the 1950s most people abandoned settlements in Nyasaland (now Malawi) and destroyed contour ridges and terraces in Sukuma-land in Tanzania (Bassett 1993).

As mentioned earlier (Section 2.1) income generation was the major thrust of colonial governments. To this end, large tracts of natural forests were cleared for estate cash crops and industrial forest plantations. There was no requirement to compensate displaced people since the law did not protect them. The sovereign (i.e. the colonial power) had all rights over land, and this facilitated easy access to land for various ends. Further, the productive natural forests were subjected to intensive selective harvesting of high value commercial species. The logs were exported and processed elsewhere with virtually no significant returns or benefits to the people of these two countries. Since industrial harvesting was concentrated in few species this gradually led to their complete depletion in some areas. Adverse consequences of overexploitation and use of inappropriate harvesting practices were noted and regulation for wise use of natural forest resources started early in the twentieth century, first in Mozambique and later in Tanzania.

Overall, the main feature of the land tenure system in both countries during this period remained state ownership. The governments controlled all land, and maintained authority to grant rights of use and occupancy to different sections of society including villages, individuals, companies, parastatal organisations and various investors. Formal land markets were non-existent (NCSSD 1995; RPM 1979). However, much of the land in rural areas remained "owned" under customary land tenure conditions where land administration was initially controlled by local chiefs and later on by village governments. However, the state could revoke customary ownership rights. This resulted in complicated tenure arrangements and conflicts between local people who were *de facto* owners (some consider it "private" ownership) and the state, which had *de jure* property rights.

Conflicts between customary law and statutory titles have been observed in both countries, for example in those areas that were affected by valorisation in Tanzania under the Valorisation Act of 1975 (Tale 1991). In these areas some of the newly established villages collapsed forcing farmers to sometimes opt to return to their old villages where they had owned land customarily. At times they found the state had already allocated their land, especially to large-scale farmers. In either case there was extensive clearing of forests by both smallholder and large-scale farmers to create land for agriculture, habitation, supporting infrastructure, and other activities. The 16-year old civil war in Mozambique also displaced villagers from their land and constrained their return to

former settlements. To a large extent this encouraged deforestation for similar uses as in Tanzania, and other short-term income generation activities (Saket 1994).

The existing land legislation and the supporting institutional framework for land tenure were inadequate to deal with dynamic changes, which were emerging as early as the mid-1980s. The changes included a shift from centrally-planned to a market-oriented economy, privatisation thrust, increased urbanisation, democratisation, and growth of population densities in many localities, rapid dwindling and deterioration of natural resources, and increased poverty (NCSSD 1995). Compounding the situation were lack of incentives for efficient use of resources, scarce investments for land improvement and development, and inadequate mechanisms for resolving land conflicts. The traditional machinery for dispute settlement or administering land rights and justice was virtually broken down because:

- There was overlapping jurisdiction between various bodies including organs and members of the executive and the ruling party in resolving disputes.
- Disputes lasted for a long time without final, conclusive and certain resolution. Organs of justice were remote and inaccessible both physically and socially.
- People showed great dissatisfaction with the decisions of judicial organs, considering them unjust and unfair.
- Government organs, including courts, were accused of nepotism, corruption and bias.

Generally, people accused the so-called machinery of justice of inefficiency, illegitimacy and injustice.

As regards women's access to land, the Tanzanian post-independent government largely adopted a pluralistic legal system that ignored women's land rights. Only in 1971 the Law of Marriage Act protected spouse rights in the matrimonial home (Rwebangira 1999).

Both Tanzania and Mozambique's political-economic history since independence has had a number of environmental, institutional and economic consequences. The notable ones are:

- The orientation to socialism and poor economic performance that left the countries incapable of handling conservation and development initiatives. For example, the Government of Mozambique embarked on large-scale industrial plantations in late 70's and later attempted to involve the rural communities in tree plantations. This did not contain deforestation. Participation in the plantations program was negligible due to lack of secure land tenure as an incentive to long-term investment, and benefit-sharing mechanisms were not clear. This example demonstrates the separation of tree and land ownership rights. The same can be said about Tanzania when in the second half of the 1960s it embarked on a village/community forestry initiative without much success.
- The attempt by the two governments to change land policy and law did not affect the boundaries of the state-protected areas defined during the colonial period. The national game parks, forests and game reserves remained unchanged, irrespective of whether local communities were earlier forcibly removed from these areas. In the case of Tanzania, new protected areas were also gazetted.
- Despite the fact that coercive collective production was enforced, collective-choice did not exist as the users/stakeholders had no say in devising operational

rules and lacked minimum recognition of rights to organize outside what was defined through constitutional rules. This was a disincentive to increased agricultural production and productivity. The forests continued to be major sources of income and other resources to rural households.

3. CURRENT LAND AND FOREST RESOURCES TENURE POLICIES

3.1 Common property regime: the main feature of the current resources tenure polices

The objectives of land policies in Mozambique and Tanzania appear to address three main issues. First, to ensure the rights of the countries' citizens over land and other natural resources, and especially creating an enabling environment for development and growth of the household or family-farm sector. Second, to encourage investments into land from the commercial sector, and thirdly to promote sustainable and equitable use of the natural resources.

Towards the middle and late 1980's serious internal analysis of the results of the socialist policies and planning process were undertaken by the governments of Mozambique and Tanzania. This reflection was responsible for the policy changes especially with respect to resources access and economic planning approach (Table 2). The flowchart in Figure 1 illustrates the factors and results of such change. It shows the theoretical assumptions in which the current polices are based and potential practical implications on the local institutions and sustainability of resources use.

Despite being progressive the current land law, still maintains the state as the owner of land and other resources. Hence, there is no indication that governments are ready to totally relinquish ownership of land and some natural resources. While some might argue that such undertaking would enable long-term investment, the risk of building a population of landless cannot be overlooked.

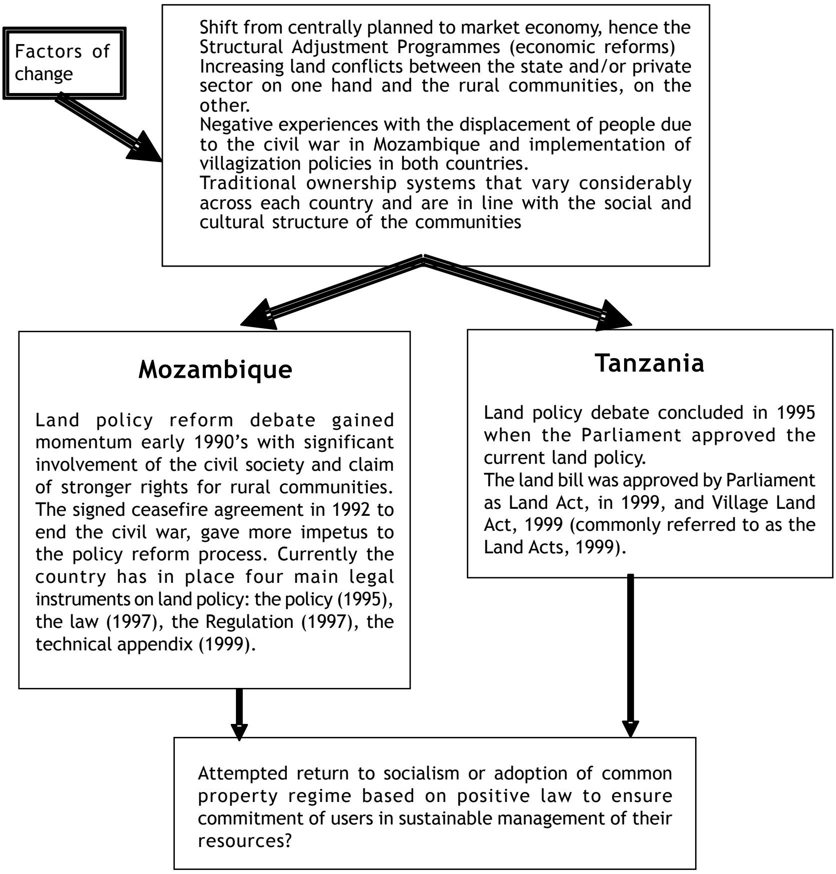
Bruce (1999) identifies various 'sources of vulnerability' in the legal frameworks that create opportunities for common property regimes. These include lack of legal provisions in the national laws of both organizational form and clear property rights, the claim by the state as a sole owner of the resources as indicated in the previous paragraph, and poor integration or conflicting statutory and customary laws.

The establishment of common property regimes requires a number of principles, which are not a blueprint but a guide (Ostrom 1998) (See Box 1).

While application of these principles lies mainly at the community level, legal instruments have to be in place to address the issues of boundaries and community organization as they are central for the application of any of the other principles. The Mozambique law defines community as a group of families and individuals living within the boundaries of a locality, and that they share resources and have a common interest in their management (AR1 1997, AR2 1997). Therefore, through provision for delimitation of community land for which a formal certificate for land use rights can be issued, the creation of local representative entity to hold the rights on behalf of the community ensures that the principles can be observed. In fact, the entity created is an important platform, on the basis of which the community can obtain tangible gains through access to resources.

Continuing with the common property regime debate, an important issue is the fact that environmental degradation has been attributed in most cases to market failure.

Figure 1. Factors driving the policy change and results



Box 1. Principles of common property

- Clear definition of boundaries
- Consonance between appropriation and provision rules with local conditions, i.e., defining the quantity and quality of products as well as appropriate period of harvesting
- Collective choice arrangements entail the design of rules to regulate the daily use of resources and this constitutes an instrument for self-enforcement
- Monitoring for effective restriction of appropriation activities
- Graduated sanctions to ensure internal enforcement
- Conflict resolution mechanisms to resolve any internal and external disputes
- Minimal recognition of rights to organize enables the community to devise its own institutions
- Nested enterprises allow the design of rules appropriate for different levels

However, perhaps an interesting issue in this era of emphasis on devolution of resources to communities is whether these are really efficient resource users or not. McCay and Jentoft (1998) who apart from considering common property a social construct argue that environmental degradation can also be a result of 'community failure' rather than 'market failure'. They attribute this to the fact that communities are not always adequately integrated, homogenous, and cooperative in addition to lack of equitable distribution of the resources. Shortfalls in communities may also be due to lack of knowledge, disorganization, social stratification, conflicts of interest and even inter-ethnic rivalry. This is an important aspect to reflect on. The establishment of natural resources management councils or land councils as provided by the Mozambique law aims at creating such local structures which will effectively devise the norms for resources use as well as monitor compliance. It should be noted, however, that in some cases the communities do not identify themselves with the created structures, as those are overtaken by entities that already hold power (economic, political or otherwise). As a result the decision-making does not in reality lie with the bulk of the community but with only a few individuals.

Consequently, understanding the local politics and power relations is essential since they can for example influence the two levels of decision-making regarding tenure: the operational and the collective-choice. According to Forster (1999) communities, have a *de facto* authority as regards the daily use of the resources (withdrawal rights) through the exercise of their traditional rights. The users set the rules for access, use and management of the resource. This entails participation of the users (the councils referred to previously) in decision-making concerning their rules, taboos and other beliefs known to have contributed to rational utilization of resources. However, in both Tanzania and Mozambique, such rules are limited to few tree species and patches of forest perceived to offer direct benefits (fruit trees, sacred forests, etc) for the communities. The rest of the forest resources are effectively unregulated, therefore the challenge facing the councils is to devise and enforce rules to ensure sustainable use of a range of natural resources, wood or non-wood.

Article 3 of the current land law in Mozambique (AR2 1997, MAP 1999), reinforces the notion that the land still belongs to the state as provided for in the Constitution of 1975, and as revised in 1990. However, the law recognizes the rights obtained through customary land ownership rules as well as the methods and principles of traditional land management, as reflected in Articles 12.a and 29 in the Land Regulation. The current policy also provides for land utilization without paying rent by the state and its institutions, farmers associations, the household sector, and other users (Article 29). Such provision is essential for ensuring that rural and other population strata with less income available can also have access to land. However, in effect there is a land market in Mozambique, the price of a plot of land for housing with 450 $m^{2,}$ for instance, can cost as much as USD 1944 in Maputo. Of course such price will decrease or increase depending on its location, and closeness to Maputo and other cities. Land markets do also exist in the rural areas as local people sell land in exchange of immediate cash.

The present land policy in Tanzania identifies four central tenets of the current land tenure system as:

- Land is publicly owned and vested in the President as a trustee on behalf of all citizens (i.e. radical title).
- Speculation in land is controlled.
- Right of occupancy, whether statutory or deemed, is the main form of tenure.
- Land rights are based on use and occupation, i.e., security of tenure is dependent on use.

Based on these provisions, the main feature in the present land tenure system in Tanzania is that the government controls and owns all land and in turn grants rights of use and occupancy to different stakeholders. Also much of the land in rural areas is still under customary land tenure that is officially recognized. However, the government, as the landowner, has powers to revoke customary land rights. This is a source of conflicts between different stakeholders and it continues to prevail even after the present land policy and Act came into force. Insecurity of tenure and conflicts have promoted open access to forests and woodlands, as well as facilitating urban squatting and mismanagement of public lands.

3.2 Opportunities for local communities in forestry

Forestry and wildlife tenure is important because of the potential socio-economic opportunities in these resources and the many restrictions faced by local users in accessing the resources. In addressing these issues the two countries through their forest policy documents, define four main objectives (CM 997, MNRT 1998).

- The *economic objective* has the private sector as the major player and the aim is to provide incentives for maximization of returns through promotion of local processing in order to add value to the forestry products.
- The *social objective* acclaims that local communities should benefit from existing resources in the surrounding areas through Community Based Natural Resources Management (CBNRM).
- The *ecological objective* has the state as the main actor. Its role is management of state protected areas in partnership with other stakeholders.
- The *institutional objective*, which comprise the reform and capacity building of the National Directorate of Forestry and Wildlife (Mozambique) and Division of Forestry and Beekeeping (Tanzania) including their establishments at provincial and district level.

The social objective also aims at giving more power for decision-making and control over natural resources to the local communities. This forestry policy objective is supported by the land law in Mozambique in terms of provision for delimitation of community land (AR1 1997). This land policy provision allows the communities to negotiate with other partners possessing land or other resources as their share in joint business. In this case the forestry and land policies complement one another, and further the land policy creates a good environment for operationalising the social forestry policy objective.

The operationalisation of these four objectives depends on engagement of the main actors such as the state, local communities and the private sector. The emphasis in the southern African region in land, forestry, and wildlife policies is devolution of rights and benefits to local communities on one hand, and co-management on the other. Much as the recognition of the concept of group (community) ownership is a milestone on the way towards group cohesion, institutionalization of the governance for collective action, and sustainability of resources use (Knox and Meinzen-Dick 1999), there is however a general trend in government macroeconomic policy to assume that private ownership of property as leading to efficient resources use. This is especially true given the current emphasis on privatization policy, which is one of the strategies for economic reforms these countries are implementing. Arnold (1998) cautions that

individual ownership can also lead to overuse and degradation especially in low productivity areas which are characteristic of many common property areas in the miombo woodlands of eastern and southern Africa. Knox and Meinzen-Dick (1999) add that private property rights are a necessary but not sufficient condition for adoption of technologies. With respect to community based natural resources management practices, such technologies could be associated with issues such as design of management plans, identification of alternative income generating activities, business management, and monitoring.

Rihoy (1998) considers two important opportunities for community involvement in the sustainable management of natural resources. One is the recognition of customary tenure systems in the land law (as is presently the case in the two countries), and the other consists of provision for establishment of wildlife management areas, managed by local community with direct benefits to them. There is a move in both countries towards involvement of local communities in wildlife management. It is argued that efficient enforcement lies at the level of the local communinty that has responsibility over land and other resources (*ibid.*).

In both countries forestry and land tenure policies have been revised to be in line with the changing socio-economic environment. Apparently, there are no conflicts of principle. While it might appear that policies and legislation favor community based forestry in Mozambique and Tanzania, there are a few flaws that need attention:

- While the land policies and laws in both countries recognize the right of occupancy, the forestry and wildlife policies and supporting legislation require possession of at least a simple license from the government for use of the resources within the community boundaries, or possession of a government concession for commercial purposes. There is no provision in the current legislation for a full bundle of rights.
- Another common problem of the two policies revolves around definition of the community boundaries (delimitation) and the procedures for acquisition of title by communities.

Delimitation involves creation of boundaries and design of rules for exclusion of others. The definition of community boundaries is a fundamental question, as it constitutes the basic principles for successful common property regimes (Ostrom 1998; Forster 1999). The rights of exclusion or negotiation of use cannot be enforced without clear boundaries. Areas with existing or potential conflicts, requests by the communities and areas proposed for development have been given priority for delimitation in Mozambique. Nevertheless, areas with CBNRM projects also are being targeted for delimitation with support from rural development projects. The process is expensive. The lack of awareness by the communities holds potential to reduce the probability of many communities securing their land rights before such rights on the same land are taken by the private sector and other entities. Therefore, the basis for establishing common property management arrangements, for creating partnership and community development are weakened further.

Arnold (1998) identifies four advantages of managing resources, especially forests, as common property regimes. These include:

- Indivisibility or need to take an ecosystem approach to management;
- Uncertainty in location of productive areas, which would be the case of the multiple use areas where the variation in productivity is considerable.

- Internalization of externalities increasing efficiency in production minimizing destructive use.
- Administrative efficiency resulting from the fact that managing individual and independent parcels is relatively more expensive than when the group creates and enforces the rules over use of the resources.

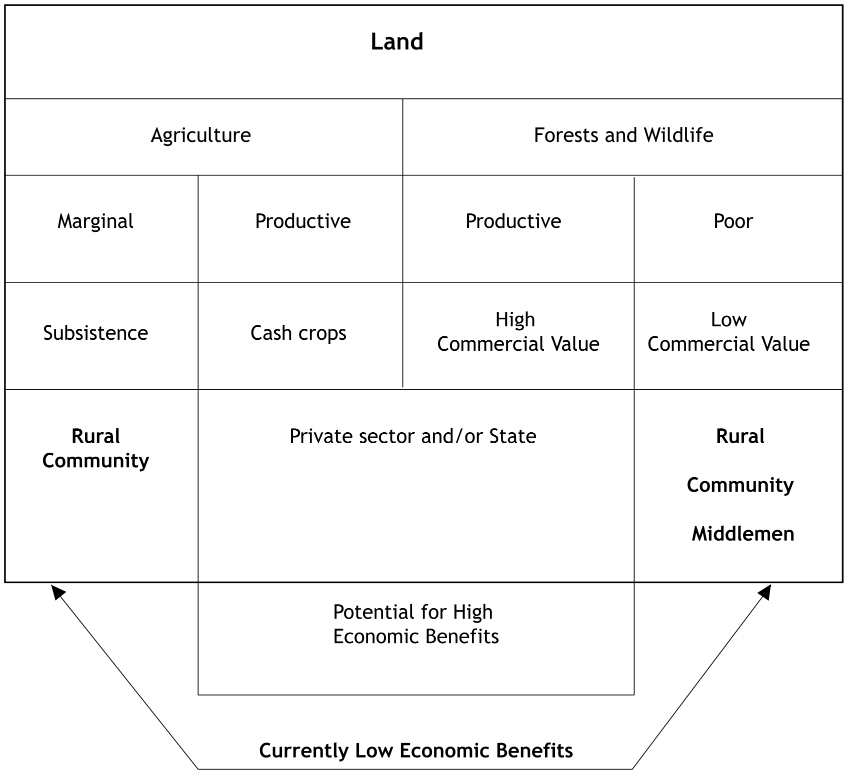
The latter advantage is the one the governments of Mozambique and Tanzania capitalize on. The enforcement role that is expected from the community in its involvement in the resources is stated clearly in the Mozambican forestry and wildlife policy of 1997 (AR2 1997) and in Article 33 of the land law (AR1 1997). The latter provides for the delegation of powers for management of the resources from the state to the communities. Therefore, decentralization is recognized as having an important role in facilitating implementation of this policy. Again, both land and forestry laws recognize the need to create local institutions such as management committees or councils to represent the community. Despite the few shortcomings, both forestry and land policies together with supporting legislation give considerable weight to a community based approach to managing natural forest resources. This thrust is also in line with relevant theoretical principles on community-based endeavours.

3.3 Imbalances in development opportunities: communities vs. private sector and state

The current land policy and legal framework provides for land access by the rural population and other relatively disadvantaged sectors of society. It has been previously stated that the settlement of the poor was mainly in marginal land. This was a deliberate move/policy to force the population to supply labor for the commercial agricultural sector. The communal/ujamaa villages brought another type of concentration of the population, again breaking the existing social and cultural networks. As a consequence of these changes it is interesting to look at the quality of land that the community is entitled to and can administer as a consequence of these changes. This is the only way to establish whether we are dealing with false or real devolution of resources to communities. Experience from some Latin American countries indicates that land reform meant allocation of marginal/fragile land to peasants. This resulted into very high environmental costs such as erosion, deforestation and diminution of bio-diversity (Foster 1999). This land administration pattern is similar to that prevailing in Mozambique and other countries in eastern and southern Africa as illustrated in the Figure 1. On one hand, there are few private/commercial farmers owning large and high productivity areas for cash crops, while on the other hand, there are smallholder farmers (who constitute the bulk of the population) confined to marginal land (characterized by low fertility, scarce water supplies, etc.,) (Nhantumbo 2000c).

It is only fair to ask whether restructuring and relocation of the communities would be a solution, or else ensure that in the process of delimitation, productive areas are also part of the community land. However, lack of capital (human, monetary and physical) would limit the economic exploitation of such resources by communities. Despite that, perhaps this would indeed create opportunity for establishing favorable partnerships with the private sector such that provides a fair share to the *de facto* managers of the resources.

Figure 1. Rural community in the periphery in terms of access to resources and benefits attained (Nhantumbo 2000c)



The rural communities have very limited access to the productive forests and state protected areas (Figure 1). They have to compete with other uses such as agriculture (shifting cultivation), pasture, development projects for access to the resources in the multiple use areas (Nhantumbo and Soto 1999). The productive and state protected areas have an abundance of industrially non-important tree species, mainly used for firewood and charcoal, products that have high demand in the urban areas. Two actors are involved as suppliers. The community is the main producer, supplying to traders who in turn supply the final markets in urban areas. The supply by communities is deemed illegal, while the intermediaries/brokers or traders (or private sectors) have rights certified through a license issued by the forestry authorities.

In Mozambique the land law emphasizes partnership between the various stakeholders be it in the productive or multiple use area. This creates an enabling environment for establishment of fair contracts between the private sector and communities in the exploitation of the productive areas (forest and agriculture). Further, investment on capacity building at community level (training, technology, credit, etc) is necessary to provide encouragement for their involvement in the economic exploitation of natural resources.

3.4 Institutional arrangements, gender and equity issues

(a) Mechanisms for self-organisation

Ostrom (1998) states that appropriators can put up monitoring mechanisms to control their own activities. One of the requirements for this is existence of strong local institutions to regulate use of common pool forest resources. These include authorization and securing use, setting and enforcing rules, and monitoring. Strengthening local institutions in order to secure property rights and collective action increases the chances of community adoption of new technologies for natural resources management (NRM) (Knox and Meizen-Dick, 1999). Arnold (1998) quotes Sarin (1993) in defining the guiding principles for joint forest management in India as:

- The group has to be an autonomous and viable social unit organization. Being a smaller and homogenous group is advantageous but not essential;
- Existence of norms and procedures that are clear and flexible to adapt to changes, accountability and conflict resolution mechanisms.

These principles appear to be applicable for community based natural resources management and the management committees. Further, self-organization of the group and its empowerment to exercise exclusive rights constitute other requisites of common property regimes (*ibid*.).

The principal difference between the two countries lies in the definition of community. In the case of Mozambique the community can encompass all families within a locality (the smallest administrative unit) or smaller if that definition of boundaries suites the local community. On the contrary, in Tanzania, the community is a village (Table 3). However, the most significant common feature is that both countries create the necessary institutions to regulate the resources use and management.

Table 3. Institutions of NRM in Mozambique and Tanzania

Country	Institutions
Mozambique	• Land council comprised of representatives of the community (3 to 9) – Land Law • Participatory natural resources management committee (NRMC) including the community representatives, the private sector, associations and local government authorities – Forestry and Wildlife Law
Tanzania	Natural resource management or environmental committee at village level (smallest administrative unit)

The communities differ in area and number of inhabitants. This will influence the type of institutions and the way they relate to the rest of the group. Literature suggests that smaller groups managing resources under common property regime seem to work better (Bruce, 1999; Rihoy *et al*. 1999; Knox and Meinzen-Dick 1999). This seems to contradict some of Sarin's observations regarding the group sizes. The reasons given for smaller groups managing resources better include: the tendency to have shared values; may gain substantial benefits and ensure equity in distribution; have lower

costs of intra-group enforcement, extra group exclusion, decision-making and coordination.

In the case of Mozambique there are two major concerns regarding the created structures. One relates to the lack of clarity on whether the land councils also hold a mandate for managing other resources such as forests, wildlife, and water. This raises the possibility of duplication of fictitious institutions undermining the aim of the policies that is to identify a community representative. The other concern relates to the fact that the NRMC apart from perhaps including the local elite as defined by the strata within the community, can also include stakeholders with clear economic and political power (e.g., the private sector and local government). The latter may determine the decision made by this institution, thus carrying the decisions as usual, which means the status quo at the community (powerlessness) is likely to be maintained. If this happens, it will certainly affect the access of resources by the powerless and poor. The immediate consequence will be further deterioration of livelihood support opportunities, hence perpetuation of poverty.

In the short period over which village-based forest management has taken root in Tanzania, villagers claim that there has been a sharp reduction in resource abuse arising from illegal pit-sawing, forest clearing for farming and charcoal production, and ring barking for production of grain storage containers (locally known as *vilindo*). Further, they have noted a significant decline in the sale of forest products in the local markets. The experience of Duru-Hitemba village in Tanzania illustrates how important it is for the rules of each village to be embedded in village by-laws, and approved by the relevant district council. Such approval not only formally recognizes the right of the village to manage and control the forest area in question, but also provides the legal basis upon which it may contain resource abuse by, for example, levying fines. Without such a framework an offender is able to claim immunity. The legal framework also provides a basis for the village to retain or expend funds arising from all village resources, including agriculture and livestock. The by-laws are approved and respected by local and central governments. They therefore guide the communities to legally organize themselves for natural resources management.

(b) Gender considerations

Regarding gender, the Mozambique land law is explicit in terms of rights to acquire and hold user rights by people of both sexes. For instance, the land law states that all national entities, individual or collectively, men or women, and communities have right to use land. Article 13:5 of the same law reinforces that by stating that men and women can apply for individual titles within the area delimitated as community land. Further, men and women can give testimony on rights to use the land by a third person, and members of both sexes can inherit land. In Tanzania, land can be owned through state leasehold, private right of occupancy, customary tenure, and collective or village ownership. Under traditional tenure ownership of land is through inheritance or customary rules among tribes, clans or kinships. Since women were traditionally not allowed to own land in some clans, land laws discriminated against them. The 1995 Land Policy as well as the 1998 Land Act and Village Land Act have rectified this.

Gender consideration with respect to access to resources is essential considering the different roles played by men, women, and children. For example, food security and household fuel supplies in the southern African region continue to be the concern or responsibility of women. In addition, women and children also collect other non-timber

forest products for household consumption. The role played by women in the household economy in the rural areas is significant. Hence representation of women in the village/ community 'management committees' is also important to provide a fora for this social group to share its experiences, challenges and solutions to various problems related to resources management. Nevertheless, the implementation of land policy and law will require a thorough study in addition to better understanding the traditional forms of land inheritance, participation in decision making, and awareness raising at the local community level. Okoth-Ogendo (1996) citing the case of Kenya, argues that some rights acquired by the communities through land reforms take a long time for social and cultural legitimacy. This is likely to be the case in the enforcement of rights of women that in many cases are likely to go against established traditional practices. There is therefore potential resistance in local communities to adoption of pro-women changes in laws and regulations. Further, the land law in Mozambique recognizes the customary law and emphasizes the dual system, hence enabling discrimination at the local community level.

(c) Equity considerations

Equity in access to resources and distribution of benefits is an issue of social justice. Adoption of common property regimes is argued to be partly influenced by the ability to define boundaries and institutions. However, it is ultimately influenced by the benefits the community perceives to obtain from such resources. In Mozambique the forestry and wildlife social objective aims at providing benefits to local communities. How this will be achieved and how the benefits will be shared equitably by members of the community remains unclear. Tchuma Tchatu, a community based wildlife management program jointly managed by a safari/tour operator and local community, is the only example with a government decree issued specifically to define the distribution of resources. In Tanzania, 20% of the benefits arising from wildlife management are ploughed back to the relevant communities. Good examples of this are villages near Lake Manyara National Park. Despite this, there is need to clearly establish the impact of such benefits on the well being of the beneficiaries.

Bruce (1999) indicates that Niger issued a decree requiring that management plans guide use of forest resources and that benefits from exploitation of such resources go to the village community. In Guinea the legislation goes further stating that not only the benefits from harvesting forest products should go to the concerned community, but all benefits 'after deduction of costs of forest administration'. It is important to recognize the cost aspect in the legislation because communities incur costs, either in kind or cash and these are often ignored. In addition, the communities also tend to ask for benefits and demand that other entities such as government and others should bear the cost. However, Knox and Meinzen-Dick (1999) caution that collective action does not necessarily lead to equity. Further, they consider common property regimes as accommodating multiple users beyond the household level and spreading benefits more evenly than individual private property.

One of the gaps in the legal frameworks of Mozambique and Tanzania is the absence of a requirement for the community to design a constitution which spells out clearly, among others, the creation of the institutions and their substitution, norms for management of resources, benefit distribution, etc. Some other countries in Southern Africa have made progress in this direction. Examples can be gleaned from a 'Practitioner's Guide' developed in Botswana and a 'Guide to Creation of Conservancies' from Namibia (Nhantumbo 2000c).

4. POLICY FORMULATION PROCESS: STAKEHOLDERS' PARTICIPATION

The formulation of Tanzania's land policy was guided internally by the government ministry responsible for lands and in consultation with foreign-funded organizations and consultants. Public participation in the process was limited to what was referred to as "rapid appraisals" made by consultants, in which case the consultants were the appraisers and the people were appraised. The ministry organized several workshops, but only carefully selected participants from vocal stakeholders were invited. Overall, there was no genuine popular participation in the process, which was seemingly manipulative in character (Shivji 1996).

In Mozambique land policy formulation started in 1992 as a result of increasing land conflicts between refugees and locals, and between these two groups and the private investors, especially following the end of the civil war. The then prevailing land law, despite stating that land belonged to all Mozambicans, failed to protect the rights of the smallholders. Further, changes in economic policies and political environment precipitated conditions for reforms in both sectoral and extra-sectoral policies. Case studies were carried out in pilot zones of the agricultural sector to analyze land use and management issues in the family-farm, private, and state sectors. Particular emphasis was placed on participation at district and community levels. These studies were enriched by public debate in regional seminars and the outcomes provided the basis for policy formulation. According to the national land program under the Agricultural Sector Investment Program (PROAGRI), regional involvement was ensured through participation of representatives of all provinces. Gender in land ownership is an important aspect and women were represented as permanent members of the 'Resource Group' (MAP 1997). In addition, there was also active participation of Eduardo Mondlane University, the only university in the country at that time. The government of Mozambique therefore worked with academia, donors and civil society in general to build the current resource tenure legal framework. The formulation process of the present land policy was perhaps, the most participatory policy formulation exercise involving the widest range of stakeholders that was ever undertaken in Mozambique (Nhantumbo 2000b).

5. SOME OBSERVATIONS

From the discussions in this paper, the following observations are made:

5.1 On the present land policies

(a) Both Tanzania and Mozambique were colonised and after their independence they followed centrally planned economic policies. Therefore their land policies and laws reflected communal systems that failed to address the expectations of the people and disrupted their existing resources tenure rights leading to degradation of land and natural resources. In addition, such policies did not prove to address the priority issues that the government had hoped to tackle.

(b) The land laws of Mozambique and Tanzania strive to provide a platform for investment at local level, hence enticing the much-needed development by creating provision for local land ownership or use rights. However, there are still some shortfalls related to the strength of local institutions, the capacity to address gender issues,

equity in access and distribution of costs and benefits. Furthermore, it is clear that having land by itself does not lead to having secure rights over other resources (for which a special permission for use is also required).

(c) The land policies and laws of Tanzania and Mozambique, despite being progressive, are not yet sufficiently encompassing to address all the burning issues for the various stakeholders in both countries. For example, the present land policy of Tanzania does not seem to adequately address and resolve the question of radical title on land. In some cases it gives contradictory statements even on very sensitive matters to society. For example, the law states that land can be owned by stakeholders but it again vests its control in the executive arm of the government (i.e. the president through the land commissioner who can overrule any claim on land). In Tanzania gender equity in access to land and benefits from management of natural resources should be adequately addressed in both the policies and practice. However, in the Mozambique land policy explicitly recognises the rights of both men and women.

(d) The current land policy in Tanzania provides for the centralisation of decisional powers in the government domain with respect to allocating and reallocating land. This challenges the basis of private rights on land, especially for individuals. Further, as this represents a top-down approach in the introduction of government initiatives, it has the potential to deny local communities the opportunity to devise their own ways to suit evolving situations. It also has potential to compromise the essence of local knowledge and relevance of new practice.

(e) The present land policy in Tanzania emphasises the role of the government on the administration of land as well as action over rights of occupancy. This is opposed to a market-led policy for economic development in which the market allocates resources.

5.2 On impact on access, ownership and management of natural forest resources

(a) The current Tanzanian land policy preserves the ambiguity between open access and common property. For example, it is not clear which agency is responsible for management of public land.

(b) The current land policies in both countries attempt to correct past mistakes in light of the new economic environment: an open market economy. Nevertheless, the process of devolving rights over land and natural forest resources, particularly to the community has yet to yield meaningful results. In the case of Mozambique, there are complexities or rather lack of clarity on the procedures for acquiring the rights, and especially as regards concessions or licenses for the rural communities. Tanzania, on the other hand, is confronted with lack of full consideration of basic issues such as rights of women and adequate recognition of the customary laws. In addition, one of the most critical outcomes of the weaknesses in the land policy of Tanzania is the continued maintenance of a mosaic of many ordinances and Acts on land, which lack both comprehensiveness and coherence. This has potential for more conflicts and confusion among land users.

(c) The importance of boundaries for community land, their potential problems, the need for strong institutions, and sharing benefits from natural resources have been addressed in present land policies. However, for the latter it is necessary to establish a more detailed and perhaps procedural legal instrument to guide the sharing of benefits (for all involved stakeholders) generated out of common property regimes. In particular,

the enforcement of such instrument in order to guarantee that communities accrue such benefits is paramount for their engagement in sustainable use of natural resources. Such communities have up to the present not gained any significant and legally recognized returns from forest resources, except direct consumption of forest products.

(d) By and large the new resource tenure legal frameworks in both countries establish the basis for ensuring access to the resources for all stakeholders, thereby enhancing common property regimes and sustainable use and management of natural forest resources. However, the challenge to the governments of the two countries as well as to relevant non-governmental organisations is to devise ways to move towards a more stable system of secure property rights based on land tenure and market allocation, grounded in law, upheld by the courts of law, and observant of people's needs and preferences.

6. GENERAL RECOMMENDATIONS

(a) The present Land Policy of Tanzania should address the issue of radical title on land and develop provisions in the law to address gender issues.

(b) The Communities (villagers) should be given the opportunity to devise their own arrangements on administration of the land to fit their evolving situations. This will provide venues for recognition of essence of local knowledge and relevance of new practice.

(c) There is need to ensure clear boundaries for the resources in order to ensure identification of responsibilities in its management.

(d) There is a need to establish a legal mechanism for benefit sharing as a result of involvement of various stakeholders, particularly the local community in the management of natural forest resources.

ENDNOTES

1. In 1928 the British redefined "the Right of Occupancy" to include the title of a native community lawfully using or occupying land in accordance with customary law. This was an attempt to protect native rights and provided for clearing forestland for subsistence farming. However, compulsory acquisition of native lands by the colonial government for the benefit of immigrants was left unchanged

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ANNEX 1 LIST OF ABBREVIATIONS

AR	:	Assembleia da República (Parliament)
CAMPFIRE	:	Communal Areas Management Programme for Indigenous Resources
CBNRM	:	Community Based Natural Resources Management
CBFM	:	Community Based Forest Management
CM	:	Conselho de Ministros (Ministers' Council)
FRELIMO	:	Frente de Libertação de Moçambique
MAP	:	Ministério da Agricultura e Pescas
PROAGRI	:	Agricultural Sector Investment Programme
RPM	:	Republica Popular de Mocambique now Republica de Moçambique
SADC	:	Southern African Development Community

10.
Agricultural policies and forestry development in Malawi, Mozambique, Tanzania and Zimbabwe: Complementarities and conflicts

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ABSTRACT
This paper presents a review of agricultural policies deemed relevant to the management of natural forest resources in Malawi, Mozambique, Tanzania and Zimbabwe. The competition between agriculture and forests for land and the role of man in influencing the balance between the two requires an articulation of sectoral, extra sectoral and macroeconomic policies in order to minimise undesirable policy effects.

The paper presents a brief review of evidence from studies carried out in different parts of the world on the influence of agricultural policies on deforestation. This is followed by a review of agricultural development in the pre-independence and post-independence periods in Malawi, Mozambique, Tanzania and Zimbabwe, paying particular attention to agricultural policies that shaped and continue to influence the sector and their consequent effects on forest development.

Key words: Deforestation, shifting cultivation, land tenure, commercial/estate agriculture, economic reforms, smallholder farmer.

1. INTRODUCTION
While forest conditions affect opportunities for national development, the development process shapes what these forest conditions are, and what they will become. The use, development, and conditions of forests are fundamental consequences of the wider configuration of national policy and economic development. National development is constantly creating incentives and capacities to exploit and enhance forest resources. Economic growth and social conditions tend to shift the location and composition of forest resources. Understanding how national policies affect forests provides the basis

for achieving desired types of forest conditions, including the aggregate contributions they provide, and the required trade-off with other national objectives.

Arguably, policy failure outside the forest sector may be even more important (World Bank 1996). Government policies relating to trade, land, relative prices, taxation, expenditure and subsidies provide incentives (positive or negative) in other sectors that often have detrimental consequences for forest resource use and conservation. This is particularly true to agriculture, the principal source of forest depletion and degradation, and the mainstay of future economic growth and poverty alleviation, especially in Sub-Sahara Africa.

The adoption of an inter-sectoral approach to address forest management issues has been partly due to the inability of traditional forestry strategies to contain deforestation and forest degradation, and the fact that the root causes of forest degradation and depletion are often found outside the forestry sector (de Montalembert 1992).

Agriculture is critically dependent on environmental resources such as land, water, forest, and air. However, the use of these resources can affect directly or indirectly, other natural resources, through dynamic and complex interrelationships existing in the natural systems. This implies that wrong use of land, water, and forest in the production of crops and livestock can have far-reaching effects on environmental integrity. To avoid any adverse consequences, agricultural sector policies must fit in the overall environmental policy. This is critical in guiding proper and balanced use of natural resources and in defining sectoral responsibilities for environmental management. Agricultural policies, besides being internally consistent, must provide for a mechanism to link the sector with other sectors in protecting and enhancing environment.

This paper examines the evolution of agricultural policies and their influence on forestry development in Malawi, Mozambique, Tanzania and Zimbabwe. This shall provide a cross country comparison of influences of these policies and identify trends that are of regional nature from those specific to individual countries. The paper does not always develop quantitatively the causal linkages between the policies and forest condition but combines a qualitative assessment of the situation prevailing in these countries with results from quantitative studies on such phenomenon from other countries. This is due to the scarcity of quantitative studies in these countries on this subject.

As a proportion of total land area, forest cover in these countries is estimated at 43%, 71%, 47% and 51% respectively (Nyasulu 1997). In all these countries forests are the main land users followed by agriculture. These two sectors compete for land and other resources and at times with disastrous effects on the environment. Further agriculture and agricultural processing form the backbone of the economies of these countries. The hypothesis is that deforestation and environmental degradation is partly a result of previous agricultural sector policies, which had no built-in incentives to safeguard land and natural forest resources. These disincentives are related to land size, ownership and use.

The paper is organized as follows: The second section gives a brief overview on how policies directed at the agricultural sector have influenced forestry development. The third section examines the evolution of agricultural policies in the pre independence period in these four countries. The fourth section extends the analysis to the post independence period. The final section summarises the main implications on forestry development in these countries.

2. AGRICULTURAL POLICIES AND FORESTRY: AN OVERVIEW

Although the potential for agricultural production is far greater now than in Malthus's time, the environmental impacts of farming systems raise concerns on long-term sustainability. The challenges vary greatly from one system to another. The agricultural sector, which is composed of both the livestock and crop components, hinges on the exploitation of land resource (soil and vegetation). In this context, it has direct and indirect influences on the indigenous forest resources in terms of their exploitation and conservation. The direct effects result from the competition for land between forests and agriculture while the indirect effects result from the exploitation of the forest resources either for subsistence purposes (food, energy, building material) and/or for income. Wanton deforestation and land degradation are a reflection of unsustainable land use emanating from poor agricultural and poverty related policies in most Sub-Saharan African countries. Many studies have demonstrated the potential effects of agricultural policies on the forest condition. Unfortunately, there are only few such studies in the four countries that explicitly show the link between agriculture and forest condition when compared to similar literature for other parts of the world. Thus, it is important for these southern African countries to glean at experiences from other countries in order to understand the potential implications of some of the agricultural policies they adopt. However, caution should be exercised because in some cases the magnitude and direction of some agricultural policy variables still remain inconclusive as shall be demonstrated in the evaluation of individual policy effects below. This section provides a very condensed account of this. Kaimowitz and Angelsen (1998) provide a good account of tropical deforestation while Angelsen and Kaimowitz (2001) provide a detailed account on influence of agricultural technology on the forest condition. However, only a few policy impacts are highlighted because of their relevance in these four countries, and especially at present when these countries are implementing economic and institutional reforms, referred to as Structural Adjustment Programmes (SAPs). The SAPs employ most of these policies.

(i) Prices of agricultural products and inputs

The effects of input prices on forest degradation are mixed. Fertilizer price increases were reported to have had practically no short-term effect on land use (Ruben *et al.* 1994; Monela 1995). However, Monela (1995) suggests that they increase deforestation in the long run. Holden (1993, 1997) and Nghiep (1986) found that higher fertilizer prices lead farmers to change from sedentary farming to shifting cultivation and to clearing more forest land. Increases in prices of pesticides, seeds and hand tools, together with high interest rates were found to reduce forest clearing (Ruben *et al.* 1994; Monela 1995; Ozorio de Almeida and Campairi 1995).

Reduction of subsidies on inputs has shown mixed results on expansion of cropland area. Removal of fertilizer subsidies had little effect on cropped areas in Tanzania, in areas where fertilizer use was low (Aune *et al.* 1996). On the other hand, Mwanawima and Sankhayan (1996) report that eliminating fertilizer subsides contributed to deforestation in Zambia. In Mexico, Barbier and Burgess (1996) argue that reduced fertilizer subsides and elimination of price support for maize has direct negative effect on maize profitability, leading to area reduction. On the other hand, the shifting of labour from maize to competing crops leads to area expansion. The net effect of such policy measures on deforestation is therefore indeterminate.

Agricultural product prices have been found to lead to expansion of cropped areas

(Angelsen *et al.* 1999; Barbier and Burgess, 1996; Deininger and Minten, 1996). Agricultural prices behave more like exogenous variables when export products are involved and the countrys' total exports of those products are too small to affect world prices. When agricultural prices are exogenous, policies taxing agriculture will reduce deforestation while subsidized agriculture will increase deforestation. High agricultural produce prices reduce the period of time that farmers leave their land fallow, thus reducing the areas of secondary forests (Jones and O'Neill 1992, 1993). The effect will be stronger when agricultural supply is price elastic.

Subsiding public rural road construction, protectionism, high guaranteed prices and eliminating trade and marketing policies that act against agricultural production will increase deforestation. Reduction of agricultural crop export taxes generates similar effects as currency devaluation (Thiele and Wiebelt 1994). Fiscal subsidies have also been found to stimulate deforestation (Andersen 1996; Barber and Burgess 1966; Pfaff 1997).

Taxes (Ad Valorem and export taxes) and tariff on agricultural activities causing deforestation protect forest cover. This is due to their negative effects on profitability emanating from low prices (after tax), biding up of rural wages, or raising the costs of agricultural inputs (Jones, O'Neill 1993d, 1994).

Credit availability promotes deforestation by allowing farmers to expand cropped areas or pastures (Monela 1995 in Tanzania; Ozorio de Almeida, Campari 1995 in Brazil; Deininger, Minten 1997 in Mexico). On the other hand, indigenous households in Bolivia and Honduras have been found to clear less forest after they had received credit (Godoy *et al.* 1996, 1997). This reduction is attributed to reduced dependence on forest-based activities to smooth consumption and income or to increased involvement in off-farm employment to repay loans, leaving less time to work on farms.

Devaluation promotes deforestation through its incentive effects on the expansion of tradable agricultural products (von Amsberg 1994). Aune *et al.* (1996) found that real devaluation prompted agricultural land expansion in Tanzania, both through increasing output prices and by having land substituting agricultural inputs in response to input price increase. Similar results have been reported in Zambia (Mwanawima and Sankhayan 1996). Trade liberalization generally tends to increase deforestation (Lopez 1993; Maler and Munasinghe 1996).

(ii) Agricultural technology

Technologies that increase farm yields have also been shown to have mixed effects on forest resources. If a technology increases marginal productivity of land, it can stimulate deforestation (Katila 1995). On the other hand, it may lead to land being substituted by labour or capital, which in effect reduces deforestation. Angelsen *et al.* (1999) claim that when technical assistance was provided, cropped area expanded rapidly in regions with high fertilizer use in Tanzania. However, Deininger and Minten (1996) indicate that the reverse was the case in Mexico. Increased farm productivity has been associated with less total forest clearing in Brazilian Amazon (Jones *et al.* 1995). This could partly be due to the fact that farmers who successfully avoided soil degradation had more productive land and thus had no need to compensate for lost productivity on degraded lands by clearing forests. Godoy *et al.* (1997) report that indigenous farmers with higher rice yields in Honduras clear less forest each year. This contrasts with the observation by Foster *et al.* (1997) that agricultural productivity growth at the village level had a high positive correlation with deforestation. According to Southgate (1994), deforestation is higher in places with technologically stagnant agricultural sector.

(iii) Roads and market access

It is argued that landholders are most likely to convert forest to agricultural use in areas with good access to markets and favourable conditions for farming. Forest conversion for smallholder agriculture requires different levels of market access and types of soil and climatic conditions in comparison to large-scale mechanised farming (Chomnitz and Gray 1996). Roads induce greater forest clearing in areas with good soils and favorable climatic conditions. Chomnitz and Gray (1996) show that the probability of an area being used for agriculture (rather than natural vegetation) on high quality land next to the road was 50%. Godoy *et al.* (1997) found that households in villages far from urban markets clear less primary forest, but they hypothesize that such villages have more secondary forest available for clearing. Liu *et al.* (1993) and Mamingi *et al.* (1996) have shown that forest clearing declines rapidly beyond distances of two or three kilometres from a road, although in some case forest clearing is associated with longer distances. According to Mertens and Lambin (1997), deforestation drops off dramatically beyond 10 km from the nearest town. Locations closer to urban markets (in travelling time) are more likely to have less remaining forests (Chomnitz and Gray 1996).

(iv) Stability of political and social institutions

There is no consensus on the effect of political stability or political system on deforestation. Deacon (1994) claims that in politically stable countries deforestation is less compared to politically unstable countries. Didia (1997) argues that democratic counties suffer less from deforestation while Shafik (1994) notes that the same is true for authoritarian regimes. Deforestation is also said to be higher in places with more unequal land tenure regimes (Rock 1996).

3. PRE-INDEPENDENCE DEVELOPMENTS

The present structure of agriculture in the four countries is closely linked to past events, stretching from pre-colonial time. The transformation of a hitherto purely subsistence agriculture to semi-commercial and commercial agriculture continues to change the form of the relationship between peasants and their natural resources. This section traces such events and lessons from the pre-colonial and colonial periods.

3.1 Pre-colonial period

The period considered in this section is that very close to the colonial period in the 1800s due to scanty information on deforestation in the distant past. Historically, removal of forest cover has been closely linked to population growth, until when it was possible to establish the population-agricultural land connection. This formed the basis of forest transition, occurring in Europe in the early 19th century. Thus, there is a long-term trend of deforestation and forest degradation determined primarily by population growth, but also (and increasingly) shaped by other factors such as economic growth, trade, technologies, ecological factors, and policies. The risk is that if these underlying factors and long-term trends are not acknowledged, one might blame only the more recent policies for deforestation while it is known that there are underlying causes of deforestation linked to the pre-colonial period. For example, historical records (e.g., pollen analysis, archaeological studies) have shown that deforestation and land degradation did occur in pre-colonial time (Siiriäinen 2000). Environmental manipulation

started with the Neolithic modes of production (agriculture), a revolution completed more or less 1500 years ago in Sub-Sahara Africa. Regional deforestation occurred long ago in various parts of Africa. The earliest large scale forest retreat started about 2000 years ago, when Bantu speaking farmers occupied large parts of Eastern and Southern Africa. A second wave took place about one thousand years later, coinciding with high charcoal demand for iron production. Production became intensive in many densely populated areas, with large clusters of settlements taking hold during the 13th and 14th centuries. Exhaustion of soils in these areas, combined with high population growth, resulted in less productive land being cleared and put into use, something which resulted in practices such as the *chitemene* in Zambia. Misana *et al.* (1996) report that changes in the miombo woodlands have taken place in phases starting with the pre-colonial long distance caravan trade characteristic of the 1700s and 1800s followed by some pre-colonial era tribal migrations such as that of the Ngoni, the rinderpest epidemic, the introduction of the plough and the market economy.

In the pre-colonial period agricultural production was based on traditional technology with shifting cultivation or fallow systems as the means to maintain labour productivity and to regenerate soil fertility (Abrahamsson and Nilsson 1994). Low population density in most areas permitted long periods of fallow, which contributed not only to soil fertility regeneration but also allowed forest regeneration. Although shifting cultivation was one of the major agricultural production practices, this was not carried out indiscriminately. Some areas were reserved for other functions such as water catchment protection, livestock grazing as well as religious rituals and ceremonies (Kjekshus 1977).

Traditions and/or customs prevailing at that time in the clan or tribe governed the ownership of the means of production and assets, i.e. land, labour, livestock and the little farm implements. Thus, the problems related to or arising from the “haves and have-nots” never arose in most societies. It is also true that feudal societies developed in certain groups, such as the *Nyarubanja* systems in Bukoba, Tanganyika (Mbilinyi *et al.* 1974). However, no part of the family or clan was left to suffer because of scarcity of land, labour, lack of tools or implements.[1]

Production and distribution systems were organized such that whatever was being produced or gathered was geared first to family needs, second to the clan, third to the tribe and only finally to the inter- and intra-tribe trade. Thus, local resources were mobilized and utilized to produce commodities or products that were needed locally by the community, contrary to the so- called modern agricultural sector which was in some cases geared almost wholly to the export sector (Mbilinyi *et al.* 1974; Negrão 1995). There is no evidence however, to suggest that land use for agriculture and the associated production technologies led to unsustainable exploitation of forest resources. Kjekshus (1977) concluded that…. “The pre-colonial economies developed within an ecological control situation – a relationship between man and his environment which had grown out of centuries of civilised work of clearing the ground, introducing managed vegetation, and controlling the fauna”.

With increasing population pressure and shortening fallow periods, people evolved agricultural practices that addressed the land degradation processes through, for example, crop-rotation, inter-cropping as well as multiple-cropping (Kjekshus 1996). In Tanzania, it is now known that by 1500 AD there were stable and permanent societies in Kilimanjaro, West Lake (Kagera) and the Southern Highland areas (Omari 1976, Illife 1971). The same is true in the case of Zambezi delta in Mozambique where local communities were planting perennial crops such as coconuts and bananas (Negrão 1995).

Indigenous knowledge was used to maintain soil fertility and conserve water for agriculture as well as livestock. People managed to establish agricultural land suitability using simple indicators (plants as well as soil colour) (Trapnell 1937). For example, soils were given names on the basis of their property and, more important, their suitability for crop production. An example is *Mbuga* (vertisols) soils in Sukumaland farming systems of Tanzania that indicate dark heavy soils found in the valley bottoms (Budelman *et al*. 1995). In some cases indicator plants were used to assess the suitability of land for crop production, which also aided the decision on whether to clear the land or not. Cultivation techniques also evolved to address soil erosion problems and water management. The "matengo pits"[2] in Southern Highlands of Tanzania and *majaluba*[3] (in Sukumaland) are examples of the strategies that were evolved to maximize the utilisation of water for agricultural production.

Food crops dominated agricultural production during the pre-colonial period. These were meant to cater for household food requirements, social obligations, and for local trading.

The geographical location of Mozambique and Tanzania on the coast brought the coastal local communities in contact with the external world as early as the fifteenth century. These contacts were in the form of trade in ivory, wax and later slaves (Newitt 1997) The slave trade disrupted the settlement patterns as communities were forced to abandon their settlements to seek refuge in areas of poor access and low agricultural potential (Negrao 1995). In the case of Tanganyika (Tanzania mainland), it has been reported that slave trade flourished because slave labor was important for clove plantations in Zanzibar. There were constant caravans either of slaves or labourers from mainland to Zanzibar. Illife (1971) and Baumann (1891) claim that the Zanzibar slave plantation economy could not have survived if people from the mainland did not produce enough food for the Zanzibar market. This introduced cash economy to the mainland people and the practice continued up to the time of German's rule.[4] With the abolition of slave trade, oilseeds and copra became important products traded by local communities in exchange for cloth, beads and alcohol (Negrão 1995; Newitt 1997). These trade contacts provided a new dimension to the relationship between the peasants and the natural resources, as it involved the exploitation of natural resources for commercial purposes. However, lack of or inadequate infrastructure to the hinterland might have restricted such trade to only few accessible areas.

There is little evidence to show that during the era most close to the colonial period crop production strained land/forest resources in most areas. The exception would be areas with high population densities and easy access by international traders. However, there is evidence to show that growing land scarcity in highland areas of Kilimanjaro, Meru and Pare Mountains of Tanzania necessitated movement of people to other parts to open land for agriculture. Omari (1976) notes that the people in these areas began to cultivate and settle on the slopes of mountains.

To sum up, low population densities in most areas, existence of customary rules governing the use of natural resources and local knowledge about the environment explain the limited degradation of land and forest resources during this period. In those cases where trade contacts existed with the external world, lack of infrastructure limited the extent of exploitation of forest resources for commercial purposes.

3.2 Colonial period

The partitioning of Africa during the Berlin Conference of 1885 legalized the colonial control of African natural resources. This saw the 'nationalization' of land and other natural resources like forests and wildlife belonging to various communities into state land, forest and game reserves. This disrupted the way local communities lived and related to their natural resources. Further, the colonial administration created a dual agricultural-led economy characterised by peasant/smallholder and commercial sectors. The commercial sector, referred to as estate sector in some countries like Malawi, had access to the most productive land while the smallholder sector was mainly relegated to marginal lands. There was massive forest clearing in both sectors for crop production and supporting infrastructure.

3.2.1 Confinement of peasant farmers and build up of environmental pressure

There were various developments in the peasant and commercial sectors, which contributed to forest conservation and degradation. In the peasant sector there were moves that reduced and restricted peasant farmers to fixed land areas, irrespective of their increasing human and animal populations. Further, there was deliberate segregation in the provision of agricultural services, with the commercial sector and export crops receiving more attention. There is also evidence of restricting certain crops to estate/commercial agriculture, to the disadvantage of smallholders. These and other events are evaluated in this section as well as their bearing on forest sector development.

In Zimbabwe peasant farmers were confined into communal and resettlement areas. The Land Apportionment Act of 1930 facilitated the alienation of land among the races. Increasing population pressure in the communal areas resulted into landlessness, and by 1978 half of the African population was landless, up from 30% in the late 1950s (Moyo *et al.* 1995). These African farmers occupied less than 50% of the arable land in the country at independence in 1980. The reserves constituted about 90% of the communal areas (in which 2/3 of the population lived), and are located in poor ecological zones for agricultural production (Chenje *et al.* 1998). In the communal areas the farms averaged 5 hectares per household, which was the minimum size for subsistence farming. According to Chipika (1998), in the peasant sector (communal farm sector) land increased by about 21% between 1961/62 and 1981/82 (and has not increased appreciably since then), while the number of households and cultivated area increased by 144% and 204% respectively. Further, grazing area remained relatively unchanged, while the population of cattle and goats increased by 78% and 67% respectively, during the same period (*ibid.*).

In Mozambique, the initial colonial administration was effected through settlers who were given large land concessions (prazos[5]) for which Portugal retained the mineral rights. From the second half of the seventeenth century to late eighteenth century, these concessions were not used for agricultural production but acted as a source of labour for ivory and slave trade. The families occupying land in the concession areas were required to pay tax (in kind -produce and labour) and sell their surplus produce to the prazo owners (Newitt 1997). Although customary land tenure system at the village level within the prazos was not affected, the peasants had effectively lost the right over the land through the requirement to pay tax for its use (Negrão 1995). In 1891, a distinction was made between land already conceded and lands under the jurisdiction of the state. Within the land under the jurisdiction of the state, the natives had a right to a title of

holding for the land they occupied, and the title could only be exchanged among the natives on the basis of customary laws. Commercial agriculture was only initiated in early 1870 when the Mozambique opium cultivation and trading company was established (*ibid.*). Coconuts and sugar cane were the first crops produced on large scale. In 1901, legislation was passed allowing the natives to have access to 1 hectare of land per hut within the area conceded to the settlers. In 1909 the land title of holding by natives was repealed and a category of land reserves for natives was created. Within the reserves, land occupation was flexible, but without a right for a title of holding.

The coming to power of Salazaar in 1928 marked the end of the prazo system and Portugal assumed direct political control of the entire territory of Mozambique. Only companies or settlers who were productive and undertook genuine investment were retained (Newitt 1997). The economic policy of Portugal required its colonies to be producers of raw materials for its industry, and Mozambique assumed a central role in supplying raw cotton to Portuguese textile industry. Cotton became a compulsory crop and villages were assigned quotas that they had to meet (Newitt 1997).

Although the introduction of commercial agriculture did not per se create landless families, the rural communities were forced to occupy marginal lands with limited irrigation possibilities and with poor market access (Negrao 1995; Newitt 1997).

Further, the success of the labour intensive commercial agriculture required a guaranteed supply of cheap labour. Forced labour (*chibalo*) for agriculture was mainly in the central and northern provinces. The southern provinces became labour reserves for South African mines (Abrahamsson and Nilsson 1994). Forced labour for agriculture was one form of tax payment introduced by the colonial government (Negrao 1995). This meant that families had less labour time to allocate for subsistence production. Although the forced labour laws and forced cultivation of cotton and rice were abolished in 1961, their effects are even felt today. Cotton crop for example is still considered as a slave crop.

The Portuguese policy meant that in the peasant sector cultivation could no longer be carried out with the same flexibility since land access was restricted. At the same, time male labour for land clearing was less available and the absence of complete property rights reduced the range of incentives for land improvement. In addition, use of land, as security to access credit was not possible. The actual effects of these changes on the forest resources have not been documented.

In Malawi a similar pattern emerged, with the colonial policy promoting land alienation to European settlers. Many people subsequently moved on to European estates thereby losing all their original rights. African land rights were left in great ambiguity, which made their position insecure and created difficulties for the future (Phiri 1991). Estate owners were allowed to charge rent to all Africans on the estate. The estate owners preferred tenants who worked in lieu of cash rent. Paying “rent” for land that Africans believed was theirs but “bought” for so little by Europeans led to conflicts between tenants and settlers (Minde *et al.* 1997).

Effectively development of agriculture was at two levels, viz. estate and smallholder. This then put in place an asymmetry in agriculture development which remained up to the present time, and which formed the basis for allocating government attention and resources for developing the sector. The government decreed by law that certain cash crops be exclusively for estate or smallholder farmers. Further, the customary land tenure system discouraged the development of the rural credit market for individual smallholder farmers because the land could not be held as collateral for

loans. This was because customary land was communally owned and the chief, in consultation with community elders, allocated it to individuals.

As the number of settlers increased, the pressure on land became greater, because settlers acquired land mainly from fairly high densely populated areas. The displaced Africans were confined to small and marginal lands and on the settler estates as tenants. Due to land conflicts, the land given to settlers was gradually returned to Africans, and by independence in 1964, most of the land had been returned to traditional customary control. In 1948 the land under European freehold amounted to 490,000 hectares, about 4.1 % of the total land area of Malawi. This percentage was reduced to 3.7 by 1954 and less than 2% by 1964. Therefore, at independence in 1964 about 87% of the land in Malawi was under customary ownership (Kachule *et al.* 1999). The 1962 "African Private Estates Bill" and the 1964 "Malawi Land Bill" suggested that future land policies would centre on customary law (Minde *et al.* 1997). However, considerable damage had already been done on the environment and especially on estates or plantation agriculture, which necessitated clearing of large forest areas, as well as on marginal lands, which supported high African populations.

Tanzania faced settler (albeit to a smaller extent as compared to the other countries) and plantation agriculture on one hand, and a cash crop oriented peasant agriculture on the other. Prime agricultural land was allocated freehold, mostly to German settlers on the slopes of Mount Kilimanjaro, Mount Meru and Usambara Mountains with the assistance of collaborative chiefs (MLHUD 1995; Hyden 1980). Sisal and cotton plantations were established in coastal areas. Although land clearing was part and parcel of plantation agriculture for crops like sisal, coffee, and sugarcane, the establishment of flue-cured tobacco and tea had significant implications for forest resources as these crops required wood for crop curing in addition to land for their cultivation. In order to ensure that agricultural production was in line with colonial objectives, long-term land leases were given to estate producers. Most land in Tanzania is covered by miombo woodlands, which are potential areas for livestock keeping. However, due to presence of tsetse flies, the strategy to eradicate tsetse flies led to massive clearing of trees to pave the way for livestock husbandry (Kjekshus 1977).

Hyden (1980) argues that the German colonization of Tanganyika not only put an end to the prosperity of the indigenous pre-colonial economies but also gave rise to a number of diseases and natural catastrophes. Further, the German colonial policies wrecked the fragile balance between man and nature on which the pre-colonial economies rested. Colonization disrupted the man controlled ecological systems that supported pre-colonial economies. For example, evidence suggests that the German Government by then could not generate enough revenue outside the peasant sector given the growing revenue demands by the state (Hyden 1980). The Governor of the then German East Africa (Tanganyika) forced Africans in 1901 to grow cotton as a revenue generating measure despite the fact that the crop had shown dismal performance in northern parts of Mwanza and Musoma (Magoti 1984). Thus, taxation of the African population in Tanganyika (introduced in 1897 as a hut tax) was further reinforced to ensure compliance. People became employees on plantations or directly involved with growing cash crops to ensure that tax was paid. Efforts to promote agricultural production were accompanied by extensive opening up of forested land for plantation agriculture and supporting infrastructure. The Germans were not very successful in agricultural production and by the time World War I began only sisal showed uninterrupted growth.

The British Government showed little interest in expanding large-scale agriculture partly due to failure of settler agriculture in Uganda in 1920s (Mamdani 1976). Land alienation continued but remained small in terms of the area. By 1958 the estate or plantation sector covered approximately 1.0 million hectares with only one-third of this area actually used under plantation or other farming (Ruthenberg 1964). Most of the estate or plantation owners were British or Greek although there were also some Indians and Pakistanis. The plantation sector again depended on hired labour, often recruited far away to ensure that family demands would not interfere with their work. Labour recruitment was done by compulsion, as there was no shortage of land that would have forced peasants to seek employment in plantations.

British policy of indirect rule tried to expand peasant agriculture. Ordinances were the major instruments used to achieve agricultural development under peasant agriculture. The coercive approach was passively resisted by peasants[6] leading to low agricultural productivity (Ruthenberg 1964).[7] By mid-1950s the British shifted to persistent persuasion approach towards peasant agricultural development. By that time, however, the effects of the earlier policies to improve peasant agriculture had already changed the political situation in favour of the nationalist movement for independence.

In all these four countries emphasis on agricultural production by settler/estate farmers was the motive for withdrawing good land from natives and confining them into marginal lands and/or smaller productive land units. The spatial arrangement of smallholder and commercial farmers was legally put into place. The scene was then set for the smallholder African farmers to eke a living from 'confined', small, and mostly low productivity land units, given their fast increasing human and animal populations, and many other demands. A tremendous pressure on land and other natural resources was created leading to environmental problems that the colonial governments unsuccessfully tried to contain. A few examples highlight this.

In Malawi, the importance of agriculture to the economy of the country as well as to the livelihoods of the people was recognized and an attempt was made to develop the sector (Minde *et al.* 1997). Lack of resources hampered development of the sector at a time when 95% of agricultural land was under Africans whose population was doubling every twenty-five years. This created problems in that shifting cultivation was increasingly becoming limited due to scarcity of land. This gradually led to soil exhaustion with declining productivity accompanied with increasing maize mono cropping. Crop rotation scarcely existed for maize with only a few inter-planted legumes.

By the end of the World War II, Tanganyika (now mainland Tanzania) already had developed and *underdeveloped* areas. During this time the so-called *developed* areas were already facing land problems due to erosion and low productivity on one hand and population pressure on the other. To address these problems, the British colonial government introduced cultivation measures that would improve land husbandry and productivity[8] (Omari 1976). Although different schemes were initiated not only did they end in disastrous failure but also resulted in opening up of forest resources.

In Zimbabwe, overstocking and overgrazing is attributed mainly to little marginal land reserved for natives in 1920s and further concentration of natives in those areas through legislation in the 1950s and 1960s. However, by the end of the 1920s there was evidence of degradation in the native areas as the farmers increased land under cultivation in order to cope with taxes and falling grain prices. Livestock numbers were also increasing compounding the degradation problem. During the same period land held by settlers increased from 20% to 50% of the total land area. Livestock

management and conservation attempts under a 1951 Native Land Husbandry Act, including de-stocking attempts met with stiff native resistance (Chipika 1998). Further, the concentration of people in reserves shortened the fallow periods, moving from woodland fallow to bush land and finally to grassland fallow. This led to not only decreased soil productivity but also to increased labour demands (*ibid.*). Ironically whilst the Zimbabwean African reserves were getting overcrowded and severely deforested and degraded, by 1973 only 4% of the land allocated to the settlers was under cultivation with most of the land reverting to woodland (Riddell 1979).

3.2.2 Strategies in agricultural production and their effects on forest condition

Having secured land for settler farmers the colonial authorities organized other inputs and services for agricultural production in favour of settler farmers. The inputs manipulated were labour and other production incentives like crop prices, extension and marketing services.

(i) Marketing and pricing

In Mozambique, the peasant farmers were deliberately discriminated in two ways, viz., through controlled prices for which the Portuguese settlers were paid higher prices than the peasant farmers, and through controlled low wages to guarantee cheap labour supply to the plantation agriculture (Branco 1994). In Zimbabwe, Nhira *et al.* (1998) report that for the same crops, prices were deliberately made low for peasants and higher for commercial farmers. Such a system indirectly encouraged peasants to sell their labour to commercial farms, mines, and urban centres and to other sectors.

Different policies in marketing of agricultural produce from the estate and smallholder sector influenced Malawi's agricultural production in diverse ways. Crops grown by the estate sector were sold on the export market. These were marketed by private agents or in private auctions to foreign buyers. On the other hand, smallholder farmers had access to two types of markets. The first were local markets where produce was sold on small scale at whatever price the buyer could offer; and the second were markets administered by the colonial government such as the Tobacco Native Board and the Maize Control Board. The asymmetric marketing arrangements arose in the early 1920s under the influence of the estate owners. The estate farmers produced for the better-priced export markets.

(ii) Labour

In Mozambique forced labour (*chibalo*) for agriculture was mainly in the central and northern provinces. Forced labour for agriculture was one form of tax payment introduced by the colonial government (Negrao 1995). This meant that families had less labour time to allocate for subsistence production. Further, in order to guarantee an adequate supply of raw cotton to the Portuguese textile industry, cotton was made a compulsory crop in 1921. Rice cultivation was made compulsory in 1941 to feed the urban population. In Malawi, Africans on estate farms paid rent in form of their labour to the estate-owners. This in essence was one form of exploiting the Africans. Furthermore, the Africans, who at that time were commonly known as the "Natives" were disgustingly employed under a wage agreement only to be paid in kind, thus in some case the natives would simply be given cigarettes or tobacco as their payment. This was known as the "Thangata system". The involvement of the local communities in this manner reduced labour available for smallholder production.

In Tanganyika, any portion of the territory, which was not the locus of large-scale capitalist investment or whose people did not generate local products for cash sale automatically, became a labour reserve (*manamba*). By 1903 the German colonial Government required local leaders (*akidas* and *jumbes*) in the southern coastal districts to establish cotton plots worked by communal labour.

(iii) Credit and extension services

The availability of credit, extension and marketing services was almost non-existent to smallhoders. For example Chipika (1998) report that only 2% of smallholder farmers had access to these facilities when Zimbabwe became independent in 1980. The implications included perpetuations of old farming practices and low crop productivity in the peasant sector. In Zimbabwe, commercial farmers who had access to these facilities evolved modern farming methods and saw farm yields rising to about four times those obtained from similar crops and on similar acreage in communal farms (*ibid.*).

Peasants in Tanzania had no access to credit partly due to lack of meaningful collateral and they could not borrow from private traders since under the Credit to Natives (Restriction) Ordinance of 1923 no debt was legally enforceable against an African other than one holding a license (Msambichaka, Mabele 1977). However, non-Africans could borrow from commercial banks existing at that time. Land Bank was established in 1947 to provide credit to non-Africans. In 1957 the minimum bank loan was raised from £10,000 to £15,000 (IBRD 1961), which was very much out of reach of indigenous smallholder farmers. Thus, along with coercing people to work on foreign owned export oriented plantations, the colonial government ensured that settlers received credit to expand agricultural production. Given the limited resources to peasants, their response to this economic opportunity was phenomenal (Msambichaka, Mabele 1977).[9] Credit programmes for peasants were initiated later but geared towards producing export crops. Thus, if availability of credit was associated with expansion of export crop production then the impact on forested lands was much more severe in areas where export crop production potential was high. Overall, credit programmes during the colonial period were pre-occupied with export crops.

In Mozambique, an attempt to create agricultural credit facility for the natives was only made in 1940 when the indigenous credit fund was established. This fund was to be accessed by the natives considered to have attained a certain level of civilisation. The first meeting of the fund was only held in 1958 and no credit was conceded (Negrão 1995).

(iv) Traditional vs. government institutions

No serious efforts were devoted to harmonizing traditional institutions in agriculture with government institutions, and at least exploiting the complimentarity of the two. For example, when it came to livestock development policies, governments' emphasis was on beef and dairy products, while the peasants emphasis was on manure, milk, draught power, prestige (in numbers), cultural and social needs. It was not suprising that destocking policies failed in Zimbabwe (Chipika 1998)). Governments did not invest much in pasture improvement and animal husbandry in the peasant sector. Livestock production by this sector, and especially by nomadic tribes, is mainly carried out in woodlands.

Effects on forestry resources of the agricultural policies, practices, and associated legislation adopted during the colonial period are summarized in Box 1. The colonial period has been reviewed in greater detail than the other periods because this is the

period where many of the post-independence structures in land use, and agriculture in particular were laid. The post-independence governments continued for a long time to operate with such structures and even today agriculture is still a smallholder-estate farmer affair. It is also during this period that considerable deforestation took place to give way to agriculture. For example in 1963 FAO estimates indicate that communal areas of Zimbabwe had 60% of their area under woodlands, while by 1978 (two years before independence in 1980), this area had been reduced to 30% (Bradely and Dewees 1993).

It is therefore important to understand what factors shaped or continue to shape events in agriculture and the eventual impact on forestry. A lot of what is happening today has its roots in the past. "An object is as far behind the mirror as it is in front" (Anon.)

Box 1. Some effects of colonial agricultural policies, practices, and associated legislation on forestry resources

1. Commercial/estate farmers drew land from forests because of extensive nature of plantation/estate agriculture.
2. The lack of complete property rights on the land could have been a disincentive to the adoption of land conservation measures.
3. The low prices of agricultural products to smallholders as well as restricted access to markets, credit and extension services did not promote an increase in marketed surplus. To the contrary non-farm activities and off farm employment was promoted as alternative sources of income, thereby reducing labour available for crop production and possibly constraining deforestation. However, some of these activities were conducted in the forests, resulting into deforestation and forest quality deterioration. Further, with low incomes, investments in agriculture were negligible, leading to land exhaustion and need for 'new' land which was excised from forested areas.
4. The forced labour and migratory labour meant that family agriculture was essentially left to women. The reduced availability of men labour for land clearing meant overuse of land without fertility recovery with consequent yield decline and land degradation, and therefore need for 'new' land mainly from forested areas. However, reduced availability of male labour could have constrained opening up of new agricultural land, thereby reducing the pace of deforestation.
5. Geographical differentiation of economic activities resulted into imbalanced growth or development in each of these countries, with some areas more adversely affected by environmental problems than others. For example, in Mozambique the southern provinces became a supply of migrant labour to South Africa, while the central provinces were dominated by plantation agriculture. The northern provinces saw little colonial economic development.
6. Although the distortion policy measures satisfied the short-term interests of the colonial governments, they left serious structural problems, which were eventually inherited by national governments at independence. These included weaknesses in land tenure and legislation, unequal regional development pattern, controlled pricing and marketing of agricultural products, and lack of skilled manpower. Many of these imbalances have yet to be addressed fully in the individual countries, and yet they are the final determinants of success in sustained natural resource use and management in these countries.
7. The colonial governments did not put into place policies and strategies to internalise the negative externalities arising from land use policies and practices in agriculture.
8. In this period the framework was established for almost all-environmental problems these countries faced and continue to experience. Effectively the colonial administration laid the foundation on whether or not forestry and natural resource in general, could be managed and used sustainably.

4. POST-INDEPENDENCE DEVELOPMENTS

In this period some of the agricultural structures built up during the colonial period remained intact to the present day. The pattern of agricultural production continued to be polarized: smallholder and estate/cooperative/commercial farmers. Changes in agricultural production were realized through relocation of people and using economic incentives.

The post-independence period is characterised by two distinct economic regimes in all these countries. The early post-independence period witnessed good economic growth in each of these countries, although this was short lived in Mozambique as the country was plunged into civil war. The countries experimented with economic and political policies to speed up economic development. This period was characterised by economies that were centrally planned, with state ownership and/or control of most means of production and distribution. The role of market forces in allocating resources was very much constrained. With the exception of Malawi, the other countries had socialist oriented policies, ranging from a Marxist-Lenin government in Mozambique to home-grown brand of socialism in Tanzania called 'Ujamaa'. These experiments, combined with unfavourable regional and global events like the oil crisis of the early 1970s, eventually stifled economic growth, and forced the governments to adopt economic reforms backed by international financial institutions, commonly known as structural adjustment programmes (SAPs). They started to be implemented in Malawi, Tanzania, Mozambique and Zimbabwe in respectively 1980, 1986, 1987 and 1991. These reforms are on going. SAPs place emphasis on a number of things including increased private sector involvement in the national economy, trade liberalisation, reduction in budget deficit through fiscal retrenchment and domestic credit contraction, and substantial currency devaluation. These policies demanded major re-orientations in the environment in which economic activities are operated. The countries gradually shifted from the pre-SAP centrally planned economies to decentralised economies that were increasingly becoming market oriented.

4.1 Pre-SAP Period

During this period many of the colonial policies and practices remained in place (Box 2). However, there were some significant changes in policies and strategies for rural development, which affected the sector and eventually forest cover. A notable one was the increased state intervention in production, processing, marketing and pricing. This saw the emergence of parastatal organisations to implement these state functions. There was a deliberate effort by governments to increase agricultural production. This was notable in Zimbabwe, up to mid-1980s when agriculture flourished. The land area under maize, sorghum, soya bean groundnuts, cotton, sunflower and burley tobacco in communal and resettlement areas expanded by about 12.3% in this period (Chipika and Kowero 2000). In Tanzania the production of staples, namely maize, paddy and wheat between 1975/76-1976/77 and 1984/85-1985/86 increased by respectively 38%, 48%, and 18% (Bagachwa *et al.* 1995). The extent to which increased crop production drew land from forests and grazing land is not known.

Another feature of the period was the continued concentration of smallholders to confined land areas although the objectives and patterns for such concentration changed. In Tanzania, the 'ujamaa' policy introduced a villagisation programme that saw massive

Box 2. Some notable pre-SAP period policies and practices

1. Continued ownership of land by state, only changing hands from colonial governments to national governments. In Tanzania and Mozambique, the private commercial farms were nationalised and transformed into state farms, and communal villages were established as a basis for the transformation of the smallholder sector.

2. Absence of a comprehensive agricultural policy in each of the countries for practically all this period. The sector was driven by a number of policy statements and strategies which were part of larger programmes known by various names like rural development plans, integrated rural development programmes, five year development plans, etc. Otherwise they were part of major political pronouncements, like the development strategy for Mozambique that was formulated in the third FRELIMO party congress of 1977 (FRELIMO, 1977). The sector continued with a top-down approach to its development.

3. Government intervention in pricing and marketing (through price controls and state run marketing institutions) had negative effects on agricultural production in Mozambique and Tanzania.

4. Estate and smallholder agriculture continued to characterise the sector, with increased support from governments going to the former.

5. The main agricultural strategy mostly remained unchanged, with the estate farmers largely producing for both domestic and export markets, while smallhoders produced mainly for subsistence and domestic market. The latter saw increased production through agricultural extensification while the estate sector realized good productivity growth through agricultural intensification.

6. Continued institutional, technological, and pricing differentials between estate sub- sector, state monopolies, and cooperatives on one hand, and smallholders on the other. This discouraged the latter from making any meaningful investments in agriculture, encouraging peasants to continue to mine the land and the few forests and trees left.

movement of people into communal villages. The same was true for Mozambique with the creation of communal villages. Cooperative production in these villages was seen as the viable means of transforming the peasant sector into a modern sector (Abrahamsson and Nilsson 1994; Branco 1994).

In Zimbabwe, movement of people into the communal and resettlement areas continued. In Malawi, due to growth of the estate sub-sector, smallholders lost their customary lands and remained on limited land. In the late 1960s and early 1970s the thrust in Malawi was for politicians, top civil servants, and the government parastatal, Agricultural Development and Marketing Corporation (ADMARC) to go into estate farming and supported with credit from state owned banks (Kachule *et al*. 1999).

This reversed the colonial policy, which transferred the estates to customary land. Estate farming therefore necessitated clearing customary land under forests, and effectively started to mount land pressure on the smallholder farmers whose customary land was taken away. The war in Mozambique created concentrations of refugees in confined and secure areas within the country as well as in neighbouring countries. The extent of forest cover clearing to give way to habitation, farms and other infrastructure associated with these massive movements of people in the region has never been assessed.

One notable aspect is that during the colonial time people were confined to specific areas, and this trend was entrenched during the independence era. A lot of forest clearing was done in both periods, largely because of this. It is most likely that massive deforestation took place in these countries before the onset of the economic reforms. For example, Bradley and Dewees (1993) and Dewees (1994) report that woodland cover in the communal areas of Zimbabwe had been reduced to 30% by 1978.

This fixity of smallholders and with very little room to manoeuvre in terms of land accessibility not only increased clearing of forests and indigenous trees on farms but also degraded their land because they invested very little in improving land and agriculture. It is within such a confined environment that smallholders continue to live and are expected to respond to various policies, macro-economic and otherwise, to improve their agriculture while simultaneously conserving natural resources. And this is the framework on which the SAPs have to operate successfully.

4.2 The SAP Period

This period stretches from when individual countries started to implement the economic reforms to present time (2002). These reforms have intermittently been in force in all these countries, albeit at different degrees of enforcement. They were introduced in Tanzania in 1986/87 (after a brief spell in 1985/86 with home grown reforms), Malawi in 1980, Mozambique in 1987 and Zimbabwe in 1991.

The SAPs employ most of the policies discussed in section 2. The implication of the SAPs on agricultural land expansion varies. The SAPs targeted increasing export crops through price and market liberalisation and currency devaluation. There was less emphasis given to production of food crops. Changes in area allocated to different crops in the different countries are presented in Table 1. In all the four countries there was a mixture of a decline or modest increase in the production of the staples. As regards production of cash crops which were essentially for export, the performance was much better in all countries implying that the farmers' response to the SAP policies was positive for these crops.

In Mozambique, it is estimated that the annual growth rate in agricultural production between 1992 and 1997 was 6.3% while marketed surplus through formal markets grew at the annual rate of 34% (MAP 1998). Within the smallholder sub sector, significant changes have taken place in land allocation with large increases in areas for tobacco and sunflower. The period selected (1994-2000) coincides with social and political stability in the country. However, due to earlier effects of the war cropland area declined dramatically.

In Malawi, the thrust for estate agriculture increased, with land under estates increasing from 759,400 hectares (6.4% of total land area) between 1980 and 1989 to 1,148,000 hectares (9.6% of total land area) between 1990 and 1993 (Kachule *et al.* 1999). This represented the best land and was taken from customary land, involving clearing of large areas under indigenous forests. Further, the government promoted a 'project approach' to smallholder farming, in that it launched four Integrated Rural Development Programmes (IRDP) after independence, the failure of which was followed by a National Rural Development Programme (NRDP) which divided the country into eight Agricultural Development Divisions (ADDs). The failure of both IRDPs and NRDP

meant that the government was unable to increase smallhoder farm productivity. Further, the government was unwilling to raise prices paid to smallholders for export crops and could not solve the problem of peak labour demand for smallholders during cropping seasons. Low agricultural productivity and producer prices combined with decline in average farm size led to decline in real incomes for rural families. As coping measures, rural families resorted to massive deforestation of indigenous forests as sources of income through sale of firewood, charcoal, timber and other forest products (*ibid.*).

Table 1. Percentage change in land area for different crops

	Tanzania (1986/87 – 1991/2)[a]	Malawi[b] 1989-1992	Zimbabwe (1991-1995)[c]	Mozambique 1994-2000[d]
Cash Crops			-	-
Coffee	4.8	-4.13	-	-
Tea 53.2	1.25	-	-	
Tobacco	7	33.89	55.42	536.0
Cotton	16.2	18.08	-0.09	3.1
Staple Crops	1986/87 – 1993/94	1989-1992	1991-1995	1994-2000
Maize	2.8	7.11	30.56	227.0
Paddy	1.2	-40.19	-	-38.3
Cassava	0.8	-13.85	-	-19.0
Sorghum	-	-7.81	19.81	-31.4
Soya beans	-	92.46	-66.67	-
Ground nuts	-	-116.6	-21.05	78.5
Sunflower	-	51.02	-5.71	660.2

[a] Msambichaka and Naho 1995.
[b] Smallholder hectarage between 1989 and 1992. Source: Famine Early Warning System (FEWS) Malawi.
[c] Chipika and Kowero 2000.
[d] Computed from Instituto Nacional de Estatística 2001, Ministerio da MAP 1994. The data only represent the household sub-sector.

This period is characterised by rapid erosion of some previous agricultural related policies and legislation. These included a gradual to complete elimination of subsidies on agricultural inputs; increasing role of private sector in agricultural production, distribution of inputs, and marketing of agricultural output; and increasing role of the marketing forces in pricing of agricultural inputs and outputs. This paper does not intend to review in detail the effects on forestry of SAP policies on agricultural production. However, the noted agricultural land expansion (which could be attributed to these policies), if allowed to continue could have disastrous effects on the remaining public woodlands and those forests not under effective government control in these countries.

The same could be true of the resettlement and commercial farms of Zimbabwe because these areas have significant woodland cover and response to these policies could result into clearing of woodlands. For example, in a study undertaken in Tanzania

Apparently the road constrains expanding this maize farm into the woodlands, but for how long? (Photo: G. Kowero)

by Monela *et al.* (2000), about 45%, 44%, and 32% of farm land was acquired by clearing public woodlands and from open public land in intermediate, remote, and peri-urban sites respectively. In Malawi, opening up of gardens in natural forests constituted 21% of farmers' explanation on environmental degradation (Minde *et al.* 2000). This shows that some of the remaining natural forests are still accessible, albeit illegally, to farmers.

The implications of the individual SAP policies on agriculture and eventually on forest cover in this region have not been sufficiently studied and therefore need further scrutiny. However, the potential of these policies to increase land under agricultural crops in this region has been demonstrated in various studies including Bagachwa *et al.* (1995), Chipika and Kowero (2000), Minde *et al.* (1997), and Reed (1996). Expansion of cropped area and livestock grazing remain the major sources of deforestation and degradation of miombo woodlands.

5. OVERALL IMPLICATIONS FOR FORESTRY DEVELOPMENT

5.1 Pre-colonial period

There was very limited degradation of land and forest resources during this time, due to low human and domestic animal populations. Customary rules and indigenous knowledge guided the use of natural forest resources.

5.2 Colonial period

- Boundaries were put between some natural forest resources and agricultural land thereby restricting shifting cultivation. The boundaries or restrictions were in form of rights of access to natural forest resources. In order to contain

restrictions on shifting cultivation fallow periods were initially reduced and later eliminated in some areas, given the pressure on land. The confinement of poor people to small and declining land parcels coupled with their inability to improve farming using better inputs gradually led to land degradation and demand for 'new' land.

- Agriculture was divided into smallholder and estate/plantation, and this firmly laid the basis for government attention and resource allocation to the two sub-sectors as well as defining the symmetry for agricultural development to the present day. The estate agriculture was comprised of few technically and financially strong players, yet it commanded more attention and incentives than the smallholder sub-sector, which had poor and ill-equipped farmers. These relative positions of the players were to later become decisive in the capacity of either of the players to make meaningful responses to economic policies relevant to the sector. However, both sub-sectors cleared large tracts of land for agriculture.
- The colonial governments had to raise money for managing the new states they created. This was done in form of taxes, which introduced an additional burden on both smallholder and estate farmers to increase acreage in order to pay for taxes. Also modernization of living standards led to increased demands on the people thereby demanding more income, and since this came largely from agriculture, then additional land for production must have been drawn from forested areas. To meet the state's foreign currency requirements, estate/plantation crops, intended mainly for export, were introduced. These resulted into massive clearance of forests for land to grow the crops, provide supporting infrastructure, and in some cases like tobacco forests were cleared for firewood to treat the crops. Thus the introduction of the 'nation' state and improvement of living standards was very costly and came with significant additional demands on forested land.
- There were many disruptions in the way local people used to do things. These included introduction of new crops, confinement to marginal lands, introduction of large scale commercial agriculture which absorbed cheap rural labour, tensions due to loss of land to estate sub-sector, and inequalities in terms of incentives for smallholder and estate farmer for same crops. The rural communities could not evolve ways of dealing with all these changes and to their advantage. Many of these changes led to disruption of the ecological systems that were controlled by the local communities.

5.3 Post-independence period (up to 2002)

- Post-independence governments did not redress the imbalances between smallholder and estate farmers. Smallholder farmers, in most of these countries, continue to operate on land, which is shrinking in relation to human and animal population growth. Further, these farmers have limited or at times do not have capacity to invest in agriculture. On the other hand estate farmers have land in excess, can access credit, and therefore can invest in improving agriculture. Yet the same macroeconomic policies, and in particular those under SAPs, are applied to both sub-sectors to improve agriculture. The failure of smallholder farmers to respond to economic reform policies to improve their

way of living has given rise to a drastic surge in informal businesses, which largely involve forest products like firewood, charcoal, wood carvings, and non-timber products. The sustained supply of such products cannot be ascertained let alone the extent of deforestation of the forest estate.

- Also post-independence governments introduced measures, which were viewed correct, but had serious implications on forests. The movement of people into collective villages in Tanzania and Mozambique, the resettlement of people in resettlement and communal areas in Zimbabwe, the rapid expansion of estate agriculture in Malawi necessitated clearance of massive forest areas for agriculture and supporting infrastructure.
- There was little consideration given to forests in agricultural policies and plans. There were and continue to be plans to expand agriculture and livestock development, but these plans do not indicate which land such expansion should take place. The forests and grasslands would appear to be the logical areas.
- The development process, either at individual or government level, required resources. Governments as well as individuals continued to rely mainly on agriculture for this. Like in the colonial period, post-independence governments continued to give emphasis to export crops, and in addition set up their own structures of production, parastatal organizations. Agricultural cropland expansion has been significant in this period, and has been accompanied by increased rates of deforestation. Apart from forests under government control, forests and trees are more abundant in estate/commercial farms as compared to smallholder farms. The latter is now a candidate for agroforestry.

6. CONCLUSION

a) There is asymmetry in agricultural development, which is rooted in the history of these countries, and post-independence governments have not managed to change it. On one side are poor smallholder farmers on fixed small plots with limited capacity to make meaningful responses to economic production incentives as these require them to make minimal investments in agriculture (e.g. buying of fertilizers, pesticides, and other inputs), or to expand agricultural land so as to take advantage of economies of scale. On the other side are relatively rich estate/commercial farmers with big farms, which are rarely fully cultivated. These can respond to economic policies by expanding area under crops and making investments to improve productivity.

b) The success to contain deforestation will very much depend on how governments eliminate the factors, which create the wide gap between smallholder farmers and estate/commercial farmers in some of these countries. Smallholder farmers have very little room to manouvre in terms of responding to macro-economic incentives to reduce their dependency on natural forest resources. In fact such dependency, and especially for income, has increased markedly in some of these countries during the SAP period.

c) Increasing privatization and individualism and the onset of property rights imply that smallholders will continue to be confined to their small plots for their agricultural and forestry related needs. Increasing populations on such fixed land combined with increasing poverty will rapidly deplete these areas of their forest resources in order to make way for agricultural land. On the other

hand there will be more forest resources on the estate/commercial farms.

d) Deforestation is gradually becoming an issue for estate/commercial farms and less so of smallholder farms where there are few trees left. The latter are better candidates for agroforestry.

e) It is not only the demand for basic forest products like firewood and building poles, which have contributed to massive deforestation. The process of modernization, which includes the establishment of the nation state and its structures demand financial means of support that have indirectly created pressure on forest resources. The cash requirements of governments have partly been met through taxes, which have compelled people to open more land for cash crops or surplus production of staples for sale. Also the government desire for foreign currency has led to the cultivation of crops for export which were hitherto not grown by local people, e.g. sisal, cotton, tea, coffee. Their cultivation has drawn considerable land from the forests. Even plantation forests of exotic species have replaced indigenous forests.

ENDNOTES

1. The major economic activities in the traditional societies were simple in present day context. They included farming (growing of food crops, cereals, root crops, etc.); livestock rearing (mixed farming and ranching in the form of nomadism; hunting and fishing; and gathering (wild-food crops, vegetables, fruits, honey, etc.). In order to carry out the above activities, some kind of supportive services, especially industries, had to be provided for. For example, farmers needed farm implements and tools (e.g. axes, hoes); fishermen required fish-nets, fish traps, fishing rods, hooks and lines; hunters needed spears, bows and arrows, snares, knives, etc.; while gatherers needed containers of various makes, designs and colours. In addition to these items, a lot more items were needed in the household cooking and eating utensils, items for storing foodstuffs and medicines. In short, there was some kind of an industrial manufacturing sector quite distinct from the farm and gathering activities.

2. Pits that are dug on steep slopes to control runoff water.

3. These are bunds constructed around rice fields.

4. By 1899, about 69% of the value of the mainland's exports was shipped to Zanzibar and about 66% of its imports came from the mainland (Illife 1971). Baumann (1891) reports that…"The Wazigua produce considerably more grain than they need for their own consumption. As a result they export grain in very considerable quantities to Sadani and Pangani (*both are along the coast*)"

5. Prazos are land concessions that were held under the Roman law. The peasants living in the prazos were required to pay an annual tax (mussaco) in kind (payable in grain, cotton cloth (muchira), ivory or gold dust) to the prazo owner. The prazo owners derived their profit from the tax, labour and monopoly commerce in the areas under their jurisdiction. The prazos were technically feudal corporations.

6. Meru land case and revolt by the Lugurus.

7. Pratt (1976) reports that as a result of colonial policy of agricultural development through coercion some 75,000 persons were convicted before native courts in 1946 alone.

8. Terrace farming was introduced to prevent soil erosion and improve soil fertility to the over-cultivated land. Under this policy several schemes were initiated including the Mlalo Scheme that restricted cattle grazing on flat lands and ridged or terraced all cultivated hill slopes. The Uluguru scheme was started in 1949 with a similar objective. The Mbulu scheme aimed at reducing cattle herds (de-stocking) among the Iraq tribesmen by a third in order to arrest land degradation in marginal areas, while at the same time resettling them in other areas. The Sukumaland scheme implemented from 1947 aimed at redistributing human as well as livestock populations from overpopulated to less populated areas. The multi-million pounds ground-nut scheme in Kongwa,

Urambo and Nachingwea started from 1946 aimed at supplying oil to the export market; testing modern agricultural technology developed in England after World War II; provide employment to ex-soldiers and local people.

9. For example coffee exports from Bukoba increased from 1,138 tons in 1918 to 10,881 tons in 1935. In Kilimanjaro, coffee produced by smallholders increased from 32 tons in 1923 to 2,141 tons in 1939. Cotton production, introduced in the Lake Victoria Zone by the Germans, increased from 3,714 bales of lint in 1913 to an average of 34,681 bales between 1935 and 1939 (Iliffe 1971).

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11.
Forest policies in Malawi, Mozambique, Tanzania and Zimbabwe[1]

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ABSTRACT
Many countries in eastern and southern Africa have lost significant natural forest resources. Initially the pace was gradual, but it has accelerated very much in the recent past. Some of the efforts made to contain the situation include revising past policies to improve forestry development and conservation. This paper traces the evolution of such policies together with corresponding implementation mechanisms in Malawi, Mozambique, Tanzania and Zimbabwe. Although broad policy statements on involving local communities in forestry have existed in some countries for several decades, adequate resources have not been committed for their effective operationalisation. Generally, the forestry sector in southern Africa has lagged behind other sectors in revising its policies to adequately reflect political and socio-economic changes. Political and socio-economic policies appear to have taken precedence over forest sector policies, with far reaching consequences for the sector. However, current forest policies are more comprehensive in terms of stakeholders considered and issues addressed.

Key words: Policies; legislation; communities; forestry; Southern Africa.

1. INTRODUCTION
Forestry policy is "concerned with the manner in which forests and tree resources should be managed to serve the needs of people and meet society 's demand for the goods and services that forests and forestry can provide, as well as with regard for the non-material values that trees and forests represent "(FAO 1993). Viewed this way, a forestry policy is essentially a statement of objectives of forestry practice and includes guidance on how these are to be operationalised. In this paper, legislation is considered as one of the means for operationalising policies. The objectives in the

policy are a reflection of the demands of stakeholders on forest resources. Since such demands evolve with time, national forestry policies have also evolved in order to provide guidance on how to meet the changing needs of their societies, as well as reflect regional and global concerns.

Forestry policies have evolved from simple unwritten intentions and statements that catered for a very small number of society 's requirements to today 's comprehensive and broad ranging expressions of multiple-stakeholder expectations on forest resources. For example, Goumandakoye (1996) notes that the initial forest policy of Kenya in the early 1900s was aimed at providing firewood to the Kenya-Uganda railway. Similarly, from 1930 to 1960 forestry practices in many Sahelian countries were aimed primarily at protecting land where groundnuts, a major export crop, were grown.

Given the increasing awareness of the roles trees and forests play in the lives of people, there has been a growing interest since the 1980s to examine whether existing national forestry policies provide sufficient guidance towards sustainably meeting forest-related needs.

This paper briefly examines the evolution of forestry policy objectives in Malawi, Mozambique, Tanzania, and Zimbabwe. In each of these countries, 20 to 50% of the total land area is under forests, with woodlands as the main form of forest cover. The authors recognise that the forestry policy-making process has evolved over time, and in many of these countries, the process has moved away from the top to bottom approach in which policies were dictated to the people by their governments, to a more consultative approach. This in itself has brought into play many stakeholders with varying demands on forestry. The process has also shifted the domain of forestry from the hands of central governments to encompassing many stakeholders, the principal ones being local communities, the private sector, and the international community.

The paper seeks to highlight factors that have shaped and continue to shape forest policy objectives and therefore the forest condition in the four countries, as well as the changing focus in forest management. The hypothesis is that in some of these countries, there is weak government commitment to forestry and long delays in revising the sector's objectives. Therefore, policies responding to broader political and socio-economic orientations have taken precedence over forestry policies in shaping the way the forest condition has evolved. There is scope for generalising the findings to the other countries in the region with similar forest cover, colonial history, as well as post-independence socio-economic regimes.

The paper is organised as follows: Sections 2,3and 4 review pre-colonial, colonial, and post-independence forestry. Section 5 presents a summary of major conclusions.

2. PRE-COLONIAL FORESTRY

The pre-colonial period was characterised by the absence of written records by the local populace on their utilisation and management of forest resources. What is known today about how people and forest resources interacted is based mainly on oral history recorded after this period, and on the records of early foreign explorers to the region.

Evidence available in some of these countries suggests that the land use systems in this period were sustainable (Kaoneka *et al.* 1999). For example, shifting cultivation and nomadic livestock rotation systems were practised. The long fallow period allowed the land to recover fully before the next rotation, whereas low livestock densities minimized over-grazing. This ensured sustainable productivity of land. However, there

were areas where people settled or lived in clusters for several reasons, and this could have resulted in deforestation and forest degradation due to dependence on limited land. For example, the Shona people of Zimbabwe are reported by Misana *et al.* (1996) to have settled around hill fortresses that were easy to defend against invaders. They farmed and grazed cattle in lower lying areas.

Forest resource management and utilization were regulated through customary laws. The authority on forest resources was vested in traditional leaders like chiefs, who were responsible for law enforcement and other management decisions. These leaders were effectively the custodians of the unwritten policies. This has been the tradition in many parts of Africa.

The traditional leaders were responsible for much less extensive land areas than those controlled by central governments today. Moreover, at that time there were fewer stakeholders with fewer demands on the forest estate. Their demands were mainly in terms of fruits, firewood and fodder for livestock, and simple building materials like poles and thatch grass. Forests were also used for spiritual purposes. These demands shaped the objectives for administering the forest estate. The means or instruments employed for achieving the desired objectives constituted management prescriptions on protecting and conserving trees and forests as well as on harvesting products from them.

2.1 Protection and conservation of trees and forests

There are many examples of how traditional authorities protected, conserved, and regulated the harvesting of trees and forests. For example, in Tanzania, chiefs like Kimweri of the Shambaa tribe declared some forests as traditional forest reserves to be used for rituals and cultural ceremonies. The Sukuma people of Tanzania established traditional forest reserves called Ngitili in order to protect medicinal plants and fodder during the dry period. In Zimbabwe sacred forests or sacred groves were set aside with tree cutting and access to such areas forbidden (du Toit *et al.* 1984). Also Gumbo (1998), cited in Chenje *et al.* (1998), reports that a number of tree species were protected in the Wedza Mountain area of Zimbabwe for their medicinal values, while others were left alone because people believed that cutting them would bring them bad luck. In Mozambique, communities in Serra-Choa are reported to have totally protected some forests for religious purposes (Virtanen 1999). These measures correspond to present-day gazetting of forests for specific purposes.

In some communities taboos were invoked in order to maintain control over such resources. For example, Mukamuri (1987) and Matose (1992) report that in Zimbabwe these taboos were based on the notion that the resources belonged to the past, present and future communities/generations. This effectively linked the forests to ancestral spirits, and also introduced the concept of intergenerational ownership of natural forest resources. In Mozambique, Virtanen (1999) reports that Serra-Choa is “replete with traditions about powerful ancestral spirits which protect natural resources and especially the sacred places in the form of mhondoro (ancestral spirits) lions or snakes”.

2.2 Harvesting and use of trees and forest products

In many communities there were specific regulations to guide harvesting of forest produce. Chimedza (1991) and Grundy (1990) report rules such as those regulating spacing between trees to cut, and others prohibiting the cutting of fruit and sacred

trees in Zimbabwe. Matose (1992) reports a number of rules including those restricting fuelwood collection to dry wood only, collection of bark restricted to one side of the tree only, and no collection of bark and medicines from trees that had previously been harvested. These restrictions guided the way the trees and forests developed after such interventions, and the communities formulated them with a desire to see the forest develop the way they wanted. In Mozambique, Virtanen (1999) reports that cutting of trees was regulated, as was the seasonal burning of grassland and bush. The latter was done under the supervision of local elders. There is considerable evidence that indigenous knowledge was capable of regulating resource management and utilization (Kaoneka *et al*. 1999). These taboos and rules could parallel modern forest legislation.

The following were present in the local communities to varying degrees:

- Intentions or objectives that guided protection and management of trees and forests;
- Recognised and respected authority over the resources;
- Knowledge and means that guided activities on trees and forests in ways which changed their structure, therefore being within the realm of forest management;
- Parallel role to present-day forestry management, in that forest reservation was practised on the basis of very localised interests which the communities subscribed to, while present day gazetting of forests takes on broader national and global considerations which local communities might not be aware of. There were also restraints and guidelines on managing and harvesting tree and forest products, much as we find today in forestry.

In essence, there was an unwritten sense of direction in some forestry matters of relevance to the local communities. In addition, there were regulations and other means to guide the related activities. During this period there were few demands on forests, the human populations were very low, the forest resources were abundant in many communities, and the communities had many other important priorities like food and security. These factors might explain the manner in which forestry business was conducted, which was in many cases less elaborate as compared, for example, with the way communities designed their security and defense strategies. However, there were some cases where the communities designed elaborate forest conservation, harvesting, and utilisation measures.

3. COLONIAL PERIOD

Colonial governments´ position on land and other natural resources

The four countries under review do not share the same colonial experience. Mozambique was under the Portuguese for some 476 years. Tanzania changed hands from German to British rule at the end of World War II, during which period the country was known as Tanganyika, with Zanzibar as an independent state. Malawi was a British colony, then known as Nyasaland. Zimbabwe and Zambia were also British colonies, known as Southern Rhodesia and Northern Rhodesia respectively.

One characteristic of all these colonial powers was how they acquired land for different purposes and functions. Natural forests were cleared for agriculture, settlement, and other infrastructure. In almost all southern African countries, the

forests are actually woodlands with limited commercial production potential. Therefore, they had little likelihood of being on the same plane as agriculture and other financially prominent sectors in terms of official attention. The colonial administrations introduced restrictions on local people's access to forests and land.

In Mozambique, commercial agriculture was only initiated in early 1870 when the Mozambique opium cultivation and trading company was established (Negrao 1995). Commercial agriculture evolved in two forms; viz. large-scale plantations by companies, and small-scale commercial farms by Portuguese settlers. Commercial agriculture introduced drastic changes with respect to land access and use by the peasants. In 1891,legislation was passed allowing the local people to have access to 1 hectare of land per household within the area conceded to the settlers. In 1909 the holding of land title by natives was repealed and a category of land reserves for Africans was created. Within the reserves, land occupation was flexible, but without the right to land titles (*ibid.*).

In Zimbabwe, the first land reserves for Africans were created by the British colonial power as early as 1894.By 1911, the reserves comprised 8.5million hectares of largely marginal land. About 60% of the estimated 700 000 indigenous population lived in these reserves, and since the population was still fairly small, degradation was not yet a problem (Whitlow 1988). By the end of the 1920s,however, as the farmers increased land under cultivation in order to cope with taxes and falling grain prices, the reserved areas began to show evidence of degradation. Livestock numbers were also increasing, compounding the degradation problem. During the same period, land held by settlers increased from 20%to 50%of the total land area.

In Malawi, the general thrust of colonial land law was to appropriate all land in Malawi to the British sovereign; entrust the administration of such land to the sovereign 's local representatives (first the commissioner and later, the governor); and later facilitate access by the settler community on the basis of private title. Since Africans had no title to land under colonial law, the only issue of concern was how to regulate occupation rights among them. The domain of customary law was severely curtailed. African land rights were left in great ambiguity – something that made their position insecure and created difficulties in the future (Phiri 1991).

In Tanzania, the German administration passed in 1895 the Imperial Decree regarding the creation, acquisition and conveyance of land, in which all Tanganyika was declared as Crown Land vested in the German Empire. This decree facilitated the alienation of land from tribal areas and the establishment of plantations. Under British rule, the enactment of the Land Tenure Ordinance Number 3 of 1923 (commonly referred to as Land Ordinance Chapter 113) declared all land in Tanganyika as public land and introduced the concept of rights of occupancy. According to this Act, rights over or inland were placed under the control of the British governor and were to be held, used or disposed of as rights of occupancy for the benefit of the indigenous people of Tanganyika (MLHUD 1995).

The colonial era therefore brought with it many changes in the lives of local people. The broad colonial policy declared "unoccupied " lands as state property. This period marked the beginning of disruption of common property regimes. Apart from present-day imbalances in access to land in some of these countries, the colonial administration was largely responsible for shaping present day forest resources and their guiding policies and management practices. As noted by Gondo *et al.* (1999), the most significant development during this era was the introduction of the concept of a

"state " or "nation ", and formal national policies and legislation. Forestry matters that had always been in the domain of local leaders were now being examined and even governed in the context of a district, province and nation. Some of the major features of the colonial period forestry are discussed below.

(a) Centralised forestry administration

The colonial administration imposed restrictions on access to trees and forest resources and introduced administrative tools for the national forest estate. However, recognition was given to local or traditional structures of administration in forest areas outside government control.

One form of controlling access was the gazetting of forests. Natural forests were gazetted as colonial government property, effectively putting these resources out of the reach of the local people.

Another measure was the creation of centralised administration of the national forest estate. Centralised administration evolved gradually and in different forms, and was shaped by the needs of the colonial authority. A number of tools, referred to as legislation in this paper, were put into place. These featured in different countries as decrees, regulations, acts, ordinances, rules, laws, etc. The legislation was to guide selected forest activities and the functioning of forestry administration units. In some countries this was done without any formal forestry policy to guide national forestry development. These administrative units initially had a shallow focus and a very narrow range of activities. A few examples illustrate this.

In Malawi, a precursor to the current forestry department was a scientific department that was established in Zomba in 1891,with a focus on planting mlanje cedar (*Widdringtonia whytei)* on Zomba Mountain as well as conducting some experimental work in the area. In 1910 this department became the Department of Agriculture. The first forest ordinance came into effect in 1911,with the Director of Agriculture as the overall forest authority (Kachule *et al.* 1999). Since then, Malawi had a number of forest ordinances, which guided forestry development. The 1926 forest ordinance is outstanding in that it transferred authority over forestry to the Chief Forest Officer. It also provided for the creation of village or community forests, known as village forest areas, and put them under the control of village headmen (*ibid.*). This marked the beginnings of central government encouraged community forestry; in other words, the first effective decentralisation of forestry resources management to local communities in the southern African region. Malawi did not have any formal forest policy until it became independent in 1964.

In Tanzania the Germans established a forestry department in 1889.The first forest ordinance was enacted in 1895 and provided for the creation of forest reserves. The German policies and rules were applicable to the whole of East Africa. The German *Kulturpioner* (settlers) cleared forests for plantations and farmland and indiscriminately cut trees for household purposes (Raumolin 1990). The British restructured the forest department in 1921,giving more emphasis to timber production. The British introduced the first forest policy in 1953 and a corresponding forest ordinance in 1957.These remained in force many years after Tanzania became independent.

There was no formal forest policy in Zimbabwe that guided the development of the sector during the colonial period. Forestry development was largely shaped by various regulations that guided the distribution of land among whites and blacks. It was also influenced by the administration of and pressure on land in the two communities'

areas. A forest department was established in 1920 in the ministry responsible for agriculture. At that time emphasis was on gazetting of natural forest with important commercial tree species, mainly in the western areas of Zimbabwe, and their eventual controlled exploitation. However, in the African reserves forestry was relegated to a minor role in the development process, and was also inadequately funded (Banks 1981). Between the 1930s and 1950,following the enactment of the Land Apportionment Act of 1930 and the translocation of some people to make way for the European settlers, traditional institutions were generally accepted and recognized by the state and the people as the natural resources managers in the reserves (Moyo 1995).

However, from 1951,when the Native Land Husbandry Act (NLHA) was enacted, to 1969, the natural resources management and control functions of traditional leaders were transferred to central government agencies. In 1954 the Forestry Commission was established under the Forest Act of 1948. The Commission assumed control of forest resources management. Following stiff resistance by the indigenous people, the NLHA was scrapped and replaced by the Land Tenure Act of 1969.This act once again returned the natural resources management and control functions to chiefs and other traditional leaders. Unfortunately this was at the time the war for independence was intensifying, which led to the traditional leaders being discredited as allies of the colonialists (Nhira *et al.* 1998). This, coupled with a rapidly expanding population and constant displacement by war, led to encroachment into woodlands as a result of the institutional vacuum created in most communal areas.

In Mozambique there was no formal forestry policy during the colonial period. However, number of decrees and forest regulations guided forestry business, including:

- The Land Law, law number 2001,May 16,1944.
- Protection of Soil, Forest and Wildlife, decree number 40040, January 20,1955.
- Forest Regulation Act, decree number 44531,August 21,1962.
- Reinforcement of Forest Regulation Act, legislative diploma number 2642,September 20,1965 (Nhantumbo and Soto 1999).

Despite the fact that emphasis was given to harvesting of forests for the generation of foreign currency, there was also concern over conservation and ecological aspects of the resources. This led to gazetting of animal parks, game and forest reserves and hunting areas. In fact the present protected areas were all identified and declared as such during the colonial era. In these areas the ecological and economic objectives were combined, in certain cases with the involvement of the private sector. While the colonial government allowed free access to these resources by the rural communities when harvesting for their own consumption, it denied them opportunities to generate monetary benefits (*ibid.*).

In all these countries the centralized forestry administration was initially preoccupied with the gazetting of commercially important natural forests and their exploitation. Environmental concerns were given attention, albeit with different emphases across countries. Apart from Malawi, which gave practical support to local community participation in forestry, the authorities in the other countries acknowledged the role of such communities and their leaders, but did not provide incentives for their wider participation in forestry.

Much as forests constituted the major land cover in each of these countries, the administration and management of such resources was not given much priority by colonial governments. Forest administration was initially placed under agricultural

departments. Even when forest departments were created, they were placed under ministries responsible for agriculture. In this way forestry departments were overshadowed by departments that commanded more government attention and resources although they were minor land users.

Further, forestry was largely guided by legislation on the conduct of business in the forests. Such legislation did not guide the development of the forests and the sector as a whole. The absence of a clear vision in some countries, and commitment in virtually all countries, on how forestry should have developed resulted in haphazard or uncoordinated development of the sector, which continued even after these countries became independent.

(b) Policies and guiding legislation

In the absence of a formal national forestry policy in practically all these countries, guidance on national perspectives on forestry matters was derived from existing legislation and writings of the forestry departments. Emphasis on many issues differed across the countries, especially in terms of implementation, and this can be illustrated through the following common focal areas in forestry, viz. production, protection/ conservation, and shared responsibility for the resources by major stakeholders.

Production

Under production, consideration is given to harvesting natural forests for commercial purposes, and the development and use of industrial forest plantations. In these four countries the early period of colonial rule was guided by economic objectives, giving much emphasis to harvesting the natural forests for commercial purposes. For example, in Mozambique, the Portuguese government encouraged selective exploitation of certain valuable indigenous tree species through long-term concessions or short-term licenses for export as processed wood and logs, with the latter being dominant (Nhantumbo and Soto1999). In Zimbabwe, Tanzania and Malawi a similar pattern emerged, with emphasis on selective harvesting in protected or gazetted forests.

Ecological and society-wide concerns were in some cases neglected, but the administrations were generally responsive to them when problems emerged. Raumolin (1990) notes that in Tanzania the Germans granted concessions for massive log harvesting for the European market, using destructive logging methods. In Mozambique, the Portuguese government issued a number of legal decrees and forest regulations in 1944.This was a result of strong pressure from forest professionals, but also due to a growing awareness of the adverse effects of forest destruction in the country. These decrees and regulations normalised to a certain extent the utilisation of natural forests and wildlife (Nhantumbo and Soto1999). In Zimbabwe, the concept of multiple uses of forests was introduced in managing reserved natural forests. Further, some permanent sample plots were established as early as 1935 to monitor the impact of fire and harvesting intensities as well as to yield information on forest productivity and stand changes (Forestry Commission 1997).

In all the four countries, this period marked the beginning of selective and non-sustainable harvesting of the natural forests, the introduction of industrial wood processing, and industrial plantations. The fact that corrective measures were effected later in the period as forest or environmental damage became clear is testimony to the fact that harvesting methods were destructive.

Protection/Conservation

There was no formal policy on protecting or conserving the forest estate in practically any of these countries. Only legislation addressed this issue. For example, in 1965 the Portuguese government in Mozambique issued a forest regulation that provided for a category of forests called conservation areas. These included national game parks, integrated national reserves, forest reserves, and other protected and fragile forest formations like dune or hill forests, watershed systems or water resources, and forests for military defense purposes (Nhantumbo and Soto 1999). The 1953 forest policy of Tanzania also provided for the protection of forest resources.

In Zimbabwe, there was a call for controlled exploitation of natural forests and setting up of managed forest reserves as early as in 1910 (Judge 1993). The Forest Act of 1948 targeted the protection of catchment areas and maintenance of vegetation cover in ecologically fragile areas. In Malawi the Forest Ordinances of 1911,1926,1936,1942 and 1947 had provisions for the protection or conservation of natural forest resources. Initially, the primary objective of forest management in Malawi was to protect the ecology through catchment area conservation. However, soon after World War II, the1942 forest ordinance was revised to meet both ecological and economic objectives. This necessitated the institutional reorganisation of the forestry sector into specialised departments in the late 1950s (Kachule *et al*. 1999).

These regulations were largely applicable to the forest estate under government administration. For example, in Tanzania the law effectively applied to about 30% of the forests that were gazetted as reserves, with the remaining 70% essentially under open access and without legal protection (Kowero 1990; Monela and Ole-Meiludie 1997). In Mozambique, about 40% of the forest cover was classified by the 1965 forest regulation as “alienated forest areas” in which forests could be cleared after authorisation (Nhantumbo and Soto 1999). These areas were largely woodlands and were mainly open access areas, despite the authorization for-use clause in government documents.

To compound this was the unavailability of sufficient human resources, even for the government forest reserves. Raumolin (1990) notes that German East Africa was twice as large as Germany but had only five higher forest officers and fourteen middle-range officers, making the implementation of the forest conservation acts of 1908 and 1909 ineffective. Nhira *et al*. (1998) note that forestry extension in Zimbabwe relied on the goodwill of agricultural extension officers and their administrators, largely because forestry was very much under-funded. Further, Banks (1981) notes that forestry in African reserves was relegated to a minor role in the development process and was also inadequately funded. In Malawi there were very few trained forestry officers. For example, in 1950 there were 3 professional officers, 8 European foresters and 41 African rangers (Hailey 1956).

Much as there were efforts to protect or conserve considerable areas of forests during the colonial period, lack of resources for their effective management continued to subject the forests to encroachment by increasing populations. Legislation in place was mainly enforceable on gazetted forest reserves, leaving vast forest areas unprotected and under open access. Further, the gazetting of forest reserves for conservation or protective purposes denied local communities access to these resources. In fact, in some cases people were expelled from such protected areas, and this has in some cases been a source of conflicts with governments up to the present time. The gazetting effectively disrupted resource tenure, in the sense that common property became state or government property and therefore no longer accessible to local people.

Shared Responsibility for Natural Forest Management

The extent to which the colonial governments involved other stakeholders in forestry differed from country to country. However, from the very early years of colonial rule the major players in formal forestry in all the countries were the government and the private sector. The latter obtained concessions and licenses from the government to harvest, process, and export forest produce. The active involvement of local communities was in most cases encouraged only minimally, and it varied very much from country to country, as the following examples illustrate.

In Tanzania the forest policy of 1953 demanded that all sectors of the economy from the individual villager to the central government should collectively shoulder the responsibility of preserving, developing, managing and rationally using forest resources. Apart from participating in fighting wildfires in the forest, there is no evidence that the local communities received significant government encouragement in the development and management of natural forest resources.

In Zimbabwe the 1948 Forest Act, which is still in place today, provided for voluntary self-regulation of forest resources in settler (European) areas, whereas forests in communal areas (where the majority of the people lived and continue to live) were controlled and their use regulated. Such regulation offered different capacities for people to participate in forestry. The Land Apportionment Act of 1930 and the Land Tenure Act of 1969 had natural resources management and control functions under chiefs and other traditional leaders (Gondo *et al.* 1999). However, it is doubtful that the government provided significant assistance, due to scarcity of forest extension staff, funding, and low priority accorded to forest resources in the socio-economic development of native areas.

In Malawi the 1926 forest ordinance provided for the establishment and protection of village or community forests known as village forest areas. These were under the control of village headmen. This effort received considerable government sup-port and by 1946,while the government forest reserves stood at 6866 km^2, the village forests covered 1054 km^2, nearly the same as the area under government forest plantations (1099 km^2). Further, training for management of village forest areas was initiated in 1926 (Kachule *et al.* 1999).

In Mozambique, the colonial government allowed free access to the resources by the rural communities without payment of any royalties when the harvested produce was for their own consumption. However, the same government denied the generation of monetary benefits for the communities living within and around these natural resources (Nhantumbo and Soto 1999).

It would appear that it was only in Malawi that the colonial government made serious efforts to actively encourage natural forest management by local communities. In Tanzania and Zimbabwe legislation and policies related to the involvement of local communities in the governance of natural forest resources existed, but they remained largely on paper and without significant government support.

4. POST-INDEPENDENCE PERIOD

This period saw the emergence of differences in both political and economic orientations of these countries. Initially Tanzania, Mozambique and Zimbabwe had socialist policies, with Mozambique leaning more to Marxism. Tanzania had a homegrown policy called ‘ujamaa’, which largely revolved around the way village life was conducted. Malawi

adopted a more capitalistic approach. These political leanings notwithstanding, all the four countries had strongly centralised governments, with different degrees of private sector involvement in production. Private sector growth was stifled in both Tanzania and Mozambique through nationalization policies. At independence Zimbabwe inherited a more developed private sector. Having seen the failures of naionalisation in Tanzania and Mozambique, Zimbabwe left its private sector intact. These political and economic orientations largely influenced the development of the countries ' forestry sectors.

It took considerable time for some of these countries to adjust their forest policies and accompanying legislation to cater for post-independence needs. Tanzania continued to operate with the 1953 policy and a 1958 Forest Ordinance (albeit with some modifications) until 1998 when a new forest policy was adopted. Mozambique adopted its first forest policy in 1998.Malawi put into place a new forest policy in 1964,two years after it became independent. Efforts to put into place a new forest policy in Zimbabwe have been going on for a long time, and a draft forestry policy of 1990 exists, but it has yet to get cabinet endorsement. According to Gwaze and Phiri (undated draft) the Zimbabwean government is guided in forestry policy matters by the Forest Act of 1948 that was amended in 1982.

Apparently many other African countries also operated with colonial forestry policies for many years after independence. For example, Akapelwa (1996) reports that Zambia continued with a 1960 forest policy until 1991,and further that the 1991 policy was formulated as a set of instructions to the Zambian forestry department. The policy did not encourage significant participation of the private sector, local communities or NGOs in forestry. Bayoumi (1996) reports that Sudan operated with the colonial policy of 1943 up to 1986,although the country became independent in 1956.However, Namibia moved fast: at independence in 1990 it did not have a forest policy, but had one developed by1992 (Siyambango 1996). Likewise, Kenya produced its first post-independence forest policy in1968, five years after attaining independence (Kojwang 1996).

The post-independence period in most Sub-Saharan African countries is characterised by two main economic regimes. There is a period when these countries came under intense pressure from international financial institutions like the World Bank and the International Monetary Fund to make significant economic reforms that affected many aspects of life and economic activity. This period is referred to as the structural adjustment programme (SAP) period. Prior to this period the economies of these countries operated differently.

4.1 Pre-Structural Adjustment Period

This period was initially characterised by economies that were centrally planned, with state ownership and/or control of most means of production and distribution. The role of market forces in allocating resources was very constrained. With the exception of Malawi, the countries had socialist oriented policies. Much as colonial forest policies and regulations remained in force for many post-independence years, macroeconomic and political policies gradually shaped events in forestry. For example, in Mozambique the ruling political party in 1977,1983 and 1987 issued important statements that virtually constituted the forest policy goals for the country. The nationalisation of wood processing industries in Zambia between 1968 and 1990,in Mozambique in 1977,and in Tanzania in the late 1960s to early 1970s were due to

political policies not foreseen in the forestry policies and directives of these countries. Yet these events had very decisive impacts on the development of forestry in these countries. For example, some of these actions scared away private investment in forestry, constrained the growth of employment opportunities in the sector, and curtailed the availability of government funding to the sector as governments were shoring up loss-making parastatal organisations. Further, political policies, which encouraged massive movement of people into communal villages in Tanzania, into settlement and communal areas in Zimbabwe, and into refugee camps in Mozambique and Malawi precipitated varying degrees of deforestation and forest degradation in these countries. In Mozambique the government abolished customary authority after independence (Virtanen 1999). This might have reduced the role of traditional or local structures in regulating natural forest management and use.

Even in Malawi, where a forestry policy was put into place in 1964 (after independence), Sakanda (1996) notes that it did not provide guidance on the direction of the sector in that it did not define the pressing issues in the forestry sector and strategies to address them. In fact there was a deliberate effort by the Malawi government to expand estate agriculture to the detriment of the forest cover.

The early years of independence brought major changes as national governments tried to bring immediate positive changes in the lives of their people. In some cases this resulted in political ambitions overriding economic logic, political policies replacing sectoral policies, and sectoral policies from other sectors having preference over forestry sector policies in their own domain. The results were varying levels of encroachment into forest areas as well as constrained growth of the sector. Further, forestry policies were not revised immediately after political independence to take into account the peace-time socio-economic orientations of the national governments. This was partly due to the fact that the economies of these countries were largely non-monetised at the time of colonisation. As time passed the pace of monetisation increased, and this pace was much faster for other sectors, such as agriculture, which were mainstreamed in government planning. Forests remained insulated from the monetised economy for far longer and therefore were marginalised not only in economic terms, but also in terms of policy attention. The lag in commercialisation of the forestry sector partly explains the apparent supremacy of political and other macroeconomic policies over written national forestry policies.

Also, during this period the objectives of forestry policies were mainly determined by what national governments and the political machinery considered appropriate, and were rarely based on what people wanted as reflected in the market place. Primary forestry production was wasteful as governments determined prices of such produce administratively and not on the basis of market forces. Secondary forestry production was more market oriented, although when governments were in charge, this led to gross inefficiencies, massive financial losses and bankruptcies. This gave way to privatisation of wood processing during the SAP period.

4.2 Structural adjustment period

This period witnessed major changes both on the political and economic fronts. The implementation of economic reforms, mostly known as structural adjustment programmes (SAPs) and backed by foreign financial institutions, started in Malawi, Tanzania, Mozambique and Zimbabwe in 1980,1986,1987and 1991 respectively. These

reforms place emphasis on a number of things, including increasing private sector involvement in the national economy, trade liberalisation, and reduction in fiscal deficit.

These policies demanded major re-orientations in the environment in which economic activities operated. The countries gradually shifted from the pre-SAP centrally planned economies to decentralized economies that were increasingly becoming market oriented.

On the political front, this period also witnessed significant achievements in democratisation in these countries, with increased emphasis on people 's participation in decision-making. This process has precipitated, in some countries, significant diversion of resources necessary for economic development into servicing the political machinery serving the democratisation process.

In Malawi, it is reported that multi-party political systems contributed significantly to massive deforestation in some areas. Firstly, in their political campaigns, some politicians promised land from the protected forest areas if voted into power. When people voted for pluralistic government, most of the protected forests were heavily encroached. Secondly, the "freedoms " granted by the pluralistic system of government effectively silenced some forestry legislation, e.g. one that provided for strict control over the use of products from customary land. Firewood and charcoal obtained from such land are now sold openly without fear, a practice that was previously illegal (Jumbe *et al.* 1999).

The SAPs and democratisation have far-reaching consequences for forestry. For example, the SAPs discourage government monopoly on forestry and promote private sector development in forestry, including taking over some government responsibilities. They are also blamed for reduced government spending on the sector. Democratisation encourages local people to effectively participate in decisions over these resources, including their ownership and management. These and other things implicit in such political and economic orientations demanded profound changes in the forestry policies and legislation inherited from the colonial period and the pre-SAP era. However, these countries continued for along time to operate in the SAP period with pre-SAP forestry policies and legislation. Tanzania initiated some amendments to the policy document in1986, but it was not until 1998 that a new policy emerged. Malawi had a revised policy in 1996 and a revised forestry act in 1997.The revision process in Mozambique took six years, yielding the first national forestry policy in 1997.Zimbabwe still continues to operate on the basis of an amended1948 Forest Act. A 1990 draft forest policy has yet to obtain cabinet approval.

The revision of the forestry policies and legislation appears to be not so much a result of the political and SAP policies; rather it seems to reflect developments in forestry worldwide. A number of planning frameworks emerged even before some of these countries started implementing SAPs and when pressure for democracy was not so intense. Such frameworks arose from various demands on the sector, including the implementation of international agreements and conventions related to forestry, such as UNCED, Agenda 21,Chapter 11 and Forest Principles, Convention on Biological Diversity, Convention on Climate Change, Convention to Combat Desertification, and Convention on International Trade in Endangered Species of wild fauna and flora (CITES). Moreover, some environmental groups exerted pressure on governments to change the manner with which forestry business was conducted. Pressure to abandon logging in some mountainous areas of Tanzania is one such example.

Loading Brachystegia logs on lorry for the mines in Zambia (Photo: G.Kowero)

The planning frameworks that evolved in the region included National Forestry Action Plans, Forest Master Plans, Forest Sector Policy Reviews, and several others. These created conditions for revising national forestry policies and legislation or putting these into place where they did not exist before. The national forestry sectors therefore responded primarily to these international forestry orientations and less so to SAPs and democratisation pressures. The fact that the two sets of forces or influences were in place at the same time made it possible for the sector to make provisions for accommodating both the political requirements of democratisation and the economic demands of the SAPs.

This was in addition to accommodating other requirements implicit in a number of international agreements and conventions, and those of multiple local stakeholders. This process created, within the four countries, a state of confusion characterized by conflicting sector policies and poor coordination (Gondo 1999). Further, the continuing emergence of new issues that evolve into international agreements and conventions has precipitated a continued state of planning within the forestry sector that seeks to accommodate new and emerging trends in forestry and related sectors. This has considerably strained national institutional capacities and financial resources, as well as undermined long term planning. The latter is of serious concern for primary forestry production.

The major features of the present forestry policies that emerged from this process are discussed below.

4.2.1 Decentralisation and tenurial arrangements for managing forest resources

Even before the above forces acted on forestry, several central governments were already on the path of decentralising the administration of forest resources through delegation of authority and responsibilities to local governments. The local governments had their own policies and priorities, which at times conflicted with central government

policies on forestry. Further, the administrative structures for central and local government forestry were in some countries in different ministries and without effective coordination. This decentralisation was largely a reorganisation of forestry administration within the government machinery, and it rarely extended to involving stakeholders outside government.

However, present day forestry policies give considerable emphasis to the decentralisation of forest ownership and management to sectors outside government. The process is now being pushed forward to effectively involve local communities and the private sector. The policies include strategy statements, of varying clarity and emphasis across countries, on how governments intend to actively promote this. A few examples are given below as illustration. The forestry policy of Malawi emphasises, among other things, the need for:

- "Establishing appropriate incentives that will promote community based conservation and a sustainable utilization of the forestry resources as a means of alleviating poverty, including on-farm trees and fostering the growing of trees by all sections of the community to achieve sustainable efficiency of wood and forest derived products;
- Establishing a framework for community ownership and management of customary land forest resources on the basis of management plans agreed with government, and provides for community participation in co-management of forest reserves " (GoM 1996).

The corresponding statement from the forest policy of Tanzania with respect to involving the private sector and local communities in managing central and local government forest resources states:" To enable participation of all stakeholders in forest management and conservation, joint management agreements, with appropriate user rights and benefits will be established. The agreements will be between the central government, specialised executive agencies, private sector or local governments, as appropriate in each case, and organised local communities or other organisations of people living adjacent to the forest " (URT 1998). The policy therefore provides for establishment, ownership and management of central and local government forest reserves, forests on public lands (non-reserved forestland), and private and community forests. On community forestry the policy states: "Farmers will be entitled to have owner rights of indigenous species including reserved species and not only planted exotic ones. Village forest reserves will be managed by the village governments or other entities designated by village governments for this purpose, such as NGOs, user groups, associations,…" (*ibid.*).

In Mozambique the participation of rural communities in integrated management of natural forests and fire is seen as an important social policy objective. It represents a departure from an earlier emphasis on participatory reforestation and afforestation programmes. In Zimbabwe, a policy review in 1991 made a number of recommendations on community managed forests, some of which encourage sustainable management and utilisation of indigenous woodlands by local communities (McNamara 1993).

In all these countries there are directives giving ownership, authority and management of natural forest resources and trees to local communities. However, it is only in Malawi that such a practice received much support during the colonial period, died later, and emerged again recently. Governments are also clearly encouraging partnerships with other stakeholders in natural forest management. In the reviewed

policies the roles and responsibilities of the main stakeholders in policy implementation are very clear. The main stakeholders identified include government, local communities, the private sector, NGOs, and the international community. The main formal stakeholders during the colonial era were government and the private sector. The present forestry policies are therefore more inclusive of both national and international interests.

However, in all these countries central governments and local communities will continue, for the foreseeable future, to be the main stakeholders in forestry. Governments shall continue to be custodians of forestry policy; consequently, they will be interested in seeing how the whole sector develops. Further, governments, NGOs, and the international community shall continue to safeguard the sustained availability of public goods and services from the sector. The profit-oriented private sector is unlikely to invest in these areas in the near future. The concern of the private sector should be how to conduct its operation so that the availability of these public goods and services is not jeopardised. However, the major areas for private sector participation will continue to be in plantation forestry, industrial wood processing, and trade in forest products. Private sector and local community investment in research and training will continue to be minimal, leaving these areas largely in the domain of governments and the international community. NGOs and governments will continue to feature strongly in extension. Therefore, each of these stakeholders has a particular niche in forestry. The challenge is how to coordinate all these efforts for maximum impact.

4.2.2 Enabling environment for policy implementation

The policies contain statements on how an enabling environment for implementation should be realised. Some of the considerations include enactment of laws/regulations where necessary, provision of extension, financial and information incentives, partnership in management and conferring of ownership and other rights on trees and forests.

The bulk of the strategies to be employed aim to "encourage " and "promote " certain practices and initiatives. However, compared to past policies many present-day strategies are much more specific on how to go about promoting and encouraging. For example, the Tanzanian forest policy states:

- "An enabling environment for private sector involvement in forestry will be created. This involves clear ownership and tenure rights, information on forest resources and raw material, financial incentives and credit facilities, improved access to markets and marketing of products as well as effective training and extension.
- The legal framework for promotion of private and community-based ownership of forests and trees will be established " (URT 1998).

The Malawi forest policy has the following example strategies:

- "Establish a Fund to support local community forestry activities.
- Prepare and regularly update management plans for all timber plantations and key fuelwood/pole plantations, outline management plans for key forest reserves and model plans for representative Village Forest Areas (VFAs).
- Ensure that the VNRMCs (Village Natural Resources Management Committees) are entrusted with the responsibility to collect funds from sale of produce from customary land " (GoM 1996).

Firewood collection from miombo woodlands (Photo: G. Kowero)

The Mozambican forestry policy emphasises certification of forestry products as one way of managing the resource sustainably. It further states that forest exploitation has to be based mainly on long-term concessions, but allowing for fewer short-term licenses, both of which have to be guided by sustainable management plans.

The creation of this enabling environment will require considerable human, material and financial resources, as well as active support by central governments and other stakeholders.

4.2.3 Gender considerations

Unlike previous ones, some of the present policies are very specific on gender issues. This is a significant departure from the past in that the role of women in forestry is acknowledged and their participation encouraged. However, clarity of emphasis on women differs from country to country. For example, some of the Tanzanian policy directives on women state:

- "Extension on agroforestry practices will be gender sensitive and women 's preferences on species selection will be given due consideration.
- Clearly defined forest land and tenure rights will be instituted for local communities, including both men and women.
- Women 's involvement in forestry activities will be promoted " (URT 1998).

In Malawi, the policy has a section on gender that seeks to involve women in all forestry activities from growing of trees to harvesting, processing, and marketing. Further, the policy aims at developing various strategies pursuant to this, including to "ensure that women in the Forestry Department are offered access to equal opportunities for promotion, training and career development " (GoM 1996).

Unlike the Tanzanian forestry policy, the Malawi one considers in greater depth the involvement of women in all sections of the forestry sector.

4.2.4 Regional and global concerns

National governments honour various bilateral and international agreements and conventions to which they are signatories. Although no specific mention is made of many of these conventions and agreements in the policy objectives and strategies, the thrust of the policies largely conforms to the requirements of these agreements. An example is the Tanzanian forest policy statement that "Internal trade and exports of forest produce, excluding those regulated by international agreements of which Tanzania is a party, will be promoted " (URT 1998).

According to Gondo (1999), the focus of these conventions and international agreements is on new and additional financial resources, technology transfer, loss of biological diversity, poverty alleviation, and provision of frameworks for international cooperation. The countries in the southern African region have had varied experiences with these conventions and agreements. There have been poor in-country consultations on the conventions. Further, the countries have small delegations to and inconsistent representation in international dialogues on the conventions. As a result, the region has exerted little influence on the outcomes of these dialogues. Also, the implementation of the conventions requires significant human and financial resources, largely beyond the means of these countries. Some conventions, whilst recognising the sovereignty of states, violate this principle on the grounds of global significance and weight given to consumer countries (*ibid.*).

Despite these shortcomings, the countries in the region have made notable progress in implementing these conventions and international agreements. For example, the Convention on Biological Diversity (CBD) can be credited with the development of best practices and the dissemination of lessons for dealing with the global problem of alien species that threaten biological diversity in Kenya, Malawi and South Africa. Furthermore, important projects in the region are being implemented under the umbrella of CBD, including the Lake Malawi/Nyasa Biodiversity Conservation and the SADC Regional Biodiversity Programme. The Convention on International Trade in Endangered Species (CITES) can be credited with the development of strong institutions for implementing its mandate, improving legislation and enforcement mechanisms on some aspects of the convention, promoting strong institutional linkages between law enforcement and management institutions, and improving cooperation between countries with common resources. The International Tropical Timber Agreement (ITTA) is not subscribed to by many countries in the region, but it has benefited the region in terms of assistance in developing criteria, indicators and other guidelines for sustainable forest management, as well as through technical support and capacity building (Gondo 1999).

4.2.5 Emerging/new areas and issues

Current policies address new or emerging areas like eco-tourism, environmental impact assessment, transparency in forestry dealings, and criteria and indicators for sustainable forest management. They also give more emphasis to areas previously treated lightly, such as forestry extension, agroforestry, research and training, inter-sectoral linkages, and broader financing mechanisms for the sector. With respect to the latter, for example, some strategies outlined in the Malawi forest policy aim to:

- "Reduce dependence on government budget by maximising use of existing international arrangements that provide financial support to national forestry activities of global significance.

- Facilitate the institution of arrangements that enable revenues from economic forest-dependent activities outside forestry, such as water supply and hydroelectric power generation to be used to enhance the protective and in-direct economic functions of forests ” (GoM 1996).

With respect to ecotourism, the Tanzanian forest policy sates “… Private sector and community involvement in developing eco-tourism products and services such as lodges, trails and guided tours, will be promoted. Linkages and co-operation with other sectors involved in wildlife based tourism development will be promoted. Establishment of an appropriate legal framework to regulate ecotourism in forest areas will be developed in the context of the tourism and other appropriate legislation ” (URT 1998).

There are many other examples illustrating the shift in focus and emphasis of current policies, together with the clarity of policy objectives and corresponding strategies on many issues that never featured in or were treated lightly by previous policies. In this manner the current policies not only cater fora significantly greater number of stakeholders, but also take on many new issues that in the past did not constitute the portfolio of the forestry sector.

5. CONCLUSIONS

In both the lusophone and the anglophone countries discussed in this paper, the following generalities emerge:

(i)There have always been intentions or objectives for managing and using forest resources in many local communities, as well as recognised and respected authority and means for operationalising such intentions.

(ii) The forestry sector has, in many cases, lagged behind other sectors in revising its policies and legislation to respond to many socio-economic and political developments. Policies driving such developments have for quite some time taken precedence over forestry policies with far-reaching consequences on forestry. This is in agreement with the initial hypothesis.

(iii) Recent policy revisions appear to be largely attributed to global shifts in environmental thinking and in the way forestry business is conducted, and less so in response to internal or national political and socio-economic policies. Again this partly alludes to the initial hypothesis.

(iv) Current policies demonstrate a very clear shift in emphasis from previous ones.

Significant shifts are from:

- emphasis on management of plantations of exotic tree species to one on better management of natural forests;
- centralised forest ownership and management to decentralised, devolved and joint management and ownership;
- forestry practice revolving around tree and forest management to forestry as rural development or as integrated land management;
- a heavily service-oriented forestry practice to sustainable profitable forestry;
- heavy emphasis on exports of industrial roundwood to increased emphasis on meeting a myriad of domestic socio-economic and ecological needs;

- forestry as largely a male activity to one that effectively incorporates women as partners;
- a very localised or national focus to a much broader one that even considers sustained production of international public goods;
- policies that were out of tune with political and socio-economic realities of the time to ones that are in tandem with prevailing circumstances;
- intra-sector oriented policies to ones involving or embracing many relevant sectors of the economy;
- a diffused or unclear environment for policy implementation to an enabling one that is very clear on many strategies to employ. The strategies include financial incentives, legal provisions, empowerment, rights, roles and responsibilities for major stakeholders.

(v) Many forestry sectors have and continue to accommodate various international agreements and conventions in their policies and plans. Donors and foreign lending institutions continue to support the sector, but they have different approaches to forestry. These developments have precipitated a situation whereby some forestry departments/ services have been caught in a loop of continued planning to suit these demands. The consequences include a strain on both human and other resources necessary for implementing the forestry plans, continued confusion in the sector brought about by these demands, and the loss of a long-term planning horizon in forestry.

The successful implementation of these conventions and other international agreements alongside national forestry plans requires that the following be addressed:

- harmonisation of relevant policies and legislation;
- development of an institutional framework with clearly defined responsibilities, procedures and accountability;
- development of clear mechanisms for consultation and stakeholder participation;
- development and mobilisation of qualified human resources;
- development and mobilisation of financial resources;
- establishment of systems for information generation and dissemination.

ENDNOTES

1. This paper also appears as: Kowero, G., A.R.S. Kaoneka, I. Nhantumbo, P. Gondo, C.B.L. Jumbe. 2001. Forest policies in Malawi, Mozambique, Tanzania and Zimbabwe. In: M. Palo, J. Uusivuori and G. Mery (Eds.) *World Forests, Markets and Policies*. World Forests Volume III, Kluwer Academic Publishers, Dordrecht/London/Boston. pp. 311-326. It is reproduced with kind permission of Kluwer Academic Publishers.

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12.
Policies and gender relationships and roles in the miombo woodland region of Southern Africa

M. Chitiga and N. Nemarundwe

ABSTRACT

Government policies may have indirect or direct effects on the environment as well as on various natural resource users. These effects may be different for men and women given that these two gender groups are essentially involved in different activities and are found in different proportions in the rural areas where the majority of the population depend on miombo woodlands for their livelihoods. This paper uses Malawi, Mozambique, Tanzania and Zimbabwe as case studies to bring out the linkages that exist between policies and gender in the management of miombo woodlands. The analysis of the paper brings to light that some policies have differential impact on men and women and that because women, as opposed to men, are ill-equipped to benefit from most policies, they tend to be left out of the benefits from policies. This may mean that women increase their reliance on forests as a way to augment their incomes. This may result in the mismanagement of forests. The paper further notes that women are constrained from effectively making decisions on issues of access to and control over natural resources. This is mainly because of the way women are viewed by society and because of the low positions they occupy in different institutions. This treatment of women means that they may not fully participate in NRM programmes whose aim is to decentralize control and management of natural resources to rural communities. As a result, failure to consider this gender difference may mean that miombo woodlands together with other natural resources may continue to be mismanaged.

Key words: gender, policies, miombo woodlands, decentralisation and institutions.

1. INTRODUCTION

Many government policies do not incorporate any environmental objectives when designed but at implementation they may have unintended direct and /or indirect effects on the environment. Such effects may have different impacts on different people depending on, among other things, their gender. The 1995 World Summit on development called for the provision to women of equal access to productive resources in addition to strengthening their capacities to control resources in their own right. This call was made partly due to the realization that the roles of policies and institutions in determining people's choices and lives may have significant differences between men and women. In relation to forestry management, policy and institutions affect people differently, for example according to how the following questions are answered:

- Do different groups value resources differently?
- What are the roles and responsibilities of the different groups regarding forest management?
- Who controls access to resources and who makes decisions about them?
- Who benefits from each activity or enterprise and who bears any associated costs?
- How do relationships and roles influence the decision making of the group regarding resources?

If the reactions of males and females are different, we can expect that the answers to the questions above depend on, among other things, gender.

Since the colonial period there has been a wide range of policies and programmes that have been implemented and which have affected households and their use of forest products. It may be misleading to evaluate the impact of policies on a country's people under the assumption that they are gender neutral.

The last two decades have witnessed a "paradigm shift" in conservation and natural resource management (NRM) away from costly state-centered control towards approaches in which local people play a much more active role (Shackleton *et al.* 2001; Kajembe *et al.* 2001). Coinciding with the mainstreaming of participatory approaches in development theory and practice, there has been a policy shift to advocate that local resource users and their organizations play a much more active role in the protection and management of land and other natural resources (Shackleton and Campbell 2001). Concomitant and complementary to this was the recognition that state control has been largely unsuccessful, costly and financially unsustainable requiring a new decentralized approach to local level resource management. These reforms purportedly aim to increase resource user participation in NRM decisions and benefits through the transfer of management authority to local level organizations. Studies that have been done to test the degree of the power shift and decision making to the communities (for example, Goebel 1998; Meinzen-Dick and Zwarteveen 2001, Nabane 1997) show that such power and decision making has generally shifted to men and rarely to women.

The women and environment literature highlights that women have stronger links with the environment than men, yet, despite their strong links, women do not control land and related natural resources such as forests (Shiva 1988). Allocation, occupation and use of communal lands is generally done through government selected bodies such as Rural District Councils in Zimbabwe, which grant occupation according to customary law where an adult married man is allocated land for use by him and his family. Thus, women only have access to land and related natural resources through their spouses or

male relatives (Chipika *et al.* 1998). Even for Malawi where some areas have matrilineal systems, Kachule *et al.* (1999) report that, overall, women have limited access to and control over productive assets and social services. Cromwell (1992) reports that female-headed households in Malawi are clustered on the smallest holdings of land and they tend to be the ones who cannot meet their food needs. This is despite the fact that they have a central role to play in various sectors of the economy including agriculture. Thus women are alienated from controlling land and other natural resources because their access is secondary while that of men is primary, with only a few exceptions. This may have an impact on the way men and women manage natural resources in communal areas.

In Africa more has been written on women and agriculture than on women and forestry. However, of late, the contribution of women and men as distinct social groups in the forestry sector is increasingly being recognized (Nyoni 1989). The role of women has received special attention because more women than men collect and use a variety of forest products (Fortmann and Bruce 1993; Fortmann and Nabane 1992). Women are more heavily involved and dependent on woodland products than men. Fortmann and Bruce (1993) observe that there is often a clear division of the use of trees and tree products according to gender. Fortmann and Nabane (1992) argue that women have the major (often, sole) responsibility for providing the household with tree products such as fuelwood, fodder and food. As a result, both they and their households suffer when they lose access to the trees that provide these products. Therefore failure to consider gender is especially distorting in Africa where women and men in the same household may use natural resources in separate production systems and with different strategies.

This paper looks at four southern African countries, namely, Malawi, Mozambique, Tanzania, and Zimbabwe to explore whether there are any gender[1] related impacts of policies and programmes related to forestry. It examines three kinds of policies and programmes namely,

- Macro-economic policies,
- Sectoral policies and
- Decentralisation policies.

The subject matter of this paper is quite complex. Not only is there no consensus but there is also little and scattered knowledge on the impacts of policies on the environment including forests in the southern African region. There is also little known about the differences or similarities in the impacts of policies and institutions on management of miombo woodland along gender lines. Thus, it is important to emphasize that the paper aims to examine the potential linkages that exist and to highlight the relevance of gender considerations in forest management.

The rest of the paper is arranged as follows: section two gives a brief background of the study countries. This section discusses the role and situation of women as opposed to that of men in addition to a brief economic background of the countries. In section three the paper discusses possible impacts of macroeconomic and sectoral policies on gender in the management of miombo woodlands. In section four the discussion is on the impact of decentralisation policies and programmes on gender and how this might affect the management of woodlands. Section five summarizes the main ideas raised in the paper.

2. BACKGROUND TO THE STUDY COUNTRIES

2.1 The roles of males and females in rural households

In Malawi, Mozambique, Tanzania and Zimbabwe, the majority of the population lives in rural areas. Women make up a larger proportion of the rural population and rural poor than men. In Malawi 52% of the population are women, 93% of whom are in rural areas. Sixty-five percent of Zimbabweans live in communal areas, and of these, 85% are women. More than half the population of Mozambique is made up of women (51.4%) and 80% of these live in rural areas. In Tanzania 68% of the population lives in rural areas, of which more than half are women (Byers 2001). In all four countries, there is empirical evidence that men and women in rural areas are essentially engaged in different activities and have different responsibilities. For instance, in Malawi, males are usually preoccupied with non-farm activities such as fishing, trading, casual work and own businesses as well as socializing. Women are concerned with taking care of the family and house including fuelwood gathering (Carr 1991). Women in Zimbabwe contribute about 70% of the agricultural labor force yet they very rarely control land for agriculture. This has caused women to be left out in programmes that may benefit the agricultural sector as well as the environment (Carr 1991). In Tanzania, Monela *et al* (2000), report that although men and women work together on the fields, women have an extra load of crops that men are not involved in. As a result, women are more involved in agriculture than men.

2.2 Overview of the countries

The four countries selected for the study are host to the miombo woodlands, on which the majority of the rural population depends. The miombo and other woodlands ecoregion extends[2] for approximately 3.6 million km^2 (Byers 2001). This ecoregion extends from the Angolan escarpment in the west to the coastal woodlands and the forests of Mozambique and Tanzania in the east. To the west and southwest it is bounded by Kalahari Acacia woodlands in Namibia and Botswana and to the south by Highveld grassland and mixed Acacia Woodlands in South Africa. The northern boundary is the moist evergreen forest of the Congo Basin and the dry Acacia Commiphora bushland of Tanzania on the northeast (Byers 2001). Miombo woodlands are the most extensive woodlands in the countries of the study as shown in Table 1. Furthermore, for all the countries except Tanzania, where the ecoregion coverage is substantially lower than in the other three countries, the population living in the ecoregion is close to half the total national population. Most of the woodlands, as can be expected, are found in the rural areas where the majority of women live.

Table1. Miombo ecoregion proportion and population in the countries under study (1997)

Country	Ecoregion as percent of total country area	Ecoregion population as percent of country population
Malawi	75	51.7
Mozambique	80	47.8
Tanzania	48	30.6
Zimbabwe	90	57.5

Source: Byers (2001).

Campbell (1996) estimated that in 1990, 40 million people lived in areas covered by or previously covered by miombo woodlands and that another 15 million urban dwellers relied on miombo wood or charcoal as a source of energy. The woodlands provide a range of products from medicines to food to building materials to fuel and agricultural support. They are used for other physical needs as well as for spiritual purposes. They also contribute to the quality and quantity of the water in these areas and to the global climate. Thus, the miombo woodlands are central to people's lives making their sustainable management and use of paramount importance. It is in such a context that it is important to understand the differential gender impacts, if any, of policies and programmes, on the management of these woodlands.

The study countries, with the exception of Zimbabwe, are generally ranked within the very poor category of countries within the region as shown by the high human poverty indices in Table 2. These statistics have changed substantially in some of these countries in the recent past. For example, Mozambique has exhibited much higher economic growth rates, Tanzania has reduced its inflation rate from 34% in the mid 1990s to about 5% per year, the inflation rate in Zimbabwe has grown to about 116% in early 2002 while the parallel exchange rate for the local currency to US dollar is about six times the official rate. Malawi has also experienced a tremendous erosion of its local currency.

Table 2. Gross Domestic Product (GDP), per capita incomes and human poverty index

Country	Average Annual GDP growth rate % 1988-1997	Per Capita US$, 1997	Human Poverty index %Value, 1997
Malawi	3.5	169	47.7
Mozambique	4.2	126	48.5
Tanzania	2.8	160	39.8
Zimbabwe	2.5	705	25.2

Source: UNDP/ UNEP/ World Bank/ WRI, 2000, UNDP/SADC/SAPES, 1998.

Since the poor are more reliant on natural resources than the rich in rural areas (Bradley and Dewees 1993), this may imply that reliance on natural resources is most likely significant in these countries. Furthermore, as pointed out earlier, most of the rural population consists of women and we may expect that there are likely to be more females relying directly on woodland resources than males. Also in many countries and in Zimbabwe in particular, as reported by Tichagwa (1998), the proportion of women falling in the low-income category is greater than that of men.

The countries are characterized by dependency on production of a small range of primary commodities. In most cases each country has traditionally been dependent on the export of a single commodity, i.e., tobacco for Zimbabwe and Malawi, coffee for Tanzania and fish & shrimps for Mozambique. The industrial and agricultural sectors still bear the characteristics of the colonial era as post-independence policies have largely failed to reconstruct and transform these economies (UNDP/SADC/SAPES, 1998). Agriculture contributes on average 34% of Southern Africa's gross domestic product, employs 80% of the total labor force, the majority of whom are women, and accounts for about 26% of the raw materials to industry (SADC 1996). Cash cropping in the

Southern African region accounts for at least 60% of export earnings (Byers 2001). Hence, agriculture promotes growth in its own right and in the manufacturing sector. The importance of agriculture, which is inversely related to the survival of natural forests, suggests that it is important to further investigate the sustainable management of these natural resources in these four countries.

3. POLICY IMPACTS

3.1 Macroeconomic policies

3.1.1 Colonial period

The main policy thrust of the colonial governments was in favor of minority white settlers. Economic policies contributed to overvaluation of national currencies on foreign exchange markets. In addition, tariffs and quotas on trade that protected some favoured domestic sectors were put in place. Other policies of the time resulted in encouraging or forcing African males to seek urban employment. As a result, most women were left to look after the rural home and to take care of agriculture in their rural areas (Tichagwa 1998). Women were therefore more likely to be in touch with natural resources than men. Most of the policies had no deliberate recognition of the welfare of this group of farmers.

3.1.2 Post- colonial period

At independence, most countries inherited social, political and economic inequalities between the white settlers and the local people due to colonial policies. The new native governments sought to redress these as well as to promote economic growth. Thus, most post independence macro policies implied growth with equity[3] , for example through the National Development Plans of Zimbabwe, the 1978 National Rural Development Programme (NRDP) of Malawi and the 1967 Arusha Declaration of Tanzania. Governments borrowed heavily both locally and abroad in order to not only repair the damage to infrastructure caused by wars or conflict in the colonial periods but to also cater for the large group of poor Africans at independence. Most prices were either state controlled or managed, including interest rates and currency exchange rates. Basic goods, and basic social services were heavily subsidized. Governments were forced to increase public sector employment in order to accommodate the increasing numbers of school leavers (Duncan and Howell 1992). Policy making was thus highly centralised, (Bagachwa *et al.* 1995). These needs, which implied increased government spending, were a main feature of the internal policy weakness of these countries.

Countries faced many problems for several years after these expansionist policies were implemented. These included huge balance of trade deficits and debt burdens, high interest rates, high inflation and high unemployment, all of which combined to increase poverty (UNDP/UNEP/World Bank/WRI, 2000). For instance, in the early eighties, 60% of Tanzanians lived below the poverty line and the majority of those lived in rural areas (Bagachwa *et al.* 1995). As poverty increased, we can expect that the rural poor, the majority of whom are women, would have been forced to rely excessively on forest resources. Bagachwa *et al.* (1995) report that for Tanzania during this pre economic reform period, the natural resource base was coming under threat because of continued clearing for agriculture and an alarmingly increasing demand for firewood. Countries

were then forced to make a complete turnaround in policy orientation by structurally adjusting their economies.

3.1.3 Reform period

The policies pursued in post independence, ostensibly to redress the imbalances of the colonial periods landed most of these countries in macroeconomic crises. As a result there was intense pressure from international financial institutions for economic reforms, away from centrally planned economies towards more market-oriented nations. Much has been written about the impact of countrywide reform policies on the environment and on society. Most of these studies note that a primary problem is to establish the nature of the links between the economy and the way it responds to structural adjustment, and the specific micro-economy in which rural people operate. In this paper, the same problem is noted together with an additional one of generalizing over several countries. However, there appear to be some fairly well established stylized aims, instruments to employ and results of macroeconomic policies of adjustment in these countries. All these hold potential for influencing the use and condition of natural forest resources, as well as affecting men and women differently and possibly reshaping their roles.

The broad aims of structural adjustment policies (SAPs) are:

- To bring about equilibrium or manageable deficits in the fiscal budget and the balance of payments,
- To reallocate domestic resources to the more productive sectors,
- To reduce the role of the state in commercial and productive activities and
- To promote the private sector and the role of market forces (Duncan and Howell 1992).

The range of instruments normally used to achieve these goals is:

- Liberalization of foreign trade, with tariffs generally replacing quantitative restrictions on imports and with attempts to provide incentives for exports, via for example, devaluations,
- Monetary restraint, implying also increasing interest rates,
- Lowering or removal of subsidies,
- Reducing reliance on administered prices, including also foreign currency,
- The reform of public enterprises and
- Privatization of some state-owned enterprises (Duncan and Howell 1992).

As governments restructured their budgets in order to reduce budget deficits, they were forced to reduce expenditure. The reduction in government expenditure has meant reductions in the resources available for the provision of economic and social infrastructure. Reductions occurred in many spheres such as in health and education, in production sectors like agriculture and in production factors like labour. This had adverse effects on the poor and in particular their children. Chisanga (1990) reports that in many African countries, women and children, especially girl children, carried a disproportionate share of the costs in cuts in government spending on education. Chisvo and Munro (1994) also arrive at a similar conclusion for Zimbabwe. Girls are withdrawn from schools in order to use the scarce resources on the boy child. These authors further argue that female illiteracy rates are likely to increase due to cuts in government expenditure, limiting women’s potential to earn formal

sector wages and forcing them to be more reliant on the land and other natural resources than men. Also since women and children are intensive users of health services they tend to suffer more than men as health fees increase (Chisanga 1990). As mentioned earlier, women are more preoccupied with child rearing than men, and therefore these adverse effects on children would also be mainly borne by women. Such policies could be expected to have led women into exploring ways to increase their income sources, with one potential avenue being increased reliance on forests where available (through, for example, extending area for agriculture, and selling firewood) and other natural resources.

In order to reduce expenditure, some governments were forced to retrench civil servants, and this led to reduced incomes and remittances to rural areas, thereby adversely affecting rural people dependent on remittances. Evidence exists that female-headed households, compared to those headed by males, are more reliant on remittances as a source of income in rural areas (World Bank 1996). Upon loss of this source women are expected to look for alternative sources of income (Chisanga 1990), and these are likely to include further use of natural resources. In addition, the retrenchments have encouraged significant urban to rural migration and encroachment on natural forest resources by these new and poor farmers. The retrenchments have also led to a booming informal sector and wood products are some of the most important of informal sector goods. Most directly affected were those previously employed in the formal sectors, the majority of whom were men. The fiscal policies thus had the potential to lead to conditions that might have caused overexploitation of natural resources, by both men and women, especially in rural areas where the majority of the poor are found.

The policy of currency devaluation is meant to raise the price of imports and increase consumption of locally produced goods at the expense of imported items. Devaluation is also meant to promote exports. The effects of these are to correct the trade imbalance. However, in the countries that have to import goods needed in the production process, such as the ones in this study, devaluation had the overall impact of raising virtually all prices in the economy (see, for example, Chipika *et al.* 1998). Rising inflation began to erode the rising nominal producer prices leading to falling real producer prices even in the face of devaluations (Bagachwa *et al.* 1995). Since women are in general dependent on fixed housekeeping allowances from their husbands, they suffered most in the face of rising prices. They found themselves trying to raise extra income through other activities (Chisanga 1990). Such activities include harvesting and trade in forest products. Bradley and Dewees (1993) report that surveys carried out in parts of Zimbabwe showed that one primary advantage of wood-related income generation activities is that they can be used to reduce risk in times of income scarcity, thus serving as safety nets.

The liberalization of prices and trade meant moving away from controls and regulation to a more market oriented approach. Together with the tight monetary policy implemented during adjustment, one impact of these liberalization policies was to increase interest rates, thereby benefiting savers and disadvantaging borrowers. Rural poor people are not savers and thus did not benefit from rising interest rates. Poor women in rural areas have very limited access to credit and this increase in the cost of borrowing made the situation worse (Chisanga 1990), even if borrowing was from the formal financial sector. Without credit, women could not fully take advantage of the market's encouragement to grow export crops and thus enhance their incomes. Yet, in the face of increasing hardships, the need to enhance incomes is greatest. Most probably women increased their reliance on the "free" natural resources under such circumstances.

It thus seems that throughout the history of these countries, the very poorest were seldom the target of macro policies that operated mainly in the framework of free markets, in which the poor have little capacity to participate. The rural poor therefore rarely benefited from the SAPs and often suffered from the unintended effects of these policies. Since this is the group in which most women are found we can infer that women have generally been left to rely on several extra means, mainly natural resource based, to enhance their incomes. It is likely that such uncontrolled exploitation could lead to rapid degradation/deforestation in addition to other negative environmental problems.

3.2 Sectoral policies and political influences

3.2.1 Colonial period

Major disturbances in lifestyles and management of resources occurred during the colonial period. Land was appropriated by settlers for purposes of agricultural production. The state also appropriated land for establishment of public amenities such as national parks and forest reserves. These two measures physically reduced the amount of land available for agricultural and non-agricultural use by the rural communities, as well as access to natural resources found in them. Overcrowding in the native reserves began as human and animal populations increased on confined lands that were largely of low fertility. This period marked the beginning of disruption of common property regimes. Lack of property rights and the prevalence of open access to land have also been cited as potential causes of mismanagement of natural resources, including forests (Sparr 1994). Campbell *et al.* (1993) report that much of the deforestation in Zimbabwe took place during this period because of new settlement and colonial land use policies, among other reasons.

The movement of people into small and confined areas to give way for large scale agriculture by the settlers led to agriculture being divided into smallholder and large-scale or estate plantations. This division has largely persisted to this day in most of the countries under study. This division also influenced the way sectoral policies were formulated and thus, there was a well-defined symmetry for policies in these two sectors. The large-scale agricultural sector was favored in terms of policies for research, marketing, credit availability, infrastructure development, macroeconomic policies to promote trade, pricing, etc. Land policies allowed large-scale farmers to own or have rights to land, water and forests but not the small-scale farmers. The small-scale sector was largely ignored, and yet, it was the sector in which the majority and the poorest lived and in which the potential for natural resource degradation was greatest because of overcrowding in the communal areas following land expropriation by the colonial government. The result could have been further pressure on forests and their products especially from those who could not secure formal employment, that is, mainly women.

Some sectoral policies for forestry protection were put in place during these periods. Boundaries were put between local communities and natural forest resources thereby restricting shifting cultivation (Kowero *et al.* 2001). There was a set of rules, laws, regulations, acts and ordinances that were to set the direction of the use of resources. Legislation on protected forests was limited to government forest reserves leaving most of the forest areas as public lands (open access). Policies on environmental resources were not intended to be operative in communal areas of Zimbabwe because these

areas were meant to be a reserve for cheap labor (Katerere *et al.* 1993). Thus, there was no policy concern for protecting and preventing damage to the forests in the rural areas. The large-scale forced movement of populations also weakened and in some cases removed indigenous management mechanisms and cut many links between people and their land. As a result of lack of clear management laws, these forests were easily and freely available to the rural poor. Since firewood was the major product for rural dwellers and culturally women collect firewood, women and children interacted with these resources more than men. In addition to firewood collection, women and children also collected wild vegetables, fruit, mushrooms, fibre, leaf litter for manure and elderly women also participated in performing traditional rituals such as rainmaking ceremonies. Men had relatively limited interactions with these resources. Their forest-related activities included principally employment in industrial forestry where it existed, collecting honey, hunting wild game, and performing various rituals.

3.2.2 Post colonial period

At independence, the countries under study pursued different sectoral policies guided by different political philosophies. Mozambique leaned towards Marxist policies, Tanzania had a homegrown Ujamaa policy, and Malawi was more on a capitalistic path. Zimbabwe practiced socialism in some spheres such as in price controls and land reform policies but practiced capitalism in others such as in leaving the private sector intact. In practice, conservation policies were directed towards large-scale and commercial sectors, and most countries maintained the land policies of the colonial period. The governments did not redress the issue of land redistribution to any significant measure and as such, the structure in the colonial periods was maintained. By and large, the amount of land under cropping has remained stable over the eighties and nineties with the exception of Tanzania and Zimbabwe as shown in Table 3. The land on which rural people were operating continued to shrink and get eroded as population increased. This also implied increased pressure on forestlands in order to expand cropland and this is supported by evidence from Malawi and Tanzania. In Malawi the total area of rain fed crops and fallow increased from 37% of total land area in 1983-84 to 49.2 % of total land area in 1988-90 (Eschweiler 1993). In Tanzania, area under tobacco cultivation increased by over 50% between 1985-86 and 1990-91 (Byers 2001). Besides large-scale commercial tobacco farming, smallholder farmers increasingly took up tobacco farming.

Because of the imbalances inherited from the colonial era, governments embarked on agricultural policies to put communal farmers on an equal footing with the large-

Table 3. Agricultural cropland in the study countries

Country	Total Hectares (000)		Hectares per 1000 people	
	1987	1997	1987	1997
Malawi	1 610	1 710	199	170
Mozambique	3 090	3 180	225	172
Tanzania	3 501	4 000	151	127
Zimbabwe	2 814	3 210	313	286

Source: UNDP/UNEP/World Bank/WRI 2000.

scale commercial farmers. The agricultural policies were on increasing access to credit, marketing facilities, research and extension. Poor farmers could not have access to credit because they had no collateral and women found themselves in worse positions than men as they had no land rights or enough other assets in their names. Thus, policies to improve the marketing and credit conditions for the small-scale farmers were more beneficial to men than women. Also, since most rural people, especially women, are risk averse and want to satisfy food needs before selling (Ellis 1999), the policies pursued to encourage commercial agriculture, would have effectively affected only a small percentage of the relatively well off rural population, most of whom would be men. The rest of the poor would be expected to continue to rely on or 'overuse' other natural resources for income.

These policies, in general, promoted cash crop production, which was mainly the domain of men. Women found that the land for food production was sometimes reduced in order to increase cash crop acreage. Since they did not own land and were not fully involved in decisions over family land use, women may have found it difficult to control the acreage for food production. Further, most of the proceeds from cash crops were managed and controlled by men even in cases where women had also contributed their labor. This left women with few options to enhance their food and income sources, one of the major ones being more reliance on forests and forest products. Also, women found that they had to do more work, as they were often required to work in their own fields as well as their husband's cash crop fields.

Such economic and political policies as nationalization of wood industry in Tanzania and Mozambique, and massive movement of people into communal villages in Tanzania, settlement and communal areas in Zimbabwe, refugee camps in Mozambique and Malawi had profound impacts on forests. For example, these processes resulted in massive clearing of forests and loss, or reduced role, of traditional structures of managing these forests (Kowero *et al.* 2001). How the effects were distributed between men and women remains unclear. Regarding land allocation, the policies of resettlement in Zimbabwe mainly helped male-headed households, while female-headed households were given low preference. These resettlements, which could have contributed to increased agricultural possibilities for the poor families, also resulted in increased forest/woodland clearing for agriculture and habitation (Katerere *et al.* 1993).

3.2.3 Developments in the agricultural sector

This section focuses mainly on policies in the agricultural sector because of its close links with the rural people. The main policies discussed are those implemented during the reform periods. One of the main aims of liberalization policies is to bring about a shift from economically low value commodities to high value commodities by raising the relative price of the latter. Producers of goods viewed as having low economic value and food consumed locally have benefited less from the favorable agricultural terms of trade. In the rural setting, women are concerned mainly with production of goods for household consumption while it is the men who are involved in the production of goods for commercial purposes. Much of the work that women do is not economically valued, for example, cleaning homes, child-minding, fetching water and firewood. They therefore do not directly benefit from policies, as the policies do not promote what are viewed as non-economic activities. As argued by JCGP (1991), in most African settings, women farming on their own have been less able to go into export production than have males. Hence, men gain more than women from trade liberalization policies

of this nature. Cromwell (1992) reports that most rural households maintain separate income streams and most women have no access to their husbands' income. Thus, where the advantages of policies were disproportionately in favor of men, women would not have received much financial benefit.

With respect to marketing of produce, other bottlenecks such as lack of transport reduce the participation of the poor, the majority of whom are women, who end up selling to informal traders (middle men) who pay them below market rates. Binswanger (1989) also found that agricultural outputs are more responsive to non-price factors, such as irrigation, capital, technology, extension services and credit markets than to price incentives. If the policy promoted increased use of land by men we may expect that women became more marginalized because they often have restricted access to land.

Devaluation led to unequal distribution of land in the agricultural sector in two ways. First, distribution of land went in favor of large-scale/estate farmers. In Malawi, estate expansion in response to devaluation pushed the already marginalized small-scale farmers, further increasing their exploitation of forestlands[4] (Cromwell 1992). Thus, because of the extreme land inequalities the policy of encouraging agricultural exports had negative effects on the environment through the actions of poor farmers. Second, it increased acreage of male dominated cash crops such as maize and reduced that for female cash crops such as groundnuts (Due and Gladwin 1991). In the Kagera region of Tanzania, land previously used by women for food production was put under tea, in response to devaluation, thereby depriving women of land for food production and income from production surpluses (Chisanga 1990). As a result, women were left to extend their agricultural efforts into the marginal lands, thus exploiting forests more than men. Tichagwa (1998) reports that women in Zimbabwe had to turn to the informal sector for livelihood support with the introduction of the structural adjustment programme.

Cuts in government expenditure would have counteracted any favorable relative price effects enjoyed by producers of commercial goods in poor rural areas. In Tanzania, farmers' access to fertilizers was limited by the huge increase in prices when an 80% subsidy removal was effected (Reed 1996). There is also evidence in Malawi of reduced fertilizer use because of increased prices (Cromwell 1992). Daikosavvas (1989) found that a 10% increase in government expenditure increases production in agriculture by 3% on average in Sub-Saharan Africa. Thus, government cuts in agricultural subsidies and other expenditure during adjustment may negate the incentives provided by other measures such as devaluation and price and trade liberalization (Ahmed and Lipton 1997). Where this happens, those without collateral for credit for fertilizer purchase, mainly women, are at a disadvantage and may be forced to explore other livelihood support options like informal businesses, reliance on natural forest resources, gardening, etc.

In general, structural adjustment, even in countries where it has been applauded as having had some positive effects, such as in Ghana, left out some important groups, those producing non-tradables and those who are net buyers of agricultural commodities. These are usually the very poor, the majority of whom are women. The weak links between the rural poor and the general economy also constrain poor farmers in participating fully in the monetised economy. Lastly, the potential benefits of SAPs were not captured because of lack of resources such as inputs, extension, research and credit service.

4. DECENTRALISATION POLICIES

This section explores changing roles of women within communities and how they may be sidelined or play a crucial role in local institutional arrangements within the framework of decentralisation of natural resource management. Colonial natural resource management policies resulted in over-centralisation because they were designed in the context of conquest and subjugation (Mandondo 2000). Much of the colonial legislation was inherited piecemeal by most post-colonial governments, including the four countries covered by this study. Amendments to the colonial legislation in Southern African countries have not democratised the various legal instruments (*ibid.*). However, state control over the use and management of natural resources such as woodlands has been largely ineffective because the state lacks the resources and capacity to enforce such controls. This has partly led to the enactment of decentralisation policies to facilitate the participation of local communities in resource management. This has in turn coincided with the general shift in the development paradigm from top-down to the adoption of bottom-up, participatory approaches.

Decentralisation describes the process by which bundles of entrustments, including regulatory and executive powers, responsibility and authority in decision-making, institutional infrastructure and administrative capacity, are variously transferred to local groupings such as local governments and/or communities (Mandondo 2000; Agrawal & Ostrom 1999; Ostrom 1990). The literature on decentralisation has concentrated on defining what should be decentralised to local communities, often treating communities as homogenous entities (Murphree 1991; Murombedzi 1991; Mandondo 2000; Mamdani 1996 and Ribot 1999). Few studies have examined the heterogeneity of communities and how resource management decentralisation has affected the different community groups, such as women (Shackleton and Campbell 2001; Shackleton *et al.* 2001; Meinzen-Dick and Zwarteveen 2001; Sithole and Kozanayi 2001; Fortmann & Bruce 1993; Nabane 1997). These studies have shown that decentralisation of resource management to local communities, with multiple and often competing interests and actors, go beyond the mere targeting of appropriate 'communities'. Communities are highly differentiated along several axes that include gender (Mvududu 1993; Fortmann and Nabane 1992; Goebel 1998).

This section examines the impact of decentralisation policies and initiatives on various community groups differentiated by gender, drawing on experiences in the management of miombo woodlands in Tanzania, Malawi, Mozambique and Zimbabwe. We focus on three themes, namely, participatory forest management, conflicts and local level organisations in natural resource management in the context of decentralisation of resource management. The literature on decentralization of resource management has often treated communities as homogenous groups, with common objectives as in the case of the "unitary models" of the household in economic literature (Meinzen-Dick and Zwarteveen 2001). The assumption in this literature is that all members of the household have common objectives and that there is pooling of all household resources. On the contrary, gender analysis literature abounds in examples of how systematic, socially constructed patterns of differences between and among women and men affect the distribution and use of resources, as well as decision making processes, within households (Hart 1995). Agarwal (1997) argues that leaving decision making analysis at the household level is incomplete because it does not take into account the effects of the community on gender relations in the household or vice versa. Thus it is important to take into consideration decision-making processes both at household and community levels in participatory forest management.

4.1 Participatory forest management

There has been a paradigm shift in conservation and natural resource management from state centered control towards participatory resource management. Such approaches have been referred to in many ways such as Community Based Natural Resource Management (CBNRM), co-management, collaborative management, participatory management, etc. In the context of southern Africa, participatory forest resource management falls under the broad umbrella of CBNRM.

Shackleton and Campbell (2001) investigate the extent to which the move to CBNRM in eight countries in the Southern African region was accompanied by shifts in authority, decision-making and power. In the majority of cases studies described the communities participating in CBNRM initiatives were stratified and differentiated along the lines of age, gender, livelihood strategies, ethnicity, political affiliations, education, wealth, interest and/or allegiance to traditional versus modern structures. In many of these studies reference was made to a community “elite” who consistently attempted to seize any increase in authority or benefits resulting from devolution. They often took over leadership of self-initiated forest management committees from poorer forest users. These “elites” are described as the strong, educated and articulate individuals who have the potential to develop relations with the state apparatus or private operators (Shackleton and Campbell 2001). These “elites” tend to dominate local level resource management structures. Their relations with the state apparatus and private operators enable them to control decision-making processes and the flow of benefits. Literature on gender and development has often shown that women, in particular from the female-headed households, tend to fall under the poorest groups in the community (Fortmann and Nabane 1992; Feldstein and Jiggins 1994) and these are often excluded from holding leadership positions. Because of historical reasons, women have been less educated and less confident to take over leadership positions (Karl 1995). Shackleton and Campbell (2001) argue that this is a common phenomenon where communities are required to elect representatives to a committee. While it is clear that the strong, educated and articulate are the ones who develop links with the state apparatus and private operator, it is not clear how closeness to the chiefs and traditional leaders is acquired. One is left to ask whether it is kinship, wealth, or any other characteristic. It is not clear also whether women can attain the “elite” status and if not, what the impediments are.

In Zimbabwe, participatory forest management has been piloted under the Resource Sharing scheme facilitated by the Forestry Commission. Findings from the Mafungabusi Resource Sharing programme, a pilot study site, highlights the gendered access to forest resources such as thatch grass harvesting (Matose *et al.* 2001). Before the establishment of the resource-sharing scheme in Mafungabusi, collecting thatch was mostly a woman’s activity. The collection and selling of thatch grass has, however, become an important alternative source of income for many households. This has resulted in men’s taking an interest in the collection and selling of thatch grass. While previously men’s involvement in thatch grass was in assisting with its transportation, a growing trend is that men are taking over the harvesting and selling of thatch. As permits for this activity were traditionally issued to women, this new development has led to tensions within the Resource Management Committee (RMC) membership. This illustrates the gender effects of the commercialization of a common property resource. The tendency is for men to take over the resource, often with the aid of local resource management structures whose composition is predominantly male. The paper by Matose *et al.* (2001) is a welcome addition to existing literature on the gendered effects of the

commercialization of common property resources, with a particular focus on forest resources. There is therefore need to examine in-depth the role of women and men in resource management where there is commercialisation of woodland products.

The emphasis of CBNRM has often been on resources such as wildlife, livestock and timber at the expense of the less valuable but vital resources used on a daily basis by women in the home. Men are more actively involved in resources such as wildlife and timber than women because these are high value resources. For instance, in Malawi it was found that the role of women in forest management is generally restricted to certain activities and forest products such as thatch and fuel wood (Mwabumba *et al.* 2001). Despite this marginalisation, women in the two study sites in Malawi indicated that they wanted the same opportunities as men. The women believe that the only way to ensure a fair share of the benefits from forest resources is for them to have an equal say and influence in decision-making concerning forest management and utilization (*ibid*).

In the Fish River area of South Africa, cited in Shackleton and Campbell (2001), gender discrimination has been found to impede effective CBNRM. Women are generally excluded from decision making around NRM. They also do not have access to meaningful positions in local NRM structures, despite the fact that women are the primary resource users and the most knowledgeable about resource availability and condition. As a result, decisions focus on livestock and range management at the expense of other important resources. In many Southern African countries women are often excluded from decisions on NRM, as they are not included in the local management structures. As a result, the women's interests are often not taken into account even though they are the primary resource users and very knowledgeable about the resources in their environment.

One way to ensure the participation of women in CBNRM is to formulate policies targeting women (Nkomeshya 1998; Wonani 1998; Fortmann and Nabane 1992). Such policies should specify the membership and composition of local NRM structures, although care should be taken to ensure that the women's membership in these structures is not mere token representation. It is worth noting that there are, however, some countries such as Mozambique, in which devolution policies have addressed equity issues and made inroads to enhancing participation of marginalised groups such as women in decision-making.

According to Mwabumba *et al.* (2001), effective community management of natural resources depends on coordinated actions of resource users. Organisations for CBNRM at the local level should be strong, legitimate, adaptable and efficient. From their analysis of "successful and unsuccessful case studies," they found that the ingredients for success in CBNRM occur when local level organisations are democratically elected or agreed upon, and have decision making powers; when there are local enforcement and monitoring systems, local level traditional knowledge and rules are adhered to, and operated in an environment with little political interference (p. 8). Issues such as rights, election to local resource management structures, enforcement and monitoring of rules, the use of traditional rules and political influence are not gender neutral. Women are often not represented in these management and enforcement structures.

The case of villages around Duru-Haitemba Forest Reserve in Tanzania has been cited as a success story in the attempt to devolve the management of natural resources to the local communities (Kajembe *et al.* 2001; Wily and Haule 1995). They state that all the eight villages around Duru-Haitemba forest maintain "strong and effective Forest Committees". These are responsible for the enforcement of rules. One of the indicators

of success is that the composition of these committees has steadily shifted from village leaders to ordinary villagers representing their sub-villages. Most decisions concerning the forest are made through or with the guidance of these committees. The protection of the forest from offenders (both outsiders and from within the villages) is the responsibility of village forest guards. While forest committees are comprised of both men and women, village forest guards are “young men who patrol the forest against breach of conservation rules each village has developed and adopted” (p.6). This arrangement may be a cause for potential conflict between the young men and the women who rely more on forest resources than men and therefore may be more likely to be offenders. Although men are more likely to commit offences that attract heavy punishment than women, women are more likely to be frequent offenders due to their roles as collectors of firewood.

Along with other countries in the Southern Africa sub-region, Malawi is also pursuing a policy of local community involvement in forestry management (Masangano *et al.* 2001). In their study, in Mdeka and Mangwero in Blantyre District, Dzalanyama in Lilongwe District and Chimaliro in Kasungu District, Masangano *et al* (2001) found that the communities in these areas are being encouraged to participate in the management and utilization of miombo woodlands. Communal management of natural resources in both Mdeka and Mangwero was implemented through village natural resources management committees (VNRMCs). These committees work hand in hand with staff of the Forest Department. It was found that communities living around the study sites experienced a lot of conflicts around natural resources, most of which can be understood in the context of power relations as well as rights to resources which determined rights of access to resources. The authors note that those people who had more power tended to have more access to the resources than others. The rights of access varied with the type of resource. There were people who had rights of access to land and all the forest resources on that land while others would have rights of access to some of the resources but not others. For example, while the owner of land would have the right to cut down trees on his land other members of the community would only have rights to collect certain parts of the tree for such purposes as herbal medicines and natural fruit. Given that women often do not own land, their access to forest products may be restricted by such definition of access rights based on land holdings.

4.2 Conflict over resources in participatory forest management

Studies that have been undertaken on conflicts and their resolution in woodland management have identified five types of conflicts. These are ethnic, institutional, intergenerational, contested boundaries and conflict resulting from problems of co-management (Mamimine *et al.* 2001; Masangano *et al* 2001; Mvena *et al.* 2001). Mamimine *et al.* (2001), highlight that ethnic conflict is caused by attempts at excluding those regarded as immigrants by the “original” inhabitants of the areas where the resource occurs. For instance, in Mafungabusi Forest Reserve area of Zimbabwe, ethnic conflict exists between the “original” Shangwe and the immigrant Ndebele and Shona. In Romwe, ethnic conflict was between “original” Shona and the immigrant Ndebele. Institutional conflict is often a result of the discord between traditional institutions and “new,” government institutions like Village Development Committees (VIDCOs) and Ward Development Committees (WADCOs). Boundaries demarcating forest reserves and communal areas and those between villages are often contested.

Mamimine *et al.* (2001), study also found that there was often conflict over different land uses such as grazing and cropping. Intergenerational conflict pitted the younger and older generations against each other. The younger generation who still want land for ploughing tended to convert grazing land to arable land. The youth were more dependent on the forest for resources such as wood for carving because they had no land for ploughing while the elders had livestock and therefore were more interested in reserving forests for grazing. Younger people were also more likely to be accused of cutting down trees for poles to build houses. Citing the case of Mafungabusi Resource Management Committees, Mamimine *et al.* (2001) argue that such structures lack full participation in the management of forests. While Mamimine *et al*´ s paper (*ibid*) examines various actors in the different conflict situations, and differentiates them by ethnicity, length of residency, and age, the nature of the relationship between women and men is not addressed. It is important to understand such gender relations as they may be influenced by and sometimes influence the nature of conflict over resources.

Conflict and conflict resolution is also the focus of Mvena *et al.*'s (2001) study. The study was carried out in three sites in Handeni, Mufundi and Babati Districts of Tanzania. The authors identified various actors in conflict involving natural resources namely, the regulators, the commercial sector and local communities. The regulators include government, represented by the Ministry of Natural Resources and Tourism as the key player as well as non-governmental organizations such as DANIDA and SIDA. Such organisations are often male dominated. The commercial sector is made up of all those who exploit the natural resources for business purposes, who are also predominantly male. Local communities are those at the local level who benefit directly from the forests.

Conflict at the local level is complex and involves numerous sub-divisions. It exists between individuals and groups within the same village and between villages, mainly over boundaries. There are conflicts between the wealthy livestock keepers and the poor over grazing. Within the villages there is also conflict over the control and management of clan land and sacred areas. The authors conclude that many types of conflict arise from unclear policies, lack of transparency on the part of the regulators and other beneficiaries and lack of design principles for CBNRM. It is further argued that conflicts in natural resource management depict, *inter alia*, an intergenerational dimension. There has been a shift in the value system based on the age difference. The young generation view natural resources differently from the older generation. The younger generation may not respect the ritual forests for a number of reasons, such as sheer rebellion, conversion to Christianity or Islam and the temptation to make extra income. The study differentiates groups involved in conflict, along the lines of wealth, class and age. While gender analysis goes beyond the female-male divide, this is not adequately considered in the paper. There is need to have a greater understanding of gender issues, as gender influences resource management in general. While many of these studies do not specifically deal with gender, they address many other differences between community groups that are of similar importance as gender differences.

4.3 Local level organisations in forestry management

Local organisations or institutions play a central role in the management of natural resources and the institutions shape the processes of endowment and entitlement. These institutions

are a complex set of norms and behaviors that persist over time by serving valued purposes while institutional arrangements are the rules and regulations governing access to resources (Uphoff 1986; Ostrom 1990). Institutions consist of cognitive and normative structures and activities that provide stability and meaning to social behavior. These institutions are transported by various carriers including culture and social structure, and they operate at multiple levels of jurisdiction (Scott 1995). Within the context of decentralisation of natural resource management, local level organisations are often entrusted with management responsibility as well as a key role in benefit distribution.

A major assumption in the literature on decentralisation is that there is an organisation or structure at the local level, to which resource management authority can be devolved. The form and nature of these structures are rarely analysed, especially from a gender perspective. Recent studies have found that there are a number of organisations at the community level that impact upon the management of forestry resources (Mandondo 2000; Fisher 1992). These include state institutions and their departments or implementing agents, local government institutions, non-governmental organizations (NGOs), as well as community based organizations (CBOs). At the village level, a distinction is often made between "traditional" and "modern" organisations. The traditional ones are those structures whose legitimacy is based on a shared value system, collective cohesiveness, shared history and legitimacy derived from kinship and descent. Their legitimacy is embedded in the social and cultural life of rural communities. Some of the modern organisations are steeped in Western traditions, while others were created during the post-colonial period as part of the drive towards socialism.

Men often dominate representation in local resource governance institutions and organizations although women make up the bulk of the rural population and provide more labor than men in development programmes (Meinzen-Dick and Zwarteveen 2001). In a study of two villages in Mwenezi District in Zimbabwe, Mudenge (2001) found that men constituted the bulk of the registered members in orchard projects. Women, however, provided the bulk of the labor in these projects. The study found that men occupy the positions that are vested with decision-making powers whilst women occupy positions like secretaries. Given a secretary's role as note taker, the woman in that position may be restricted in her participation in discussion, as she would be concentrating on documenting the deliberations. Facilitators of CBNRM have sometimes set a quota for electing women into committees. This is a good starting point in empowering women to participate in decision making if it is done properly. Otherwise, women are given positions to fulfill project requirements without really influencing decision-making processes.

A comprehensive study on gender issues in forestry management was carried out in Mhondoro district in Zimbabwe by Fortmann and Nabane (1992). The study found that in both study sites, Nyamweda and Chamatamba, all resource use monitors were men. This has implications for the enforcement of rules for the management of the woodlands. The lack of women monitors in woodlands means that women's needs are less likely to be considered in the establishment and enforcement of rules (p. 34). They further found that women were often excluded from decision-making structures. Similar findings are reported by Goebel (1998) based on her study undertaken in the resettlement schemes in Wedza district in Zimbabwe. Although Goebel's study had little focus on gender in forest management institutions, she highlighted the fact that women are less involved in decision-making regarding access to woodland areas and products found in the various resource areas.

The role of women in the forest resource sector often reflects a deeply entrenched dichotomy between the so-called “male domain” of cash cropping and “female domain” of food crop production (Wonani 1998). Even in forestry extension in the villages, men dominate the membership. Women’s role in decision-making is often limited and this is attributed to tradition and culture (Karl 1995). There are few cases of women in leadership positions from local to national levels: For instance, female chiefs or headmen, members of parliament and district councilors are rare in most Southern African countries, including the study countries. This problem is not peculiar to the study countries as most countries in sub-Saharan Africa experience low participation of women in decision-making structures. To address this anomaly, affirmative action has been taken by some government departments and public organizations. There is more prominence of women in Mozambique both at the local and agency levels. For instance, at one time the head of the Forestry and Wildlife Department in Mozambique as well as the Head of the Forest Department at Eduardo Mondlane University were women. Presently the Head of the Centre for Forestry Research is a woman. Similarly, in Lesotho there is increasing recognition for women in CBNRM. Women do not just represent their husbands who are often away at work in South African mines.

Hierarchies, even those at the household level are usually male headed. However, this is not to say that the hierarchies cannot be gender sensitive. In the forestry sector, staffing is male dominated. This is a historical factor because the forestry sector was and still is seen as a male field, yet implementation of, for example, nursery projects were done predominantly by women. The more senior the posts, the fewer the numbers of female personnel employed in them. Females tend to be concentrated among ‘support staff’ as secretaries and clerks. The limited number of women in leadership positions may imply that women have a limited influence on the management and policy-making processes in the forestry sector. But recent studies show that women and men may influence decision-making in many different ways (Nemarundwe 2001; Sithole and Kozanayi 2001).

While the majority of the literature accessed for this study points to the fact that women, compared to men, are often less involved with forest resource management organizations at a formal level, recent studies suggest the need to investigate strategies that women use to ensure their views are taken on board (Cleaver 1998; Meinzen-Dick *et al*. 2001; Nemarundwe 2001 and Sithole and Kozanayi 2001). These studies highlight both formal and informal strategies that women may adopt where they feel their views are not considered. More studies with a focus on such strategies may shed light on the actual role of women in resource management structures and propose mechanisms through which such strategies may be used as a starting point towards empowering women to be more confident to participate in formal decision-making arenas. The forthcoming collection on gender and diversity in forest management that will document the various lessons learned within the Adaptive Collaborative Management (ACM) framework will contribute significantly towards filling this gap (Colfer [Ed.] forthcoming).

Nemarundwe (2001) finds that decision-making arenas are not always public or formal. Often women’s involvement in decision-making is measured through the number of female members in various resource management structures or through their participation in discussions during community meetings. Results from Nemarundwe’s (2001) study in Chivi District, southern Zimbabwe, show that informal platforms for decision-making exist and they are very influential. These are predominantly used by women to influence organisations governing access to woodland resources. For instance, the majority of women in the

Romwe area in Chivi District, southern Zimbabwe, do not speak out at public meetings, with a few exceptions (like the community mobiliser and the vice-chairwoman of one garden project). Women largely use informal means to control powerful male figures in the community. An example is the alleged love affairs that a powerful and most respected kraal-head in the area has with some women in the community, which sometimes constrains his power to make certain decisions. Nemarundwe's study highlights that impromptu conclusions should not be drawn on the role of women outside the public arena without in-depth analysis.

Similarly, Sithole and Kozanayi (2001) find that women may use informal means to influence decision-making processes, as they are not represented in the resource management committees (RMCs). Following, Sithole and Kozanayi (*ibid*) argue that although women may be excluded from formal channels of authority in the community, they are nonetheless political actors and they exercise modes of political action involving expression of power such as manipulating kin relationships, gossip, threats of witchcraft, and withholding sexual services from men. Sithole and Kozanayi (*ibid*) highlight a case of a wife to one kraal head in the adaptive collaborative management project in Gokwe district, who uses her position as the kraal head's wife to influence decision-making processes relating to the ACM programme. Studies that document intra-household decision making processes relating to forest management could not be easily accessed during the review that generated information for our paper. A more detailed analysis is needed to generate in-depth understanding of intra-household decision-making processes in community-based forest management. It is also worth noting that differences between and amongst female and male-headed households regarding their role in community-based woodland management institutions and organizations need to be considered.

5. SUMMARY AND CONCLUSION

The paper tries to bring out the linkages that exist between policies and gender and the management of woodlands. The subject matter is complex due to a lack of substantial research in this area. However there are some insights on how males and females view and value forests and their management. The analysis in this paper brings to light the fact that men and women have different perspectives on resource use and management issues. Furthermore, division of labor, responsibility and control over resources is along gender lines. Women are less likely to benefit from family income than men. In communal areas, the role of women is in agriculture and in ensuring primary human development. Men are more involved in other non-agricultural activities and place importance on matters concerning personal pleasures. Women are thus more directly linked to sustainable development as compared to men. Women are hurt more if there is damage to natural resources and they are likely to value these more than men.

The paper has also highlighted that throughout the colonial, post independence and reform periods, policies have in general pushed women to rely more on forests than men because of shrinking cropland per capita. Most of the policies do not have a gender bias, but instead treat men and women equally despite their different capacities to respond to such policies. It is suggested here that most policies that are related to forestry should favor women and encourage them to conserve forests by, for example, enabling them to own land in their own right and enabling them to be resettled in their own right. This is because when there is mismanagement of environmental resources,

women are likely to suffer more than men, as they work harder and longer to sustain the family needs.

The negative effects of economic policies in rural areas, especially economic structural adjustment policies, which place heavy emphasis on market forces, are being felt disproportionately by rural people. Women are ill equipped to benefit from agricultural production incentives and other economy-wide policies. They have in general, less capacity than men in terms of acquiring new technology, less time and land to devote to income generating agriculture and less command over some of the most important resources such as family land and capital. Since men often control most of the household income, women thus have less incentive to respond to economic signals. Women are in general risk averse and do not immediately venture into new projects and thus tend to be left out. Therefore, rural development policies need to be directly focused on women and further, policy makers should facilitate women's positive responses to them.

From this review, it is clear that in many countries in sub-Saharan Africa, women are constrained from effectively deciding on issues of access to natural resources. This is because in many societies, women's ideas are not valued and their initiatives do not carry as much weight as those of men. This is a critical issue as current thinking in NRM is towards giving communities the responsibility to decide on how to manage local resources. Women make up the majority of the poor in these communities.

As observed by Fortmann and Nabane (1992) many studies on access to and control over natural resources have focused on undifferentiated users, generally households without regard to gender or to class. Many approaches tend to ignore the multi-dimensional differentiation among the poor or rural people themselves based on economic, gender, age and ethnic identities. This is a serious omission as gender issues in forestry can be effectively addressed if attention to such issues is paid at the highest levels of decision-making and policy making. Gender issues are particularly important in Africa where there are frequently high proportions of female household heads (Fortmann and Bruce 1993). There is therefore a need for women to exercise more control over the resources they use in order for them to realize their full potential as development agents (Nyoni 1989). Ignoring the roles of women as resource users will lead to the failure of conservation programmes to address the needs of those very individuals who are key to the sustainable use of the environment (USAID 1996).

ENDNOTES

1. In this paper, gender refers to socially and culturally constructed roles and responsibilities and relations between and among women, men, boys, and girls in a given community. Gender is related to how we are perceived, and how we think and act as women, men or children, because of the way society is organised rather than because of our biological differences. Gender relations influence access to and control over resources such as woodlands by various groups.

2. This figure varies according to different authors. Campbell (1996) has a figure of 2.7 million km^2 for miombo woodlands.

3. The speed of this socialist outlook differed for different countries, for example for Zimbabwe it came immediately after independence but for Tanzania and Malawi it came several years after independence. For these two countries, the policies pursued just after independence were essentially similar to the pre-independence ones of relying on the promotion of foreign efforts in the country and not the indigenous population.

4. It must be pointed out though, that much of the pre-SAP expansion of Estate agriculture in Malawi was due to deliberate government policy to promote this sector.

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13.

An overview[1]: Reconciling demands on woodlands through modelling

G. Kowero

1. CHOICE OF MODELING APPROACHES

A modeling approach was employed to reconcile the demands of various stakeholders on the woodland resources in ways that safeguard incomes and food security to local communities as well as sustaining the woodlands. The aim was to model problems and not systems like general household behaviour or woodland management systems. The candidate models adopted were arrived at in two workshops in 1998 and 1999 based on the following criteria:

- suitability for policy analysis,
- capacity to model real agent's behaviour,
- availability of data,
- capacity to handle various stakeholders and their various and conflicting goals,
- availability of research capacity and skills within the group,
- possibility for including some ecological considerations in the model, and
- potential for development of models that share some of the data.

The models were considered with respect to policies driving change in rural development and specifically forestry at the household level. These included policies on:

- Financial sector reform (credit and interest rates)
- Prices of inputs and outputs, especially for agricultural production.
- Non-farm income, especially that arising from sale of forest products and labour.
- Infrastructure development, including market development and roads.
- Direct limitations on harvest quantity and/or age class of woodlands and pricing of primary forest produce

- Decentralization/devolution of power to local authorities.
- Population growth.

Other considerations that influenced choice of models included:

- Presence of farmers with varying degrees of resource endowments and economic behaviour.
- Presence of farmers mainly engaged in agriculture, and some with livestock. Others have off-farm activities.
- Availability of woodland resource of varying quality and products.
- Availability of small scale commercial activities in all rural communities.
- Presence of unequal accessibility to woodlands (in some cases strict restrictions on government forest reserves allowed minimal access or completely denied access).
- Awareness of role and effectiveness of government in managing woodland resources.
- Local community woodland resource management strategies and initiatives existing in some areas.
- Experiences with joint management of forest resources.
- Awareness on loss of biodiversity and need for environmental conservation.
- Movement of forest produce from rural localities to markets, mainly in urban areas.
- Lack of a system that integrates the efforts of all stakeholders or directs such efforts towards desired goals.

Given this background weighted goal programming and system dynamics were selected as the most appropriate modeling approaches for local community interactions with the woodlands. The key highlights from this work are summarized in the following sections.

2. IS COMMUNITY-BASED MANAGEMENT THE BEST FOR SOUTHERN AFRICAN WOODLANDS?

There is a lot of emphasis (and rhetoric) to devolve the management of woodlands and other forest types in Southern Africa and elsewhere in the world to local communities. This is rooted in the belief is that this is the best thing to do because local communities have lived with these resources for time immemorial and presumably have the best skills and knowledge to manage the resources. But this is mainly a qualitative assessment.

This section presents results of research undertaken in Malawi, Mozambique, Tanzania and Zimbabwe that examines this quantitatively and demonstrates how use could be made of a system dynamic model, MIOMBOSIM, in planning and evaluating woodland management. The model was used to evaluate the outcome of three sets of management options, namely, communities managing the woodlands on their own in a cooperative manner (cooperative model), communities and other stakeholders having free access to the woodlands and with no stakeholder in charge, i.e. an open access situation (uncooperative model), and the government (central, local or village government) being in control (command model). The latter (command model) had three management options depending on goals emphasised in management. On one hand we had emphasis on conservation or biodiversity protection (environment

concern), while on the other extreme we had society allowed to extract what they needed, but within limits set by the managing authority (social concern). This provided for the possibility of the public to satisfy their social demands for woodland products. The third option was a combination of social considerations tempered with conservation of the woodlands (environmental concern + social concern). This involved putting weights on the parameters that represented both environmental and social concerns. Thus, in total five management scenarios were evaluated using MIOMBOSIM, the evaluation criteria including total benefits that would accrue to all stakeholders (as well as to individual stakeholder groups), potential for employment creation, area of woodland converted to agriculture, standing volume of miombo on a sustainable basis. A number of sensitivity analyses were performed to test the sensitivity of some chosen variables as well as effects of some macroeconomic and sectoral policies.

Apart from supplying firewood to the rural people the next most important thing the communities looked for in the woodlands was income. The MIOMBOSIM results indicate, for all countries, that the cooperative management option, whereby the communities manage the woodlands jointly would not be the best management approach to employ if income generation to rural households were the criterion guiding management. Involvement of government in management but with guided access to these resources by local communities (i.e. command with social concerns management) would appear to be the best approach to pursue such an objective. This appears to contradict the belief that if these resources were devolved to local communities, then they would be better managed and therefore be more beneficial to the communities – an important finding for policy makers. Apparently this is also true of Joint Forest Management (JFM) in India[2] The present situation on the ground in the study countries is that mimicked by the 'uncooperative model' (open access), while policy drive in all the four countries is to move largely towards the 'cooperative' regime; though with a limited role for government (command regime). However, from the study results the best two management regimes advocated are the command with social concerns followed by the cooperative management approach.

In addition, the results show that there is no management regime capable of satisfying all goals (i.e. increased rural incomes, food security and environmental/biodiversity conservation); that is some trade-off between goals is necessary.

Rural unemployment is a serious problem in all the four countries, various policies are being implemented with one of the objectives being to increase employment. However, the model results indicate that the employment potential offered by all management regimes is fairly small. The implication is that the forestry sector appears to have a fairly small potential to alleviate rural unemployment.

The four countries, as well as others in the region, are signatories to important international agreements, protocols and conventions related to forestry. One such convention is on biodiversity conservation. The model results demonstrate that introducing biodiversity concerns in a resource abundant area (such as Gokwe, in Zimbabwe) could reduce deforestation at a lower cost in terms of loss in benefits from the woodlands as compared to a resource poor area (such as Chivi in Zimbabwe).

The specific model results are presented in Chapters 20 to 22 and should be interpreted carefully because the impact of any management regime and/or policy intervention on the welfare of stakeholders and on the forest resource will depend on the amount of natural resource endowment and the initial economic conditions on the ground. While the general direction of policy or institutional change can be predicted, the actual impact will depend on the initial conditions, which are site specific.

3. ARE HOUSEHOLD DEMANDS FOR FOOD SECURITY AND BETTER HOUSEHOLD INCOMES IRRECONCILABLE WITH BIODIVERSITY/ ENVIRONMENTAL CONSERVATION?

This question was addressed through modeling the linkages between these three important rural development goals in the countries of study, i.e. Malawi, Mozambique, Tanzania and Zimbabwe. A weighted goal programming model, MIOMBOGP, was employed to reconcile the goals of various stakeholders as they relate to improving household incomes, food security, and environmental protection or conservation. These were the three main goals identified and ranked by households in the study sites. They are also the key rural development goals in each of the countries. The model demonstrated how rural development planners can help households satisfy these goals using the principal resources they have, viz. their own labour, woodland resources and agricultural investments. Some of these issues were also evaluated using MIOMBOSIM.

In Zimbabwe the results indicated that households owning draft animals have higher incomes, are more food-self-sufficient, allocate more land to agricultural crops than non-draft owning households. It was also possible to demonstrate the tradeoffs in meeting the three goals. For example the results from Tanzanian sites indicate that the food security goal was satisfied in all sites. However, with respect to the income goal, it was only satisfied in Iringa, while there were negative deviations from this goal of about 13%, 10% and 7% in Babati, Handeni and Mufindi respectively. These deviations represent the tradeoff the households have to make in terms of incomes forgone or not realized by satisfying their food security concerns.

Overall extra sectoral policies intended to promote agriculture were observed to have mixed effects on forest development. For example, for draft-owning and non-draft owning households in Zimbabwe it is unlikely that moderate increases in the input and output prices of agricultural crops or moderate improvement in crop yield would encourage encroachment on the remaining few woodlands for agricultural land. A similar observation was made on Malawian, Mozambican and Tanzanian households. The reason is that with a moderate input price or crop yield increase, by say 25%, households contain this by re-aligning the area allocated to crops and not by expanding cropland area. However, this changes, for example when we have significant yield or output price increases, say by 75%, there is a significant shift of land from the low priced crops, and where this is not possible then encroachment on woodlands for additional land is likely. The households would definitely try to earn more through higher yields (from improved seed for example) or output prices.

It was also observed through the MIOMBOSIM for Zimbabwe that a significant increase in agricultural input prices could lead to a decrease in woodland area on both sites (Chivi and Gokwe) in the long run. However, the change in steady-state proportion of remaining woodland would appear to be indeterminate tending to support the hypothesis that there are two opposing impacts caused by input price increases, namely, decrease in deforestation due to decline in profitability, and increase in deforestation due to substitution of land for cash inputs. Also an increase in agricultural product prices has the potential to increase deforestation with the magnitude of woodland loss more in the forest resource abundant Gokwe area compared to a resource poor Chivi area. Similar trends were observed in Malawi, but with relatively insignificant changes to the area of woodland remaining at the end of the simulation period, i.e. the sustainable woodland area.

It was noted in Zimbabwe that a decrease in income required to meet subsistence needs could lead to mixed impacts on deforestation under both community profit maximisation and maximisation subject to environmental concern constraints. Though a reduction in the requirement for agriculture to meet basic needs might lead to less encroachment on forests, the labour released from existing agricultural land could promote non-agricultural forms of woodland use that exert pressure on the environment.

In general sectoral policies in the form of fees charged on various forest products manifest their impact on the forest resource mainly through commercial sector activities in the form of a reduction of harvesting activities, when there is no compensation in the form of an increase in sales price. In the case of the household sector, short-term compensation would be achieved through land clearing for agriculture. The reduced employment resulting from reduced private sector activities could have negative ramification to rural development, if complementary policies are not put into place to create alternative employment opportunities. However, it was noted that a policy that aims at controlling harvest of firewood through pricing would only have noticeable effects if firewood prices were increased substantially. We see for example that in Malawi, the response to firewood prices starts only when prices are increased by more that 50%. This could most probably be due to the fact that labour for harvesting and transporting the product on the head or with bicycles to distant markets could be a limiting factor for households to take advantage of the high prices. Further, fuelwood prices are fairly low, and modest increases in prices might not trigger a significant reallocation of labour from crop production to fuelwood harvesting and selling.

Further, policies leading to employment creation outside agriculture and forest activities appear to have insignificant impact on forest conservation when wages are low.

For both the MIOMBOSIM and MIOMBOGP:

- The results in most cases conformed to theory or logic. That is, it was possible to resort to theory (socio-economic or biophysical) to justify or understand the results.
- The two models were robust in that they provided a richness of information from each of the countries and they also provided considerable diversity in the way each country used the same generic model to suit its specific local conditions, as well as in terms of how individuals or groups of scientists manipulated the models according to their own skills.
- The results gave important scenarios that hold potential for improving planning the livelihoods of local communities that depend directly on the woodlands, as well as for improving management of the woodlands.
- There is need to emphasize that the models fail to capture some benefits of forests such as those related to biodiversity and those arising from non-marketed goods and services.

4. CAN WE USE THE MODELS TO ANTICIPATE THE EFFECTS OF HIV/AIDS AND OTHER DISEASES ON RURAL LIVELIHOODS AND THE FOREST CONDITION?

One interesting output of the MIOMBOGP model relates to potential influences on household food security, income and the woodland condition resulting from constraining availability of labour, either in its totality and/or by gender. Many things can constrain

labour availability including emigration of a family member, say to urban areas to seek employment. However, in many rural areas the message received during data collection was one of frequent deaths, some most probably due to HIV/AIDS infections. It was possible to demonstrate using MIOMBOGP the implications of total loss of household adult(s) or partial loss of their labour due to illness or attending the sick and funerals.

For example in Malawi if male labour is completely absent in the household due to death or emigration, the results indicate the potential for more firewood to be collected and sold, to maintain level of household income that results from loss in tobacco production, an activity that is male dominated. However in Zimbabwe the results imply that loss of male labour or its very limited availability results in less clearing of the woodlands because opening up of farms is a male dominated activity and firewood trade is not as pronounced as in Malawi.

This in no way claims that the model analysed the implications of AIDS because we did not collect data on the deaths and neither did we have clinical evidence of the causes of the deaths. We only performed a sensitivity analysis based on certain assumptions on the extent of labour availability at the household level, and HIV/AIDS influences this availability.

ENDNOTES

1. This text is based on chapters 14 to 22.
2. S.J. Kumar 2002. Does “Participation” in Common Pool Resources Management Help the Poor? A Social Cost-benefit Analysis of Joint Forest Management in Jharkhand, India. World Development, 30(5): 763-782.

14.
A system dynamics model for management of miombo woodlands[1]

U.R. Sumaila, A. Angelsen and G. Kowero

ABSTRACT
The miombo woodlands of eastern, central and southern Africa are some of the most extensive dry forests in Africa. They supply a myriad of products and services for local populations, governments and the private sector, the main stakeholders. Planning the management and use of the woodlands by many and diverse stakeholders who often have conflicting interests in the woodlands continues to be a great challenge to national governments and other interested parties.

This paper presents a system dynamic model, MIOMBOSIM, which has potential for facilitating planning developments in the woodlands in ways which reconcile the aspirations of the three major stakeholders. The model holds potential for analysing various policy implications on people and the woodlands, as well as the desirability of various partnership arrangements for managing and using the woodland resources.

Key words: System dynamics model, miombo woodlands, stakeholders, management.

1. INTRODUCTION
Miombo woodland is one of the most extensive dry forest vegetation types in Africa occurring in seven countries in eastern, central and southern Africa; namely Angola, Malawi, Mozambique, Tanzania, Democratic Republic of Congo, Zambia and Zimbabwe (White, 1983). They occupy an area of about 2.7 million square kilometres, almost equal to the combined land area of Mozambique, Malawi, Zimbabwe, Tanzania and Zambia.

The miombo ecosystem forms an integral part of rural communities living in them or in their proximity by providing them with virtually all their energy requirements

in terms of fuelwood. The woodlands also provide building materials like poles and grass for thatching, medicines, wild meat and other types of food and fruits, fodder for livestock and wild game, and many other timber and non timber products.

The woodlands offer a number of opportunities to various stakeholders. *National governments* are interested in them in terms of their capacity to support wildlife that is important for tourism, a major foreign currency earner. Governments also consider society wide interests which the private sector and local communities might not give high priority. These include conservation of woodlands important for water supplies and control of soil erosion.

The *private sector* (firms and individuals) is interested in the woodlands for commercial products, which may be extracted from them. The *communities* bordering these woodlands are interested in them for a number of reasons, including their clearing for agriculture, their use for livestock grazing, and as a source of a number of products for local consumption and trade.

In each country there are general policies guiding socio-economic development, which affect these three stakeholders in complex ways. Other policies attempt to target the government as an institution, are specific to the private sector, or target the rural communities. Each of these three entities responds to the policies in their own different ways.

The objective of this paper is to analyse the interaction between these three stakeholders: How do local communities and the private/commercial sectors respond to sectoral and macroeconomic policies? Given the reactions of these two agents to policy initiatives, is it possible for the country to achieve its stated goals with respect to miombo woodland use? The fulfilment of some of these goals may create undue demands on the woodland resources. It is these demands and the extent to which they manifest themselves in the woodlands that the current paper addresses. In particular, the paper focuses on how to meet these demands in a sustainable manner.

There are several approaches that can be used to reconcile the demands of these three sectors on the woodland resources. This paper presents a systems based model for miombo woodlands, MIOMBOSIM (miombo simulation), to serve as a tool for the analysis of the sustainable use of these important natural resources, given the prevailing socio-economic environment in the region. The paper is organised as follows. The next section presents some background information, and especially the context in which woodlands are managed. Section 3 presents the conceptual model and gives a description of its interpretation for purposes of empirical application. Particular attention is given to the modelling of the household sector. In Section 4 data requirements for the empirical implementation of the model are identified.

2. BACKGROUND

2.1 CIFOR research

In 1996-98, CIFOR in collaboration with institutions from Malawi, Tanzania and Zimbabwe implemented an exploratory study in these countries with the broad objective of evaluating the potential for improving the livelihoods of miombo woodland dependant communities. This exploratory project took into account the impact of some of the macro-economic policies implemented by the respective national governments in their efforts to promote economic development. The study confirmed varying dependency

of these communities on the woodlands for their incomes, with the woodlands contributing up to 70% of household incomes in some study sites in Tanzania (Monela *et al.* 2000) and as little as 10% in some sites in Zimbabwe (Campbell *et al.* 2000). Further, the study through regression analysis, confirmed the expansion of agricultural cropland (Chipika and Kowero 2000; Minde *et al.* 2001), though not always conclusively into the woodlands and/or grazing fields.

Macroeconomic policies such as the liberalization of trade, and the elimination of government subsidies to agriculture, were arguably responsible for these outcomes. Also market and policy failures lead to the under-valuation of natural forest resources. The basis for governments to jointly manage the natural forests with the local communities was challenged in both Zimbabwe (Mukamuri *et al.* 2001) and Malawi (Luhanga *et al.* 2001). The study also raised a number of potential research questions. In addition, the study did not constitute a strong basis for understanding the policy impacts and their pathways. Neither did it facilitate generating scenarios useful for developing plans to guide sustainable management and use of these woodland resources.

With financial support from the European Commission, CIFOR embarked on a four-year research initiative in 1998, which sought to carry this work further and specifically address the issue of multiple stakeholders in sustainable management of these woodlands. This was considered to be crucial because governments in the region continued to implement macro-economic reforms, which affect the stakeholders differently, with the consequence that their reactions with regards to their use of the woodlands are unclear. The emphasis has been on understanding the pathways of the policies. Such information is useful in generating alternative scenarios useful for managing and using the woodland resources sustainably. Some of the candidate policy oriented hypotheses proposed for evaluating and generating such scenarios include:

- Economic reform policies, especially those that improve credit availability to smallholder farmers and agricultural input and output prices, serve as incentives for increased agricultural land expansion into woodland areas.
- Higher incomes and the increased demand for food that accompanies population growth boost the demand for agricultural production as well as trade in forest products, and this has the potential to degrade the woodlands.

On the other hand, governments in the region are very weak in managing natural forest resources. With economic reforms central government resources are becoming increasingly limited, to the point where the central government is unable to effectively manage large tracts of land in their countries. However the emphasis on liberalization of the economies of these countries and promotion of democracy has led to increasing participation of local communities and other entities in decision making, even in natural forest resource ownership and management.

2.2 New perspectives in forest management

According to Matose and Wily (1996), there is a clear move away from the centralised and state-driven forest and woodland management of the colonial and post-independence periods towards decentralised, and mainly community-based regimes. This shift has prompted governments and non-government agencies to realign their own functions away from direct management functions towards supporting technical

and advisory roles. The local communities, who are actually the main user groups, are increasingly becoming partners in natural forest management. In some cases they manage the forests on their own.

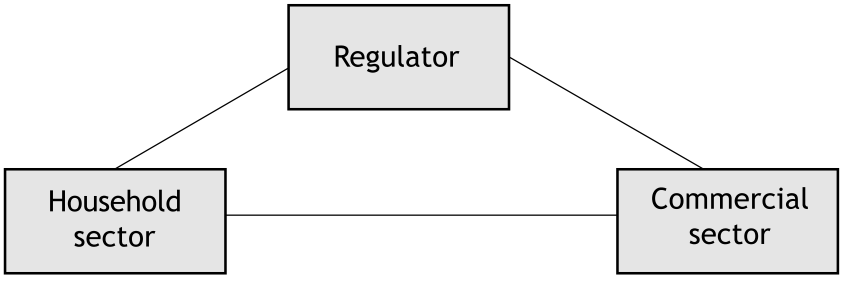
However, local management and control of natural forest resources is constrained by the weakened state of local institutions and the presence or even absence of policies and legislation that are either not enabling to local management and control or else absent altogether. Further, the rural communities are undergoing rapid social, economic and political change, due to economic development and modernisation. The question is whether local management of these resources will survive and persist, in the face of modernisation pressures and other socio-economic developments. This notwithstanding, the said changes have increased the number of stakeholders in natural forest resources, with the government (central and local), private sector, and local communities as the major stakeholders in this region.

Besides providing a methodology for analysing the effect of various economic policies, the paper also presents a framework for evaluating different partnership arrangements for managing the woodlands and especially those involving local communities, private/commercial sector and the government/state. The methodology can be employed to demonstrate impacts on long-term resource use and income for different user groups. For example, it can be used to answer questions about what, for the different groups, will be the gains of some form of joint forest management (*cooperative*) compared to a situation of unregulated resource competition (*non-cooperative*) among the groups.

3. THE CONCEPTUAL MODEL

A model is developed with two user groups (that is, commercial and household users) of miombo woodland resources who are under the control of a *regulator* (Figure 1). The regulator can be a central/local/village government, or any other authority. Three different versions of the model are presented and are based on some assumptions on the relationship between the user groups and the regulator. In what is denoted as the *command* model, the regulator can dictate the behaviour of the two sectors directly. In the *cooperative* model the users reach an agreement on how best to jointly use the miombo resources. On the other hand, in the *non-cooperative* model each of the different user groups aims to maximize its own private benefits without any regard to the implications of their actions on the other groups (see Sumaila 1999 and the reference

Figure 1. The main agents in the model



therein).[2] It should be noted that in the cooperative and non-cooperative versions of the model, the regulator could influence the use of miombo resources indirectly by changing the parameters that affect the decisions taken by the commercial and household users.

3.1 Modelling woodland resources

The miombo woodland resource is defined in terms of the land area on which the miombo is standing or the average volume of miombo on the land. Analytically and computationally, it does not really matter which of this is considered in the model. This is especially because for simulation purposes this quantity is normalised to one. At the start of the analysis, part of the woodland is cleared for agricultural production while the rest remains forested. This is the initial condition, and conforms to reality in the region (Minde *et al.* 2000; Chipika and Kowero 2000). As described in detail later, the area maintained as miombo woodland can change from year to year due to conversion to agricultural use. Hence, in each year in the time horizon of the model, the amount of land under agricultural production is the sum of the land already under cultivation plus the *new land* converted from miombo woodland to agricultural use that year. One of the important outputs from this modelling exercise is therefore the amount of woodland resources cleared for agriculture in each year.

3.2 Modelling household users

It is assumed that household users are involved in three economic sectors, that is, miombo products (firewood, charcoal and poles), agriculture, and off-miombo/off-farm. Modelling agricultural household behaviour is complicated by the fact that farmers are not fully integrated in the market and/or that markets do not function perfectly. This implies that market prices and wages cannot be used as the only guide for economic behaviour. The opportunity cost of labour will be determined within the households by variables such as the degree of poverty, assets held, labour force participation level, etc. The market assumptions form the basis for the distinction between non-separable and separable models. In a separable model the production decisions are solved first, and then the consumption decisions. In a non-separable model they must be solved simultaneously. In the separable model, all prices (including wages) are assumed to be constant, and given by the market (perfect market assumption). Households' production decisions can be studied as a profit maximising problem. Market prices and technology determine the behaviour. Variables such as population size and poverty level are assumed to have *no* direct effect on resource use.

A more realistic, but also more complex, non-separable household model takes these factors into account, as it determines the shadow price or opportunity cost of labour within the model. The standard formulation of a non-separable model is to assume that households maximize utility, which increases consumption and leisure time. The households balance the drudgery or disutility of work against the utility of consumption, and reach a "subjective equilibrium". Further, they must allocate their labour time to different activities in the most optimal way (marginal return to labour is the same for all activities). This is often referred to as the Chayanovian model (see Angelsen 1999). In this article, the focus will be on a representative household, whose objective is to maximize utility (U (.)), a function of income (I) and leisure ($T = L^{max} - L$);

$$Max \quad U(I, T) = (I - I^{min})^{\alpha} + v(L^{max} - L)^{\beta} \tag{1}$$

This specification of the utility function, which draws on Angelsen (1999), includes both a subsistence level of consumption (I^{min}) and a limit on labour input (L^{max}). In the above equation, L is total labour used by the household in the activities they undertake, I is the gross income to households, and are parameters of the utility function.

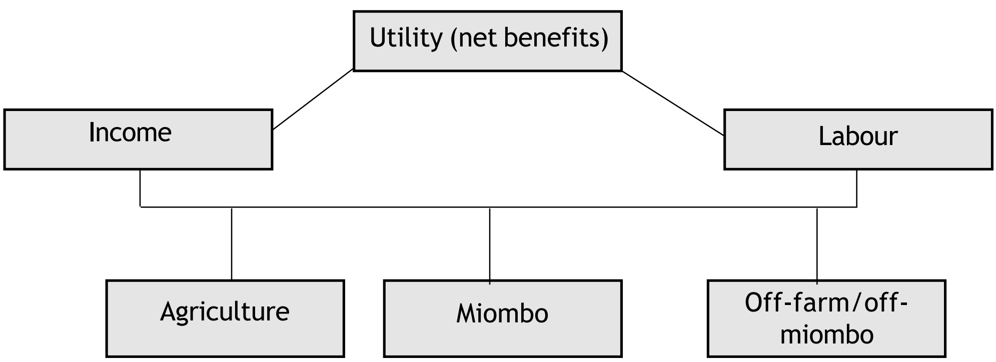
Total differentiation of the utility function in (1) yields the shadow wage rate, *z*:[3]

$$z = z(I, L) \equiv \frac{-U_T}{U_I} = \frac{v\beta\left(I - I^{min}\right)^{1-\alpha}}{\alpha\left(L^{max} - L\right)^{1-\beta}} 1 \tag{2}$$

where v is a parameter. In the current model, the household is assumed to allocate labour such that the marginal productivity of labour or marginal return to labour – *MRL* - is the same across all activities and equal to the shadow wage rate. For instance, the marginal return to labour employed in agriculture (L_a) should equal that to labour employed in harvesting wood products (L_m):

$$z = MRL_a = MRL_m \tag{3}$$

Figure 2. Main structure of the household component of the model



3.2.1 Adding-up equations

The gross household income comes from the net sale of miombo woodland products (I_m), agricultural produce (I_a), and off-miombo/off-farm activities (I_{of}), that is,

$$I_h = I_m + I_a + I_{of} \tag{4}$$

Total labour is found by simply adding the time devoted to the three main activities the household is involved in.

$$L_h = l_m + (l_a + L_n) + l_{of} \tag{5}$$

Within the agricultural work, a distinction is made between labour for cultivation (L_a) and labour for clearing new land (L_n) (i.e., converting miombo woodland into agricultural land).

3.2.2 Agricultural activities

Farmers are assumed to apply only two inputs, that is, labour and fertilizer, in addition to land. But since use is made of yield functions (and outputs and inputs are on a hectares basis), land becomes an implicit input in the model. Labour per ha (*l*) is assumed to be constant, whereas fertilizer (*f*) is a variable input. For computational simplicity (and as a fair approximation) use is made of an additive production function. Output per ha or yield (*x*) is then given by;

$$x = a + bl + cf^d \tag{6}$$

a, b, c, d are parameters to be estimated from household survey data.

The farmers decide how much fertilizer to apply per ha in such a way that the income, ignoring labour costs for the time being, is maximized;

$$Max \quad p_a x - p_f f \tag{7}$$

The condition for optimal fertilizer use is then;

$$p_a cdf^{d-1} - p_f = 0 \Leftrightarrow f = \left(\frac{p_f}{p_a cd}\right)^{\frac{1}{b-1}} \tag{8}$$

This formulation makes this part of the model recursive and easier to compute. First, fertilizer use in each period is determined by the exogenous agricultural output price (p_a) and fertilizer price (p_f) ratio, plus the parameters. The next step is to put this into the production function to determine the yield.

Net agricultural income is then defined as;

$$I_a = (p_a x - p_a f) H_a \tag{9}$$

Total labour employed in the agricultural sector is similarly expressed as;

$$L_a = lH_a \tag{10}$$

H_a is the total agricultural area, given by the sum of their initial agricultural land area (H_i) and new land converted from miombo to agriculture (H_n). A key decision for the households is whether or not to expand their land area, and if they do, by how many hectares. The starting point is to compare the net benefit that accrues to them per ha of miombo used for wood products (B_m), and that which accrues to them from the conversion of the woodland resources for agricultural production (B_a).

Current benefits from one ha of agricultural land are defined as;

$$B_a = p_a x - p_f f - zl \tag{11}$$

For new agricultural land we must also subtract the clearing costs per ha, *zl*. These should be convex in land cleared (e.g., as they move further away to convert miombo to cropping land), and a possible function would be;

$$l_c = gH_n^{\tau} \tag{12}$$

where l_c is the labour required for clearing per ha, g and are parameters, and H_n denotes new land cleared. The key is that the labour inputs should be convex in area, H^c, and therefore be raised to a number greater than one (> 1; set to 1.5 in Equation 13).

Total labour for clearing new land is then given by;

$$L_n = \int_0^{H_n} gx^{1.5}dx = g\frac{1}{2.5}H_n^{2.5} \tag{13}$$

Note that the calculation of labour for clearing becomes a bit more complex as the labour requirements per ha increase.

Thus, if the benefits from miombo are greater than those from agriculture on new land;

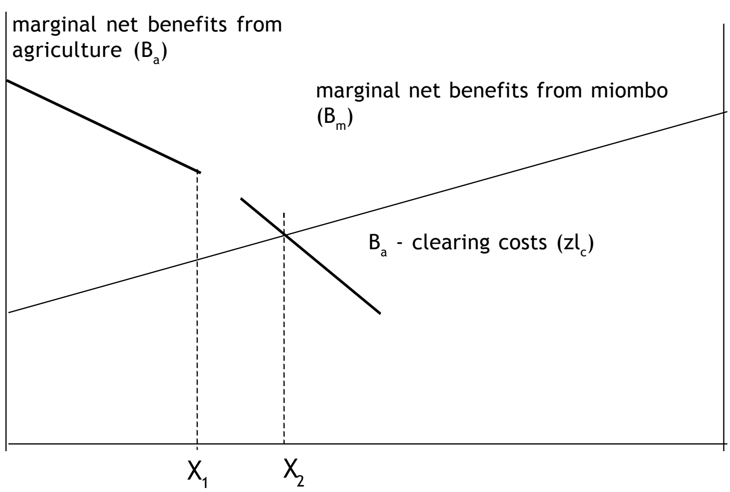
$$B_m > B_a - zl_c \tag{14}$$

for all positive values of H_n, *then* there will be no conversion of miombo to agriculture. If this is not the case, then agriculture will be expanded up to the point where:

$$B_m = B_a - zl_c \tag{15}$$

The situation can be illustrated graphically in a box-diagram as in Figure 3. The length of the box represents total land area. Agricultural land is measured from the left *y-axis* to the right, while miombo land is measured from the right *y-axis* and to the left.

Figure 3. Farmer choice of agricultural land expansion



The initial amount of land under agricultural cultivation is depicted at point X_1. Net marginal benefit from agriculture (B_a) is denoted by the thick line. This line is discontinuous at point X_1 as the net benefits from agricultural production on land beyond this point has to include the clearing costs (zl_c). As the figure is drawn, it will be beneficial to the farmer to clear some new land, up to point X_2 where the (B_a – zl_c) is equal to the marginal net benefits of the remaining miombo land (B_m). Thus, in this situation there will be some deforestation.

3.2.3 Miombo activities

Farm households are assumed to collect three different products from miombo woodlands: poles, fuelwood and timber. The gross income from this activity is given by;

$$I_m = p_{ave} H_m \tag{16}$$

where H_m is the quantity of miombo harvested for use as poles, fuelwood and timber, p_{ave} is the average weighted price received for the three different wood products. The portion of H_m that is used as poles, fuelwood or timber is determine by multiplying H_m by the corresponding relative prices.

Harvest (or miombo use) is a function of both the labour used in the miombo sector (L_m) and volume of standing miombo (N). Using a Cobb-Douglas function we get;

$$H_m = q_h N^{\mu} L_m^{\psi} \tag{17}$$

where μ *and* $\psi \in$ (0,1) parameters of the harvest function, and q_h is the harvest efficiency coefficient for the household sector. This is a fraction depicting the rate or portion of N that can be harvested or used in a given period if all the labour available to household were to be used for this activity.

3.2.4 Off-farm/off-miombo activities

We introduce a fixed off-farm and off-miombo employment (L^{OF}) and a given market wage rate (w), such that total off-farm/off-miombo income is;

$$I^{OF} = wL^{OF} \tag{18}$$

Since both the wage rate and off-farm labour are fixed, these variables can be used to study the effects of more economy-wide changes in the economy (e.g., high economic growth or recession), which usually affect both the wage rate and employment opportunities.

In summary, the total net benefits to household users, B_h, of miombo is given by

$$B_h = I_h - zL_h \tag{19}$$

where $B_h = B_a + B_m$

3.3 Commercial users

Commercial users are assumed to decide on how much miombo to harvest in each year in order to maximize their discounted economic benefits. This means they face only one economic sector, namely, the miombo products sector. Modelling commercial users behaviour is a lot simpler than modelling household user behaviour because they are involved in only one activity, that is, harvesting miombo woodland. In addition, the wage rate for commercial users (k) is exogenously fixed. In a similar fashion to the household users, we define the harvest function of commercial users as;

$$H_c = q_c N^{\mu} L_c^{\psi} \tag{20}$$

where L_c is the labour used by commercial users, and q_c is the harvest efficiency coefficient for the commercial sector. Note that the total labour available to both household and commercial sectors, L_t, is then $L_c + L_h$.

Net income (benefits) for the commercial users is then;

$$B_c = p_c H_c - kL_c \tag{21}$$

3.4 Miombo woodland dynamics

The ecology of miombo is represented by the following equations

$$R_t = K_t \tag{22}$$

$$N_t = sN_{t-1} + R_t - H_{c,t} - H_{h,t}; \qquad N_0 \text{ given} \tag{23}$$

$$g_t = \frac{\varepsilon}{1+\phi\gamma^{t}} \tag{23'}$$

Equation (22) captures any natural regeneration that takes place, with K_t denoting the volume in a given year. Equation (23') describes the growth over time of the miombo. The parameters and are ecological, they can be used to vary the quality of the miombo stand (see Frost 1996).

3.5 Institutional aspects of the model

In all countries with miombo woodlands it is assumed that a body (a stakeholder) regulates the use of this resource. This body may be a government authority, a community-based management entity or a sole owner of the resource. This body is assumed to be concerned with maximizing *overall* benefits from the use of the resource through time. Elements of the overall benefit function may include *direct economic* benefits; *social* benefits, e.g., the need to preserve settlement patterns in rural areas; and *environmental* benefits not traded in the market, e.g. benefits derived from biodiversity. The challenge facing the regulator is to determine the quantity of the woodlands to be used by the households and the commercial sectors in each year in order to maximize the management objectives.

The problem can be conceived in the following way. Let the net private benefits to the commercial and household users (from the use of the woodland resources) be B_c, and B_h, respectively, as defined in equations (19) and (21). Social benefits are

denoted B_s, while B_e represents environmental benefits. Social benefits may depend in some way on the amount of woodland resources used by one of the groups, say household users, for social, cultural or other reasons. Environmental benefits will depend positively on the amount of standing miombo ($N - H_c - H_h$) or negatively on the total woodland harvested ($H_c + H_h$), where N is the total volume (or even biomass) of miombo woodland resources at a given time.

Formally, we have,

$$B_s(\theta_c H_c, \theta_h H_h);\ B_e(N - H_c - H_h);\ or\ B_e(H_c + H_h) \tag{24}$$

where

$$\partial B_s / \partial H_c < \text{or} > 0;$$
$$\partial B_s / \partial H_h < \text{or} > 0;$$
$$\partial B_e / \partial (N - H_c - H_h) > 0;$$
$$or$$
$$\partial B_e / \partial (H_c + H_h) < 0;$$

It should be noted that $_c$ and $_h$ are the weights put on the harvests of the commercial and household users due to social concerns. These express the social preferences of society. These parameters can take values of 0 or 1. They take a value of 0 if society does not have any social preference for the harvest of a given participant, and a value of 1 if otherwise. Later we introduce an environmental parameter, , to reflect the extent to which society-wide environmental concerns are incorporated into the decision making process (see Lopez and Altobello 1994).

3.5.1 Decision making by household and commercial users

Before going into detailed discussions of the different game theoretic models in this paper, it is proper to give an overview description of how decisions by household and commercial users are made in the model. At the start of the game or simulation, we begin with the volume (or even land area) of miombo woodland (N_t). As illustrated in Figure 4, part of N_t is cleared for agricultural cultivation (N_a), while the remaining, N_m, is retained under miombo. The models that are developed are therefore concerned with the further use and allocation of N_m among household and commercial users.

Commercial users decide how much of N_m to harvest (H_c) in order to maximize their discounted benefits (profits). This is done in a single step. In the case of the households, however, their decision-making is made in three stages. First, they decide how much of N_m to retain under miombo for their use (H_h) so as to maximize their utility over time. In the second stage, household users decide how much of H_h to clear and put the land into agricultural production (H_a), and how much to retain as woodland (H_m) for supply of their forest products (see Figure 4). Again, this decision is made with a view to maximizing their utility. Finally, household users decide how much of H_m to use as fuelwood (H_{fw}), poles (H_{po}) and timber (H_{tim}). The allocation of resources to all of these activities depends on the relative prices or utilities received from each of them by the households. To elaborate more on this important aspect of the MIOMBOSIM

model, let the price for agricultural produce be given by p_a and that for fuelwood, poles and timber be p_{fw}, p_{po}, and p_{tim}, respectively. If the optimal amount/quantity of miombo resources for household use from Equation (25) is H_h^*, then the portion of this quantity forgone in preference to agricultural cultivation is given by

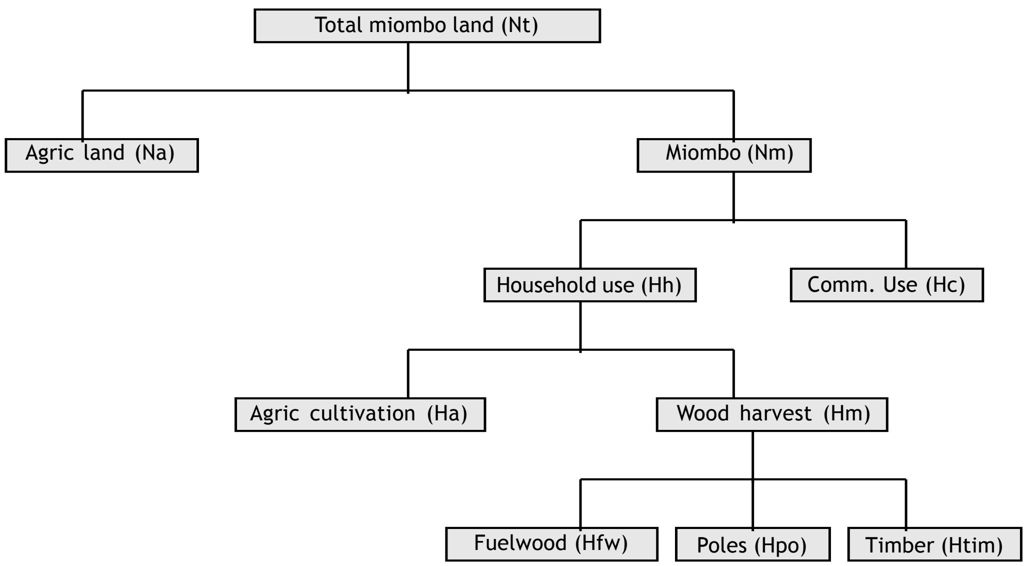
$$H_a = \frac{p_a H_h^*}{p_a + (p_{fw} + p_{po} + p_{tim})} \tag{25}$$

The quantity of miombo exploited for wood products, H_{wd}, is then given by the difference between H_h^* and H_a. Finally, the portions of H_a that go to fuelwood (and similarly for poles and timber), is given by

$$H_{fw} = \frac{p_{fw} H_a}{p_{fw} + p_{po} + p_{tim})} \tag{26}$$

In any given year, each of the above H quantities can be computed, and the total amount of land under agricultural cultivation determined by adding N_a to H_a. The total area under agricultural production is determined using relevant conversion factors.

Figure 4. Steps in decision making by the household and commercial sectors



3.5.2 The command model

The *command model* mimics the approach employed by many government forestry departments in the eastern and southern African region in the planning, management and use of their natural forest resources. Usually governments consider forest benefits to households (B_h), the private/commercial sector (B_c), the society as a whole (B_s), as well as national and international public goods like environmental benefits (B_e). The

model developed in this paper shows potential for use as a planning tool in government forestry departments. It is hence assumed in the model that the "commander" seeks to maximize total net benefits B_t through the choice of the amount of labour to be used by the commercial sector and the households in each year in the time horizon of the model, t=1.T, where T is the last (terminal) period:

$$\max_{L_h, L_c} \sum_{t=1}^{T} [B_t] \rho_{t-1} \tag{27}$$

subject to the ecological and household labour constraints described earlier.

In the above equation,

$$B_t = B_{c,t} + B_{h,t} + \theta B_{e,t} + B_{s,t}$$

$$\rho_{t-1} = \frac{1}{(1+r)^{t-1}}, \ \rho_0 = 1, \ t = 1,\ldots,T.$$

is the discount factor and r is the discount rate. It is important to note that the amount of miombo resources to be used for both agricultural cultivation and supply of wood products is determined from Equation (27). The division of these into the various activities carried out by the household users is already described in section 3.5.1.

3.5.3 The cooperative model

As mentioned earlier there are moves towards participatory management of the natural forestry resources. The command model can be modified so as to incorporate the involvement of the stakeholders in the management of the resource in a cooperative setting. For instance, if we consider a situation in which there is joint management of natural forest resources between the households (local communities) and the private sector, a cooperative management objective can be presented as follows:

$$\max_{l_h, l_c} \sum_{t=1}^{T} \left[\alpha \rho_{h,t-1} B_{h,t} + (1-\alpha) \rho_{c,t-1} B_{c,t}\right] \tag{28}$$

subject to the constraint in Equation (27).

In the cooperative setting the households and the private sector put weights and (1-) respectively on their individual benefits (which is a measure of their preferences) so as to maximize their combined benefits from exploiting the woodland resource (see Munro 1979). The private benefits are likely to differ from the social planner's benefits as represented in the command model. For instance, private stakeholders may not care much about social, cultural or environmental benefits from the woodlands, and even if they do, it is likely to be in a manner different from that of a social planner.

3.5.4 The non-cooperative model

There are situations in which local communities (households) or the private sector own and manage natural forest resources on their own and without taking the interest of other stakeholders into account. Under such situations, we have a *non-cooperative*

model. The management problem facing household users can be defined as follows:

$$\max_{L_h} \sum_{t=1}^{T} \left[\rho_{h,t-1} B_{h,t} \right] \tag{29}$$

subject to the stock constraint in Equation (27).

Similarly, the non-cooperative management problem facing the private sector can be stated as follows.

$$\max_{Lc} \sum_{t=1}^{T} \left[\rho_{c,t-1} B_{c,t} \right] \tag{30}$$

subject to the stock constraint in Equation (27).

3.6 Solving the models

To solve the above general models, appropriate Lagrangian functions have to developed. The command model is used to illustrate how this is done. In this case the Lagrangian is given by:

$$\begin{aligned} Lag = & \sum_{t=1}^{T} \rho_{t-1} \begin{bmatrix} B_c(H_{c,t}) + B_h(H_{h,t}) + B_s(\theta_c H_{c,t}, \theta_h H_{h,t}) \\ -\theta B_e(H_{c,t} + H_{h,t}) \end{bmatrix} \\ & + \sum_{t=1}^{T} \lambda_t \left[N_{t-1} + K_t - N_t - H_{c,t} - H_{h,t} \right] \\ & + \sum_{t=1}^{T} \xi_t \left[L_t - L_{m,t} - L_{a,t} - L_{n,t} - L_{of,t} \right] \end{aligned} \tag{31}$$

The first order conditions for optimisation are:

$$\frac{\partial Lag}{\partial L_{c,t}} = \rho_{t-1} \left[\partial B_c / \partial e_{c,t} + \partial B_s / \partial e_{c,t} - \theta \partial B_e / \partial e_{c,t} \right] - \lambda_t = 0 \tag{32}$$

$$\frac{\partial Lag}{\partial L_{h.t}} = \rho_{t-1} \left[\partial B_h / \partial e_{h,t} + \partial B_s / \partial e_{h,t} - \theta \partial B_e / \partial e_{h,t} \right] - \lambda_t = 0 \tag{33}$$

$$\frac{\partial Lag}{\partial \lambda_t} = N_{t-1} + K_t - N_t - H_{c,t} - H_{h,t} = 0 \tag{34}$$

$$\frac{\partial Lag}{\partial \xi_t} = L_t - L_{m,t} - L_{a,t} - L_{n,t} - L_{of,t} = 0 \tag{35}$$

In the above system of equations, and are defined as the Lagrangian multipliers or the shadow price of miombo and household labour, respectively. Equation (32) states that in any given period the net present value of the marginal harvest by commercial users plus the discounted net marginal social benefit from the exploitation of the resource by this group minus the net marginal stock effect of their exploitation activities on the environment, must equal the shadow price of the miombo resource. A similar interpretation stems from equation (33), with respect to the harvesting activities of the household users. When combined the two equations demonstrate that the optimal allocation of harvest to the two groups of users must be such that the marginal net benefit to the commercial users must equal that to the household users. Solving these equations for the unknown variables yields the optimal harvest to each user and the optimal stock levels in each period. Once these are determined the remaining task of the regulator is to ensure, by some means, that the user's harvest precisely the optimal quantities determined by the model.

3.7 Simulating the model

The numerical approach presented in Flåm (1993) and applied in Sumaila (1995), the system dynamics simulation package Powersim, and data collected during fieldwork can be combined to help us provide quantitative answers to a number of questions, including but not limited to the following:

- How much (i) harvest, (ii) benefits and (iii) employment will different woodland management options translate into for the commercial and household sectors?
- How much woodland is lost under different management regimes, government and macroeconomic policies?
- How does the harvesting technology used by the stakeholders affect the benefits they derive from using the woodlands?
- How sustainable are the harvest levels that will emerge from various government regulatory policies?
- How do prices of inputs and outputs (in agriculture and forestry) impact on production volume and methods, employment potential, and structure of the industry?
- How does off-miombo and/or off-farm income change the various outcomes of the model?
- How does change in subsistence income to household users impact on the outcomes of the model?

ENDNOTES

1. Also available as: Sumaila, U.R., A. Angelsen and G. Kowero. 2001. A system dynamics model for management of miombo woodlands. In: Modelling methods for policy analysis in miombo woodlands.

Occasional Paper No. 35, CIFOR, Bogor. pp.17-30.

2. By developing both the cooperative and non-cooperative models, it is possible to demonstrate whether decentralization of forest management could lead to the emergence of a cooperative management regime.

3. This is alternatively called the marginal rate of substitution between labour and consumption (income), the virtual price of labour, the opportunity costs of labour, or the subjective wage rate.

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APPENDIX 1. LIST OF VARIABLES AND PARAMETERS FOR MIOMBOSIM

	Model parameter
A	parameter in production function
A	superscripts agricultural sector
B	parameter in production function
B	Benefits
C	parameter in production function, subscript commercial sector
D	parameter in production function (yield effect of fertilizer)
E	effort in commercial sector
F	fertilizer (per ha)
G	parameter in labour for clearing function
H	subscript household sector
H	hectare of land
I	Income
K	costs of effort in commercial sector
L	labour per ha in agriculture
	Model variables
L	Labour
M	subscript miombo sector
N	subscript new (cleared) land)
N	stock of miombo resources
Of	subscript off-farm sector (OF)
	Model functions
P	Price
Q	efficiency parameter in harvest function
S	survival rate in miombo growth function
T	leisure for household (L^{max} – L)
U	utility for household
V	parameter in utility function
W	market wage rate for household
X	agricultural yield
	Subscripts and superscripts
Y	miombo harvest
Z	shadow wage rate for household
	parameter in utility function
	parameter in utility function
	parameter in harvest function
	parameter in harvest function
	weights in social benefit function
	discount factor
	parameter in labour for clearing function
	parameter in miombo growth function
	parameter in miombo growth function
	parameter in miombo growth function

APPENDIX 2. THE SOLUTION PROCEDURE (See Sumaila 1997)

$$\frac{\partial \ell}{\partial L_{c,t}} = \rho_{t-1}(\psi p_c q_c N_t^{\mu} L_{c,t}^{\psi-1}\nu - 0.5 k_c L_{c,t}^{-0.5}) - 0.5(\theta - \theta_c) q_c N_t^{\mu} L_{c,t}^{\psi-1} - 0.5\lambda_t \mathit{switch}\ 1 q_c N_t^{\mu} L_{c,t}^{\psi-1} \quad (1)$$

$$\frac{\partial \ell}{\partial L_{h,t}} = \rho_{t-1}(\psi p_h q_h N_t^{\mu} L_{h,t}^{\psi-1}\nu - \xi z L_{h,t}^{\mu-1}) - \psi(\theta - \theta_h) q_h N_t^{\mu} L_{h,t}^{\psi-1} - \psi\lambda_t \mathit{switch}\ 1 q_h N_t^{\mu} L_{h,t}^{\psi-1} \quad (2)$$

$$\frac{\partial \ell}{\partial N_t} = \rho_{t-1}(\mu p_c q_c N_t^{\mu-1} L_{c,t}^{\psi}\nu + \mu p_h q_h N_t^{\mu-1} L_{h,t}^{\psi}\nu) + \theta(\mu q_c N_t^{\mu-1} L_{c,t}^{\psi} + \mu q_h N_t^{\mu-1} L_{h,t}^{\psi}) \quad (3)$$

$$-(\theta_c \mu q_c N_t^{\mu-1} L_{c,t}^{\psi} + \theta_h \mu q_h N_t^{\mu-1} L_{h,t}^{\psi}) + \lambda_t \mathit{switch}\ 1(s - \mu q_c N_t^{\mu-1} L_{c,t}^{\psi} - \mu q_h N_t^{\mu-1} L_{h,t}^{\psi}) - \lambda_{t+1} s_{\text{switch2}}$$

$$\frac{\partial L}{\partial \lambda_t} = -\mathit{switch}\ 1(\mathit{switch}\ 1\ \text{arg}) \quad (4)$$

$$\frac{\partial L}{\partial \xi_t} = -\mathit{switch}\ 3(\mathit{switch}\ 3\ \text{arg}) \quad (5)$$

where,

$$\mathit{switch1} = \begin{cases} 1\ \mathit{if}\ (N_{t-1} + R_t - N_t - H_{c,t} - H_{h,t}) < 0 \\ 0\ \mathit{otherwise} \end{cases}$$

$$\mathit{switch2} = \begin{cases} 1\ \mathit{if}\ (N_t + R_{t+1} - N_{t+1} - H_{c,t+1} - H_{h,t+1}) < 0 \\ 0\ \mathit{otherwise} \end{cases}$$

$$\mathit{switch3} = \begin{cases} 1\ \mathit{if}\ (L_t - L_{m,t} - L_{a,t} - L_{n,t} - L_{of,t}) < 0 \\ 0\ \mathit{otherwise} \end{cases}$$

$$\mathit{switch}\ 1\ \mathit{arg} = N_{t-1} + R_t - N_t - H_{c,t} - H_{h,t}$$

$$\mathit{switch}\ 2\ \mathit{arg} = N_t + R_{t+1} - N_{t+1} - H_{c,t+1} - H_{h,t+1}$$

$$\mathit{switch}\ 3\ \mathit{arg} = L_t - L_{m,t} - L_{a,t} - L_{n,t} - L_{of,t}$$

The above adjustment equations can be manipulated to capture:

The command model: when , and either $_c$ or $_h$ are not zero. It should be noted that there is room for flexibility in the command model in the sense that one can give

varying emphasis to social and environment values by selecting different values for the s.

The command model reduces to a **cooperative model** if all the s are set equal to zero.

The command model collapses to a **non-cooperative model** if in addition to all the s being zero, the marginal stock effect on benefits of each stakeholder is not internalised by the users. That is, when the first term in the stock adjustment Equation (27) is set equal to zero.

APPENDIX 3. SCIENTISTS WHO PARTICIPATED IN DEVELOPING THE MODELS

Country and institution	Area of specialization
A. Malawi	
University of Malawi	
Dr. Charles Mataya	Agricultural economics
Mr. Charles Jumbe	Economics
Mr. Richard Kachule	Agricultural economics
Mr. Hardwick Tchale	Agricultural economics
B. Mozambique	
1. Eduardo Mondlane University	
Dr. Isilda Nhantumbo (now with IUCN)	Natural resource management
Dr. Gilead Mlay	Agricultural economics
Mr. Mario Falcao	Forest economics
2. Forestry Research Centre	
Mr. Jose Soares	Forestry
C. Tanzania	
Sokoine University of Agriculture	
Dr. Gerald Monela	Forest economics and management
Dr. Abdallah Kaoneka (late)	Forest economics and management
Dr. Yonika Ngaga	Forest economics
Dr. George Kajembe	Anthropology and social forestry
Dr. Zebedayo Mvena	Rural sociology
Dr. Florens Turuka	Agricultural economics
D. Zimbabwe	
University of Zimbabwe	
Dr. Ramos Mabugu	Economics
Dr. Chris Sukume	Agricultural economics
Southern Alliance For Indigenous Resources (SAFIRE)	
Mr. Peter Gondo	Forestry
E. Canada	
University of British Columbia	
Dr. Ussif Rashid Sumaila (also with CMI, Bergen, Norway)	Environmental and Natural Resource Economics and Management
F: Norway	
Agricultural University of Norway	
Dr. Arild Angelsen (also with CIFOR)	Economics
G. CIFOR	
Dr. Godwin Kowero	Forest economics and management
Prof. Bruce Campbell	Ecologist

15.
Manual for users of MIOMBOSIM: A simulation model for the management of miombo woodlands

G. Kowero and U.R. Sumaila

1. INTRODUCTION

What is Miombosim?

Miombo woodland is one of the most extensive dry forest vegetation types in Africa occurring in seven countries in eastern, central and southern Africa; namely Angola, Malawi, Mozambique, Tanzania, Democratic Republic of Congo, Zambia and Zimbabwe. The woodlands occupy an area of about 2.7 million square kilometres, almost equal to the combined land area of Mozambique, Malawi, Zimbabwe, Tanzania and Zambia.

The miombo ecosystem forms an integral part of rural communities living in them or in their proximity by providing them with virtually all their energy requirements in terms of fuelwood. The woodlands also provide building materials like poles and grass for thatching, medicines, wild meat and other types of food and fruits, fodder for livestock and wild game, and many timber and non-timber products. The woodlands offer a number of opportunities to various stakeholders. In each country there are policies guiding socio-economic development that affect the stakeholders and their environment in complex ways.

Miombosim is a system dynamics model that can be used to reconcile the demands of these stakeholders on the woodland resources in a sustainable manner. It uses a simulation software package, commonly known as Powersim, to simulate a game theoretic computational model for the management of miombo woodland resources. We first described in the model the different elements that characterize the interactions of the stakeholders (or players in game theory language) with the woodlands as a dynamic system. Mimbosim is therefore a platform on which we can evaluate the implications of different policies. This allows decision makers to understand the policy

implication for further refinement (if necessary) before recommending their implementation.

What are the goals of Miombosim?

A main goal of Miombosim is to provide researchers, resource managers, government departments and non-governmental organizations a tool for policy exploration regarding the use and management of miombo woodland resources. Miombosim therefore helps all these stakeholders to understand the complex relationships that characterize the management and use of miombo woodlands, and this can be enhanced by experimenting with different policy options or through sensitivity analysis on values of chosen parameters.

What is expected from runs of Miombosim?

Each Miombosim run will represent different policy initiatives under different scenarios for the management and use of the miombo woodland resources. The user specifies the policy options to experiment with and the Miombosim runs facilitate the selection of the most favourable policy option.

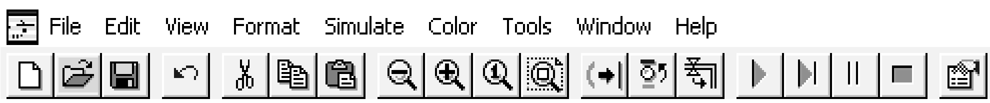
2. USER ENVIRONMENT

Powersim application window displays menus and provides the workspace for any simulation run of Miombosim. The Powersim application window is based on the same principles as any typical Windows application such as Excel, hence, knowledge of how to use other Windows based applications will be of great benefit to Miombosim users.

This manual is not intended to give the basics of Powersim; rather, it is intended to guide users on how to make use of a model (Miombosim) developed using Powersim. The assumption is that policy makers and other users will already have the problem formulated for this simulator and their interest is to use this as a basis for creating scenarios on different policy options and even testing the sensitivity of the values of various parameters. This therefore expands their scope for planning and decision-making as well as grounding such decisions in science.

For further details on this simulator and on the casual loop diagramming in Powersim see http://www.powersimsolutions.com/default.asp

Powersim menubar



The menu bar is located below the title bar at the top of the application window and contains all the Powersim commands. To view all the commands in a menu, do one of the following:

- Click the menu name
- Press Alt + N, where N is the underlined letter in the menu name. For example, press Alt + F to open the File menu.

Powersim commandbar

The commandbar is located below the menubar, and contains a set of buttons for performing the most frequently used commands in Powersim, for example, Open; Save, and Copy files; Run and Stop.

Powersim workspace
The workspace is where you view casual loop and flow diagram models and adjust model parameters using input presentations. This is the area that will be of interest to policy makers and other interested parties. It is in the workspace that scenario generation for different policies as well as sensitivity analyses are made. This can be done by modifying the casual loops and the model parameters in the equations using information supplied by stakeholders like policy makers.

Powersim statusbar

The statusbar is usually displayed at the bottom of the Powersim application window. It contains different kinds of status information, for example, context-sentitive menu help and the current simulation time.

3. MENU COMMANDS

This section provides you with a detailed description of all commands and options found in Powersim menus. Note that some of these are also available as buttons in the commandbar.

File menu

You use this menu to open, save and print documents or quit Powersim workspace. To use a document, you must first open and display it on your screen. You can then perform simulation runs.

Overview of File menu commands

- Open – Opens an existing document
- Close – Closes all windows of the active document
- Save – Saves changes made to the active document
- Save As – Saves and names the active file
- Page setup – defines page setup for the current document
- Print – prints the active window according to the parameters you specify
- Print Setup – identifies the printer you want to use and sets options for it
- Properties – Displays properties of the active documents
- Exit – Quits Powersim, prompts to save any unsaved documents

Edit menu

You use this menu to copy areas from your document, view the scaling of parameters, and searching for variables and parameters in a diagram.

Overview of Edit menu commands

- Copy – Copies the selected area and places it on a clipboard
- Scale – Displays the minimum and maximum scaling settings for variables
- Find – Searches for a variable or parameter in the active diagram

View menu

Use this menu to show or hide the commandbar and statusbar and to shrink or enlarge the diagram.

Overview of View menu commands

- Commandbar – Toggles the commandbar on/off
- Statusbar – Toggles the statusbar on/off
- Zoom – Enlarges or reduces the contents of the active diagram window

Simulate menu

Use this menu to start, stop or pause a simulation, and to inspect/specify run and simulation parameters, including time step and integration methods.

Overview of Simulate menu commands

- Run – Start a simulation
- Pause – Toggles pause on/off
- Stop – Stops a simulation
- Clear Results – Clears stored simulation results
- Run Setup – Defines run parameters
- Simulation Setup – Defines simulation parameters (start, stop, time step, etc.)

Tool menu

You use this menu to build your model in Powersim language

Overview of tool menu commands

- Level – symbol used to represent a stock
- Auxiliary – symbol representing an auxiliary function
- Constant - symbol used to represent a parameter
- Flow-with-rate – used to represent a flow into or out of a stock
- Link – used to link variables and parameters in the model
- Erase – used to erase/delete a symbol
- Camera – used to make a photocopy of a symbol
- Number – used to report a number (a parameter) in the model
- Time table – used to report results from a simulation in table form
- Time graph - employed to report results in graphical form
- Scatter gragh – illustrates results form simulations using scatter diagrams
- Array graph – used to report results of array variables (see Figure 2).

Window menu
You use this menu to rearrange windows or activate specified windows

Overview of Window menu commands
- Cascade – Arranges windows in an overlapping pattern
- Tiles – Arranges windows side by side so that all windows are visible
- Arrange Icons – Arranges icons in rows
- Close All – Closes all Powersim windows
- <list of windows> - Lists open windows

Help menu
Use this menu to get help on using Powersim

Overview of Help menu commands
- Contents – Displays the contents screen of Help
- Getting Started – Displays the Getting Started screen of Help
- Current Document - Opens the Help file associated with the current document
- About Powersim – Displays version number, copyright notice, and license information.

4. RUNNING MIOMBOSIM

This section contains step-by-step instructions on how to perform an experimental simulation session using Powersim. By following the instructions below, you will learn how to open and simulate a ready-made Miombosim model. However, for this we have to first familiarize ourselves with key symbols used in Powersim.

Symbols and building blocks for Miombosim
The aim of this section is to familiarize the user with key Powersim symbols and building blocks, which are used to develop Miombosim. Figure 1 shows a simple example that demonstrates how the symbols are put together in a model.

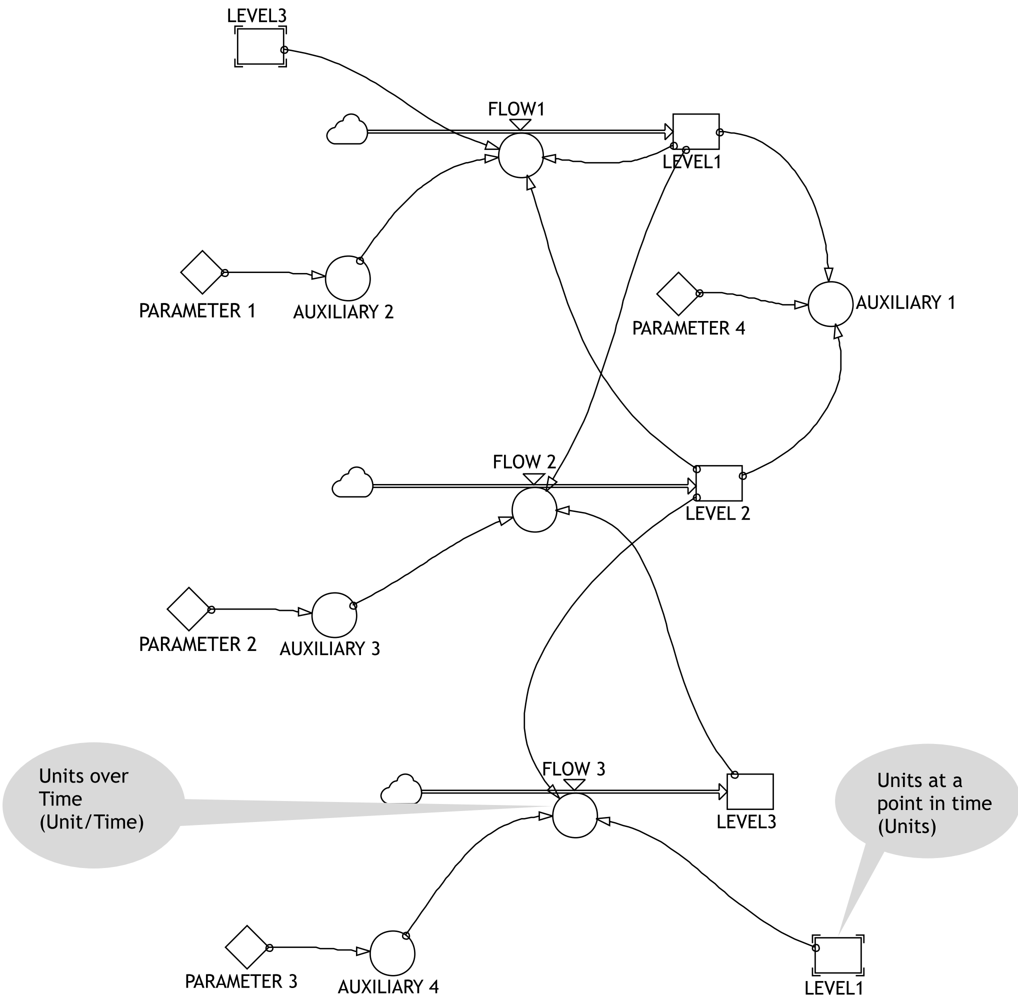
Level: Represented as a square, it is a variable type, which accumulates changes, for example, the volume of miombo in a stand or the number of people who cut miombo trees at any given time. It can be increased or decreased by what we call 'flows', as defined below (see next definition). See Appendix 1 for an example.

Flow-with-rate: Represented as a circle with an arrow sitting on top of the circle, it influences levels by adding the net flow of new stock, for example, new miombo growth, into levels. The flow is controlled by the connected rate variables, normally an auxiliary variable which defines how the stock of miombo changes (see below). Examples of these are given in Appendix 1.

Auxiliary: Represented as a circle, it is a variable type or function, which contains calculations based on other variables and parameters. It is usually a 'help' function that is used to define parts of a larger equation in the model. A function that describes miombo growth can be expressed using an auxiliary function, which can then be fed into the calculation of a flow function.

Constant: Represented as a diamond, it is a variable, which contains fixed values that are used in calculations of other variables or flows. Examples of constants are

Figure 1. The main Powersim symbols as used in a simple Miombosim model



prices in a constant price model or natural mortality rate of miombo woodland (see Appendix 1 for an example). Constants hold the parameters of the model

Cloud: Represented as a cloud, it is an undefined source or outlet for a flow to, or from a level. It denotes that we are at a model's outer limits. A cloud delimits the model; it represents the end of a model, as it were. For example, to define a flow of 'new' miombo biomass (due to growth) into the existing biomass, we show a flow by an arrow leaving a cloud and pointing into the Level. Cloud symbol expresses the fact that the growth comes from 'something' exogenous to the model.

Figure 1 and Appendix 1 display the structure of an example of Miombosim in diagram and equation formats, respectively. The diagram demonstrates how the above symbols are put together to build Miombosim, while the equations define the variables and parameters of the model mathematically. A brief description of various elements of the model are given in the Appendix 1.

Opening Miombosim

- From the File menu of Powersim choose Open or click Open in the Commandbar.
- From the Open dialog box select the model you want to open from the File Name listbox and select OK.

Data input and model runs

Choosing Start- and-Stop Time:

- An important aspect of the modeling of a problem is the choice of a time horizon for your model. The default start- and-stop times for Miombosim are 0 and 100, respectively. The time horizon may be simply units of computational time as in Miombosim, or some period of time (weeks, months, years, etc). In Miombosim, the actual computational time horizon assumed depends on how quickly the model converges to the equilibrium solution.
- Click Run in the commandbar to start a simulation run based on the original parameter values of the model.
- You may pause and resume a simulation whenever you like by clicking the Pause button.
- Let the simulation run until it has reached its stop time, or stop it manually by clicking the stop button. Note that you cannot resume a simulation after you have stopped it. You will then have to start a new simulation run.
- As the simulation runs, you will see that the current simulation time is indicated in the statusbar.

Policy analysis using Miombosim

Simulating Miombosim means to have Powersim compute the results over time based on the assumptions used to construct the model.

To simulate the impacts that different causes of actions might have on the results of Miombosim, we can make parameter adjustments before a simulation run. For example, we are interested in understanding the implication (s) of a move taken by a government of a country through a policy that leads to a 10% increase in the price of poles from miombo woodlands. This change needs to be incorporated into Miombsim, and the model re-run to determine the effect of this change on the predicted outcomes of the model. To do this physically, open the base case diagram of the model, find the price of poles parameter (see Appendix 1) and by double clicking it you will get to the interface where you can make changes to the price. Make the change and close the interface. Then run model.

After opening the relevant Miombosim model and performing a base run, follow the following steps to generate another policy scenario or to perform a sensitivity analysis:

From the Window menu, choose the parameter to be tested, for example price of poles because of policy changes or the growth rate of standing volume of miombo to check how sensitive the predicted results of the model are to any of these parameters, and hence, the consequences of policy changes that lead to such changes to the parameters

- Note base case value of the parameter(s) to be tested.
- Change the value of this parameter as the situation dictates, for example, if it is price of poles or fuelwood, it can be increased or decreased by say 10%

depending on the anticipated market condition, price controls or government policies.
- Start a new simulation.

Compare results from new simulation with those of base case simulation to identify the effect of the parameter adjustment. For example, the base results of a simulation run of a Miombosim model for one forest reserve, showed, among other things, that a 30% decrease in post harvest losses of agricultural produce could lead to a decrease in the benefits to the household sector from the use of miombo wood resources by between 3 and 6%, while the overall benefits to them would increase by about 30%. This is because the households would derive most of their benefits from agricultural produce, so the impact of the decrease in post harvest loss would be felt fully.

5. PRESENTING SIMULATION OUTPUT

Outputs and information from a simulation may be presented by any of the methods listed in Table 1.

Table 1. Outputs and information from a simulation

Name	Method
Auto Reports	Number, animation or graph
Array Graph	Presents an array of numbers in a 2-dimensional graph
Number	Presents values as numbers
Scatter Graph	Presents two variables in a 2-dimensional graph
Time Graph	Presents values as 2-dimensional line graphs and/or areas
Time Table	Presents values as tables of numbers

Auto reports

Auto reports are presentations of simulation results automatically displayed within or next to variable symbols in a diagram. Powersim offers 3 possible auto reports. It should be noted that the user does not have to do anything to initiate the auto reports:

Animation auto report:

Levels are animated as vertical hollow bars that capture changes in the simulated value of the variable represented by the level.

Auxiliaries and constants are animated as gauges, i.e., as needles with their center at the bottom of the variable symbol.

Number auto report:

The variables value is presented as a number, outside the variable symbol, at the side opposite of the variable name

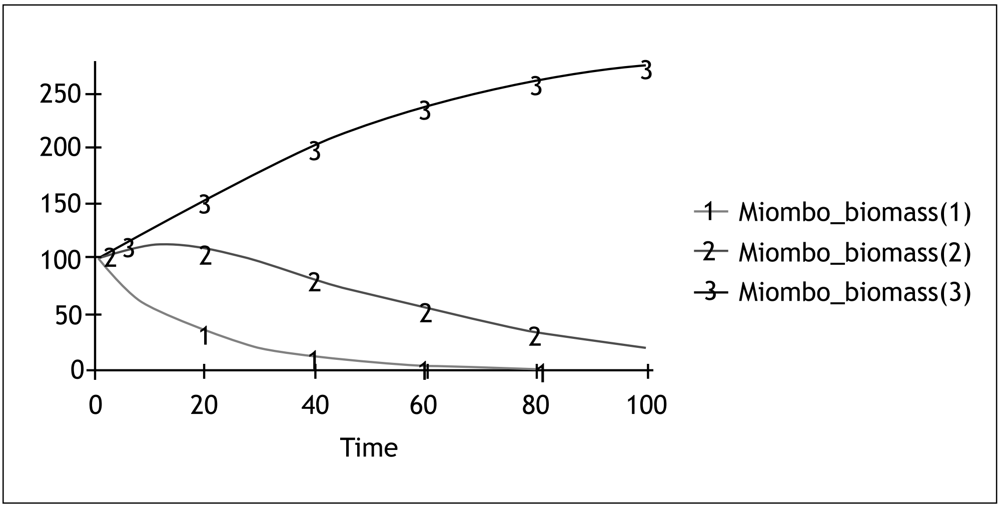
Graph auto report:
The graph is drawn as a simple line graph inside the level rectangle. The line color follows the symbol color.

To see examples of each of the above simply start a simulation and watch the symbols representing the various variables in the model.

Array graph
The array graph is an input/output presentation that displays an array variable or a series of scalar variables as a line graph or bar, optionally filled with a color. Figure 2 gives an example of an array graph. The graph shows the time paths of different year classes of miombo biomass. To construct array graphs do the following:

- Click the tool menu
- Select 'Array gragh'
- Click any where in the diagram view, and an empty graph will appear
- Double click inside this graph and an interface will appear.
- Choose the array variable(s) to be graphed
- Close platform and run model

Figure 2. Array graph of the variable miombo-biomass



Number
A number presentation displays the current value of a certain variable as a real number. An example is provided in Figure 3. To construct this, do the following:

- Click the tool menu
- Select 'Number'
- Click any where in the diagram view, and an empty 'Number' box will appear
- Double click inside this box and an interface will appear.
- Choose the variable to be reported
- Close platform and run model

Figure 3. Number boxes showing the price and revenue from a simulation

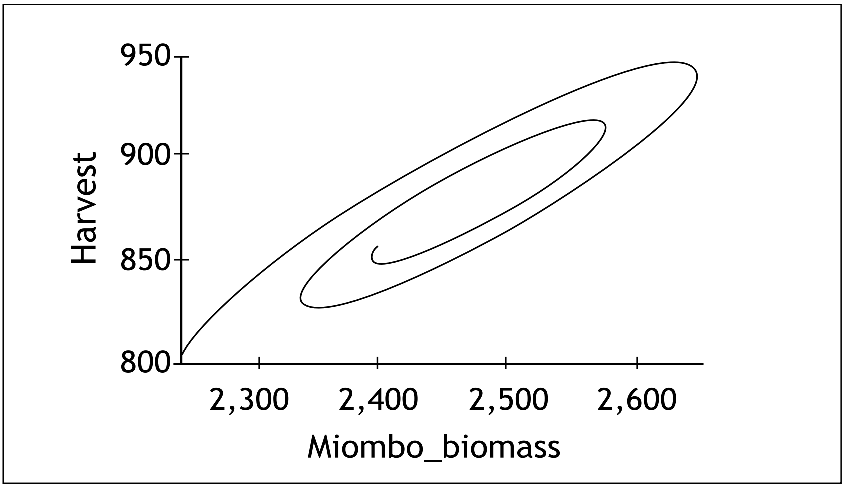
Revenue	478.36
Price	10.00

Scatter graph

A scatter graph displays the relationship between two variables in a 2-dimensional graph by using one variable as the X-coordinate and the other as Y-coordinate. Figure 4 is an example of a scatter graph. To construct this, do the following:

- Click the tool menu
- Select 'Scatter graph'
- Click any where in the diagram view, and an empty graph will appear
- Double click inside this graph and an interface will appear.
- Choose the variable(s) to be reported
- Close platform and run model

Figure 4. Scatter graph illustrates the possible path of biomass and harvest levels



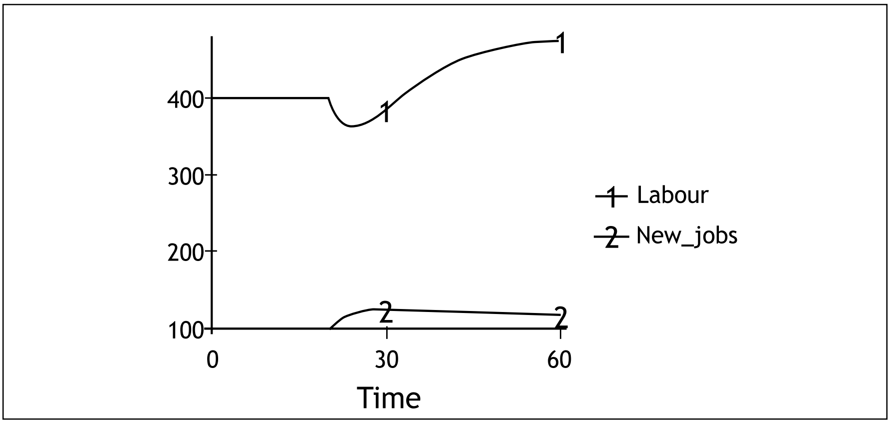
Time graph

A time graph displays a graphical overview of one or more variables' development over time. It has Time as the variable along the x-axis, and one or more dependent variables along the y-axis. Figure 5 is an example of a scatter graph. To construct this, do the following:

- Click the tool menu
- Select 'Time graph'
- Click any where in the diagram view, and an empty graph will appear
- Double click inside this graph and an interface will appear.

- Choose the variable(s) to be reported
- Close platform and run model

Figure 5. Time graph illustrates the possible time path of the current level of labour and new jobs over time



Time table

A time table presents the time paths of certain variables in columns and rows. An example of a time table is given in Figure 6. To construct this, do the following:

- Click the tool menu
- Select 'Time table'
- Click any where in the diagram view, and an empty table will appear
- Double click inside this table and an interface will appear.
- Choose the variable(s) to be reported
- Close platform and run model

Figure 6. Time table reports the miombo biomass and the growth in biomass over time

Time	Miombo_biomass	Growth_in_biomass
24	11,212.85	1,233.41
36	12,446.26	1,369.09
48	13,815.35	1,519.69
60	15,335.04	1,686.85
72	17,021.90	1,872.41
84	18,894.30	2,078.37
96	20,972.68	2,306.99
108	23,279.67	2,560.76
120	25,840.44	2,842.45

FURTHER READING

Byrknes, A. and Cover, J. 1996 Quick Tours in Powersim 2.5. Powersim Press, 99p.
Byrknes, A. 1996 Run-Time User's Guide and Reference Manual. Powersim Press, 57p.
Byrknes, A. and Cover, J. 1996 Quick Tours in Powersim 2.5. Powersim Press, 99p.
Anon. 1996 Powersim 2.5 User Manual, 225p.
Sumaila, U.R., Angelsen, A. and Kowero, G. 2001 A system dynamics model for management of miombo woodlands. In: Modelling methods for policy analysis in miombo woodlands. Occasional Paper No. 35, CIFOR, Bogor. pp.17-30.

APPENDIX 1: SAMPLE MIOMBOSIM MODEL IN POWERSIM EQUATION INTERFACE

The following are equations in a typical Miombosim model. The first column presents model variables (levels, flows, auxiliaries, and constants) by their dimensions (whether a scalar, vector or matrix); the initial value (init) if variable is a level; and documentation (Doc) explaining the variables. For instance, in the case of the variable 'labour' the dimension or 'dim' is a vector consisting of 'player' and 'period'. Like all levels, labour has to be given an initial or 'init' value to start of the simulation, this is defined as '0.1' in the example below – in theory this could be any number but in practice it should be a reasonable guesstimate of the model solution to speed up the simulation. Flow into the variable, labour, is defined next. The second column defines the variables, for instance, the 'flow into labour' is defined by the time step (dt) multiplied by the rate at which labour changes in a time step (Rate_labour).

dim	labour = (p=player, t=period)
init	labour = 0.1
flow	labour = +dt*Rate_labour
doc	labour = Effort level: initialized
dim	Mu = (t=period)
init	Mu = 1
flow	Mu = +dt*RMu
doc	Mu = Multiplier constraint for labour: initialized
dim	Multiplier = (t=period)
init	Multiplier = 1
flow	Multiplier = +dt*RMultiplier
doc	Multiplier = Multiplier constraint for WLRs: initialized
dim	WLR = (t=period)
init	WLR = 1/(1+0.02)^INDEX (t)
flow	WLR = +dt*Rate_WLR
doc	WLR = Miombo woodland resources
dim	Rate_labour = (p=player, t=period)
aux	Rate_labour = IF ((labour (p, t) + R_labour (p,t)/ (2*TIME+1))<0,0,R_labour (p,t)/(2*TIME+1))
doc	Rate_labour = Rate of labour equation
dim	Rate_WLR = (t=period)
aux	Rate_WLR = IF ((WLR (t) + R_WLR(t)/(2*TIME+1))<0,0,R_WLR(t)/ (2*TIME+1))
doc	Rate_WLR = Rate of stock equation
dim	RMu = (t=period)

```
aux     RMu = -Switch3(t)*S3fn(t)
doc     RMu = Rate of effort multiplier
dim     RMultiplier = (t=period)
aux     RMultiplier = -Switch1 (t)*S1fn(t)
doc     RMultiplier = Rate of stock multiplier
aux     Ave_agric = SUM (t=1..LAST (period);H_agric(t))/LAST(period)
doc     Ave_agric = Proportion of miombo lost by converting land to
        agricultural (agric.) production
aux     Ave_area_of_standing_miombo = Ave_WLR*Forest_Area
aux     Ave_commercial = SUM (t=1..LAST (period); WLR_use (1,t))/
        LAST(period)
doc     Ave_commercial = Proportion of miombo harvested by the commercial
        sector
aux     Ave_converted_agric_land = Ave_agric*Forest_Area
aux     Ave_fwd = SUM(t=1..LAST(period);H_fwd(t))/LAST(period)
doc     Ave_fwd = Proportion of miombo used for fuelwood
aux     Ave_hsehld = SUM (t=1..LAST(period); WLR_use(2,t))/LAST(period)
doc     Ave_hsehld = Proportion of miombo used by households (fuel, poles
        and fraction lost by converting land to agric production)
dim     Ave_labour = (p=player)
aux     Ave_labour = SUM (t=1..LAST(period); labour(p,t))/LAST(period)
doc     Ave_labour = Average labour employed by the households and the
        commercial sector.
aux     Ave_pole = SUM (t=1..LAST(period); H_poles(t))/LAST(period)
doc     Ave_pole = Average fraction of miombo used for poles by households
aux     Ave_vol_miombo_used_by_commer =
        Ave_commercial*Forest_Area*Volume
aux     Ave_vol_miombo_used_by_hh = Ave_hsehld*Forest_Area*Volume
aux     Ave_vol_miombo_used_for_fwd = Ave_fwd*Forest_Area*Volume
aux     Ave_vol_miombo_used_for_poles = Ave_pole*Forest_Area*Volume
aux     Ave_WLR = SUM (t=1..LAST(period); WLR(t))/LAST(period)
doc     Ave_WLR = Proportion of standing miombo after some is converted to
        agric and other uses (residual miombo)
dim     Benefit = (p=player, t=period)
aux     Benefit =
        Discount_factor(1)^INDEX(t)*(price_com*WLR_use(1,t)*Forest_Area*Volume
        - cost_H*labour(1,t))|p=1;
        Discount_factor(2)^INDEX(t)*(price_hld*WLR_use(2,t)*Forest_Area*Volume
        - cost_fn(t)*labour(2,t))
doc     Benefit = Benefit function for users; 1=commercial; 2=household
dim     Converted_land = (t=period)
aux     Converted_land = H_agric(t)*Forest_Area
dim     Converted_land_t1 = (t=period)
aux     Converted_land_t1 =
        Converted_land(t+1)|t<LAST(t);Converted_land(LAST(t))
dim     cost_fn = (t=period)
aux     cost_fn = v*Disposable_income^0.5/Leisure^0.5
doc     cost_fn = shadow price of labor for households
```

dim	Cum_land_under_agric_cultivation = (t=period)
aux	Cum_land_under_agric_cultivation = Converted_land+Tot_existing_land_under_agric
dim	Disposable_income = (t=period)
aux	Disposable_income = Income_from_agric_on_converted_miombo_land + Income_from_sale_of_wood_from_converted_land + Income_from_wood_products + Net_income_from_existing_agric_land + Off_income - subs_income
doc	Disposable_income = Auxiliary to household cost function
dim	Exisitng_agric_lab = (t=period)
aux	Exisitng_agric_lab = 0.1*Tot_existing_land_under_agric/ Init_existing_agric_land
doc	Exisitng_agric_lab = Fraction of total labour in the household used for current agricultural production (that is, this labour is not available for expanding agriculture into miombo)
aux	G_benefit = Tot_Benefit(1)+Tot_Benefit(2)
doc	G_benefit = Sum of benefits
dim	H_agric = (t=period)
aux	H_agric = Price_agric*WLR_use(2,t)/(Price_agric+price_Wprod)
doc	H_agric = Fraction of miombo used for agricultural purposes in the household.
dim	H_fwd = (t=period)
aux	H_fwd = price_fwd*H_Wprod/(price_fwd+price_pole)
doc	H_fwd = Fraction of miombo resources used as fuelwood
dim	H_poles = (t=period)
aux	H_poles = price_pole*H_Wprod/(price_fwd+price_pole)
doc	H_poles = Fraction of miombo used as poles
dim	H_Wprod = (t=period)
aux	H_Wprod = price_Wprod*WLR_use(2,t)/(Price_agric+price_Wprod)
doc	H_Wprod = Total fraction of miombo used for wood products (poles, fuelwood).
dim	Income_from_agric_on_converted_miombo_land = (t=period)
aux	Income_from_agric_on_converted_miombo_land = H_agric*Forest_Area*Rev_per_ha_of_Agric_land
dim	Income_from_sale_of_wood_from_converted_land = (t=period)
aux	Income_from_sale_of_wood_from_converted_land = 0.17*H_agric*Forest_Area*Volume*price_fwd + 0.83*H_agric*Forest_Area*Volume*price_pole
dim	Income_from_wood_products = (t=period)
aux	Income_from_wood_products = price_fwd*H_fwd*Forest_Area*Volume + price_pole*H_poles*Forest_Area*Volume
dim	labour_in_man_days = (p=player, t=period)
aux	labour_in_man_days = labour(2,t)*Total_man_day_in_community
dim	Leisure = (t=period)
aux	Leisure = max_labour(t) - labour(2,t) - off_miombo_labour - Exisitng_agric_lab
doc	Leisure = Auxiliary function to the household cost function (maximum labour in household less the labour used in converting miombo into

```
             agriculture less labour employed by household to produce poles and
             fuelwood less off miombo labour less labour employed in  current
             agricultural production)
dim          M_cost = (p=player, t=period)
aux          M_cost = (0.5*0.8*v*price_hld*eff_para(2)*Disposable_income(t)^-
             0.5*Leisure(t)^-0.5*WLR(t)^0.6*Volume*labour(2,t)^-0.2 +
             v*0.5*Disposable_income(t)^0.5*Leisure(t)^-0.5)/Leisure(t)
doc          M_cost = Marginal cost of household labour
dim          MultT1 = (t=period)
aux          MultT1 = Multiplier(t+1)|t<LAST(t); Multiplier(LAST(t))
doc          MultT1 = End period mulitplier adjustment
dim          Net_income_from_existing_agric_land = (t=period)
aux          Net_income_from_existing_agric_land =
             Tot_existing_land_under_agric*(Rev_per_ha_of_Agric_land -
             purchased_inputs*Volume)
aux          Off_income = off_wage*off_miombo_labour
doc          Off_income = Off-miombo income to household users
aux          Price_agric = price_per_cum_equiv_from_agric - Conv_cost -
             purchased_inputs
doc          Price_agric = Net income from agric from use of a unit of woodland
             resources adjusted for cost of purchased inputs and conversion
aux          price_hld = (Price_agric + price_Wprod)/2
doc          price_hld = Average income to household users from both agricultural
             produce and wood products
aux          price_Wprod = (price_fwd+price_pole)/2
doc          price_Wprod = Average price to household users from timber, poles
             and fuelwood
aux          purchased_inputs = fertilizer_cost+seed_cost
doc          purchased_inputs = Cost per unit of inputs in terms of cu.m. miombo
             equivalent
dim          R_labour = (p=player, t=period)
             auxR_labour = preference*Discount_factor(1)^INDEX(t)*(0.8*eff_para
             (1)*price_com*Forest_Area*WLR(t)^0.6*Volume*labour(1,t)^-0.2 -
             cost_H) + 0.8*theta(1)*eff_para(1)*WLR(t)^0.6*labour(1,t)^-0.2 -
             beta*eff_para(1)*WLR(t)^0.6*labour(1,t)^-0.2 -
             0.8*Multiplier(t)*Switch1(t)*eff_para(1)*price_com*WLR(t)^0.6*labour(1,t)^-
             0.2  |p=1; (1 -
             preference)*Discount_factor(2)^INDEX(t)*(0.8*eff_para(2)*price_
             hld*Forest_Area*WLR(t)^0.6*Volume*labour(2,t)^-0.2 - cost_fn(t) -
             labour(2,t)*M_cost(2,t)) +
             0.8*theta(2)*eff_para(2)*WLR(t)^0.6*labour(2,t)^-0.2 -
             beta*eff_para(2)*WLR(t)^0.6*labour(2,t)^-0.2 -
             0.8*Multiplier(t)*Switch1(t)*eff_para(2)*price_hld*WLR(t)^0.6*labour(2,t)^-
             0.2 - Mu(t)*Switch3(t)
doc          R_labour = Auxiliary to rate of labour equation
dim          R_WLR = (t=period)
```

```
aux      R_WLR =
         Discount_factor(1)*Volume*(0.6*price_com*eff_para(1)*labour(1,t)^0.8*WLR(t)^-
         0.4) +
         Discount_factor(2)*(0.6*price_hld*eff_para(2)*labour(2,t)^0.8*WLR(t)^-
         0.4) +  ((theta(1) - beta)*eff_para(1)*labour(1,t)^0.8 + (theta(2) -
         beta)*eff_para(2)*labour(2,t)^0.8)*0.6*WLR(t)^-0.4 +
         survival*MultT1(t)* Switch2(t) - Multiplier(t)*Switch1(t)*(1+
         0.6*WLR(t)^-0.4*(eff_para(1)*labour(1,t)^0.8 +
         eff_para(2)*labour(2,t)^0.8))
doc      R_WLR = Auxiliary to rate of biomass equation
dim      Regeneration = (t=period)
aux      Regeneration = 0.03*WLR
doc      Regeneration = 3% constant annual regeneration assumed
dim      S_WLRuse = (t=period)
aux      S_WLRuse = WLR_use(1,t)+WLR_use(2,t)
doc      S_WLRuse = Proportion of miombo used by both the household and the
         commercial sectors annually
dim      S1fn = (t=period)
aux      S1fn = survival*WLR(t-1) + Regeneration(t) - WLR(t) - S_WLRuse(t) |
         t>1; survival*WLR0 + Regeneration(t) - WLR(1) - S_WLRuse(1)
doc      S1fn = Auxiliary to switch function1
dim      S2fn = (t=period)
aux      S2fn = survival*WLR(t) + Regeneration(t) - WLR(t+1) -S_WLRuse(t+1)
         | t < LAST(t); WLR0 + Regeneration(t)
doc      S2fn = Auxiliary to switch function2
dim      S3fn = (t=period)
aux      S3fn = max_labour-labour(2,t)-off_miombo_labour
doc      S3fn = Auxiliary to switch function3
dim      Switch1 = (t=period)
aux      Switch1 = IF(S1fn(t) <0,1,0)
doc      Switch1 = Switch function1 to enforce constraint
dim      Switch2 = (t=period)
aux      Switch2 = IF(S2fn(t) <0,1,0)
doc      Switch2 = Switch function2 to enforce constraint
dim      Switch3 = (t=period)
aux      Switch3 = IF(S3fn(t) <0,1,0)
doc      Switch3 = Switch function3 to enforce constraint
dim      Tot_Benefit = (p=player)
aux      Tot_Benefit = SUM(t=1..LAST(period); Benefit(p,t))/1000
doc      Tot_Benefit = Total benefit to each user over time horizon of model
dim      Tot_existing_land_under_agric = (t=period)
aux      Tot_existing_land_under_agric =
         Init_existing_agric_land|t=1;Converted_land_t1+Init_existing_agric_land
dim      WLR_use = (p=player, t=period)
aux      WLR_use = eff_para(p)*WLR(t)^0.6*labour(p,t)^0.8
doc      WLR_use = Proportion of miombo used by either the household or the
         commercial sectors annually
const    beta = 1
```

doc	beta = Environmental concern parameter, takes values of 0 or 1. Zero if you care about the environment and 1 if you do not.
const	Conv_cost = 0
doc	Conv_cost = Conversion cost per cu.m. of miombo, which can easily be converted to per ha (it is the opportunity cost of labour because labour is the sole input, otherwise it includes cost of other inputs).
const	cost_H = 4.18
doc	cost_H = Cost of inputs including labour used by commercial sector
dim	Discount_factor = (p=player)
const	Discount_factor = [0,0.893]
doc	Discount_factor = Discount factor
dim	eff_para = (p=player)
const	eff_para = [0,0.103]
doc	eff_para = Labour efficency parameter: This implies commercial sector will need 11.06 years, at full capacity utilization, to harvest all miombo woodlands in the area. The household will need the same time because they employ people from the same pool.
const	fertilizer_cost = 0.52
doc	fertilizer_cost = Cost of fertilizer
const	Forest_Area = 44508
doc	Forest_Area = Forested area at the beginning of the analysis
const	Init_existing_agric_land = 15844
doc	Init_existing_agric_land = Existing agric land at start of analysis
dim	max_labour = (t=period)
const	max_labour = 1
doc	max_labour = Maximum annual labour available to household users: normalized
const	off_miombo_labour = 0.1
doc	off_miombo_labour = Labour employed by household users on off-miombo activities
const	off_wage = 2001120
doc	off_wage = Off miombo wage
const	preference = 0
const	price_com = 6.04
doc	price_com = price per cu. m. of miombo used for charcoal by the commercial sector
const	price_fwd = 2.4
doc	price_fwd = Price per cu.m. of miombo used as firewood by the household. Impose royalty fee of 25% of price of firewood.
const	price_per_cum_equiv_from_agric = 5.05
doc	price_per_cum_equiv_from_agric = Value of agricultural products obtained when land which that supports a cubic metre of miombo (firewood or poles or timber or a combination of these) is put under crops (Opportunity cost of agricultural production in terms of wood lost)
const	price_pole = 2.40
doc	price_pole = Price per cu.m. of miombo used as poles
const	Rev_per_ha_of_Agric_land = 252.61

doc	Rev_per_ha_of_Agric_land = Revenue from a hectare of land used for agricultural production.
const	seed_cost = 0.28
doc	seed_cost = Cost of seeding
const	subs_income = 1909800
doc	subs_income = Subsistence income for the community
const	survival = 0.95
doc	survival = Survival rate for miombo woodland
dim	theta = (p=player)
const	theta = [0,0]
doc	theta = Social concern parameters: Takes values of 0 or 1. They are zeros when no social concerns are taken into account and are I otherwise.
const	Total_labour in person days_in_community = 4562558
doc	Total_labour in person days_in_community = Total person days in community per year available for miombo woodland activities.
const	v = 0.5
doc	v = parameter to labour cost function of households
const	Volume = 50
doc	Volume = Standing volume of wood per hectare
const	WLR0 = 1
doc	WLR0 = Initial volume of miombo for the site

16.

A goal programming model for planning management of miombo woodlands[1]

I. Nhantumbo and G. Kowero

ABSTRACT

This paper presents a methodology employed in reconciling demands of households, private sector, and government on miombo woodlands of Southern Africa.

A Weighted Goal Programming approach is presented for planning management and use of the woodlands as well as a framework for policy analysis. The approach is based on essentially two models, viz., household and private sector models, which are linked into a miombo woodlands model (MIOMBOGP). The MIOMBOGP provides a framework for evaluating the impact, on these two sectors and the woodlands, of some government macro-economic policies as well as some forestry and agricultural sector policies.

Key words: Weighted goal programming, miombo woodlands, household sector, private sector, and Southern Africa.

1. INTRODUCTION

Miombo woodland is an African woodland dominated by species of *Brachystegia*, either in pure stands or in association with those of *Julbernadia* and/or *Isoberlinia* (Lind and Morrison 1974; White 1983). It occurs in seven eastern, central and southern African countries namely Angola, Democratic Republic of Congo, Malawi, Mozambique, Tanzania, Zambia, and Zimbabwe (White 1983). These woodlands are the major forest formations in this region. They occupy an area of about 2.7million km^2 and support over 40 million people. The people live in the vicinity of the woodlands, while some reside in woodlands that are in public domain. They rarely live in the woodlands set aside as government forest reserves, but do encroach on them for several demands.

Where the woodlands occur outside forest reserves, their clearing for agriculture has taken place over the years.

Dewees (1994) report that what is known about these woodlands is very much limited to their ecological and silvicultural characteristics. Further, most of the woodlands have been very heavily disturbed given the high local value they have to the inhabitants of this region. The woodlands offer a number of opportunities to various stakeholders, being people and/or institutions.

The national governments are interested in them in terms of revenues realized from licences and concessions issued to organizations and individuals harvesting forest produce, as well as their potential for tourism. In some cases the governments are interested in conservation of woodlands important for water supplies.

The private sector (institutions and individuals) is interested in extracting commercial products from the woodlands.

The communities bordering these woodlands are interested in them for a number of reasons. The woodlands are cleared to give way to agriculture. They are used as domestic animal grazing areas. They offer a number of timber and non-timber products for local consumption and trade.

In each country there are many policies guiding socio-economic development. Some of the policies target the government as an institution, or are specific to the private sector or target the rural communities. Each of these three entities has ways through which it can respond to the policies.

The objective of this paper is to present a methodology for planning woodland management and use, as well as for evaluating how the three principal woodland stakeholders respond to some macroeconomic and sectoral policies in ways that satisfy the achievement of their goals. The satisfaction of some of these goals makes demands on the woodland resources. It is these demands and the extent to which they manifest in the woodlands that the paper seeks to address, and especially their sustainable satisfaction.

There are several approaches for evaluating the impact/effect of the trade-off between the demands of these three sectors on the woodland resources. A weighted goal programming model is proposed as one of the approaches which can be employed to reconcile the objectives of the State, the household, and private sectors as they relate to the miombo woodland resources in this region.

This paper shall not present the basics of goal programming. Such information and examples of relevant applications can be found in, but not limited to, Romero (1991), Romero and Rehman (1989), Rehman and Romero (1993), Norton and Schiefer (1980), Nhantumbo (1997), Mendoza and Sprouse (1989) Hazell and Norton (1986), Day (1963) McCarl (1992), and Yoon and Hwang(1995).

The goal programming (GP) approach, of the acronym MIOMBOGP, is used side by side with a system dynamic approach (MIOMBOSIM) to model these sectors in chosen sites in Malawi, Mozambique, Tanzania and Zimbabwe as part of a CIFOR research project funded by the European Commission and implemented in these four Southern African Development Community (SADC) countries. These two approaches are intended to operationalise one of the objectives of this research project, which is to evaluate how some selected macroeconomic and sectoral policies are impacting on local communities and the industry dependent on these woodlands. Also evaluated is how the policy responses by these two sectors are impacting on the woodland resource management, use and conservation.

The paper is organized as follows. Section 2 gives a brief overview of the problem environment. Section 3 presents the methodology for modelling the household sector, while Section 4 presents the same for the private sector. For each sector the most important activities are described, followed by a general mathematical formulation of the MIOMBOGP model. In Section 5 the two sectoral models are linked together to reflect the role these sectors play as producers and intermediaries in marketing forest products extracted from these woodlands. Section 6 demonstrates how sectoral government policies are incorporated into the MIOMBOGP model. Section 7 presents limitations of this modelling approach.

2. PROBLEM ENVIRONMENT

In the miombo woodland region planners and policy makers are faced with the challenge of maintaining land under woodland cover (Dewees 1994). This is because of the pressure for agricultural land arising from growing populations in these countries. Further, there is also pressure for increasing livestock population, not only in terms of space but also demands for fodder. The future of these woodlands would depend very much on how the demands of various sectors are reconciled in any specific location.

Planning for the welfare of the local communities depending on the woodlands would demand consideration of decisions and responses to policies at various levels as illustrated by Figure 1.

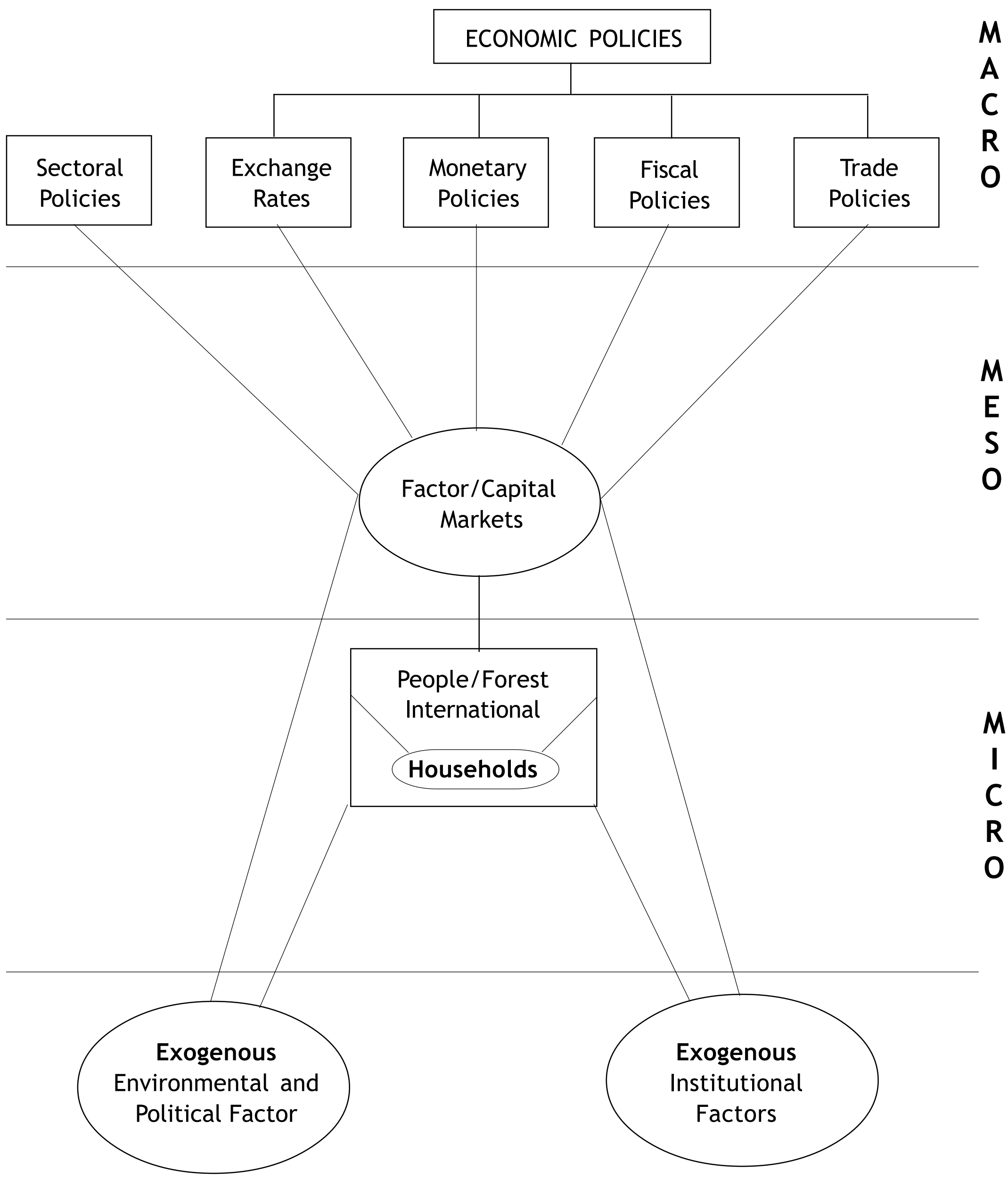
The inter-relationships between macro-economic policies, food, agriculture, natural resources (woodlands) and people in these developing countries are extremely complex. Yet, understanding of the inter-relationships is paramount in influencing the process, pace, magnitude and direction of development necessary for enhancing people's welfare. There are strong linkages between macro-economic policies (such as monetary, fiscal, exchange rate, trade and employment) and sectoral policies (such as land, agriculture, forestry, population and the environment). The macro policies influence the various sectors of the economy, including households through the following tools and instruments: market reforms, tariffs, subsidies, and taxes and transfers (Minde *et al.* 1997).

The markets (meso-level) from which these sectors and household obtain their inputs and sell their surpluses are in turn influenced by the macro-economic factors mainly through product and factor markets (capital, labour and land). Households (micro-level) absorb the overall effects of the macro and meso-level interactions and this in turn influences their decisions on employment, output, income sources and food consumption. Apart from their welfare being influenced directly by the outcome of these interactions, positive or negative effects result in the natural resource base and the environment of which they are a part. Positive effects may include increased employment in the short or long term, increased income from better product prices or factor prices. Negative effects may include increased deforestation, soil erosion leading to reduction in income and environmental degradation in the long term (*ibid.*).

Exogenous factors, mainly of institutional and political nature, also impact on the households causing further (secondary) impacts on the environment. The Mozambican war and the resulting refugee influx into Malawi is one example of exogenous factors that led to considerable depletion of forest land in Malawi (*ibid.*).

Unfortunately macro-economic policies and strategies as well as sectoral policies and strategies for forestry, livestock, agriculture development are often drawn

Figure 1. Macro-meso-micro linkages in the miombo woodlands



independent of one another and by different government departments and ministries, giving a piecemeal approach to planning.

A number of policies related to both financial and goods markets, as well as other factors have potential to influence human-woodland resource interactions. The approach presented in this paper is expected to highlight the effects of macroeconomic policies affecting prices of agricultural inputs and outputs, off-farm incomes, subsidies and credit. These are some of the key macroeconomic policies driving changes in rural areas in the region. Kaimowitz and Angelsen (1998) provide an excellent review on the impact of different policies on forest condition, and more specifically on deforestation. The impact of some agricultural and forestry sectoral policies is also expected to be demonstrated by this approach. The incorporation of different stakeholder partnerships and their impact on managing and using the woodland resources shall also be demonstrated.

The next two sections demonstrate how the weighted goal programming model (MIOMBOGP) is developed for some sites in the miombo woodland region. The research sites are located in Malawi, Mozambique, Tanzania, and Zimbabwe. Some of the assumptions made are therefore specific to those sites. Participatory Rural Appraisals (PRAs) provided the basic information on woodland condition, household economy, and demands by various sectors on the woodlands.

3. MODELLING TYPICAL HOUSEHOLD POLICY RESPONSES

The household sector is modelled in terms of major activities undertaken in order to meet daily needs and demands such activities put on family labour, land and woodland resources. The sector is comprised of mainly subsistence farmers whose primary goals are self-sufficiency in food (food security) and financial income for basics such as food, health, and education. Though local communities are aware of environmental values, these are largely secondary because the pressing needs are food security and income for meeting basic requirements.

3.1 Activities carried out by the typical household

There are three basic activities undertaken by most households in the miombo region. These are *agricultural crop production*, *livestock rearing* and *collection of firewood* for domestic use and sale. Each of these activities is further examined in greater detail. There are many other smaller activities, which can also be incorporated into the model, but these three will serve to illustrate how household activities can be modelled. The less important ones can be added onto the model as need arises.

3.1.1 Agricultural crop production activities

Many rural communities are involved in a number of agricultural activities for cash and subsistence. However, for simplicity only three crops are used in this paper to illustrate how crop production can be taken up in a model of this nature. The crops are *maize, beans* and *peanuts*. The activities associated with these three crops can be categorised as *Production, Selling, Buying, Consumption,* and *Storage*. These activities are spread over two climatic seasons prevailing in most of the countries namely, *dry* and *wet* seasons.

For crop production, information for developing the model will be needed on the following:

- Cost of inputs such as seeds and fertilizers, so that the cost of production can be determined.
- Prices for sold and bought agricultural produce. It may be reasonable to assume that the bulk of crop harvesting takes place at the beginning of the dry season making selling prices in this season lower than in the wet season. Further, buying at the market place in either season may be assumed to be at a higher price (because of the profit margin of middlemen) than the price farmers receive. Buying is an activity that allows the households to purchase food to supplement production.
- Consumption activities should incorporate demand for calories per individual member of the family and nutrient composition per crop.
- Storage allows transference of food from one season to the other. An estimate of individual crop storage losses has to be known.
- Land area demanded per crop.
- Labour demanded per crop and as supplied by each family member, as well as hired labour.
- Quantity of production per crop.

Decisions have to be made on the following and supplemented by assumptions and observations from household studies in the region:

- Size of the household and its composition.
- Supply of family labour for agricultural activities.
- Supply of labour for other activities.

3.1.2 Livestock activities

There are a number of livestock types kept by the local communities, but the main ones considered are cattle, goats and sheep. Chicken and pigs are also found in some communities. Livestock is modelled using cattle as an example.

The main activities associated with cattle are *rearing/grazing, reproduction,* and *selling*. For these activities the following information will be needed:

(a) Cattle rearing:

- Demand for pasture in tons of dry matter (DM) per animal unit. The assumption is that households already have the animals.
- Pasture supply (according to the type of vegetation in the locality of the household). This is to be estimated in terms of tons of DM that are available for grazing.
- Labour available for grazing.

(b) Selling of cattle:

- Selling price per animal.

(c) Reproduction:

- Number of animals per household
- Rates of reproduction

This helps to gauge the growth of the animal stock.

3.1.3 Wood related activities

The main woodland related activities of households in the region are collection of firewood and poles, as well as their selling. Processing of round wood into charcoal and selling charcoal are activities that can also be incorporated into the models developed for Tanzania, Malawi, and Mozambique. A basic assumption is that harvesting of the natural forest for firewood is free of charge. However, a scenario whereby the farmers might in future be required to pay a fee to the government for harvesting government forest reserves can be examined, as well as the impact of various levels of such fees. Another assumption is that the natural forest supplies wood for household consumption and sale.

For analysis of activities related to firewood and poles information shall be needed on:

- The quantity of the standing stock (volume of miombo per hectare) on which the household depends for these supplies.
- The annual increment/growth of the stock. One could introduce a constraint on amount of wood harvested not to exceed annual stock growth. This might already be a requirement of the forest sector policy.
- The quantity and price of firewood and poles sold per household. This is the gross income per household from this activity. One can assume a uniform price throughout the year or differentiate it into seasons since access to the forests during the wet season is difficult therefore constraining supplies and raising the price. The latter has been noted in Mozambique, i.e. higher prices of charcoal in the wet season.
- In the case of charcoal production, the data required should include the relevant conversion factors (from round wood to charcoal) for the alternative technologies of making charcoal. These are essentially efficiency parameters that will allow evaluation of the suitability of these technologies and their long-term impact on the woodlands.

3.1.4 Other activities

There are various domestic activities in any household. The labour distribution for such activities per member of the household (women, children and men) has to be established. Other relevant activities include the collection of non-timber products from the woodlands. In addition to data on their labour requirements, information will also be needed on the quantities harvested, prices (if sold), and use categories (e.g. by household, sold to markets or middlemen, etc).

Many of the activities in this category are what we may call off-farm activities. Apart from domestic and non-timber collection activities, relevant activities could include brewing beer, pottery, and small businesses. All these activities have to be identified, their labour demands estimated, their outputs known and quantified, and associated expense and income data collected.

Dietary demands

These communities are assumed to consume food that satisfies a minimum set of dietary requirements. The proportions of different foods (maize, beans, peanuts, etc.) that largely reflect the eating habits in these communities have to be established. This is important for establishing whether or not the typical household is self-sufficient

in food. This parameter is very relevant since giving more rights to communities for management of the natural resources aims at reduction of poverty, and food security is one of the parameters or indicators that can gauge its achievement.

3.2 The general household sector model

The modelling approach that is proposed in this paper is to be constructed for representative households in different sites in Malawi, Mozambique, Tanzania, and Zimbabwe. There are two ways of going about this: identifying an average or a typical household in each of the sites and building the model around it. An average farm may not be found in the field. However, it is possible to identify a typical household from field data. This is advantageous in that frequency analysis using median and mode can allow us to gauge the principal combination of activities in the region. Further use can be made of a typical household in cross-checking the data input as well as gauging the outcome of the model.

The mathematical expression of the MIOMBOGP model is presented as follows:

(a) Objective function

The objective in the weighted goal programming context is to minimise the sum of deviations, both positive and negative, from the target levels set by the decision-maker. In this case the decision-maker is the household, the private investor, and the government. The principle of WGP is simultaneous minimisation of the sum of weighted deviations, and is given as:

$$\text{Min} \mathop{}_{i=1}^{k} (\;_i n_i + \;_i p_i) \qquad (1)$$

The weights ($_i$ and $_i$) are associated to goals and with deviations (n_i, p_i). This means that the decision maker (household, private investor or government) has to set a target associated with the objective and express whether he/she would allow a negative or positive deviation from the goal (objective + target).

On the other hand the expression for a linear programming (LP) objective function is maximisation of the total gross margin and is given as:

$$\text{Max} \mathop{}_{j=1}^{n} g_j x_j \qquad (1')$$

where g_j = gross margin per unit of the activity, for example from cropping and livestock activities, and harvesting wood products; and

x_j is the level of activity X_j,

(b) Constraints

(i) Land availability

Land allocation to various crops should not exceed the total land available to all households in a specific location.

$$\mathop{}_{i=1}^{n} X_i <= ß \qquad (2)$$

X_i is the amount of land area allocated to crop i (i = 1,2,3 – representing, initially, the three crops, respectively maize, beans, and peanuts. The area allocated to the crops should not exceed the size of the land, *ß*, for the average or typical household. However, other constraints on land can be introduced to ensure fair representation of land allocation to different crops grown in household.

(ii) Demand for various crops

The demand for each crop (positive sign in the equation) for selling, storage, and consumption, should be less or equal to the quantity of that crop produced per ha in addition to supplements made through purchased food when deficits occur (negative sign in the equation 3).

Let:

S_i represents the quantity of crop i sold,
A_i represents the quantity of crop i stored,
B_i represents the quantity of crop i bought,
C_i represents the quantity of crop i consumed

Total crop production in a specific area is given by $y_i X_i$, where y_i is the yield per unit area of crop i. (X = 1 ha.) Total demand for each crop is then given as:

$$-\sum_{i=1}^{n} y_i X_{ij} + \sum_{i=1}^{n} S_{ij} + \sum_{i=1}^{n} A_{ij} - \sum_{i=1}^{n} B_{ij} + \sum_{i=1}^{n} C_{ij} <= 0, \tag{3}$$

Production Selling Storage Buying Consumption

where j represents the two seasons, viz. j = 1, 2, for respectively dry and wet seasons.

The prime use of production in the study areas is for consumption. Therefore it is assumed that selling activities take place after the satisfaction of family consumption and that the household stores food from one season to the other. Given that losses (*a*) occur in crop storage (A) the following equation is relevant for the wet season:

$$\sum_{i=1}^{n} aAij - \sum_{j=1}^{n} Bij + \sum_{j=1}^{n} Cij + \sum_{j=1}^{n} Sij <= 0 \tag{4}$$

(iii) Labour demand

The total labour demand for each of the crops, SL_{ik}, is the labour demanded by crop i and supplied by source k, where:

k = 1 represents male labour
k = 2 represents female labour,
k = 3 represents child labour.

Let LA represent labour demand for livestock activities; LN, labour demand for non-farm/off-farm activities; and LD labour demand for domestic activities. The total labour demand for crops, livestock, off-farm and domestic activities should not exceed that available in the household (SL_k); and is given as follows:

$$\sum_{k=1}^{n} L_{ik} + \sum^{n} LA_k + \sum^{n} LN_k + \sum^{n} LD_k - \sum^{n} L_k <= 0 \tag{5}$$

(iv) Tie constraints

The family labour is tied to the size, gender, and age of the household members. For

example, in the equation below it is assumed that the size of the family is 5, comprising of one adult male, one adult female and three children. All or some of the children can be assumed to be old enough to perform activities such as cattle rearing and domestic chores.

$$L_k = 5 \tag{6}$$

(v) Dietary constraints

The demand for food for household consumption in equation (3) is in kilograms. This is linked to the energy constraints through supply of Kilocalories (Kcal.) and grams of protein by each crop to family members. The supply should at least satisfy demand per season, which in turn depends on household size and composition as determined by Equation 5.

Energy supply (E) per crop to the household

$$-\sum_{k=1}^{n} E_i + E_{kj} <= 0 \tag{7}$$

The supply of energy from all crops (E_i) should satisfy the energy requirements by household members (E_k), where k = 1, 2, 3.

Protein supply (P) per crop to the household

$$-\sum_{j=1}^{n} P_j + P_{kj} <= 0 \tag{8}$$

(vi) Livestock constraints

Livestock grazing

The demand for feed for cattle (g tons of dry matter per head) should at least be satisfied by the amount of available pasture (p tons dry matter per ha) in a specified grazing area.

$$gC - pF <= 0 \tag{9}$$

where:
C = cattle stock numbers.
F = land area for natural production of feed for cattle.

To take into consideration the carrying capacity of the grazing land we can set the limit on land area available or let the model calculate the grazing area necessary to satisfy the herd size of the typical household. Therefore, F can have lower and upper bounds to limit the land available or accessible for grazing by the household. In both cases the model output will indicate whether there is overgrazing or not, and this depends on the number of families keeping or owning cattle and other livestock.

Cattle herd size

The size of the cattle herd should at least equal to f.

$$C >= f \quad (10)$$

where:
f = average herd size for a typical household

Cattle reproduction or growth of animal stock
The calving per year should supply the herd. The total herd size is therefore the sum of new borns (cvC_f) and existing stock (C); and the relationship between the two depends on the calving rate, denoted as cv net of mortality.

$$-cvC_f + C >= 0 \quad (11)$$

where Cf is the number of female animals of reproduction age

Sale of animals
The number of animals sold, SC, should not exceed the number of the animals calved. This is assuming that the household would like to maintain a minimum stock size.

$$-cvC_f + SC <= 0 \quad (12)$$

where SC =sale of animals

(vii) Forest products constraints

Harvesting wood for energy
The standing forest stock should at least satisfy the demand for household fuelwood consumption and for sale.

$$-SS + FwC + WdCh + SFw <= 0 \quad (13)$$

where
SS = Standing stock (volume of miombo per hectare)
FwC = firewood consumption
SFw = sale of firewood
Wd = quantity of wood required to produce charcoal (Ch)

and:

$$-WdCh + SCh <=0 \quad (14)$$

where
SCh = selling of charcoal

This indicates the transference of the production to the market, in that charcoal sold cannot exceed that produced. We can also include upper and lower limits for Ch since there is limited capacity in terms of labour undertaking this activity in the household in each season. The limits will eliminate unrealistic allocation of labour to produce charcoal only in the season with higher selling price (e.g. wet season in Mozambique).

FwC is determined by the size of the household and estimates of consumption in the Southern Africa indicate that in average a person consumes 1 to 2 m^3/year.

Sustainable firewood harvesting
The amount of firewood sold, if the harvesting is to be sustainable, should not exceed the annual growth in the stock. If the annual growth is denoted as s, then this relationship can be given as:

$$SFw + SCh <= sSS \quad (15)$$

This can be introduced as a goal of the regulator, which in these countries is the government. The assumption here is that harvesting for household consumption does not endanger sustainable firewood supplies.

Firewood sales
Alternatively the amount of harvested wood for sale will be limited by the capacity of the household in terms of labour. Therefore the amount sold will be tied to a maximum number of firewood sales, Qmax, in order to ensure that sufficient quantities are sold given the labour available for this.

$$SFw + SCh <= Qmax. \quad (16)$$

Other constraints, accounting or 'tie' constraints, can be introduced in order to guarantee that the solution is logical and better reflects the household situation.

The complexity of the model can be increased depending on the number of activities households undertake and structure of the households. Any restrictions from the government will be incorporated later after linking the farm and private sector models.

(c) Goals
For realism various goals guiding household behaviour and activities have to be incorporated. This is because planning household activities based on the assumption that they are driven by profit maximisation distorts reality in households' decision-making environment in the miombo region. Most households produce food and even encroach on the forest for income generation in order to meet their basic need, i.e., food security. In a broader sense food security is achieved through production or access to the market, i.e., having a purchasing capacity/power. This seems to suggest that the rural household plan (or combination of activities) in the miombo woodland has at least two goals. In the model, the goals are represented as equalities. Earning of cash income is one of the household goals in these countries. This then makes the sum of the gross margins of all activities (cropping, livestock, forest harvesting, etc) contribute to the target level set by the decision-maker, in this case the head of the household. This can alternatively be derived by running the household model as a simple linear programming (LP) model. Generally the decision-makers' aim would be to minimise the negative deviation from the set target. Therefore the income goal, I, with gross margins per activity and for all activities (X_j), could be expressed as:

$$\sum_{i=1}^{n} giX_j + n_i - p_i = I \quad (17)$$

The other common household goal is to ensure food security or meet minimum

nutritional requirements. Such requirements will be defined in terms of total N Kcal of energy required by each family. Therefore the food nutritional goal, (N), can be expressed as:

$$E_k + n_i - p_i = N \quad (18)$$

The achievement of these goals in the WGP model is subject to:

$$f_i\,(x) + ni - p_i = b_i$$

where,
f_I (x) is the general function of the goal as already demonstrated by Equations (17) and (18).

$x \quad G,$

G is the feasible set

$x \quad 0, n \quad 0, p \quad 0$

The expected output from the model with these two goals is the opportunity cost of satisfying one goal instead of the other, i.e., giving greater weight (or higher priority) to one goal rather than the other. This means that when the income goal is given greater weight, the household can sell most of the produce in order to maximise income realised, even if in some cases this might result into minimising consumption from their own production. Alternatively, the household could harvest large areas of forest for firewood and poles for sale, while ensuring that there is food produced and any food deficits are met through purchases using such income. All this should ensure that the minimum energy requirements are met.

Two problems might arise while solving this problem. One is associated with the fact that the coefficients might be distributed over a very wide range. This can be contained by dividing them into the constraint coefficients. The other problem is related to the fact that the simultaneous minimisation of the deviation in the WGP may result into the model mixing goals that are expressed in different units. This means that the solution might be difficult to interpret. To overcome this it is necessary to adopt a normalisation procedure, like the use of percentages. This means that all goal constraints have to be expressed in form of percentages.

4. MODELING TYPICAL PRIVATE SECTOR RESPONSES

4.1 An overview of the sector

The private sector in most of the rural areas functions like an intermediary between producers and markets for agricultural and forestry products. The producers, the household sector in this analysis, generally lack means and capacity for taking the products to the final consumer. The simple functions of the private sector are then collection of produce from farmers, transporting, storage, and selling them to retailers and rarely to final consumers. The volume of business is a function of many things, including the number of trips that the private sector entity makes between the farmers/households and the market place.

In this modelling exercise we start with a scenario in which the profit margin per unit of product, like a bag of charcoal, made by the private sector is lower than the profit margin of the household (producer). This is based on the fact that the latter does not incur high costs apart from employment of family labour. For example households do not pay harvesting fees and transaction costs. However, the private sector has a higher total profit due to the number of sales units and trips they are able to make within a specific period, e.g. a month, as compared with the household sector. Furthermore, the transport capacity in each trip surpasses the production capacity of a household.

There are two types of private sector entities for miombo woodland products. The first category comprises of people and firms exploiting wood products such as fuelwood, poles, and construction timber. This category has strong links with the household sector. The latter actually carries out all operations that make such products available. The second group is comprised of either transporters of logs to supply the industry or the industries themselves with licenses for harvesting, transporting, and processing logs. This group generally has a diffuse association with the household sector since it can hire labour from urban and other rural areas to perform all the activities required to get the products into the industry and to the final consumer. For the sake of simplicity the modeling is done with the first type of private sector entity in mind.

One general characteristic of these private sector entities is that their main capital is old transport equipment like lorries, tractors and trailers. Bicycles are commonly used in Malawi, around Lilongwe, and in Manica province in Mozambique. This has in most cases facilitated payment for amortization. The transport costs are high due to the frequent breakdowns and there is therefore need to compensate for the high maintenance costs.

Another common characteristic is that the private sector is in most cases wholesalers, supplying retailers in the urban or other markets. They are essentially intermediaries in the energy and construction material commercialization channel.

4.2 The MIOMBOGP model

4.2.1 Context and major assumptions

Some of the assumptions, requirements and the context in which the private sector operates include:

- The private sector *buys* and *sells* firewood, charcoal and poles. This varies from one country to another. However, buying and selling are the two main activities included in the model.
- The private sector has licenses that limit the amount each of them can buy from rural markets to supply urban markets.
- The license fees are volumetric (i.e. defined per m^3) and are different for firewood and poles.
- The transportation cost should be known.
- Apart from the license fees and the transportation costs, the private entities may incur other costs. For example, they might have to pay a commercialization fee, which goes to the local council (municipality) at the urban market. Again this varies from country to country.

- The other major cost is labour. For a typical lorry or tractor operation labour could comprise of three people, a driver and two assistants. These load and unload the trucks and tractor-trailers. Nevertheless, there might be cases where some other people are hired for unloading at the market place.
- The number of trips made and capacity of trucks or other transport facility used must be known.
- The salaries or wages of the driver and assistants must be known.
- There are many buyers or retailers in the urban markets and few suppliers (represented by lorry drivers) hence the market structure can be described as oligopoly. On the other hand, at the production site, there are many producers (households) and few buyers (represented by lorry drivers) or oligopsony.

4.2.2 Mathematical presentation of the model

(a) The objective function

The LP objective function for the private sector is:

$$\text{Max} \sum_{i=1}^{n} g_i x_i \qquad (1)$$

where g_i is the gross margin of each of the products (firewood, charcoal and poles: I=1,2,3), (i.e., revenue obtained from the sales after deducting the costs) and x_i is the level of each activity, in this case selling of each of the products. In other words this can be stated as:

$$- \sum_{i=1}^{n} Pp_i Pr_i - \sum_{i=1}^{n} Tr_i \, Pr_i + \sum_{i=1}^{n} Ws_i \, Pr_i \; - Mc = 0 \qquad (2)$$

$$\sum_{i=1}^{n} Pr_i \, (-Pp_i - Tr_i + Ws_i) - Mc = 0 \qquad (2')$$

where:
Pr_i = quantity of product i (i = 1, 2, 3)
Pp_i = producer price of the i_{th} product in rural markets
Tr_i = transportation cost of the i_{th} product to the market
Ws_i = wholesale of the i_{th} product in urban markets
Mc = Maintenance cost per trip

Additional costs and fees specific to individual countries, like commercialization fees in Mozambique, can be incorporated in the wholesale price, hence reducing the sales price.

In the case of goal programming, the objective function is expressed as:

$$\text{Min} \sum_{i=1}^{n} (\;{}_i n_i + \;{}_i p_i) \qquad (1')$$

This represents the minimisation of deviations from target levels, assuming that the private sector also has other goals, apart from profit maximisation. We can run

the model as a classic LP assuming one main objective that drives the activity of the private sector. Alternatively we can assume that apart from maximising profit, it is important for the private entity to minimise risk of the business, especially that arising from frequent truck breakdowns, and therefore a desire to minimize truck maintenance costs.

(b) Constraints
The major constraints of the private sector model include:

(i) Licensed amount
The quantity transported of each of the i^{th} product with a truck of capacity $a_{i,}$ should not exceed the quantity AQ stated in the licence.

$$\sum_{i=1}^{n} N_{ti} Tc_{i\ i} <= AQ \qquad (3)$$

where
N_{ti} is the number of trips middlemen make in transporting forest product i
Tc_l is the lorry/truck capacity for transporting product i

(ii) The supply of i_{th} wood product should be less or equal to the amount delivered to or demanded by retailers at the market.

$$-\sum_{i=1}^{n} Pr_i + \sum_{l=1}^{n} Ws_i <=0 \qquad (4)$$

c) Transportation capacity
The quantity of the i^{th} product transported, Pr, will be equal to the truck transport capacity, Tc, for each of the products. Measurements of capacity could be in bags or m^3.

$$Pr_i = Tc_i \qquad (5)$$

d) Labour demand
The availability of drivers' labour and that of his assistants is expressed as L_{ij}, where j=1 denotes drivers' labour and j=2 denotes drivers' assistants labour.

Truck driver assistants labour

$$\sum_{i=1}^{n} L_{i2} <= LT_a \qquad (6)$$

where,
l_i is the truck driver assistants' labour allocation for loading and unloading the trucks with product i and expressed in man-hours/trip
LT_a is the total labour available in a month or year.

Driver's labour

$$\sum_{i=1}^{n} L_{i1} <= LT_d \qquad (7)$$

l_i is the driver's labour allocation to ferrying $product_i$
LT_d is the total labour available in a month or year.

Details on each of the activities in the above constraints will vary during the dry and wet seasons because the costs Pp_i, Tr_i, and Mc are different for each of the seasons.

(c) Goal

The objective function of the LP model complemented with the deviations from the set target can be expressed as:

$$\sum_{i=1}^{n} g_i x_i + n_i - p_i = \$ \qquad (8)$$

Since we assume that the private sector's prime objective will be maximisation of profit, then the target $ can be derived from the LP. In this case n_i, or the negative deviation from the goal would have to be minimised.

$$Mc + n_i - p_i = b \qquad (9)$$

The implication is that the maintenance cost has to be kept as low as possible, and that is set at the target level b. The decision maker's interest is to minimise the positive deviations from the target level. This means that in order to maximize profit, the targeted maintenance costs should be kept as low as possible.

5. LINKING HOUSEHOLD AND PRIVATE SECTOR MODELS

As mentioned earlier, there are two players in the exploitation and commercialization of the wood products from the miombo woodlands, the households and the private sector (middlemen).

Selling activities (for wood products) were defined for the household model. However, these were not differentiated into the three products included in the private sector model. But it is known or assumed that all the supply to the intermediaries (the private sector) comes from these rural households. It is at the buying points where we would then know what the households are selling. Therefore, a simple accounting or tie constraint should be able to link the two sectors.

Such a constraint states that the supply by the rural household should at least be equal to the quantity demanded by intermediaries or private sector in the commercialization channel. When the first part of the equation is higher than the second one, the producer takes longer to exhaust his/her stocks.

$$-\sum_{i=1}^{n} Ws_i + \sum_{i=1}^{n} Pr_i <= 0 \qquad (10)$$

As far as the goals are concerned there can be several of them and the MIOMBOGP model offers the possibility of evaluating how each of the goals of the actors is affected by changes in their prioritization.

6. INCORPORATION OF GOVERNMENT SECTORAL POLICIES

This section deals with potential for using MIOMBOGP model to evaluate the impact of sectoral policies. Four example policy scenarios will highlight this.

In the household model we introduced a constraint stating that for sustainable use and management of the resource, the amount harvested for sale should not exceed the allowable cut. This restriction has potential to significantly influence the producers' output (household) as well as the supply to the intermediaries (household-private sector trade) and ultimately to the retailers and urban consumers. However, it is in the government's interest to ensure that the present and the future generations benefit from these natural resources.

The constraint for this intention can be expressed as:

$$Ws_i <= AAC \tag{11}$$

Harvesting of miombo woodland stock for sale should be in quantities less than or equal to the annual allowable cut (AAC). The basic assumption is that harvesting for household consumption is currently at sustainable levels. Otherwise we can add such consumption to the left-hand side of this equation.

This constraint has to be tied to the buying constraint by the private sector.

A second sectoral policy worth exploring could be the introduction by government of license fees for producers (the rural households in our case) when they harvest forest produce from government forests for sale because in some countries harvesting for household consumption is free. Under such situation the unit profit realized by the household will have to shrink by the unit charge in fees. For instance, in the case of firewood or charcoal, the price will be reduced by a factor, ff. In the objective function reproduced below, Pp_i will have to be reduced by this amount.

$$-\sum_{i=1}^{n}(Pp_i - ff)\,Pr_i - \sum_{i=1}^{n} Tr_i\,Pr_i + \sum_{i=1}^{n} Ws_i\,Pr_i - Mc = 0 \tag{12}$$

A third policy scenario is the introduction of a penalty to the private sector as well as to the household sector for harvesting any amount above that stated in the license.

This also works through the objective function as an added cost, Fe, which then lowers the net revenues (Ws_i -F).

$$-\sum_{i=1}^{n} Pp_i Pr_i - \sum_{i=1}^{n} Tr_i\,Pr_i + \sum_{i=1}^{n} (Ws_i - Fe)Pr_i - Mc = 0 \tag{13}$$

The fines are imposed when the harvesting exceeds that allowed in the licence when the condition below prevails (c.f. equation 13):

$$\sum_{i=1}^{n} N_{ti} Tc_i >= AQ \tag{14}$$

A fourth example relates to national governments' concern on improving the welfare of rural people. As a measure to contain this concern national governments might allow for bigger landholdings for the farmers in order to ensure food security and cash incomes. Therefore, where land is available or can be made available through degazettment of forest reserves or resettlement of people in new adjacent areas, the land constraint can be relaxed to the appropriate size of the land.

$$\sum_{i=1}^{n} X_l >= e \qquad (15)$$

From equation (2) in the household model, we can see that the limitation now becomes one of >= e. In reality the size of farmed land depends on family labour and capital.

If this is enforced and all other conditions are favourable then households will have the potential for surplus agricultural produce, which can in turn be sold. Nevertheless, it has to be noted that despite the good intentions of governments, in practice additional land might come from clearing forests or from grazing land. This could then conflict directly with the sustainable use of resource objective.

Linking the two models with the market involves aggregation of the households in the miombo woodlands as well as determination of the aggregate number of intermediaries (size of private sector) and then linking production and the market. To link to the final consumers it is necessary to estimate the total demand in the urban market, i.e., number of households still using firewood for cooking or poles for construction.

This means that the production activities in the household part of the model would have to be summed up in terms of surplus from the production activities undertaken by the household. The quantity sold wholesale by the private sector would then be a summation of the quantities sold by each player in this sector. In the market place the sum of these wholesale quantities would have to be to be linked to consumer demands.

7. MAJOR LIMITATIONS OF THE MIOMBOGP MODELLING APPROACH

Apart from limitations that are implicit in the basic structure of the functions in the model, the following are some other potential limitations:

- Scarcity of and/or unreliability of data to estimate the coefficients can significantly distort the household organisation and consequently the model results.
- Inability of the decision-makers like farmers and middlemen to list and state in a consistent manner priorities or weights they attach to each target level.
- Making an appropriate choice of the number of variables and constraints capable of producing meaningful results, as well as interpretation that reflects the decision makers' space, i.e., interests, activities, and goals.

ENDNOTES

1. Also available as: Nhantumbo, I. and Kowero, G. 2001 A goal-programming model for planning management of miombo woodlands. *In*: Modelling methods for policy analysis in miombo woodlands. Occasional Paper No. 35, CIFOR, Bogor. pp.5-15.

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17.

A goal programming model for planning management of miombo woodlands: A case study of Chivi and Gokwe communal areas, Zimbabwe

E. Guveya and C. Sukume

ABSTRACT

This paper reports results on the use of a goal-programming model to the management of woodlands in two communities in communal areas of Zimbabwe – one abundant and the other less abundant in woodlands resources. The relatively well-endowed community borders the Mafungautsi Forest Reserve in Gokwe. The less endowed site was Mutangi in Chivi area. The objective of the modelling exercise was to simulate the effects of changes in agricultural policies and demographic changes in farming households on how local households use woodlands under an open access regime and under institutional constraints imposing sustainability concerns.

The findings presented in the paper point to the following basic conclusions: a) households in communal areas are highly differentiated with regards to ability to satisfying family sustenance goals; b) relatively poor households depend on woodlands for a significant part of their income needs but richer families are more efficient in harvesting woodlands; c) increase in agricultural product prices as well as an increase in yields tend to increase woodlands harvesting among the better off and reduce woodland harvests among the poorer households; d) increase in input costs tends to increase reliance on woodlands especially among the poorer households; and e) loss of an adult member of a household increases the degree of poverty especially among the relatively poor with the greatest impacts being realised with loss of female members of households.

Key words: Woodlands, weighted goal programming, communal area, Zimbabwe

1. INTRODUCTION

Indigenous forests and woodlands in Zimbabwe provide a wide range of goods and services that include edible fruits, medicines, honey, poles and fuelwood. About 80% of the population of Zimbabwe depends on woodfuel for their cooking, heating and lighting requirements. There is concern however at the rate of deforestation of the indigenous woodlands in Zimbabwe. Deforestation has led to various environmental problems such as siltation of rivers and dams, soil erosion, flooding, general land degradation and fuelwood shortages. In addition, an estimated 80 000 ha (FAO, 1988) of woodland in Zimbabwe are cleared annually to give way to other land-uses including agriculture and domestic animal grazing which though profitable, have negative externalities.

The need for proper management and conservation of woodlands is an area of high priority. In Zimbabwe there are many policies guiding socio-economic development. Some of the policies target the public sectors while other affect private sector operations. Each of these sectors has ways through which it can respond to the policies. The view of this study is that some current policies lead to inappropriate deforestation, since the people who clear forests and woodlands do not have to pay for the negative externalities associated with their actions, both at the local or national levels. Regardless of the decisions made by woodland users, policy makers should at least be aware of the potential impact of their policies on forest and woodland cover. In rural areas the policies that have potential to impact most on the behaviour of rural households are mainly those associated with agricultural crop production and trade, since the majority of rural people are involved in agriculture. The objective of this paper is therefore to assess how the communal area households of Zimbabwe might respond to agricultural input and output pricing policies and to household labour supply and how this impacts on the use of woodlands.

The study uses a weighted goal programming modeling approach to address this objective. In particular, we follow a specification of the goal programming application to woodlands management developed by Nhantumbo and Kowero (2001). The next section provides a description of two communities of Gokwe and Chivi that were the basis of the study. It is followed by a detailed model description along the lines of the weighted goal programming model developed by Nhatumbo and Kowero (2001). Section 4 presents the data used to run the model while section 5 presents and discusses simulation results of the potential impacts of different policy scenarios on the households in these two communities and their woodland resources. The last section gives a summary of major conclusions from the study.

2. DESCRIPTION OF STUDY SITES

The study sites are Chivi and Gokwe districts of Zimbabwe. The two districts were purposely selected as they have differing agricultural potential, and settlement history. In Chivi district, Mutangi, a dam catchment area 80 km from Masvingo town and 19 km from the Chivi business centre, was selected. Chivi communal area, the major part of Chivi district, covers 3534 km^2 and has been settled since the mid 19^{th} century. The 1992 census shows a total population for Chivi district of 157 428, with a growth rate of 1.98% and a population density of 44.5 people per square km. Mutangi is estimated to have population density of close to 58 persons per km^2 (Campbell *et al.* 2001).

Chivi is a poor area agro-ecologically with a long-term mean annual rainfall of 545 mm (1913-2001). In addition, the amount, intensity and distribution of the rainfall within a season are highly variable, and inter-annual variation is large (Campbell *et al.* 2001). Droughts are recurrent in the area with that of 1991/92 being the worst on record, when only 83 mm of rain fell in some parts of the district. This is compounded by very poor soils within the region.

The dominant vegetation in Mutangi is the woodland that forms an enclave of approximately 360 square kilometres surrounded and shared by about five villages (Campbell *et al.* 2001). The top three dominant tree species found in the area are *Colophospermum mopane*, *Terminalia sericea* and *Acacia tortilis*. Forest products like honey, mushrooms, and medicinal plants also occur in the woodlands. There is very little wild game except for small animals like rabbits that can be found in some parts of the woodland. The woodland is mainly utilised as a grazing area for livestock, source of firewood, construction poles and occasionally as a source of fruits and other non-timber products (NTFPs). Due to high population pressure, the demand for arable land, firewood and construction timber the woodlands are being cleared fast.

In the Gokwe study area, villages within a radius of about 30 km from the western edges of the Mafungautsi state forest were selected. The study site is about 50 km from the Gokwe business centre. These communities have settled in the area for less than 70 years. The families are relatively sparsely distributed.

The mean annual rainfall for the area is around 819 mm. The Mafungautsi State Forest is entirely situated on the Mafungautsi plateau, one of the most northerly extensions of the Kalahari sands in Zimbabwe (Vermeulen 1997). The soils are dystrophic with poor water holding capacity.

Most areas in this survey site are still covered by woodlands. Furthermore the communities have access to the Mafungautsi State Forest, which is a government protected forest covering an area of 82 659 hectares (Vermeulen 1997). Villages located near the boundaries can access a total area of about 600 square kilometres of the forest to graze their livestock, collect dead wood and NTFPs like mushrooms, thatch and broom grass. However, the communities are not allowed to cut down trees, collect honey or hunt for game. Fishing is only allowed if it is done using fishing rods as use of fishing nets is prohibited.

The forest is very dense with a lot of tall and old trees. The dominant tree species is *Terminalia sericea*, while important timber trees like *Baikiea plurijuga* and *Pterocarpus angolensis* are also abundant. Wild game especially warthogs and antelopes still occur in large numbers in the forest.

Data was collected in a series of random sample surveys and participatory rural appraisals (PRA) in the period 1999 to 2000 in the two sites. A descriptive summary of the survey is reported in Siziba and Mutamba (2002). For the purposes of this study, the households in each study area are distinguished into draft owning and non-draft owning households. The rationale for this distinction being that the two types of households' utilization of woodland is hypothesized to be different. Households with draft animals tend to be larger and efficiency of collection of woodlands products and farming operations tend to be higher due to a higher degree of mechanisation in the processes.

3. MODEL SPECIFICATION AND DATA

3.1 Objective function

We model a household that allocates labour and other productive resources to agriculture, household chores and woodlands harvesting activities so as to minimize simultaneously the weighted sum of deviations from two goals – food security and income targets. This optimization problem is considered under two regimes, namely a regime where utilization of forest resources are restricted to be within sustainable levels and under a regime where this restriction is relaxed, i.e. an open access situation. How the sustainability requirement is modeled is discussed under woodland use constraints.

From surveys in both Gokwe and Chivi more households ranked the achievement of food security above income maximization in their decision-making. In the two-goal model considered in this study, giving equal weight to positive and negative deviations from goals, the weighted goal programming (WPG) objective function can be specified as,

$$\text{Min } \{(w_1n_1+w_1p_1)+(w_2n_2+w_2p_2)\} \qquad (1)$$

where w_i is the weight associated with the goal i, and n_i and p_i are negative and positive deviations in the achievements of goal i; and i = 1, 2.

Ranking of goals by households is translated into weights using the transformation:

$$w_i = \frac{\frac{1}{r_i}}{\sum_j \frac{1}{r_j}} \qquad (2)$$

r_i is the ranking of goal i.

Using the above transformation, the food security goal (goal 1) has a weight of 0.67 while that for income (goal 2) is 0.33.

Household food security goal

Given this background, the household food security goal can be expressed as:

$$e_{mz}\ CsMz + e_{gn}\ CsGn + e_{sg}\ CsSorg + e_{mk}\ CsMk + e_{bf}\ CsBf + n_1 - p_1 = E \qquad (3)$$

where,

e_{mz}, e_{gn}, e_{sg}, e_{mk}, and e_{bf} are per unit calorie content for maize, groundnuts, sorghum, milk and beef, respectively,

CsMz, CsGn, CsSorg, CsMk, and CsBf are respectively units of maize, groundnuts, sorghum, milk and beef consumed by the household in a year, and E is the recommended minimum household calorie requirement per year.

The food security goal is to strive to get enough food to satisfy yearly requirements for energy. According to University of Minnesota (2002) the average minimum daily kilo calorie requirements are 2944 for a man, 2180 for a woman and a child's daily requirement are 2048. For a household the requirements for men (HHcM), women, (HHcW) and children (HHcChn) in a year would equal the target (E) calorie intake, and this is expressed as:

$$E = 365(2944\ HHcM + 2180\ HHcW + 2048\ HHcChn). \quad (4)$$

The per unit energy content of different food commodities are given in Table 1.

Table 1. Energy contents of different food types

Food type	Energy content [kilo calories/kg]
Maize	3450
Groundnuts	5700
Sorghum	3450
Milk	660
Meat	2350

Source: USDA 2002.

Household income goal

The income goal for the household is the residual income. The residual income is gross household income after taking into account costs of inputs, hired in labour, money spent on buying extra food (maize, groundnuts, sorghum, milk and beef). The residual or target income (I) was obtained from maximizing a linear programming model of the representative household in each site. The income goal is then stated as:

$$CrR + LvR + Wg + DftR + FwR - CrCst - DftCst - LabCst - FdCst + n_2 - p_2 = I \quad (5)$$

We define the components of this function as follows:

(a) Revenue from sale of crops

In the above equation CrRv is crop revenue computed from the product of crop price and the quantity of maize sold in wet and dry season (SgMzW, SgMzD), groundnuts in the wet and dry seasons (SgGnW, SgGnD), sorghum (SgSorgD, SgSorgW), cotton (SgCtn) and sunflower (SgSun). That is

$$CrR = P_{mz}\ (SgMzD + SgMzW) + P_{gn}\ (SgGnD + SgGnW) + P_{ct}SgCtn + P_{su}SgSun + P_{sg}(SgSorgD + SgSorgW) \quad (6)$$

where P_{mz}, P_{gn}, P_{ct}, P_{su} and P_{sg} are farm gate prices of maize, groundnuts, cotton, sunflower sorghum in both wet and dry seasons.[1]

(b) Revenue from livestock

Similarly, LvR is revenue from sale of livestock and livestock products. Thus LvR is the sum of products of unit price and the units of goats sold (GtSg), cattle sold (CaSg), donkeys sold (DkSg) during the year, and milk sold during wet and dry seasons (SgMkW, SgMkD),

$$LrR = P_{gt}GtSg + P_{ca}CaSg + P_{dk}\ DkSg + P_{mk}\ (SgMkD + SgMkW), \quad (7)$$

where P_{gt}, P_{ca}, P_{dk}, and P_{mk} are prices of goats, cattle, donkeys and milk, respectively. For households with neither cattle nor donkeys, selling of cattle, donkeys and milk is restricted to zero to contain possible unrealistic computational solutions where households can buy and sell these within a year, situations which were not encountered in the Gokwe and Chivi households.

(c) Revenue and expenditure related to labour and draft power

The income, Wg, the household gets from hiring out labour is the product of labour (HrOutLab) days hired out and the wage rate (w),

$$Wg = w\ HrOutLab. \tag{8}$$

In the case where a household hires in labour, it incurs payments (LabCst) equal to the product of labour days hired in (HrInLab) and the wage rate (w),

$$LabCst = w\ HrInLab. \tag{9}$$

Similarly, the household can either hire out draft power to generate revenue (DftR) or hire in draft services and incur expenditures (DftCst). In either case the revenue generated or the payment incurred is the product of draft-days hired in (HrOxIn, if oxen, and HrDonkIn, if donkeys) or out (HrOxOut, if oxen, and HrDonkOut, if donkeys) and the rate/price for hiring draft animals (r_{ox}, if cattle and r_{dk}, if donkeys). As is explained later in this section, differentiation between oxen draft and donkey is due to the differences in rates/prices as well as efficiency of draft services. Thus

$$DrftR = r_{ox}\ HrOxOut\ + r_{dk}\ HrDonkOut \tag{10}$$

$$DrftC = r_{ox}\ HrOxIn\ + r_{dk}\ HrDonkIn. \tag{11}$$

(d) Revenue from woodland products

Even though institutional constraints exist limiting the shipment of timber and fuel wood from communal areas to areas outside, sale of poles and fuel wood goes on between households within the areas in the form of contract cutting and carting. Prices of wood products sold in these ways are not well defined in form of amount paid per volume of wood. One way of going around this problem is to express the value of the sales in terms of value of time spent gathering and carting wood for payment. Using this approach, revenue from wood harvesting for sale (FwR) is the product of the wage rate (w) and the time devoted to collecting wood for sale (ClFwSLab). That is,

$$FwR = w\ ClFwSLab \tag{12}$$

(e) Household expenditure on farming and food

The major farm household expenditure item is on crop production (Crest). It is the sum of production expenditure (cost) on each hectare and area cropped to maize (GrMz), cotton (GrCtn), groundnuts (GrGn), sunflower (GrSunf) and sorghum (GrSorg),

$$CrCst = cmz\ GrMz + c_{ct}\ GrCtn + c_{gn}\ GrGn + c_{su}\ GrSunf + c_{sg}\ GrSorg \tag{13}$$

where c_{mz}, c_{ct}, c_{gn}, c_{su} and c_{sg} are per hectare expenditure on materials inputs to the production of maize, cotton, groundnuts, sunflower and sorghum, respectively.

The other major expenditure item was on food, (FdCost), which was the sum of the products of 'buying prices of the food items' and their respective quantities. The major goods bought by households in dry and wet seasons are maize (BgMzD, BgMzW), groundnuts (BgGnD, BgGnW), sorghum (BgSrgD, BgSorgW), beef (BgBfD, BgBfW) and milk (BgMkW, BgMkD) to supplement own production. Expenditure on food is thus

$$\begin{aligned} FdCst &= P_{b,mz}\,(BgMzD + BgMzW) + P_{b,gn}\,(BgGnD + BgGnW) \\ &\quad + P_{b,sg}\,(BgSrgD + BgSorgW) + P_{b,bf}\,(BgBfD + BgBfW) \\ &\quad + P_{b,mk}\,(BgMkW + BgMkD) \end{aligned} \qquad (14)$$

where $P_{b,mz}$, $P_{b,gn}$ Pb,sg, $P_{b,bf}$ and $P_{b,mk}$ are buying prices of maize, groundnuts, sorghum, beef and milk, respectively.

The goals are expressed in monetary values (for income) and in kilo-calories (for food security). To facilitate ease of interpretation of the results each goal is normalized so that the target is 100 percent by multiplying both sides of the goal equation by 100 and dividing by the nominal value of the target.

Coefficients utilized in the models for Gokwe and Chivi study areas are summarized in Table 2.

It is important to note that goals will differ between farmers of varying resource endowments and in varying agro-ecological environment. In the above model, target energy requirements differ between households in the different areas due to differences in size and composition of the households. Income goals differ in that these are the product of maximization of residual farm income after taking into account food consumption needs. Differences in feasible cropping mixes between farmers in diiferent areas and with different resource endowments imply that attainable incomes will also differ.

3.2 Model constraints

The weighted goal-programming problem is optimized subject to constraints on:

- Land availability,
- Availability of ready cash to finance inputs and services,
- Draft power availability,
- Supply and utilisation of food crops,
- Labour availability,
- Minimum dietary requirements,
- Maximum livestock production potential, and
- Forest products availability/supply.

3.2.1 Land constraints

Land allocated to growing maize, cotton, groundnuts, sunflower and/or sorghum should not exceed the average area, A^T, available to the representative household in a site. Thus

$$A^T - GrMz - GrGn - GrCtn - GrSunf - GrSorg \quad 0 \qquad (15)$$

Table 2. Parameters in the goal functions

Category	Coefficient	Gokwe		Chivi	
		Draft	No-draft	Draft	No-draft
Target	E ('000 kcal)	6701	4845	5920	4879
	I (US$)	998	135	870	128
Selling prices	P_{mz} (US$/kg)	0.13	0.09	0.09	0.07
	P_{gn} (US$/kg)	0.28	0.24	1.22	0.30
	P_{ct} (US$/kg)	0.45	0.42	0.34	0.37
	P_{su} (US$/kg)	-	0.09	0.10	0.08
	P_{sg} (US$/kg)	-	-	0.08	0.04
	P_{gt} (US$/goat)	13.16	13.16	13.16	13.16
	P_{ca} (US$/beast)	105.00	105.00	105.00	105
	P_{dk} (US$/beast)	53.00	53.00	53.00	53.00
	P_{mk} (US$/litre)	0.52	52	0.65	0.65
Buying prices	$P_{b,mz}$ (US$/kg)	0.14	0.10	0.10	0.09
	$P_{b,gn}$ (US$/kg)	0.31	0.26	1.34	0.33
	$P_{b,bf}$ (US$/kg)	2.00	2.00	2.00	2.00
	$P_{b,mk}$ (US$/litre)	0.52	0.52	0.65	0.65
	$P_{b,sg}$ (US$/kg)	-	-	0.09	0.09
Wage	w (US$/day)[a]	0.44	0.44	0.44	0.44
Costs of production	c_{mz} (US$/kg)	15.39	16.29	24.60	15.03
	c_{ct} (US$/kg)	35.31	47.26	43.13	37.24
	c_{gn} (US$/kg)	25.00	25.00	15.50	21.31
	c_{su} (US$/kg)	-	4.50	5.42	4.23
	c_{sg} (US$/kg)	-	-	1.84	2.47
Draft hiring rates	r_{ox} (US$/day)	4.21	4.21	4.21	4.21
	r_{dk} (US$/day)	3.95	3.95	3.95	3.95

Source: Field Survey Data: 1999-2000; [a] stipulated wage for farm labourer (Commercial Farmers Union, pers. Comm.).

Average land holdings for sampled households were 2.31 and 1.92 hectares respectively for draft and non-draft animal owning households in Chivi. Corresponding figures for Gokwe were 5.11 and 3.6 hectares for draft and non-draft animal owning households, respectively.

3.2.2 Cash constraints

Availability of income to finance inputs and services at the inception and during the crop-growing season is a major constraint to most farmers in rural Zimbabwe. High interest rates following removal of credit subsidies brought about by economic reforms have exacerbated the liquidity constraint. To reflect this problem we include in the

model a constraint requiring that households must have, as a minimum, the cash C for producing all crops as well as other requirements including hiring in labour or draft services. This budget constraint can be expressed as:

$$- c_{mz}\,GrMz - c_{ct}\,GrCtn - c_{gn}\,GrGn - c_{su}\,GrSunf - c_{sg}\,GrSorg - 0.44{*}HrInLab + C \quad 0 \qquad (16)$$

Per-hectare costs of production for the four representative households modeled are given in Table 2.

3.2.3 Draft animal hire

A significant proportion of households in both Chivi and Gokwe do not have enough number of cattle or donkeys to perform farm operations such as ploughing, mechanical planting, cultivating and transporting. Only 41% of households in Chivi and 47% in Gokwe have enough cattle for use as draft (Mutamba and Siziba 2002). Those without have to hire draft from those with animals especially for the critical task of ploughing. Given a pair of oxen or donkeys can plough 1 hectare of land over 4.5 days (Guveya 1995) and that the critical period in the planting season when draft is required is only two months, there only about 44 days available for hiring out draft animals for those households with animals. Thus the number of days that draft hiring out can be offered by a household with draft (HrOxOut in the case of oxen, or HrDkOut for donkeys) should be 44 days less the time the household needs the draft to prepare its own fields.

$$44 - 4.5(GrMz + GrGn + GrCtn + GrSunf + GrSorg) - (HrOxOut + HrDonkOut) \quad 0. \qquad (17)$$

Households without draft animals will need to hire in enough draft services (HrOxIn/HrDkIn) to plough all their fields,

$$HrOxIn + HrDonkIn = 4.5(GrMz + GrGn + GrCtn + GrSunf + GrSorg). \qquad (18)$$

This means that there is virtually minimal farm preparation using hand hoe.

3.2.4 Crop production and utilization

The two cash crops grown in the project sites – sunflower and cotton – are sold soon after harvesting at the beginning of the dry season. In both areas farmers may sell some of their produce, store some for consumption during the wet season, or buy some food crops to supplement own production (Mutamba and Siziba 2002). How much is consumed, sold and stored during the dry season should not exceed what is harvested and bought by the household in the season. Similarly, during the wet season how much is consumed and sold should not exceed the amounts bought during the season and how much was stored taking into account storage losses. Storage losses for sorghum and maize were assumed to amount to 4 percent while those for groundnuts were assumed not to exceed 2 percent.

If $YIELD^{Mz}$, $YIELD^{Gn}$, $YIELD^{Ctn}$, $YIELD^{Sunf}$ and $YIELD^{Sg}$ are yields of maize, groundnuts, cotton, sunflower and sorghum, respectively, and StMzD, StGnD and StSorgD are respective quantities maize, groundnuts and sorghum carried over (stored) into the wet season, the following relationships capture the constraints implied by the above:

Maize

$$YIELD^{Mz}\ GrMz - SgMzD - StMzD + BgMzD - CsMzD \quad 0 \qquad (19)$$

$$0.96\ StMzD - SgMzW + BgMzW - CsMzW \quad 0 \qquad (20)$$

Sorghum

$$YIELD^{Sg}\ GrSorg - SgSorgD - StSorgD + BgSorgD - CsSorgD \quad 0 \qquad (21)$$

$$0.96\ StSorgD - SgSorgW + BgSorgW - CsSorgW \quad 0 \qquad (22)$$

Groundnuts

$$YIELD^{Gn}\ GrGn - SgGnD - StGnD - CsGnD \quad 0 \qquad (23)$$

$$0.98\ StGnD - SgGnW - CsGnW \quad 0 \qquad (24)$$

Cotton

$$YIELD^{Ctn}\ GrCtn - SgCtn = 0 \qquad (25)$$

Sunflower

$$YIELD^{Sunf}\ GrSunf - SgSunf = 0 \qquad (26)$$

In both Chivi and Gokwe sites, households with draft animals tended to be self sufficient in maize production and no household was observed buying maize in the dry season for the purposes of selling during the wet season. To add realism in the household model further restrictions were added to take into account these two observations.

Table 3. summaries the average yields of the different crops in the two study sites and the draft and non-draft animal owning representative households.

Table 3. Crop yields (kg/ha) by survey site

	Gokwe		Chivi	
	Draft	Non-draft	Draft	Non-draft
Maize	911	754	1413	916
Cotton	834	689	1512	546
Groundnut	535	446	604	491
Sorghum	-	-	1053	722
Sunflower	667	384	875	834

Source: Field Data, 1999-2000.

3.2.5 Labour constraints

Members of the household – men, women and children - in the communities studied contribute to activities undertaken with different degrees of specialization. Activities undertaken on the farm that demand labour include crop production, livestock tending, paid farm work at other households within the community, harvesting fuel wood and timber for domestic use and for sale, working with hired draft animals, as well as domestic chores around the homestead such as fetching water, laundry, cooking, cleaning and taking care of infants. For each class of household members (men, women or children),

labour input into all activities must not exceed maximum labour available from the members in the class plus any labour hired in to supplement the class' labour. That is

$$TotLab_i - CropL_i - LiveL_i - HireOutL_i - WoodlandsL_i - DomL_i \quad 0 \qquad (27)$$

where j=1,2,3 for men women and children respectively.

Total labour (TotLab) consists of labour from the gender class/category of household members (number of days in a year available to each category of household member (D) multiplied by the number of members in that labour category, $L_{i,}$) and hired labour days allocated to supplement requirements by gender/class (i.e. the fraction, , of hired labour allocated for the gender class or category) multiplied by total labour hired by the household (HrInLab)). That is

$$TotLab_i = D\ L_i \ + \quad (HrInLab) \qquad (28)$$

Labour input by a household class into crop production (CropL) is defined as

$$CropL_i = \ (L_{mz,i}\ GrMz + L_{gn,i} GrGn + L_{ctn,i}\ GrCtn + L_{sunf,i} GrSunf + L_{sorg,i} GrSorg\ ) \qquad (29)$$

where $L_{mz,i}$, $L_{gn,\ i}$, $L_{ctn,i}$, $L_{sunf,i}$ and $L_{sorg,i}$ are labour input per hectare and by a household gender category in the production of maize, groundnuts, cotton, sunflower and sorghum, respectively.

Labour input by a household gender category in livestock related activities ($LiveL_i$) consists of labour required to tend animals and labour use in working with hired out draft animals. Working with hired draft animals is generally considered a preserve of men in the household and so the following constraint applies to men only

$$LiveL_i = L_{lv}(0.8\ Ca + 0.04\ Gt + 0.6\ Dk) + \ (HrOxOut + HrDonkOut) \qquad (30)$$

where: Ca, Gt and Dk are numbers of cattle, goats and donkeys owned by the households.

L_{lv} is the household male labour input per livestock unit into livestock operations. is an indicator variable taking on a value 1 if a household works with hired draft animals and zero otherwise.

In addition, households may supplement incomes through selling of labour (HrOutLab) to other households' farming operations. In the communities studied adult members –men and women - of the household mostly do this. In the model we assume equal sharing of this activity between men and women in the household and exclude children. Children are excluded since they go to school and their little labour is available during school holidays and largely not hired out. Thus the proportion of male and female labour to total hired out labour, HireOutL, available in the household can be represented as

$$HireOutL = \quad HrOutLab \qquad (31)$$

where takes on a value of 0.5 for men, 0.5 for women and zero for children.

In the communities studied households harvest woodlands for firewood and non-timber forest products mainly for domestic use with very little for sale directly (Mutamba and Siziba 2002). However, firewood collection and use statistics mask activities

related to harvesting of firewood for brick making and beer brewing, activities that generate incomes for some households and this is therefore an indirect way of selling firewood. The total labour supplied to woodlands harvesting (WoodlandsLi) by a household gender class (i) is modelled as

$$WoodlandsL_i = (L_{nt,i}\ NtFp + L_{fw,i}\ ClFw + {}_i\ ClFwSLab) \qquad (32)$$

where $L_{nt,i}$ and $L_{fw,i}$ are respectively labour inputs into collection of non-timber forestry products and fuel wood for home consumption by gender class i, and ${}_i$ is the proportion of household labour used for collection of fuel wood for sale (ClFwSLab). NtFp and ClFw are indicator variables taking on a value 1.

Lastly, each gender class' contribution to domestic activities ($DomL_i$) is specified as:

$$DomL_i = L_{dom,i} DomA \qquad (33)$$

where $L_{dom,i}$ is the number of days of the year gender class i is involved in domestic chores. DomA is a scaling constant, taking on a value 1/8 to indicate that a member of a household only works one hour in an eight-hour day on such activities.

On total labour time available, the overriding assumption is that adults work for 260 days in a year while each child provides labour during the 95 days of the year they are on school holidays and week ends. Also all labour inputs of children are in adult equivalent assuming children labour input is 50 % of adult labour. Each child can only make available 47.75 labour days to the household labour pool. Table 4 summarises the labour constraints parameters used in the four models analysed in this study

3.2.6 Dietary constraints

The types of foods households consume greatly affect their food production and purchasing decisions. Thick porridge of maize and/or sorghum (locally known as sadza) forms the base of most meals consumed by households in Gokwe and Chivi and is the main source of energy. The meals are complemented by relish consisting mostly of boiled or partially fried vegetables (from gardens or forests) in vegetable oil or peanut butter. Depending on affluence and opportunity households also consume meat (bush meat, chicken, goat, or beef), fresh and dried fish, butter, milk and pulses (beans and pigeon peas). Little research has been done on the nutritional composition of these meals. Discussion with food scientists at the University of Zimbabwe's Food Science Department in 1999 indicate that almost all of the energy requirements of households in communal areas of Zimbabwe come from consumption of maize, groundnuts, milk products, meat and sorghum with maize contributing a minimum of 50 percent of the energy. These food commodities are also estimated to contribute at least half of the protein intake of households with the rest coming from vegetables as well as other foods.

Household energy demand in the dry season (EnDD) and in the wet season (EnDW) are equivalent to the sums of half yearly energy requirements for the men (HHcM), women (HHcW), and children (HHcChn) in the household, based on recommended daily intake. Thus

$$EnDD = EnDW = 0.5\ (365)\ (2944\ HHcM + 2180\ HHcW + 2048\ HHcChn)/1000 \qquad (34)$$

where EnDD and EnDW are measured in thousands of kilocalories.

Table 4. Values of parameters in labour constraints

Parameter		Gokwe		Chivi	
		Draft	Non-draft	Draft	Non-draft
L_l	Men (HHcM)	2	1	2	1
	Women (HHcW)	2	1	1	2
	Children (HHcChn)	4	4	4	3
D	Men	260	260	260	260
	Women	260	260	260	260
	Children	47.75	47.75	47.75	47.75
	Men	0.4	0.4	0.4	0.4
	Women	0.4	0.4	0.4	0.4
	Children	0.2	0.2	0.2	0.2
L_{mz}	Men	20.81	23.44	23.4	24.83
	Women	20	23.44	35.28	37.59
	Children	19.4	11	41.23	41.45
L_{gn}	Men	23	37	27	33.1
	Women	77.78	37	48.23	61.24
	Children	20	17	62.57	64.33
L_{ctn}	Men	151.79	142	107.38	162
	Women	149.25	142	117.81	149
	Children	67.82	65	112.25	111.5
L_{sunf}	Men	16	16	13.57	11
	Women	16	16	18.14	18.14
	Children	14.34	7	25.57	25.57
L_{sorg}	Men			23.4	33.9
	Women			35.3	43.33
	Children			41.23	50
L_{lv}	Men	3.89	12	3.65	22.1
	Women	2.57	18.5	1.97	18.2
	Children	0.02	0	1.64	2.9
	Men	1	1	1	1
	Women	0	0	0	0
	Children	0	0	0	0
	Men	0.5	0.5	0.5	0.5
	Women	0.5	0.5	0.5	0.5
	Children	0	0	0	0
L_{nt}	Men	59.3	58.1	87.4	99.1
	Women	27.3	16.7	10.1	7.1
	Children	22.3	23.5	40.2	26.2
L_{fw}	Men	8.4	6.7	6	5.1
	Women	22.9	39.5	43.6	35.6
	Children	15.3	11.6	22.3	16.7
	Men	0.5	0.5	0.5	0.5
	Women	0.2	0.2	0.2	0.2
	Children	0.3	0.3	0.3	0.3
L_{dom}	Men	5.7	1.9	12.8	11.1
	Women	95.7	97.5	320.6	238.8
	Children	94.1	93.5	190.4	138.2

Energy supply on the other hand is the sum of contribution of the amounts consumed by the household from produced and purchased foodstuff. Contributions of each major energy source (maize, sorghum, groundnuts, milk and meat) are given in Table 1. Thus the relationships for household energy supplied in the dry and wet seasons are, respectively,

$$\begin{aligned} EnSD = {} & (3450\ CsMzD + 5700\ CsGnD + 2350\ CsBfD + 660\ CsMkD \\ & + 3450 CsSorgD)/1000 \end{aligned} \tag{35}$$

$$\begin{aligned} EnSW = {} & (3450\ CsMzW + 5700\ CsGnW + 2350\ CsBfW + 660\ CsMkW \\ & + 3450\ CsSorgW)/1000 \end{aligned} \tag{36}$$

where EnSD and EnSW are measured in thousands of kilocalories.

If the identified major crops supply all the energy required by the household, then the supply and demand constraint requires that demand should be less than or equal to energy supplied. That is,

$$EnSD \quad EnDD \tag{37}$$
$$EnSW \quad EnDW \tag{38}$$

That a minimum 50 percent of energy comes from food grains (maize and sorghum) implies that in the two seasons,

$$3.45(CsMzD + CsSorgD) \quad 0.5\ EnDD \tag{39}$$
and
$$3.45(CsMzW + CsSorgW) \quad 0.5\ EnDW \tag{40}$$

Given that recommended average daily intake of protein are 0.057 kilograms for men, 0.048 kilograms for women and 0.051 kilograms for children (University of Minnesota 2002), household demands for protein in dry (ProtDD) and wet (ProtDW) seasons are,

$$ProtDD = ProtDW = 0.5\ (365)\ (\ 0.057\ HHcM + 0.048\ HHcW + 0.051\ HHcChn) \tag{41}$$

Similarly, given that maize supplies 0.1 kilograms, sorghum 0.1 kilograms, groundnuts 0.25 kilograms, meat 0.180 kilograms per kilogram of food taken while milk supplies 0.035 kilograms per litre consumed (USDA 2002), the protein supplied by the major food products in the two seasons, ProtSD (dry) and ProtSW (wet) are:

$$\begin{aligned} ProtSD = {} & 0.100\ (CsMzD + CsSorgD) + 0.250\ CsGnD + 0.180\ CsBfD \\ & + 0.035\ CsMkD \end{aligned} \tag{42}$$

$$\begin{aligned} ProtSW = {} & 0.100\ (CsMzW + CsSorgW) + 0.250\ CsGnW + 0.180\ CsBfW \\ & + 0.035\ CsMkW \end{aligned} \tag{43}$$

Thus, if the major foods provide for a minimum of roughly 55 percent of protein required by the household, the protein supply and demand constraint in the two seasons becomes:

ProtSD 0.55 ProtDD (44)
ProtSW 0.55 ProtDW (45)

In an effort to reflect the consumption habits in study areas constraints requiring a minimum consumption of 0.5 kilogram of meat per household per week as well as maximum groundnut consumption limitation per half a year were imposed on the models.

CsBFD 0 (46)
CsBFW 0 (47)
30 CsGnD (48)
30 CsGnW (49)

3.2.7 Livestock grazing constraints

Feed for livestock in study areas is provided by pastures in the agricultural areas (fallow land and non-arable land between fields), accessible forest areas as well as stover from harvested fields during the dry season. Since fallow land is only available in seasons in which farmers plough less than their total agricultural land, the availability of this land is transitory. The guaranteed or minimum grazing land available is the forest portion the households have access to, while the maximum grazing land is the combined area of this forest portion and the average fallow land when it is available.

Natural pastures in communal areas of Zimbabwe are estimated to yield 1800 kilograms of dry matter (DM) per hectare per year (Guveya 1995). Stover from grain production on the other hand is estimated to yield about 423 kilograms DM per hectare annually. An animal weighing 500 kilograms (i.e. 1 livestock unit) requires about 8 kg DM per day or 2.92 tonnes per livestock unit (LU) per year (Guveya 1995). Livestock unit equivalents of cattle, goats and donkeys, the major classes of animals kept in study areas, are respectively, 0.8, 0.04 and 0.6 LUs.

Based on the above information, feed supply (FeedS) from stover and natural grassland (Graz) is

$$\text{FeedS} = 0.253\ (\text{GrMz} + \text{GrSorg}) + 1.8\ \text{Graz} \quad (50)$$

where FeedS is measured in tonnes of DM.

Feed demand for each animal type/class is equivalent to feed requirement per livestock unit multiplied by the livestock unit equivalence of the animal and the product multiplied by the number of animals in the class. Thus, total feed demand becomes:

$$\text{FeedD} = 2.92\ (0.8)\ \text{Ca} + 2.92\ (0.04)\ \text{Gt} + 2.92\ (0.6)\ \text{Dk} \quad (51)$$

where Ca, Gt and Dk are respectively the number of cattle, goats and donkeys owned by the household at the start of the year.

Supply and demand constraints for feed require that feed demanded is less than or equal to available feed,

FeedS FeedD (52)

3.2.8 Livestock production and utilization constraints

Apart from draft services, livestock provides a number of benefits including income from their sale, capital gains from reproduction, income from sale of milk as well as direct consumption benefits. Capital gains due to reproduction will depend on the number of females in the herd as well as the calving/kidding rate net of mortality. Data collected in the study areas did not include this information. For the purposes of the modeling exercise we resorted to national estimates for the communal sector reported in Guveya (1995). Calving/kidding rates net of mortality are estimated to be 45% for cattle and donkeys and 120% in the case of goats. Percent of females in national herd are estimated to be 56% for cattle, 67% donkeys and 75% goats.

Given these statistics end of year stocks of livestock can be specified as

Cattle: $Ca_f = 0.45\ (0.56)\ Ca + Ca$ (53)

Goats: $Gt_f = 1.2\ (0.75)\ Gt + Gt$ (54)

Donkeys: $Dk_f = 0.45(0.67)Dk + Dk$ (55)

where Ca, Gt and Dk are beginning stocks of cattle, goats and donkeys. and $Ca_{f,}$ Gt_f and Dk_f are end of year stocks for the respective animals.

To maintain a stable herd size, we assume that livestock sold cannot exceed livestock born. Thus,

$0.45\ (0.56)\ Ca - CaSg\quad 0$ (56)

$1.2\ (0.75)\ Gt - GtSg\quad 0$ (57)

$0.45\ (0.67)\ Dk - DkSg\quad 0$ (58)

where CaSg, GtSg and DkSg are numbers of cattle, goats and donkeys sold, respectively.

Most of the households with draft animals milked cows for household consumption and sale even though the yields were quite modest. In Mutangi, Chivi district, households got an average of 253 litres per year while in Mafungautsi, Gokwe district, they got about 294 litres per year (Mutamba and Siziba 2002). Given that average cattle holdings by households with draft animals in Chivi and Gokwe study areas were 6 and 8, respectively, the proportion of cows in the herd and the assumed calving percentage lead to milk yield per milking cow of 167 and 144 litres in Chivi and Gokwe, respectively. Availability of better forage in the wet season implies that most of this yield will be obtained during the wet season. It is estimated that dry season production is half of that during the wet season. Thus in Chivi a milking cow is estimated to yield about 56 litres in the dry season compared to 111 litres during the wet season. In Gokwe a milking cow produces 48 litres in the dry season and 96 litres during the wet season.

The seasonal milk production constraints are then:

$MyieldD\ (0.45)\ (0.56)\ Ca - PrMkD\quad 0$ (59)

$MyieldW\ (0.45)\ (0.56)\ Ca - PrMkW\quad 0$ (60)

where MyieldD and MyieldW are milk yield during dry and wet seasons, and PrMkD and PrMkW are household milk production during dry and wet seasons, respectively.

Milk produced is either consumed or sold. How much is consumed and/or sold in a season is assumed not to exceed the volume of milk produced. That is,

$$PrMkD - CsMkD - SgMkD \quad 0 \tag{61}$$
$$PrMkW - CsMkW - SgMkW \quad 0 \tag{62}$$

where CsMkD and CsMkW are litres of milk consumed during the dry and wet seasons, and SgMkD and SgMkW are litres sold during the dry and wet seasons, respectively.

Since no household milking cows were reported the purchase of milk to supplement own production and that consumed by the household was limited to be at most equal to the amount produced. That is

$$PrMkD - CsMkD \quad 0 \tag{63}$$
$$PrMkD - CsMkD \quad 0 \tag{64}$$

3.2.9 Household fuelwood consumption and sales constraints

In addition to labour allocated to domestic and farming related activities, households devote labour time to collection of fuelwood and poles for household use as well as for sale. Across the two sites, average per capita consumption of fuelwood was 1.56 cubic metres. Assuming a woodland stocking of 50 cubic metres per hectare, the area of woodlands harvested to satisfy household needs for fuelwood and poles (StkMioH) should at least be equal to household needs divided by woodland stocking. That is

$$StkMioH \quad 1.56\ (HHcM + HHcW + HHcChn)/50 \tag{65}$$

Very little of direct marketing of woodland products was observed in the two study sites. The insignificant commercial harvesting was for use as inputs into other income generating activities, such as beer brewing and brick curing. In this study we assume that the value of the harvested firewood and poles is equal to the opportunity cost of labour utilised to harvest these products. How much is collected for income generation is then equal to how much the household can allocate to harvesting for sale (ClFwSLab) multiplied by how much the household can harvest per unit of labour input. How much a household can collect per labour-day – a form of firewood and poles collecting efficiency measure (EfCoef) – is estimated by dividing domestic needs of these products by the time the household devotes to collecting them. That is,

$$EfCoef = [1.56*(HHcM + HHcW + HHcChn)]/(\ {}_{j=1}^{3} L_{fw,i}) \tag{66}$$

where ${}_{i} L_{fw,i}$ is the sum of labour allocated to collecting firewood and poles by men, women and children in the household for domestic use. Area of forest used to satisfy harvests for income generation (StMioS) is therefore:

$$StMioS \quad EfCoef\ ClFwSLab \tag{67}$$

Total area, Areamio, of woodland harvested by the household is thus

$$Areamio = StkMioH + StMioS \tag{68}$$

Government conservation regulation enforced through chiefs and village heads in the study areas is that no harvest for poles and firewood from communal areas should be

for sale outside the areas of origin. This is an imperfect way of ensuring that woodland harvest is as close as possible to biological sustainable harvest, if we assume that harvesting for household consumption does not degrade the woodlands significantly. To try to mimic this policy we introduce into the model a constraint limiting the amount harvested by a family to be less than its share of regeneration of the woodland stock in the community. The communities in Gokwe and Chivi can access 60,000 hectares and 5670 hectares of woodlands respectively. A 3 percent regeneration rate for woodland is assumed in the two sites. Given that the number of households in Gokwe and Chivi are 4558, and 453 families, respectively, the per household maximum biologically sustainable harvests (Miomax) are estimated at 0.40 and 0.38 hectares in Gokwe and Chivi, respectively. The woodland biological sustainability requirement can be specified thus,

$$\text{Miomax} \quad \text{StkMioH} + \text{StMioS} \tag{69}$$

4. RESULTS AND DISCUSSION

The model allows us to answer a number of questions about the likely effects of changes in the socio-economic environment in which the Gokwe and Chivi communities under study reside. Specifically, we scrutinise the likely impacts on levels of achievement of a weighted household goal combining food security and income, resulting from woodlands use, crop mix, labour utilised in woodlands related activities relative to agriculture, among others, under the following scenarios:

- Current price and cost structure with no sustainability restrictions,
- Current price and cost structure with sustainability restrictions,
- Changes in all agricultural commodity prices,
- Changes in agricultural productivity,
- Changes in agricultural input prices, and
- Restrictions on household labour availability, e.g. through death or institution of laws preventing use of child labour in production.

4.1 Baseline results

Tables 5 and 6 present the base case results from the model simulation runs. With the exception of non-draft owners in Gokwe, all other representative households were shown to potentially achieve fully their food security and income goals as well as harvest timber within sustainable harvest levels identified in section 3.2.9. In those households that harvested woodlands unsustainably, simulations showed forcing sustainable harvesting entails more than proportionate loss in achievement of income goals. For non-draft owning households in Gokwe, a 32 percent reduction (0.71 to 0.40 hectares) in harvest forced by sustainability restrictions led to an increase in income deficit of 61 percent compared to baseline predictions.

The baseline results seem to support the view that natural resource degradation tends to occur in areas with abundant resources. Baseline simulation results clearly show higher levels of woodland use in Gokwe compared to Chivi, a resource poor community. Draft owning households in Gokwe harvest 0.25 hectares compared to 0.22 hectares harvested by their counterparts in Chivi, while non-draft owning households in Gokwe harvest 0.71 hectares compared to 0.20 in Chivi. In addition, as expected draft owning households tend to crop more land compared to non-draft owning households in both project sites.

Table 5. Baseline results of simulations in Chivi

		Chivi—Draft owners			Chivi—Non-draft owners		
		No-Env[a]	Env[b]	Change	No-Env	Env	Change
Food security goal	N1	0	0	0	0	0	0
	P1	0	0	0	0	0	0
Income goal	N2	0	0	0	0	0	0
	P2	0	0	0	0	0	0
Labour allocation to woodlands (%)		59.37	59.37	0	61.13	61.13	0
Labour allocation for woodlands for sale (%)		0	0	0	3.73	3.73	0
Area of woodlands harvested (ha)		0.22	0.22	0	0.20	0.20	0
Area under food crops (ha)		2.15	2.15	0	0.83	0.83	0
Area under cash crops (ha)		0.00	0.00	0	1.09	1.09	0
Total cropped land (ha)		2.15	2.15	0	1.92	1.92	0
Dual price of agricultural land		0	0	0	0	0	0

[a] No-Env implies that no environmental restrictions like in an open access situation.
[b] Env implies that environmental restrictions are enforced.

Table 6. Baseline results of simulations in Gokwe

		Draft owners			Non-draft owners		
		No-Env	Env	Change	No-Env	Env	Change
Food security goal	N1	0	0	0	0.00	0.00	0.00
	P1	0	0	0	0.02	0.02	0.00
Income goal	N2	0	0	0	1.55	62.70	61.15
	P2	0	0	0	0.00	0.00	0.00
Labour allocation to woodlands (%)		46.6	46.6	0	219.9	122.0	-97.9
Labour allocation for woodlands for sale (%)		0	0	0	162	64	98
Area of woodlands harvested (ha)		0.25	0.25	0	0.71	0.40	-0.32
Area under food crops (ha)		2.16	2.16	0	0.95	0.95	0.00
Area under cash crops (ha)		0.77	0.77	0	0.42	0.42	0.00
Total cropped land (ha)		2.93	2.93	0	1.37	1.37	0.00
Dual price of agricultural land		0	0	0	0.00	0.00	0.00

4.2 Effects of an increase in output prices

To assess the impact of a general increase in output prices that could be brought about by for instance improvement in road infrastructure, setting up of marketing infrastructure closer to the community, devaluation of an overvalued exchange rate or removal of explicit government taxes on outputs, we simulated the Gokwe and Chivi models with output prices set at 25 % more than the current prices. Tables 7 and 8 report the changes from base model results obtained for the two study sites. As expected, simulation results

indicate that a general output price increase has potential to improve the attainment of income and nutrition goals. Draft owners in Chivi and Gokwe and non-draft owners in Chivi fully satisfied both goals under the with- and the without environmental concerns scenarios. Gokwe non-draft owners under unrestricted forest access manage to fully achieve both goals. Even with a sustainability constraint (Env), Gokwe non-draft owning households improve achievement of the income goal by about 16 percent.

Table 7. A 25% output price increase of simulations in Chivi

		Chivi—Draft owners				Chivi—Non-draft owners			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
Income goal	N2	0	0	0	0	0	0	0	0
	P2	0	0	0	0	0	0	0	0
Labour allocation to woodlands (%)		59.4	0	59.4	0	57.4	-3.73	57.4	-3.73
Area of woodlands harvested (ha)		0.22	0	0.22	0	0.19	-0.01	0.19	-0.01
Area under food crops (ha)		2.02	-0.13	2.02	-0.13	0.86	0.02	0.86	0.02
Area under cash crops (ha)		0.00	0	0.00	0	1.07	-0.02	1.07	-0.02
Total cropped land (ha)		2.02	-0.13	2.02	-0.13	1.92	-2.1E-07	1.92	-2.1E-07
Dual price of agricultural land		0	0	0	0	0	0	0	0

Why not cultivate more cash crops when prices increase and additional land is available? A close look at the model results points to two major constraints to increasing cash crop production. The first is the high labour and cash input requirement of the major cash crop, cotton, which makes the liquidity constraint binding. The second is the draft power constraint in a situation of limited draft leasing.

Table 8. A 25% output price increase of simulations in Gokwe

		Gokwe—Draft owners				Gokwe—Non-draft owners			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	0.00	0.00	0.00	0.00
	P1	0	0	0	0	0.02	0.00	0.02	0.00
Income goal	N2	0	0	0	0	0.00	-1.55	47.12	-15.58
	P2	0	0	0	0	0.00	0.00	0.00	0.00
Labour allocation to woodlands (%)		46.57	0	46.57	0	235.6	15.8	122.0	0.00
Area of woodlands harvested (ha)		0.25	0	0.25	0	0.76	0.05	0.40	0.00
Area under food crops (ha)		2.09	-0.06	2.09	-0.06	1.10	0.15	0.95	0.00
Area under cash crops (ha)		0.79	0.02	0.79	0.02	0.34	-0.08	0.42	0.00
Total cropped land (ha)		2.88	-0.04	2.88	-0.04	1.44	0.07	1.37	0.00
Dual price of agricultural land		0	0	0	0	0	0	0	0.00

A priori, we would expect a general increase in output prices to make returns to labour in agriculture to rise relative to returns from woodlands activities leading to more land and labour being demanded for agriculture and reduced reliance on woodlands, at least in the short-run. Using data from 19 Tanzanian regions Angelsen *et al.* (1999) observed significant increases in cropped area with increases in agricultural output prices. A study by Deininger and Minten (1999) using satellite imagery information from Mexico found a significant and positive relationship between forest area converted to agriculture and agricultural output price increases. Similar results were found in two separate studies on deforestation in Thailand by Cropper *et al.* (1997) and Panayotou and Sungsuwan (1994). However, in Zimbabwe, a study by Chipika and Kowero (2000) found a weak positive relationship between agricultural land expansion and crop output price increases.

Results from simulations in the two sites and for the two household type models provide evidence both supporting and refuting the above observations. The results show a decrease in woodlands area harvested with increase in output prices. Draft owners in Chivi and Gokwe show no change in labour use in woodlands from baseline while non-draft owners in Chivi and Gokwe register decreases in both labour use in woodlands and total area of woodlands harvested. Further, in all areas with the exception of the no-draft owners in Gokwe that predicted no change, a general decrease in total area cropped under both with and without sustainability concerns were predicted. These results tend to suggest that improvement in output prices over a situation where both food security and income goals are met would reduce the need to over-achieve these goals through expansion in either agriculture or woodland harvesting with households preferring to enjoy more leisure. In households where agriculture is currently failing to satisfy income requirements and woodlands are already making a significant contribution to household income, the 25 percent improvement in selling prices of commodities would lessen dependency on forests. In the case of non-draft owners in Gokwe, however, the improvement would not be large enough to wipe out the deficit in achievement of the income goal, thereby making reduction in agriculture in favour of more leisure an unaffordable luxury.

4.3 Effect of an increase in agricultural productivity

In general, we would expect the changes in crop productivity to have an indeterminate direction of impact on woodland use. This indeterminacy on the impact of productivity on deforestation is borne out in empirical research. On one hand, an increase in productivity that does not have an appreciable impact on commodity prices and labour demand could lead to an increase in agricultural profitability and hence promoting a shift from harvesting of woodlands towards agriculture. On the other hand, yield improvements may trigger declines in prices affecting agricultural profitability promoting harvesting of forests (Kaimowitz and Angelsen 1998). Studies by Deininger and Minten (1996) and Panayoutou and Sungsuwan (1994) showed that increase in agricultural yield was associated with a reduction in deforestation while studies by Angelsen *et al.* (1996) and Katila (1995) reported an increase in deforestation with productivity improvement. Yet studies by Barbier and Burgess (1996) and Chakraborty (1994) showed no significant effect of yield changes on deforestation.

To assess the impact of general increase in agricultural productivity, we simulated the Gokwe and Chivi models with yields increased by 25 %. Crop yields increases could

be due to use of improved seed, fertilizers and pesticides. Table 9 and 10 report the changes from base model results obtained for the two study sites. As expected, yield improvements promoted achievement of both food security and income goals. In all areas under both 'with' and 'without' environmental concern scenarios, there is full achievement of the nutrition and income target levels.

Table 9. A 25% yield increase simulations in Chivi

		Chivi – Draft owners				Chivi – Non-draft owners			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
Income goal	N2	0	0	0	0	0	0	0	0
	P2	0	0	0	0	0	0	0	0
Labour allocation to woodlands (%)		132.19	72.82	101.94	42.67	57.4	-3.73	57.4	-3.73
Area of woodlands harvested (ha)		0.49	0.27	0.38	0.16	0.19	-0.01	0.19	-0.01
Area under food crops (ha)	1.67	-0.48	1.67	-0.48	1.29	0.46	1.29	0.46	
Area under cash crops (ha)		0.00	0	0.00	0	0.00	-1.09	0.00	-1.09
Total cropped land (ha)		1.67	-0.48	1.67	-0.48	1.29	-0.63	1.29	-0.63
Dual price of agricultural land		0	0	0.00	0	0	0	0	0

Table 10. A 25% yield increase simulations Gokwe

		Gokwe– Draft owners				Gokwe – Non-draft owners			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	0.00	0.00	0.00	0.00
	P1	0	0	0	0	0.02	0.00	0.02	0.00
Income goal	N2	0	0	0	0	0.00	-1.55	0.00	-1.55
	P2	0	0	0	0	0.00	0.00	0.00	0.00
Labour allocation to woodlands (%)		46.57	0	46.57	0	252.1	32.2	122.0	-97.9
Area of woodlands harvested (ha)		0.25	0	0.25	0	0.82	0.10	0.40	-0.32
Area under food crops (ha)		1.68	-0.48	1.68	-0.48	1.19	0.24	1.03	0.08
Area under cash crops (ha)		0.91	0.14	0.91	0.14	0.20	-0.22	0.38	-0.04
Total cropped land (ha)		2.59	-0.34	2.59	-0.34	1.39	0.02	1.41	0.04
Dual price of agricultural land		0	0	0	00	0	0	0	0

On woodlands use, simulation results seem to support the indeterminacy hypothesis. Draft owning households in Chivi were predicted to increase the labour allocated to harvesting woodlands while their counterparts in Gokwe were predicted to have no change in woodlands related activities under the with- and without

environmental concern management regimes. On the other hand, non-draft owning households in Chivi projected a reduction while those in Gokwe projected an increase in labour allocated to woodlands harvesting under the without environmental concern scenarios. Evoking sustainability (i.e. enforcing the environmental constraint) would lead to a reduction in labour for harvesting woodlands with crop yield increase in households without draft animals.

As the case with output price increases, and possibly for the same reason, crop yield increases would induce declines in total area cropped with the exception of non-draft owners in Gokwe. This tends to suggest that household decision-making is largely guided by the principle of satisfaction of minimum requirements rather than maximizing surplus. To test whether this result is due to the structure of the model we ran the model without the requirement of minimising positive income deviation. The results for both categories in Gokwe showed insignificant sensitivity to this modification.

4.4 Effect of an increase in input prices

Increasing the prices of inputs is likely to lead to two opposing effects (Kaimowitz and Angelsen (1998). On one hand, an increase in crop input prices will lead to a decrease in agricultural profitability and could promote the harvesting of woodlands for sale to compensate for loss in crop income. On the other hand, subsistence farmers following a "safety-first" food production strategy could substitute cash inputs with land if input prices were increased, and this could lead to an increase in agricultural labour relative to that for harvesting woodland. The net effect would most probably be indeterminate. In a number of CGE modelling efforts that looked at the impact of lowering agricultural subsidies – which is the same as increasing input prices – this indeterminacy seems to be supported. A study by Mwanawina and Sankayan (1996) in Zambia estimated that an increase in input prices tends to increase the area under agriculture, while a similar study in Tanzania showed no effect due to input price increases. A study by Coxhead and Chively (1995) in the Philippines estimated a reduction in deforestation due to input price increases.

Another dimension that may affect how responsive a community's woodlands use is to input price increases are the initial levels of cash inputs and the cropping patterns. Communities that use a lot of cash inputs and are involved in cash crop production such as cotton (that tend to demand more cash inputs such as fertilisers, seed and agrochemicals) would tend to exhibit more inelastic response to changes in prices compared to communities that traditionally use little bought inputs. Thus we would expect the response to be more muted in Gokwe where cotton growing is a major enterprise compared to Chivi which is relatively more subsistence oriented.

To assess the impact of general increase in cash input prices we simulated the Gokwe and Chivi models with cash input prices increased by 25 %. Tables 11 and 12 report the changes from base model results obtained for the two study sites.

For the relatively well-off draft owning households in both sites, an input price increase would not affect the achievement of both food security and income goals. For non-draft owning households however there would be a reduction in ability to meet goals. In Chivi they would underachieve the nutrition goal by 1.5% while in Gokwe they would underachieve the income goal by 14 percent (or by 75% if environmental sustainability is enforced).

Table 11. A 25% input price increase simulations for Chivi

		Chivi—Draft owners				Chivi—Non-draft owners			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	1.53	1.53	1.53	1.53
	P1	0	0	0	0	0	0	0	0
Income goal	N2	0	0	0	0	0	0	0	0
	P2	0	0	0	0	0	0	0	0
Labour allocation to woodlands (%)		59.37	0	59.37	0	61.75	0.62	61.75	0.62
Area of woodlands harvested (ha)		0.22	0	0.22	0	0.20	0.00	0.20	0.00
Area under food crops (ha)		1.89	-0.26	1.89	-0.26	0.81	-0.03	0.81	-0.03
Area under cash crops (ha)		0.00	0	0.00	0	1.11	0.03	1.11	0.03
Total cropped land (ha)		1.89	-0.26	1.89	-0.26	1.92	1.5E-07	1.92	1.5E-07
Dual price of agricultural land		0	0	0	0	0.03	0.03	0.03	0.03

Table 12. A 25% input price increase simulations for Gokwe

		Gokwe—Draft owners				Gokwe—Non-draft owners			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	0.00	0.00	0.00	0.00
	P1	0	0	0	0	0.02	0.00	0.02	0.00
Income goal	N2	0	0	0	0	15.48	13.93	77.00	75.45
	P2	0	0	0	0	0.00	0.00	0.00	0.00
Labour allocation to woodlands (%)		154.7	108.2	73.7	27.1	219.9	0.0	122.0	-97.9
Area of woodlands harvested (ha)		0.83	0.58	0.40	0.15	0.71	0.00	0.40	-0.32
Area under food crops (ha)3.65		1.5	4.64	2.55	0.95	0.00	0.95	0.00	
Area under cash crops (ha)		0.00	-0.77	0.00	-0.79	0.42	0.00	0.42	0.00
Total cropped land		3.65	0.73	4.64	1.76	1.37	0.00	1.37	0.00
Dual price of agricultural land		0	0	0	0	0	0	0	0

Response to the reduced economic prospects due to higher agricultural input cost differs in all areas. In Chivi, draft owning households would respond through a shift in the composition of their food crop mix towards higher value, and high labour demanding crops such as groundnut and reducing maize without increasing harvesting of woodlands and actually reducing total area cropped. However, draft owning households in Gokwe, probably due to ease of obtaining woodland products in Gokwe, would respond to high agricultural costs by harvesting poles and firewood. The non-draft owning households in Chivi suffering reduced food security would respond with an increase in harvesting woodland products and an increase in area under production emphasising cash crops. The increase could be higher as the positive dual price of land suggests. Very limited options seemed to be available for non-draft owning households in Gokwe. The already high labour allocation to woodlands resource harvesting (220 days) leaves little scope

for cropland expansion under the without environmental sustainability constraint. Unsustainable baseline harvest levels would imply that the household could not expand forest related employment to counter poor agricultural returns under the sustainability constraint scenarios. Further, input buying related liquidity constraints could force farmers to reduce plantings.

4.5 Impact of loss of some household members

The HIV/AIDS epidemic has reached unprecedented levels in Zimbabwe. In 1999 an estimated 1.5 million people were living with AIDS representing an adult prevalence rate of 25.1 percent and leading to 160,000 AIDS related deaths (UNAIDS 2000). According to a recent FAO/UNAIDS (2001) study, agricultural output of small farmers in some parts of Zimbabwe may have fallen by as much as 50 percent in the past five years, mainly because of AIDS. The study attributed to AIDS over 50 percent of deaths - 78 percent of which were men - in the areas studied (UNAIDS 2001).

The problems of HIV/AIDS in farming communities begin as soon as the first adult in the household becomes sick. Those suffering need the help of their kin, so the family loses not only the labour of the sick but also of other relatives. The situation worsens if other household members get the disease. The family budget is squeezed to pay for medical bills and, ultimately, funeral costs thereby reducing money available to buy seeds and other inputs, and forcing the sale of livestock and other assets. Further, one would expect labour shortages due to HIV/AIDS to cause a range of farm changes, including a reduction in land under cultivation, a decline in crop yields and a shift from cash crops to subsistence crops. Labour shortages may also lead to shifts towards much easier coping strategies for the household such as harvesting woodlands for sale.

To gain insight into the likely impact of AIDS and other common diseases like malaria, on the household's welfare we model situations where a household loses an adult (woman/man) or a child. Tables 13 and 14 report the potential impacts in the two study sites.

Table 13. Simulation of effects of loss of household member in Chivi

		Chivi—Draft owners (loss of child labour)				Chivi—Non-draft owners (loss of a woman)			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	74.36	74.36	74.36	74.36
	P1	0	0	0	0	0	0	0	0
Income goal	N2	0	0	0	0	306.1	306.1	306.1	306.1
	P2	0	0	0	0	0	0	0	0
Labour allocation to woodlands (%)		86.93	0.00	86.93	0.00	57.4	-3.73	57.4	-3.73
Area of woodlands harvested (ha)		0.27	0.00	0.27	0.00	0.16	-0.04	0.16	-0.04
Area under food crops (ha)		2.07	0.16	2.07	0.16	1.23	0.40	1.23	0.40
Area under cash crops (ha)		0.00	0.00	0.00	0.00	0.00	-1.09	0.00	-1.09
Total cropped land (ha)		2.07	0.16	2.07	0.16	1.23	-0.70	1.23	-0.70
Dual price of agricultural land		0	0	0	0	0	0	0	0

Losses of child labour through the death of a child, or alternatively through enactment of laws preventing employment of child labour, was modelled for draft owning households in Chivi and non-draft owning households in Gokwe. For Chivi draft owning households, loss of a child did not prevent satisfaction of both food security and income goals. Simulations also show that there was no effect on area of woodlands harvested. However, since loss of a child means demand of woodland products for domestic use goes down, it implies harvest of timber for sale goes up. Simulations for Gokwe non-draft owning households however showed dramatic impacts of loss of a child. Simulations show a worsening failure to achieve both food security (15 percent) and income (10 percent) goals. Labour allocated to woodlands harvesting drops by 97 labour days while total land cropped also drops. Results also show a shift in production towards cotton (cash crop) production, a labour intensive activity, explaining why there was a drop in cropped area accompanied by an increase in land under crops.

Loss of one woman's labour in a household was modelled for Chivi non-draft owning households (Table 13). Simulation results show dramatic impacts on the household. The household fails to attain food security goal by 74 percent and by more than 100 percent the income goal. The household significantly reduces area cultivated and even stops growing cash crops altogether shifting efforts toward food production. Despite these impacts, simulations show surprising little reduction in labour used on woodland harvesting with only 4 days reduction in woodland harvesting labour. However, there was noted a slight decrease in area of woodland harvested, while the opposite was observed in Gokwe when there was a loss of adult male labour (Table 14).

Table 14. Impact of loss of household member in Gokwe

		Gokwe—Draft owners (loss of a man)				Gokwe—Non-draft owners (loss of child labour)			
		No-Env	Change	Env	Change	No-Env	Change	Env	Change
Food security goal	N1	0	0	0	0	15.41	15.41	15.41	15.41
	P1	0	0	0	0	0.00	-0.02	0.00	-0.02
Income goal	N2	0	0	0	0	11.48	9.93	11.48	9.93
	P2	0	0	0	0	0.00	0.00	0.00	0.00
Labour allocation to woodlands (%)		74.78	28.21	73.69	27.13	122.50	-97.40	122.50	-97.40
Area of woodlands harvested (ha)		0.40	0.15	0.40	0.15	0.33	-0.38	0.33	-0.38
Area under food crops (ha)		4.79	2.63	4.79	2.69	0.81	-0.14	0.81	-0.14
Area under cash crops (ha)		0.00	-0.77	0.00	-0.79	0.49	0.08	0.49	0.08
Total cropped land (ha)		4.79	1.86	4.79	1.91	1.30	-0.07	1.30	-0.07
Dual price of agricultural land		0	0	0	0	0	0	0	0

All in all the results indicate substantial increase in poverty due to diseases like HIV/AIDS that can constrain availability of labour. The total absence of adult female labour in the household due to such diseases has potential to adversely affect both

income and food security by mainly to disrupting agricultural productivity, and could increase woodland harvesting for sale as this would remain an important income source for households during this predicament.

5. MAIN FINDINGS AND CONCLUSIONS

This paper modeled woodland use in four representative households: draft animal owning households and non-draft animal owning households in a woodland abundant area and a woodland poor area. The results indicate that woodland use tends to be higher in wood abundant areas compared to the resource poor areas and that woodland resources are important sources of household income for the poor in resource abundant regions compared to households in the resource poor areas.

The study also simulated the likely impacts of agricultural incentives and effects of absence of labour from productive members, for example due to death from diseases such as HIV/AIDS and malaria. The results indicate varied woodland use response depending on household characteristics. Basically three household types emerge that are likely to influence household response to policy or situation change stimuli:

- Type I households are those fully satisfying both food security and income goals from current agricultural activities with woodlands resources only used for domestic requirements. In this category falls draft animal owning households in Gokwe and Chivi.
- Type II households are those fully satisfying both food security and income goals from current agricultural activities with some supplementary income coming from harvesting woodlands over and above domestic requirements. However, woodland resource harvest is still within sustainable levels. In this category are non-draft animal owning households in Chivi.
- Type III households are those currently failing to satisfy either of their food security or income goals from current agricultural activities even with supplementary income coming from harvesting woodlands over and above domestic requirements and beyond sustainable levels. This category describes non-draft animal owning households in Gokwe.

The characteristics of the households described above are found to be closely linked to how households respond to external shocks. In the event of drastic reductions in agricultural incentives (e.g. reduction in yield or increase in input prices) Type I households have some room to restructure agricultural activities to satisfy goals before turning to harvesting woodlands for income. Type II households have less opportunities compared to Type I households to restructure agriculture to counter adverse conditions. However, because they are currently harvesting within sustainable levels, they have room to increase harvests from the forests to increase incomes and be better able to achieve goals. Type III households however are in a difficult situation. Because they are unable to satisfy goals from agriculture and from devoting maximum possible labour to harvesting woodlands, these households are likely to respond to adverse agricultural incentives by turning even more to woodland harvesting in an open access situation. However, under strict environmental sustainability enforcement, and because Type III households exceed sustainable harvest under free access baseline condition, they cannot respond to adverse agriculture activities by resorting to woodland harvesting.

Better agricultural incentives (from say an increase in agricultural product prices) should allow Type I and II households to satisfy goals with less agricultural land freeing up labour to either boost woodland harvesting or improvement in leisure. Type III households, because they are not satisfying goals in the baseline and due to improvement in relative returns to agriculture, are predicted to respond to improvement in agricultural incentives by allocating more land and labour to agriculture and less to woodland harvesting.

Loss of household members were shown to make the relatively poorer non-draft animal owning households poorer while draft owning households could absorb the losses without losing their standards of living. Poorer households, already depending on woodland resources to a significant level tend to reduce labour allocated to woodlands and increase land under food crops in the event of loss of household members. The richer households could increase dependence on woodland resources in the event of a loss in a household member. The results also indicate a strong gender bias in effects of household member loss. The loss of a woman member induces debilitating decline into abject poverty compared to other gender classes highlighting the central roles women play in the household production process.

The above conclusions demonstrate the strong effect on woodland use of agricultural policies, HIV/AIDS related diseases, and institutional arrangements protecting forests. As Zimbabwe proceeds with its second - and much expanded - phase of the land reform and redistribution exercise, it is important that issues of protection of the woodlands are not ignored. Of particular concern is the lack of consideration for development of local level institutions governing the use of forest resources in the current land redistribution exercise. The model presented here provides a tool for potential use in crafting new policies and institutions governing woodland resource use in the newly settled areas.

ENDNOTES

1. Even though prices are held constant across seasons due to government price controls, separating wet and dry season takes care of possibilities of storage losses, labour limitations during wet season as well as differences in milk productivity across season, etc.

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18.
Management of miombo woodlands in Malawi: An application of goal programming

H. Tchale, R. Kachule and C. Mataya

ABSTRACT

Miombo is a local name for African woodlands prevalent in seven eastern and southern African countries, namely Angola, Democratic Republic of Congo, Malawi, Tanzania, Mozambique, Zimbabwe and Zambia. The woodlands are surrounded by subsistence farmers who largely depend on them for their livelihood. Unfortunately, there is no guarantee that the utilization of the resources from the miombo woodlands is sustainable in the long-run, mainly due to the absence of effective control and management of these vast resources.

In an effort to come up with a methodology for planning woodland management and use, a model called MIOMBOGP based on the weighted goal programming (WGP) method is employed. This methodology is used to evaluate how the various principal woodland stakeholders respond to some macro-economic and sectoral policies in ways that satisfy the achievement of their goals. We identify households, the private sector and governments as the main stakeholders in the woodlands, who often have interests that conflict with each other. This has potential to reduce the sub-optimization of the benefits they derive from the woodlands as well as adversely affecting the woodland condition.

Using this model on the data collected from the communities surrounding Dzalanyama, Chimaliro and Mdeka forest reserves, the results imply that use of the miombo woodland resources is mainly influenced by prices of agricultural commodities, technological changes in agriculture, labour supply changes and prices of firewood and other energy sources. Thus when planning to change any of these variables, there is a need to quantify the impact on the woodland resources because any pressure on agriculture holds potential to negatively affect woodland resource condition as well as the benefits that flow from them.

Key words: Goal programming, miombo woodlands, Malawi

1. INTRODUCTION

Miombo woodland characterise most of the African woodlands which are mainly dominated by species of *Brachystegia*, either in pure stands or in association with those of *Julbernadia* and/or *Isoberlinia* (Lind &Morrison 1974; White 1983). These woodlands are most prevalent in seven eastern, central and southern African countries namely Angola, Democratic Republic of Congo, Malawi, Mozambique, Tanzania, Zambia, and Zimbabwe (White 1983). They occupy an area of about 2.7million km^2 and support over 40 million people. The people live in the vicinity of the woodlands, while some reside in woodlands that are in public domain. They rarely live in the woodlands set aside as government forest reserves, but do encroach on them for several demands. Where the woodlands occur outside forest reserves, their clearing for agriculture has taken place over the years.

These woodlands are surrounded mostly by subsistence farmers who largely depend on them for their livelihood in the form of energy sources, poles for the construction of dwellings, thatch, food in the form of fruits, fungi, indigenous vegetables, insects and grazing ground for livestock. Given this extensive dependence on these resources, there is need to ensure that the resources are managed and used sustainably because the very existence of the communities depends on them. Apart from the communities, there are also other stakeholders like the private sector, the government and the international community that have commercial and conservation interests in the woodlands.

All the countries with miombo woodlands are implementing economic reforms that seek to restructure their ailing economies. The policies and strategies employed affect all the miombo woodland stakeholders differently and in ways that are not clear but with potential effects on woodland based rural livelihoods and the forest condition.

The objective of this paper is to present a methodology for planning woodland management and use, by evaluating how the various principal woodland stakeholders respond to some key macroeconomic and sectoral policies in ways that satisfy the achievement of their goals. The satisfaction of some of these goals exerts pressure on the woodland resources. It is this pressure and the extent to which it manifests itself in the woodlands that the paper seeks to address, and especially the sustainable satisfaction of the needs of the key stakeholders.

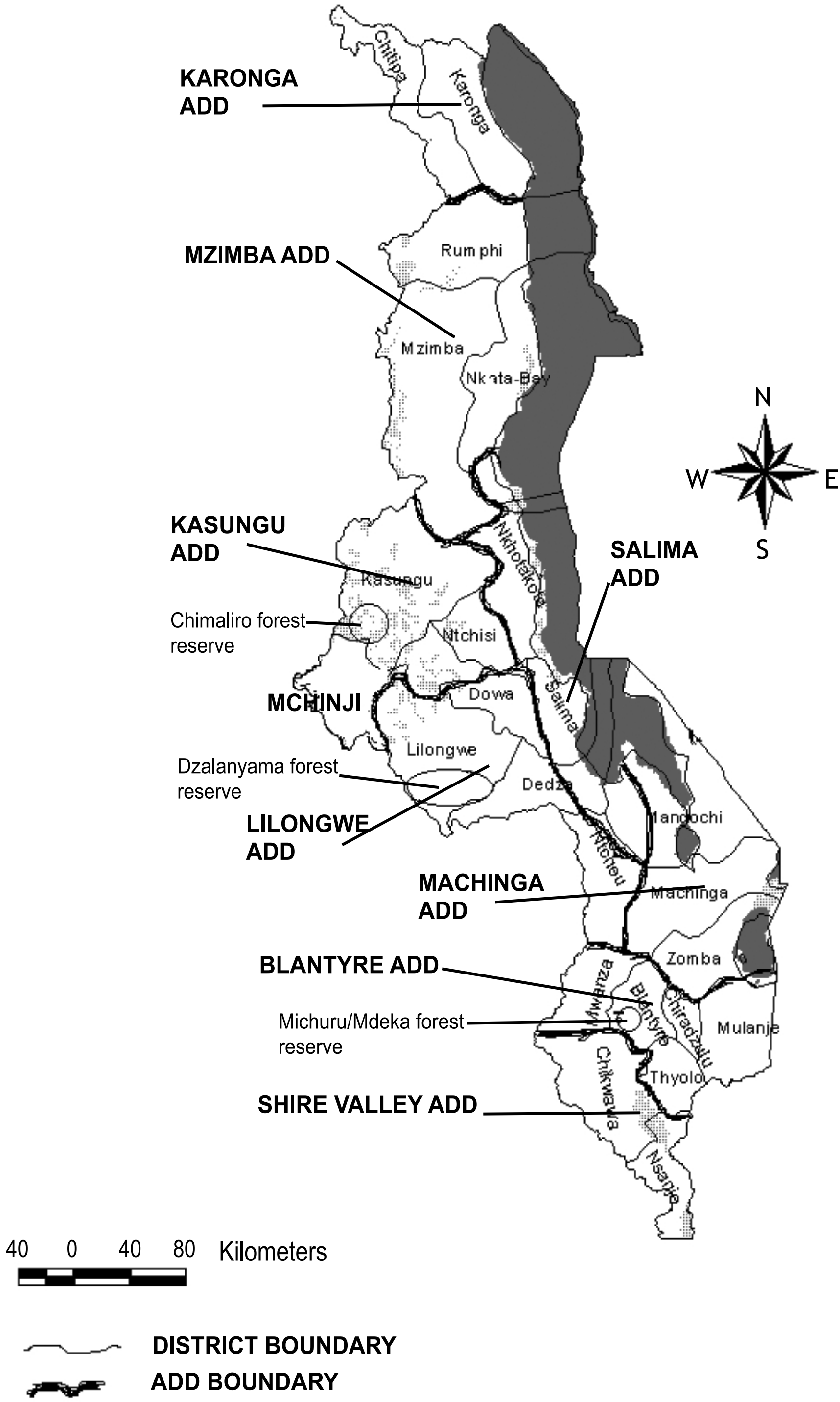
This paper presents the results derived from a weighted goal programming model (MIOMBOGP) based on data collected from communities living around three forest reserves in Malawi namely Chimaliro in Kasungu district, Dzalanyama in Lilongwe district and Michiru in Blantyre district.

The paper is arranged as follows: it starts with a description of the study sites, presentation of the goal programming model adapted for Malawi, the baseline results, the discussion of results from the sensitivity/alternative scenarios analysis, and finally conclusions and recommendations. The basic goal programming model is presented in Nhantumbo and Kowero (2001) and Annex1 presents the data used in building the models for the three study sites while Annex 2 presents the variable definitions and units of measurement.

2. DESCRIPTION OF THE STUDY SITES

The research was conducted in three different sites namely, Chimaliro and Dzalanyama in the central region of the country and Mdeka in the South of the country (Figure 1). This section describes the characteristics of these sites.

Figure 1. Map of Malawi showing the survey districts and the forest reserve sites



2.1 Chimaliro

Chimaliro is a gazetted forest reserve with tree species of *Brachystegia* and *Jubernardia* as the predominant woodlands. The reserve is wholly indigenous, i.e. there is no plantation of exotic species. The reserve was declared a protected area in 1926 with an initial area of 98 square kilometres. All villages in the vicinity of the reserve were closed except one which acted as a caretaker. The people of this village were allowed to cultivate specific areas within the reserve. At the time the reserve was declared a protected area, there were plenty of indigenous trees on the customary land such that there was no need or motivation for the villagers to go to the reserve for wood and other forest supplies/products. In 1945, the Forest Department prohibited cultivation in the reserve since the agricultural practices were considered detrimental to the woodlands. In 1952, the government began to employ people to manage the forest. At that time, encroachment on the forest reserve had already started. The boundary of the reserve was then changed to its present position. Currently the reserve stretches over an area of 160 km^2 from the north east Zambian boarder (Lowore *et al*. 1995).

Food crops grown in the area include maize, groundnuts and beans, with tobacco as the major cash crop. However, maize and groundnuts surpluses are also sold for cash. Livestock form another source of income through sales of milk, eggs, chickens and occasionally the stock itself. Minor sources of income include local beer brewing, moulding of bricks and sale of firewood. The traditional form of agriculture practised was shifting cultivation which involved clearing some of the miombo woodlands. The minimum fallow period could be as long as 15 years. This allowed rejuvenation of soil fertility and re-growth of some tree species. Increasing land pressure due to population growth has led to a sedentary form of agriculture with continuous cultivation on the same piece of land that eroded soil fertility. Due to increasing importance of the tobacco crop and also due to the liberalization of tobacco production by allowing smallholder farmers to also grow it, there has been a considerable conversion of the forest to cropland by estate and smallholder farmers.

All along, management and control of the reserve has been under the Forest Department. Communities surrounding the reserve were never allowed access into the forest reserve for any forest products. However, beginning from the late 1990s, the concept of co-management was introduced along certain stretches of the reserve. Communities are now allowed access to the forest for non-timber products such as wild fruits, honey, grass and caterpillars. The estate sector is occasionally allowed access for poles and fuel wood.

2.2 Dzalanyama

Dzalanyama forest is gazetted as a protected forest reserve and it is designated as public land under the Land Act of Malawi. The reserve lies on the Dzalanyama range stretching over a distance of 65 km. It covers a total area of 98,909 ha and runs through three districts; Dedza to the south covering 35,600 ha (bordering Mozambique); Lilongwe to the center covering 61,909 ha (about 40 km to the west and south west of Lilongwe city) and Mchinji to the north covering 1,400 ha (bordering Mozambique & Zambia).

The indigenous component of the reserve covers 45,420 ha and the remaining 53,489 ha is a plantation with *Pinus* and *Eucalyptus* as the dominant species. Ultimate

management and control of the forest and its resources lies with the Department of Forestry. Management focus has been on protection against fire, over-exploitation and encroachment. Firewood, poles and timber are legally obtained by licenses (for the plantation only). Prior to 1987/88, the commercial sector was allowed to salvage dead wood from the indigenous forest for sale in the city of Lilongwe. Due to abuse, this privilege was removed because it was discovered that when dead wood was getting scarce, people started felling live trees for eventual use as firewood. Illegal procurement of forest products especially fire wood by the commercial sector occurs around the boarder of the reserve.

The indigenous part of the forest reserve is composed of tree species of *Julbernadia* and *Brychystegia* with the dominant species being *Julbernadia paniculata, Uapaca kirkiana, Uapaca sensabarica, Parinari curatellifolia* and *Brachystegia spiciformis*. Dense grass growth dominates throughout the reserve with *Hyparrhenia, Andropogon, Themeda, and Digitaria* being the most common grass types.

By 1921, most of the reserve was cleared for agricultural purposes and this led to serious deforestation. Tobacco is the main cash crop in the area with maize as the major food crop. Since the reserve was constituted, it has been under the management and control of the Forest Department and management of the reserve has primarily aimed at protecting the reserve to conserve water and soil. Generally, management of the reserve has been carried out on a minimal budget for implementation of the Forest Department's fire policy, protection against overexploitation and encroachment. From the late 1990s, the Forest Department embarked on a co-management approach whereby communities in the vicinity of the reserve are encouraged to participate in management of the reserve. In turn, the communities are allowed access to the indigenous forest to collect dead wood, thatch grass, and other non- timber forest products.

2.3 Mdeka

The Mdeka site lies near the Michiru forest reserve and is about 30 km south of Blantyre city, a major commercial city in Malawi. The area is neither gazetted as protected area nor designated as public land (i.e. open access). Despite the fact that rules and regulations regarding management of the indigenous forest are there from the Forest Department, virtually no elements of management by the local communities exist in this area. The indigenous forest is largely under customary tenure system whereby the local leaders are the custodians of the land and resources available on the land. Construction of a major bitumised road which passes through Mdeka and connecting the cities of Blantyre and Lilongwe has encouraged overexploitation of the indigenous woodland by the communities living within the forest area. The communities largely cut wood for sale as fuelwood and for purposes of producing charcoal. The bitumised road has eased transport between Mdeka and Blantyre city thereby increasing trafficking of wood and charcoal into the city. Furthermore, growth of the construction industry in the city of Blantyre has also contributed to degradation of the natural forest in this area because people harvest wood from this area for purposes of curing bricks.

3. THE MODELLING APPROACH

3.1 Description of the typical household

The model is based on analysing the decision making process of a typical household using data[1] derived from a broader and detailed field survey that was conducted in the three-study sites. The sites were selected in consultation with the Department of Forestry and the Forestry Research Institute of Malawi (FRIM) who have good knowledge of the forest reserves and related issues around these sites.

The typical household was defined by taking a mean of the sample which comprised a total of 300 households (100 households from each study site). Simple random sampling was used in identifying the households. The sampling frame was developed together with forest assistants and agricultural field assistants from each study site. The sampling design also provided for at least 30 female-headed households based on the understanding that 30 percent of the rural households in Malawi are female headed.

Subsistence agriculture predominates the activities of the households in all the sites. As shown in Table 1, the main cash crop is tobacco and the predominant cropping system is inter-cropping of maize with beans and groundnuts. However other minor crops such as cassava and sweet potatoes are also planted as sole crops, especially when planted as a second crop soon after harvest.

Table 1. Crops commonly grown in the study sites (%)

Crop	Mdeka	Chimaliro	Dzalanyama
Maize	92.1	77.3	83.3
Sweet potato	6.0	9.0	15.9
Cassava	22.8	-	14.5
Beans/pulses	12.6	9.1	16.5
Groundnuts	17.2	20.3	19.0
Tobacco	8.3	45.1	30.8

The key household activities were food production and consumption including the collection, consumption and selling of forest products such as firewood and fruits. Each of these activities uses the labour available to the household. The core of the household's decision making is based on best allocation of the labour in ways that will ensure the satisfaction of its production and consumption goals.

3.2 Key descriptive statistics

The following information characterise the typical household on whom the goal programming model is based.

Table 2. Key descriptive statistics for typical households

Variable	Dzalanyama	Michiru/Mdeka	Chimaliro
Land coefficients (hectares)			
Maize	0.91	0.35	0.72
Tobacco	0.53	0.20	0.53
Average land holding size per household	1.44	0.55	1.25
Yield coefficients (kg/hectare)			
Maize (intercrop)	1277.14	695.60	1569.44
Beans (intercrop)	168.06	100.00	197.14
Groundnuts (intercrop)	366.08	318.88	529.66
Tobacco (monocrop)	666.04	643.40	1250.00
Total mandays/year (agric. season)	112.5	112.5	112.5
Total mandays/year (other activities)	200.5	200.5	200.5
Family size (3 working adults and 2 children)	5	5	5
Livestock ownership			
Cattle	3	1	3
Goats	4	2	7
Firewood demand (m^3/season/household)	4.39	2.80	5.48
Consumption (wet season)	3.29	3.72	3.62
Consumption (wet season) Selling (dry season)	4.35	5.40	2.94
Selling (wet season)	3.30	6.44	2.83
Dietary requirements (%)			
Maize	70	70	70
Beans	20	20	20
Groundnuts	5	5	5
Others	5	5	5
Income target (USD per household)	538.00	284.10	364.90

Note: The dry and wet seasons in Malawi are on average, 7 and 5 months long, respectively. The agricultural season is assumed to be approximately 3 months.

3.3 The basic goal programming model[2]

The objective in the weighted goal programming (WGP) model is to minimise the sum of deviations, both positive and negative, from the target levels set by the decision-maker. In this case the decision-maker is the household. The objective function of the WGP is the simultaneous minimisation of the sum of weighted deviations, and is given as:

$$\mathrm{Min} \sum_{i=1}^{k} (\ {}_i n_i + \ {}_i p_i) \qquad (1)$$

The weights ($_i$ and $_i$) are associated with the goals of food security, household income and environment conservation and positive (p_i) and negative (n_i) deviations from the goals. This means that the household has to set targets it wishes to attain with respect to the goals. Sections 3.4.1 to 3.4.3 explore this further.

Constraints

As with any other programming model, the attainment of the goals is subject to a number of constraints. In this particular model, the constraints are on arable land, labour, dietary requirements, requirements for livestock grazing and the demands for forest products for both food and domestic energy needs.

Land constraint[3]

The total land holding (ß) has to satisfy the demand for arable land by a household for the various crops denoted by Xi.

$$\sum_{i=1}^{n} X_i <= ß \qquad (2)$$

Total demand (by season j) for each crop is used to satisfy the selling (S_{ij}), storage (A_{ij}) and consumption (C_{ij}) needs, where j=1, 2 represent dry and wet seasons respectively. This total demand is met through production (X_{ij}) and buying (B_{ij}).

$$-\sum_{i=1}^{n} y_i X_{ij} + \sum_{i=1}^{n} S_{ij} + \sum_{i=1}^{n} A_{ij} - \sum_{i=1}^{n} B_{ij} + \sum_{i=1}^{n} C_{ij} <= 0 \qquad (3)$$

Production Selling Storage Buying Consumption

Labour constraint

The total labour demand for crops (Li), livestock (LA), off-farm (LN) and domestic (LD) activities should not exceed that available in the household (L_k); and is given as follows:

$$\sum_{k=1}^{n} L_{ik} + \sum^{n} LA_k + \sum^{n} LN_k + \sum^{n} LD_k - \sum^{n} L_k <= 0 \qquad (4)$$

Tie constraints (labour)

L_k = 5. This is based on the assumption of an average household size of 5,

with k=1,2,3 for adult male, adult female and children respectively.

Dietary constraints

Energy supply (E) per crop to the household

$$-\sum_{k=1}^{n} E_i + E_{kj} <= 0 \qquad (5)$$

where Ei denotes energy supply sources and Ekj denotes energy demands.

The calorific figures that have been used in the model are based on the dietary recommendations for healthy living of males, females and children (Latham 1979).

Protein supply (P) per crop to the household

$$-\sum_{j=1}^{n} P_j + P_{kj} <= 0 \qquad (6)$$

where Pi denotes protein supply sources and Pkj denotes protein demands.

Livestock grazing
The demand for feed for cattle (g tons of dry matter per head) should at least be satisfied by the amount of available pasture (p tons dry matter per ha) in a specified grazing area.

$$gC - pF <= 0 \tag{7}$$

where:
C = cattle stock numbers.
F = land area for natural production of feed for cattle.

Forest products constraints
The standing forest stock (SS) should at least satisfy the demand for household consumption (WdCh - charcoal and FwC- firewood) and for firewood sale (SFw).

$$-SS + FwC + WdCh + SFw <= 0 \tag{8}$$

3.4 The MIOMBOGP for Malawi

In modelling the interaction of the communities and the *miombo* woodlands in the case of Malawi, the following observations were taken into account. First, the State, household and the private sector have stake in the *miombo* woodlands. Second, the household's goal is to maximize food security or to minimize the occurrence of food insecurity. Third, the private sector's goal is to maximize income from sale of woodland products or to minimize the lack of it. Fourth, the goal of the state is to ensure that the woodlands are managed and used in ways that give maximum benefits to the households and the private sector while ensuring that the environment is not compromised. Fifth, the interaction of these sectors determine the extent to which each one of them satisfies its own goals given that they all depend on the resource.

It was observed from the ranking done by the households that a typical household would aim at maximising food security as a priority goal. The other goals of securing income and environmental conservation were ranked second and third respectively.

(a) The household food security goal
The food security goal for the typical household assumes a crop mix comprising maize, beans and groundnuts. In terms of the goal programming model, the household aims to minimize the negative deviations from the minimum amount of energy, measured in kilocalories, required for an active and healthy life for all household members. Although maize is the main staple for most of Malawi, the other crops are used, some as relish or sold to get money with which to buy relish. At smallholder level, which is the sector typical of most households in Malawi, these crops are key and they take up over 80% of the cropland.

(b) The income goal
Most rural households derive income from a combination of subsistence activities including selling of crops, livestock and labour to other farms. They also harvest and sell forest products, mostly firewood and poles, charcoal and other non-timber forest products such as mushroom and fruits. The objective of the household is to maximize the

income realized from these sources. In this analysis, the target income level was calculated using a linear programming model developed for each site.

(c) The environmental protection goal

From field data, the typical household in Malawi places little weight on environmental conservation. This is manifested in the way they encroach on the woodlands for agriculture and other sources of livelihood. Ensuring the attainment of this goal is largely the responsibility of the government through appropriate policies. In this analysis, the environmental goal is evaluated in terms of the amount of firewood that is extracted annually and used for household domestic use and for sale. It is therefore essentially a fuelwood goal. Harvesting the woodlands for fuelwood is the main household demand on these resources. The extent to which fuelwood becomes sustainably available would reflect the attainment of this goal. If fuelwood supplies are not sustainable, then degradation of the woodlands is inevitable leading to the total disappearance of the woodlands in the long-run. The best measure of the extent of environmental degradation would have been woodland depletion or deforestation. However, absence of data on how this has been going on precludes its adoption.

The model syntax and the variable definitions and units of measurement appear in Annex 2.

4. BASELINE RESULTS AND DISCUSSION

Tables 3-9 present the results from the base runs. The results highlight the attainment of household goals, crop and livestock production, food consumption, sale of food production as well as consumption and sale and forest products.

4.1 Attainment of household goals

The results in Table 3 show that the food security and income goals are fully satisfied since the negative and positive deviations from them are zero. However in all the three sites the environmental goal is not fully satisfied. In all the communities under the study, the priority goal is food security, followed by income. The fuelwood goal was modeled as the amount of firewood that the household needs for household consumption in both the wet and dry seasons. As the results indicate, this goal is not attainable in all the three sites. This implies that if firewood runs out then the woodlands would have been fully depleted, an environmentally unacceptable outcome.

Table 3. Baseline Results: Attainment of goals

Objective value	Sites		
	Mdeka	Chimaliro	Dzalanyama
Food security goal (n1)	0.00	0.00	0.00
Income goal (n2)	0.00	0.00	0.00
Environment /Fuelwood target (p3)	96.84	99.70	99.04
LP target income (US$/year)	284.10	364.90	538.00

Given the resources and constraints available in a typical household in the three sites, a linear LP model was run to determine the level of disposable optimal income that can be achieved per year. The results in Table 3 indicate highest income in Dzalanyama and lowest income in M'deka. This reflects the differences in the level of income earning opportunities among the sites. For example tobacco and legume production in Dzalanyama and Chimaliro is considerably higher than in M'deka. These results actually do reflect the existing disparities in terms of income distribution in Malawi. Various research studies including the more recent Integrated Household Survey have indicated low household incomes on average among households in the Southern region compared to the other two administrative regions.

4.2 Crop and livestock production

In terms of crop production, less than half as much land is allocated to maize, groundnuts and bean intercrop in M'deka compared to Dzalanyama and Chimaliro (Table 4). This reflects the differences in the land holding sizes as households in M'deka have on average the lowest land holding compared to those in Dzalanyama and Chimaliro.

Although the land allocated to tobacco production is not very different across the three sites, there are significant differences in productivity as a result of the differences in inputs applied. It was observed from a questionnaire survey for this study that input application was much lower in M'deka compared to Dzalanyama and Chimaliro. This could possibly be the result of the differences in current and potential income earnings (Table 2).

Table 4. Baseline Results: Crop production (ha)

Activity	Mdeka	Chimaliro	Dzalanyama
Maize, groundnuts and bean intercrop	0.35	0.76	0.94
Tobacco	0.09	0.20	0.27
Total cropland	0.44	0.85	1.21
Total landholding	0.55	1.25	1.44

4.3 Food consumption

The consumption levels for maize, groundnuts and beans are as shown in Table 5 for both dry and wet seasons. These are optimal consumption levels given the resources and constraints that characterise the typical household in the three sites. The results indicate that in the dry season, maize consumption level is much lower in M'deka compared to Chimaliro and Dzalanyama. In fact, given an average household size of 5 people, most households in M'deka hardly meet the consumption requirement.

The wet season consumption levels are not very different across sites as these reflect the buying and not the actual own-farm production. For groundnuts and beans the consumption levels are slightly lower in M'deka. It was noted that these consumption levels are mostly normalized through buying from the local markets as production levels for these crops are typically lower compared to the other two sites (Table 6).

Table 5. Baseline Results: Food consumption (kg/household)

Food commodity	Mdeka		Chimaliro		Dzalanyama	
	Dry	Wet	Dry	Wet	Dry	Wet
Maize	432.79	360.67	717.36	363.07	717.36	363.07
Groundnuts	67.52	0.00	75.00	75.00	100.00	75.00
Beans	98.56	91.16	100.00	75.00	100.00	75.00
Beef	7.00	5.00	14.00	5.00	18.02	15.00
Goat meat	16.52	9.05	17.57	9.30	36.00	15.05

Table 6. Crop sales (kg/household)

Food commodity	Mdeka		Chimaliro		Dzalanyama	
	Dry	Wet	Dry	Wet	Dry	Wet
Tobacco	128.68	0.00	181.96	0.00	181.96	0.00
Maize	0.00	0.00	0.00	0.00	0.00	0.00
Groundnuts	0.00	0.00	254.25	0.00	191.08	0.00
Beans	0.00	0.00	0.00	0.00	0.00	0.00

4.4 Trade in food products (buying, selling and storage)

Tobacco is the dominant traded crop (Table 6) with quantities sold lowest in M'deka and similar in the other two sites. Given that pan-territorial selling prices were used in the model, the differences in the levels of crop sold cold only reflect the differences in the production levels. Tobacco production is dominant in the central region. The results from a questionnaire survey for this study indicate that almost all households interviewed in Dzalanyama and Chimaliro grew tobacco either on their own farms or through some form of contract or out-grower scheme with other farmers or estates. For M'deka (located in the non-tobacco zone in the southern region) less than 20% of the households grew the crop.

As can be seen in Table 7, storage activity is zero for almost all crops[4], except maize in the dry season in M'deka, while small quantities of other crops (maize, groundnuts and beans) are actually stored in the dry season by households in Dzalanyama and Chimaliro. As a result, most of the buying (Table 8) done in M'deka is to replenish food stocks in wet season that result from low production that leaves nothing, or insignificant amounts for storage during the dry season.

All the households meet their demand for livestock products from the market (Table 8) since most of them have very few livestock (goats and cattle). Even the consumption levels are far lower than the recommended consumption levels especially due to the lower budget shares allocated to these commodities.

Livestock rearing is limited to an average of 2 cattle and 4 goats per household in Dzalanyama and one cattle and two goats for households in M'deka. Households in Chimaliro have on average 3 cattle and 7 goats. These low stocking levels are

Table 7. Food storage (kg/household)

Food commodity	Mdeka		Chimaliro		Dzalanyama	
	Dry	Wet	Dry	Wet	Dry	Wet
Maize	95.60	0.00	472.80	0.00	477.22	0.00
Groundnuts	0.00	0.00	72.41	0.00	76.34	0.00
Beans	0.00	0.00	49.50	0.00	57.20	0.00

Table 8. Food purchases (kg/household)

Food commodity	Mdeka		Chimaliro		Dzalanyama	
	Dry	Wet	Dry	Wet	Dry	Wet
Maize	0.00	284.93	0.00	0.00	0.00	0.00
Groundnuts	0.00	229.90	0.00	0.00	0.00	0.00
Beans	63.56	95.36	0.00	39.55	0.00	34.75
Beef	7.00	5.00	14.00	5.00	18.02	15.00
Goat meat	16.52	9.05	17.57	9.03	36.00	15.05

characteristic of most households in Malawi where livestock levels are generally low, except for some few districts in the Northern region. However, we have used standard or average animal unit values that might not always be consistent with the averages in the specific study sites. The consumption of beef and goat meat has been calculated based on the breeding, calving and kidding rates of the Malawi stock[5].

4.5 Consumption and trade in forest products

The results on firewood consumption and selling (Table 9) indicate lower consumption quantities in M'deka compared to the other sites. However, the quantities sold are substantially higher in M'deka reflecting increased firewood sales. This could stem from the increased demand for firewood and charcoal in M'deka to supply the city of Blantyre. Also the woodlands in M'deka have for a long time been under free access as there was no regulation from the government. This could probably explain why the site is more depleted in terms of wood resources as compared to Dzalanyama and Chimaliro which are gazetted forest reserves regulated heavily by the government. For Dzalanyama[6] and Chimaliro, the potential for depletion of the woodland resources is also high as a result of the escalating demand in the nearby Lilongwe city and Kasungu towns, respectively.

Table 9. Firewood consumption and sales (m^3/household)

Activity	Mdeka		Chimaliro		Dzalanyama	
	Dry	Wet	Dry	Wet	Dry	Wet
Consumption	2.80	3.72	5.48	3.62	4.39	3.29
Selling	5.40	0.80	0.00	1.20	0.00	0.18

The selling of firewood by individual households features relatively low in Dzalanyama and Chimaliro. Firewood collection and selling is quite low in these areas i.e. on average about 4 to 6 cubic meters of wood are used for household energy needs per household per year. Between 1 and 2 cubic meters of wood are also extracted and sold to other households in the semi-urban areas per household per year. The wood used in the dry season, whether for household consumption or sale, is consistently lower than that used in the wet season in all the sites[7].

In general the results based on the slack[8]/surplus and the shadow prices[9] indicate that to a large extent, most of the constraints have been satisfied. The results are also consistent with the ranges of the coefficients on the right hand side of the constraint equations presented in Annex 1.

It may not be the case however that Malawi, in general, has excess capacity in resources to satisfy all the constraints in the model. Malawi is already at the edge in terms of resource endowment. The national average land holding size is 0.8 hectares and over 55% of the households have less than 1 hectare of land. Labour is also a constraint particularly for most crops other than maize and tobacco. However, other studies also argue that labour is not a constraint given that most people are willing to sell their labour even at wage rates far below the market rate (Zeller *et al*. 1996).

The argument that labour could be in surplus may be plausible given that agriculture is seasonal. Therefore, any slack labour has potential for employment in other off-season activities that could not be identified in the model like grazing, gardening, social work and even leisure.

5. SENSITIVITY ANALYSIS/POLICY EXPERIMENTS

A number of sensitivity analyses have been performed in order to find out the potential impact of both the endogenous and exogenous shocks as a result of policy changes within and outside the forestry sector. This is done to demonstrate the capacity of MIOMBOGP in creating alternative development scenarios based on changes in selected policy levers or instruments. In this way, the MIOMBOGP could be used as a planning tool by decision makers in demonstrating the potential impact of various decisions and policies and selecting the strategy that produces the most favourable outcome. It must be pointed out that the outcomes of the sensitivity analysis are dependent on the underlying assumptions in constructing the MIOMBOGP and the quality of the data used in generating the baseline results on which the analysis is based.

These analyses have been made in the context of the policy environment in Malawi. The country has been implementing economic reforms as a result of the adoption of the Structural Adjustment Program (SAP)[10] since the early 1980s. Due to the inter-linkage between the agricultural and forestry sectors, most of the policy reforms that have been implemented in the agricultural sector could have impacted the forestry sector. Also the policies that have been implemented in the forestry sector could have had some impact on the agricultural sector. As such most of the sensitivity analysis revolve around the agricultural or forestry policies.

The selected sensitivity analyses performed are presented in Table 10. Of particular importance within the forest sector, is gauging or evaluating the potential impact on the sector arising from fluctuations in the price of agricultural commodities for example due to weather or policies that influence crop production and markets. Also of interest to the forest sector is the potential impact on the sector due to changes in agricultural

crop yields that could result from policies that influence agricultural technologies like use of improved seeds, pesticides and fertilizers or even mechanisation.

We also examined the potential impact of changes in household labour. Apart from land, labour is the only other resource the communities have, and in abundance. We note that household labour is mobile, with the youth emigrating from rural to urban areas in search of employment. Further, strict observation of labour laws would constrain availability of child labour, which is common in rural areas. Also diseases like HIV/AIDS and malaria constrain availability of labour (and other resources) by diverting healthy members of the household to attending the sick and funerals, as well as by making less or none of the labour of those affected by these diseases because of associated morbidity and eventual death.

Table 10. Description of the sensitivity analyses

Simulation No.	Scenario	Changes made to basic model
1	Increase in prices of major inputs and crop output	25% and 75% increase in seed and fertilizer prices; output price
2	Increase/decrease in yield of major crops	25% and 75% increase / decrease in yield of maize and tobacco
3	Changes in household labour supply	i) M, F, C labour and ability to hire ii) M, F, C labour and inability to hire iii) FHH, no male labour iv) No female labour v) No child labour
4	Increase/decrease in price of firewood	50% increase/decrease in price of firewood

Note: M= male; F= female; C= child; FHH= female headed household.

With respect to forest sector policies consideration was also given to policies that aim at arresting or curbing deforestation, for example through increases in prices of woodland products.

5.1 Potential impact of changes in crop input and output prices

(a) Changes in crop input prices

When crop input prices are increased by 25%, there is a less than 25% contraction in cropland hectarage, especially for tobacco, while for crops like maize, groundnuts and beans, the levels of production do not seem to respond to the increase in input prices. Being the main food security crops, this should not be very surprising since the households primarily devote their resources to the production of food crops and would therefore cut down on the production of non-food crops such as tobacco, when faced with escalating input prices. The model response would imply that food crops are fairly inelastic to changes in input prices most probably due to the risk-averse behaviour of smallholder farmers in the study sites and perhaps Malawi in general.

On the other hand, when crop input prices are reduced by 25%, there is a corresponding increase in production levels of all crops, especially for tobacco. However, as in the previous case the firewood consumption levels remain the same in all sites.

(b) Changes in crop output prices

When the selling price of maize and tobacco is increased by 25%, there is a corresponding marginal increase in consumption requirements especially for maize in the wet season. While it would be expected that an increase in price would reduce the demand for that commodity, it should be noted that at community level the extent to which this could conform depends on whether the people are net food buyers or sellers. Where communities are net food buyers, an increase in the farm-gate prices would mean an increase in the market prices for the same and this could reduce their demand for the same commodities. However, in the case of net food sellers, an increase in prices of cash crops and food commodities would act as an incentive for them to increase production and therefore income. This could increase their share of consumption since they have additional income for more food purchases. This scenario would apply to Dzalanyama which lies within the country's food basket.

The impact of an increase in the output prices was also reflected in the amount of crop that people were willing to sell. It was noted that when the selling price for all the crops was increased by 25%, the sales of maize, beans and groundnuts were realized while in the base run they were virtually zero. Higher output prices could provide an incentive to sell.

5.2 Potential impact of changes in the yield of major crops

(a) Potential impacts due to increase in yield

(i) On cropland

The land allocated to the various crops increased with a yield increase by 25%. As shown in the Table 11a, compared to the base the land allocated to maize, groundnuts, bean intercrop and tobacco increases consistently in all sites.

Table 11a. Impact of a 25% yield increase on maize and tobacco production

Site	Base(ha)	PRMZGN(ha)	% change	Base(ha)	PRTOB(ha)	% change
Dzalanyama	0.91	0.96	5.3	0.27	0.29	7.4
Chimaliro	0.76	0.84	10.5	0.2	0.25	25.0
Mdeka	0.35	0.42	20.0	0.09	0.13	44.4

However, households in Mdeka are more constrained with land (Table 2), their response to yield improvement in terms of cropland expansion is very modest even when yield increases were set at 75% (Table 11b). However, households in the other two sites put more land under crops with increased yields.

Table 11b. Impact of a 75% yield increase on maize and tobacco production

Site	Base(ha)	PRMZGN(ha)	% change	Base(ha)	PRTOB(ha)	% change
Dzalanyama	0.91	0.98	7.7	0.27	0.31	14.8
Chimaliro	0.76	0.87	14.5	0.2	0.28	40.0
Mdeka	0.35	0.44	25.7	0.09	0.14	55.6

With yield increases as low as 25% all land in Mdeka is put under crops while a small portion remains for Dzalanyama and Chimaliro, even with a 75% crop yield improvement. In all sites farmers do not cut down on the area under food crops, but allow a faster growth of the area under cash crops (tobacco in this case) so as to increase incomes. Rural incomes are low and most of the households live below the poverty line, so any incentive to increase their income would be welcome.

It would therefore appear that households in Mdeka would probably encroach on more land (or the woodlands), if it were available, to take advantage of crop yield increases, while those in Dzalanyama and Chimaliro do not appear to have exhausted their arable land and therefore do not pose immediate pressure on the surrounding woodlands.

(ii) On firewood demand

A 75% increase in yield of maize and tobacco could result into a relatively high response in terms of the decline in firewood extracted in both dry (D) and wet (W) seasons from the woodlands in all areas (Table 12).

Table 12. Impact of 75% increase in yield on firewood demand

Site	Base (m^3 per household)	CSFWD (m^3 per household)	% change	Base (m^3 per household)	CSFWW (m^3 per household)	% change
Dzalanyama	4.39	3.95	-10.0	3.29	3.04	-7.6
Chimaliro	5.48	4.45	-18.8	3.62	3.14	-13.3
Mdeka	2.8	1.95	-30.4	3.72	3.15	-15.3

However, proportionate declines are high for Mdeka and Chimaliro compared to Dzalanyama. The former two sites are more constrained by land and forest resources than Dzalanyama and would logically be more sensitive and responsive to policies that target these two natural resources. In fact the quantities of firewood demanded for sale would still remain high in Michiru even with a substantial increase in crop yield. This means that while there are indications that increases in agricultural yields have potential to relieve the pressure on the woodlands, for woodland rich areas like Dzalanyama the effect is unlikely to be great because households have the woodlands in relative abundance making the benefit from increased crop yield unlikely to change their firewood collection habits especially when markets for such products are small and firewood collection is mainly for household consumption.

(b) Potential impact of a decline in crop yield

(i) On cropland

A decrease in crop yield has potential to reduce the area put under crops (Table 13). The decrease in crop yield could be due to drought, low output prices and/or use of inadequate inputs like fertilizers.

Table13. Impact of 25% decrease in yield on production of maize and tobacco

Site	Base(ha)	PRMZGN(ha)	% change	Base(ha)	PRTOB(ha)	% change
Dzalanyama	0.91	0.84	-7.7	0.27	0.23	-14.8
Chimaliro	0.76	0.65	-14.5	0.2	0.18	-10.0
Mdeka	0.35	0.27	-22.9	0.09	0.04	-55.6

From Table 13 we see that the response to modest decline in crop yields is stronger in Mdeka and Chimaliro, areas more constrained by land than Dzalanyama. However, for Mdeka and Dzalanyama the reduction in cropland is relatively higher for tobacco, the cash crop, than for the food crops.

A 75% decrease in yield has a correspondingly substantial impact on the area allocated to the two crops. In all areas there is a substantial shift (up to 40%) of land to maize, since the decrease in land planted with tobacco is more than that of maize. As a food security precaution, risk-averse farmers would want to increase the amount of land under maize in order to offset the decline in yield.

(ii) On firewood sales

The loss of income from reduced crop area appears to be compensated by relatively higher increases in firewood sales and especially from Mdeka and Dzalanyama that made relatively big cuts on cash cropland (Table 14). These trends are even more pronounced when crop yields decline by 75%.

Table 14. Impact of 25% decrease in yield on firewood sales.

	Base (m^3 per household)	SGFWD (m^3 per household)	% change	Base (m^3 per household)	SGFWW (m^3 per household)	% change
Dzalanyama	0	1.2	-	0.18	0.52	188.9
Chimaliro	0	1.43	-	1.2	1.80	50.0
Mdeka	0.8	1.1	37.5	0.8	1.40	75.0

Firewood is one main sources of income for the households living close to the forest reserves, therefore changes in the yield of the key agricultural crops would influence the amount of firewood that could be extracted for sale. This is because in the absence of adequate income from agricultural production, households would most probably resort to forest income for their needs. It would appear that the impact would be more pronounced in the wet (W) season as compared to the dry (D) season when the crops would still be in the field and probably with insignificant or no crop storages from the dry season.

5.3 Potential impact of changes in household labour supply

(a) On crop production and trade

Rural households have two main resources, land and their own labour. The latter is increasingly constrained by education as children go to school (making child labour less available), the youth emigrate to urban areas in search of jobs, and diseases like malaria and HIV/AIDS. Such diseases constrain labour availability through sickness and/or death, and for the healthy through attending the sick and funerals. They also affect the allocation of household resources. All this potentially impact on the attainment of household goals.

For example, when there is no adult male labour in the household and it is not possible to hire such labour the results indicate a substantial cut in the production of tobacco while the production of the food crops increases moderately (Table 15). Women provide most of the labour for growing tobacco, however they mainly do that with the male counterparts. Tobacco marketing is an activity that is mainly in the domain of men and when adult male labour is absent in the household sales decline significantly in all sites (Table 16).

However lack of adult female labour in the household and with no possibility of hiring such labour not only affects production for tobacco, but also that of all the food crops. Mkandawire *et al.* (1990) and Diagne *et al.* (1995) report that women contribute over 70% of the labour in agricultural production in Malawi making female labour critical in agriculture.

Table 15. Impact of lack of adult male labour on crop production

Site	Base(ha)	PRMZGN(ha)	% change	Base(ha)	PRTOB(ha)	% change
Dzalanyama	0.91	1.04	14.3	0.27	0.14	-48.1
Chimaliro	0.76	0.85	11.8	0.20	0.12	-40.0
Mdeka	0.35	0.38	8.6	0.09	0.04	-55.6

Further, as shown in Tables 15 and 16, absence of adult male labour makes the family to increase production of food crops in all three sites. Trade in food crops also increases, except in Mdeka.

We experimented with making 30%, 50% and 70% of male and female adult labour available, a constraint that could be due to sicknesses, attending the sick, funerals, and/or occasional migration to the urban areas. In the case of crop production the tobacco area was reduced slightly (by less than 10%) when only 30% adult male labour was made available. However the reduction was substantial (by over 30%) when only 30% of adult female labour was made available. The reduction in crop production increased with decreased labour availability, but was more affected by constraint on adult female labour availability. This reinforces the observation by Mkandawire *et al.* (1990) that most of the rural farming is done by women.

However, the implications of labour constraints on attaining household goals and improving household welfare in general are very serious because the HIV/AIDS scourge

Table 16. Impact of lack of male labour on firewood collection

Site	Base (m^3 per household)	CSFWD (m^3 per household)	% change	Base (m^3 per household)	CSFWW (m^3 per household)	% change
Dzalanyama	4.39	4.41	0.5	3.29	3.31	0.6
Chimaliro	5.48	5.49	0.2	3.62	3.64	0.6
Mdeka	2.8	3.2	14.3	3.72	3.78	1.6

tends to reduce female labour supply more than that of males because women appear to be more infected than men and that women are the traditional caretakers of the sick.

(b) On firewood consumption and sale

Changes in either adult male or female labour supply do not appear to significantly affect consumption of firewood in both wet and dry seasons (Table 17). This is mostly due to the way firewood is used in the household, the same quantity is used for cooking meals when the full family is there or one or two members are missing. Further, children also participate extensively in firewood collection, cushioning the family from firewood shortages in case the mother is sick or absent. Therefore when there are fluctuations in the supply of household labour members of the households adjust their activities in ways that minimize adverse impact on firewood collection.

Table 17. Impact of lack of adult male labour on crop sales

Site	Base(kg)	SGTOB(kg)	% change	Base(kg)	SGBND(kg)	% change
Dzalanyama	181.96	39.54	-78.3	52.2	63.20	21.1
Chimaliro	185.89	45.67	-75.4	49.5	56.70	14.5
Mdeka	125.68	25.43	-79.8	0	0.00	0.0

However, when adult household labour is absent, the results indicate an increase in the amount of firewood that is extracted and sold. This is probably because absence of an adult male reduces household incomes and this compels the other members of the household to collect more firewood for sale in order to compensate for the income loss that arises primarily from reduced tobacco production and sale. This was noted to be more pronounced in the wet season with sales potentially increasing by 50%, 17% and 13% in Mdeka, Dzalanyama and Chimaliro respectively. Also households could increase production and sale of food crops.

When there is completely no adult labour in the household an infeasible solution is obtained. This is an indication of the total collapse of the activities of the household as defined in this model. When adult household labour availability is constrained to 30%, 50% and 70% due to reasons explained earlier, the results indicate a slight reduction on firewood collected for consumption if only 30% of the adult female labour were made available. A reduction in firewood sales begun if the adult male labour available

dropped to below 70%. This could be attributed to the fact that firewood collection for domestic use is dominated by females while collection for sale is mainly done by males.

5.4 Potential impact of changes in price of firewood

(a) On firewood demand/consumption

It is often argued that one way for containing deforestation is to increase prices of forest products. In government-controlled forests, like the forest reserves in these three study sites, the prices can be regulated administratively as a way to implement a sectoral policy or strategy of this nature. This strategy was tested and the results (Table 18) indicate that there is a potential increase in the demand for firewood for sale when there is an increase in its price.

Table 18. Impact of change in the price of firewood on its demand

Site	Base (m^3 per household)	CSFWD (m^3 per household)	% change	Base (m^3 per household)	CSFWW (m^3 per household)	% change
Dzalanyama	0.0	1.4	-	0.18	0.48	166.7
Chimaliro	0.0	1.6	-	1.20	1.56	30.0
Mdeka	0.8	1.5	87.5	0.80	1.7	112.5

The result was expected because in open access forests the price signals an incentive for people to extract more firewood for the market. However, the response to price increase only starts when the increase is at least 50% of the prevailing price. This indicates that firewood demand and the requirement for land for forestry is less responsive to the changes in the prices of firewood. Actually when firewood price increases, the households that used to buy the commodity from others resort to own collection from the forests.

(b) On cropland area

For Dzalanyama and Chimaliro, increasing the price of firewood by 50% has potential to marginally reduce cropland area, as farmers decide to engage most of their labour in the more lucrative business of collection and selling firewood (Table 18). The impact appears to be high for Mdeka, where most households have traditionally relied on firewood sales for their livelihood.

Table 18. A 50% increase in firewood price: changes in cropland

Site	Base(ha)	PRMZGN(ha)	% change	Base(ha)	PRTOB(ha)	% change
Dzalanyama	0.91	0.9	-1.1	0.27	0.26	-3.7
Chimaliro	0.76	0.76	0.0	0.2	0.19	-5.0
Mdeka	0.35	0.32	-8.6	0.09	0.06	-33.3

On the other hand a 50% reduction in the price of firewood could slightly increase the scale of production, especially tobacco (Table 19). Again, this could be attributed to shifts in labour away from firewood collection and trade to tobacco production.

Table 19. A 50% decrease in firewood price: changes in cropland

Site	Base(ha)	PRMZGN(ha)	% change	Base(ha)	PRTOB(ha)	% change
Dzalanyama	0.91	0.91	0.0	0.27	0.28	3.7
Chimaliro	0.76	0.76	0.0	0.2	0.22	10.0
Mdeka	0.35	0.36	2.9	0.09	0.09	0.0

It should be noted that the magnitude of the changes would strongly depend on the relative prices in the agricultural sector. Thus, these results would only be plausible if we assume no change in agricultural input and output prices. Most households in these sites depend on both agricultural and woodland products not as substitutes but mainly as complementary products. There is a narrow range in which they can be substitutes, and this is especially in relation to excess that is marketed. Consequently the demand for firewood for sale is less responsive to some agricultural and forestry policies. The type and extent of the response would largely depend on whether a community is a net buyer or seller of firewood as well as the relative prices of the different products.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

The impact of the agricultural policy scenarios expressed through changes in output and input prices and technological improvements are manifested in increases in food consumption and selling requirements. Given that food security is the primary goal, it is unlikely that there could be any marked response in terms of required consumption levels. However, as shown in the sensitivity analyses, there is a marked impact on the levels of requirements for selling as a result of an increase in the output prices and yield improvements. The increase in production is reflected in the surplus commodities especially, maize and groundnuts which increase the storage requirements thereby necessitating the need to sell the surplus.

Increases in agricultural output through yield improvements could have substantial impact on crop production levels when the yield increases are in excess of 50%.

Firewood consumption and selling requirements increase as a result of the increase in firewood prices, more especially when the price increases are over 50%. This can only be the case in communities where people are net firewood sellers. Also it largely depends on the relative increase in the prices of firewood compared to agricultural prices. Otherwise communities that are net buyers of firewood would respond negatively to increases in prices of firewood. From the study, it would appear that the demand elasticity of the communities to firewood prices is very inelastic, implying that a marked response can only be triggered with very high increases in firewood prices.

The increase in output prices and yield improvements have potential to reduce cropland and therefore alleviate pressure on the woodlands. In so far as there is no increase in agricultural land requirements, which could trigger encroachment into forests,

the results seem to support the hypothesis that incentives in agriculture, be they price or technology related, tend to reduce the likelihood of deforestation by shifting the pressure and dependence away from the forests to the more lucrative agricultural production.

These findings serve to highlight the type of policy responses that need to be critically examined in the light of their impact on the resources. The results from this research indicate that the main factors that seem to impact on resource use decisions include: prices of agricultural commodities, technological changes in agriculture, labour supply changes and prices of firewood and other energy sources.

Given the ever-existing conflict and complimentarity between agriculture and forestry in supporting human existence, the harmonization of these policies requires sound scientific knowledge. This modeling exercise has the potential of providing such knowledge which is very important in decisions management, use and conservation of the resources.

There are still a number of fundamental policies that need to be critically examined further. For example, there is need to assess the impact of the increases in the prices of alternative energy sources. In Malawi, the notable case would be the impact of the rapidly increasing prices of paraffin and electricity, considering that these are the major alternative sources of energy in the rural and urban sector, respectively. The impact of some forestry policies that encourage the development of alternative and more efficient energy technologies are examples of typical instruments whose impacts need to be examined as well.

Despite its potential robustness given the availability and reliability of the data, the MIOMBOGP has only one major weaknesses in that as a static model, it does not account for the dynamism that characterize resources use in the ideal world. However, it might be possible to project the values of the various variables into the future and run the model to correspond to those future points thus allowing for a possibility of tracing the changes in the variables of interest over time.

ENDNOTES

1. Both a household survey and a Participatory Rural Appraisal (PRA) exercise were undertaken in each of the sites namely Dzalanyama and Chimaliro in the central region and Mdeka in the Southern region. The PRAs provided some socio-economic description of the three sites and a separate PRA report was compiled.

2. Detailed description of the basics of the goal programming model including examples of relevant applications can be found in, but not limited to, Nhantumbo and Kowero (2001), Romero (1991), Romero and Rehman (1989), Rehman and Romero (1993), Mendoza and Sprouse (1989) Hazell and Norton (1986), Day (1963), McCarl (1992) and Yoon and Hwang (1995).

3. In terms of the constraint equations in the Malawi models, the actual data on the constraints is presented in Annex 1 (1A - 1D).

4. In reality farmers harvest and sell, and seldom store large enough quantities for long periods of time. They then buy the same products in small quantities from local markets on a regular basis especially during the post harvest season. It is therefore possible to have storages of small or insignificant quantities on a weekly or monthly basis and not for the whole season.

5. The assumed calving rate net of mortality for cattle is 45%, kidding rate for goats net of mortality is 300%, breeding rate for cows and goats are 40% and 75% respectively. A cattle unit is estimated at 450kg live-weight while that for goats is estimated at 50 kg live-weight.

6. It should be noted that while the forests are still relatively thick in Dzalanyama, mostly due to the fact that these areas are protected areas, the rate at which people are harvesting wood for various uses is quite high. In the long run, these areas could be degraded as is the case with

Mdeka. This could among other factors be exacerbated by increased resettlement of people in this area and expansion of agricultural estates that surround these areas. The increasing demand for wood resources in the urban areas, as result of the increase in the prices of conventional energy providing petroleum products, could trigger increased exploitation of the resource by both long term residents and new settlers. This is an area that needs to be given adequate attention by government, in view of balancing the community needs for energy and household income and the need to conserve the forests.

7. It is logical that firewood demand should be higher in the wet season because of the increasing uses compared to the dry season. In most areas, firewood is also used for heating during the lower temperatures experienced in the wet season. Another reason could be that the efficiency of wood is higher in the dry than wet season due to the high humidity levels in the wood during the wet season.

8. Slack variable refers to a variable that accounts for any unused, or idle amounts of a resource (Forgionne 1981).

9. Shadow price refers to the change in the objective value that results from a marginal (one-unit) change in the amount of a constraint (i.e. the value on the right hand side).

10. The Malawi government with financial and technical support from the World Bank and the International Monetary Fund (IMF) embarked on SAPs in 1981 in order to address both domestic and external economic imbalances. Following the economic crises that Malawi experienced in the late 1970s resulting from external shocks such as rising interest rates and fuel prices, droughts, regional political instability and deteriorating terms of trade, the government resorted to adopting the SAPs whose primary objectives included: (i) economic stabilization (ii) accelerating agricultural growth, (iii) diversifying the export base, (iv) increasing the efficiency of import substituting enterprises and parastatals, and (v) improving the mobilization and management of public resources.

The major goal of the SAPs were to provide incentives for stimulating production of tradable goods, for rationalizing government tax base and expenditure and for strengthening key sectors and institutions. So far more than seven Structural Adjustment Loan facilities have been adopted. i.e. SAL I (1981); SAL II (1984); SAL III (1986); ITPAC (1988); ASAC (1990); ASAP (1991); etc.

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ANNEX 1. TABLES OF SOME DATA FOR BUILDING THE MALAWI MODEL

1a. Average land holding (ha) by site

Crop	Dzalanyama	Chimaliro	Mdeka
Maize, beans, groundnuts intercrop	0.91	0.72	0.35
Tobacco	0.53	0.53	0.20
Average land holding	1.44	1.25	0.55

1b. Land distribution by site (%)

Land area (ha)	Dzalanyama	Chimaliro	Mdeka
< 0.5	13.9	8.0	32.0
0.5 – 1.0	31.8	37.0	38.0
>1.0 – 2.0	36.1	35.0	19.0
> 2.0	18.2	20.0	11.0

1c. Total man-days per site per season.

Category	Mdeka	Dzalanyama	Chimaliro
Adult males	1983.00	1872.00	1003.00
Adult females	356.00	744.00	459.00
Children	42.00	86.00	103.00
Total	2381.00	2702	1565

1d. Average number of livestock kept by household

	Mdeka	Chimaliro	Dzalanyama
Cattle	1.1	3.2	3.6
Goats	2.5	6.6	3.9
Chicken	15.7	8.5	9.8
Pigs	-	7.7	4.6
Ducks	6.3	4.1	3.6
Pigeons	5.1	9.1	6.0

ANNEX 2. VARIABLE DEFINITIONS AND UNITS OF MEASUREMENT

The definitions, activities and units of measurement of the variables that are presented in this report:

Variable	Unit of measurement	Definition/Activity
PRMZBNGN	Kg per hectare	Production of maize, beans and groundnuts in an intercrop
CSMZD	Kilograms	Consumption of maize in the dry season
CSMZW	Kilograms	Consumption of maize in the wet season
MZSD	Kilograms per hectare	Maize seed rate
CSBND	Kilograms	Consumption of beans in the dry season
BGBNW	Kilograms	Buying of beans in the wet season
BNSD	Kilograms per hectare	Bean seed rate
STGND	Kilograms	Storage of groundnuts in the dry season
CSGND	Kilograms	Consumption of groundnuts in the dry season
CSGNW	Kilograms	Consumption of groundnuts in the wet season
BGGNW	Kilograms	Buying of groundnuts in the wet season
GNSD	Kilograms per hectare	Groundnut seed rate
CSFWD	Cubic meters	Consumption of firewood in the dry season
CSFWW	Cubic meters	Consumption of firewood in the wet season
SGFWD	Cubic meters	Selling of firewood in the dry season
SGFWW	Cubic meters	Selling of firewood in the wet season
CSMSHW	Kilograms	Consumption of mushroom in the wet season
CASG	Number of herds	Selling of cattle
GTSG	Number of herds	Selling of goats
GRAZ	Hectares	Grazing area for livestock
CSBFD	Kilograms	Consumption of beef in the dry season
BGBFD	Kilograms	Buying of beef in the dry season
CSBFW	Kilograms	Consumption of beef in the wet season
CSGTD	Kilograms	Consumption of goat meat in the dry season
BGGTD	Kilograms	Buying of goat meat in the dry season
CSGTW	Kilograms	Consumption of goat meat in the wet season
BGGTW	Kilograms	Buying of goat meat in the wet season
FORES	Hectares	Forest area per household

19.

Linear and goal programming models for analysis of policy impacts on livelihoods in miombo woodlands of Mozambique

I. Nhantumbo, G. Mlay and G. Kowero

ABSTRACT

An analysis of potential impacts of selected sectoral and extra sectoral policies on miombo woodlands was conducted in the Mozambican districts of Dondo, Nhamatanda and Gondola-Manica. A Weighted Goal Programming model was developed that took into consideration household goals in the context of a set of activities and resources constraints on land, labour, food production, access to forest resources and others. Policy experiments were carried out through sensitivity analysis.

Results indicated that harvesting forest products was the main off-farm source of income and employment for the household. The non-availability of adult male or female labour in the household, due to sicknesses like those from HIV/AIDS, emigration or other reasons is catastrophic to the household. This also emphasizes the need to consider the HIV/AIDS pandemic in all rural socio-economic plans.

Further, moderate decrease in crop yield seriously constrained the achievement of household goals, indicating that these households could be very vulnerable to factors that reduce crop yield like drought, floods, pests and high prices of agricultural inputs; and with adverse consequences on conservation of the woodlands. Therefore, the solutions to problems such as deforestation do not rest within the forestry sector alone; rather, an integrated rural development planning holds more promise.

Key words: Policy impact, linear programming, goal programming, miombo woodlands, rural development, Mozambique.

1. INTRODUCTION

Miombo woodland is one of the most extensive dry forest vegetation types in Africa, occurring in seven countries in eastern, central and southern Africa; namely Angola, Malawi, Mozambique, Tanzania, Democratic Republic of Congo, Zambia and Zimbabwe

(White 1983). The woodlands are dominated by the legume family Caesalpiniaceae with the most important tree species being those of *Brachystygia sp.*, either alone or in association with *Julbernardia sp.*, and *Isoberlinia sp.* (Celander 1983; Lind and Morrison, 1974; White 1983).

Although no proper surveys have been carried out to determine the number of people who depend on the miombo woodlands, estimates as high as 100 million people have been made while others put direct and indirect support at 40 and 15 million respectively, in the rural and urban areas (Campbell, *et al*. 1996). Sustainable use of miombo woodlands can offer a long-term perspective for the direct and indirect users. However, current unsustainable agricultural practices such as use of fire for land clearing, inadequate fallow systems, overgrazing, and intensive harvesting of wood for firewood and construction material threaten the increasingly scarce resources. These activities are rapidly diminishing the environmental significance and ecological diversity of the miombo ecosystem. The economic consequences are obvious as the miombo woodlands are a source of food security, employment and income from the sale of wood and non-wood forest products.

In Mozambique there are three forest categories: protected, productive and multiple use areas. Most of the miombo woodlands fall under the latter category. In the first two categories, the primary managers are respectively the state and the private sector. On the other hand, in the multiple use areas, there is competition over resource between the communities that depend on this resource for their livelihood and a large number of small scale private sector operators that have simple licenses for harvesting wood products. Furthermore, there is high competition for different land uses such as relatively large-scale agriculture for cotton, sunflower, and cashew, as well as industrial roundwood harvesting.

The communities are the main producers of cash crops as well as being largely responsible for harvesting wood and non-wood products. However, they are less advantaged in terms of gains from these activities due to their low bargaining power with middlemen and final users of these products.

The relative importance of the miombo woodlands attracts many stakeholders. The government raises revenues from those harvesting products, besides its interest in conserving the woodlands. The private sector is interested in the woodlands for commercial products that they extract. Communities living inside and bordering the woodlands are interested in deriving their livelihoods. The woodlands are important to them as they provide self-employment as well as being sources of income, goods and services.

In Mozambique there exist resource-use conflicts among the different land uses and users of the miombo woodlands. Land use policies and practices have failed with respect to sustainable use and management of the woodlands. If these conflicts are not addressed immediately, they are likely to escalate, and in turn accelerate encroachment and degradation of the woodlands. The consequence of this will be food insecurity, environmental instability, and deterioration of the livelihood opportunities of miombo inhabitants.

The study reported in this paper was a modest attempt to contribute to the on-going debate on sustainable economic development of rural communities in developing countries, basing its case on the compatibility of environmental concerns with farmers' preferences in selected villages in the districts of Dondo, Nhamatanda, Gondola and Manica in Mozambique.

The study was undertaken from 1998 to 2002 and makes use of Weighted Goal Programming (WGP). A modeling framework was constructed where both technical and socio-economic goals were incorporated in order to deal with food security, forest product supplies and household incomes within an integrated land use context. In this way, the study analysed the compatibility of demands by various stakeholders on the woodlands with household goals on one hand and rural development goals on the other.

The paper is organized as follows: section 2 presents the background to the analytical tools; section 3 presents the main characteristics of the study sites and the typical household used for the analysis of the various policy scenarios; section 4 analyzes the main features of the analytical tool used in this study; section 5 summarizes the main WGP results including the impact on the household of a set of policy experiments. Finally, section 6 highlights the main findings and recommendations.

2. MULTIPLE CRITERIA DECISION MAKING TOOLS

One of the challenges in managing miombo woodlands is the sustainability of the various interventions both at the policy level and at land use sphere influenced by daily decisions made by the users. The decision environment appears to be mainly influenced by socio-economic factors and less so by environmental concerns or even efficiency in natural resource use.

The natural resources value is determined mostly by labour invested for their extraction. Royalties paid to the government still undervalue the resources and this contributes to making the selling price of various forest products very low. Therefore, it would be useful to develop analytical tools which can help explain the potential impacts of short-term goals vis-à-vis sustainable development.

Hermanides and Nijkamp (1998) present three building blocks for measuring and judging sustainability: indicators, normative reference values, and impact assessment methodology. These authors define indicators as numerical representations of observed and measurable phenomena. The normative reference values or critical threshold values are defined on the basis of the concept of “Environmental Utilization Space”, i.e., the safe maximum and minimum levels that the ecosystem can absorb without being damaged. Examples of the normative reference values are enforcement of the allowable cut when harvesting wood products, and the frequency of fires which have positive impact on the generation of the ecosystem and its growth. Finally, impact assessment is done through ad hoc or structured methods. The latter includes quantitative techniques such as econometric or statistical models that seek to establish in a methodical form the effects of policy measures on pertinent policy variables. This is done by providing an objective set of criteria for analyzing the impact of policy on the farm household organization as well as on the miombo ecosystem. This is the approach pursued in this paper.

As explained earlier, the primary land uses, users of miombo woodlands, and conflicts of goals and priorities are endogenous to the decision environment. There are several approaches to reconcile conflicting demands on resources. Multicriteria decision analysis seeks compromise solutions for the various goals, hence it has potential application in the context of the miombo woodlands problem.

As indicated in Nhantumbo *et al.* (1997), Rehman and Romero (1993) define Goal Programming (GP) as one of the Multiple Criteria Decision Making (MCDM) tools that is based on the geometric definition of ‘best’ that is regarded as a model which

operationalizes the Simonian approach of 'satisfaction' to the fulfillment of the decision makers' objectives. GP has two variants: Lexicographic Goal Programming (LGP) which is based on pre-emptive ordering of goals and priorities by the decision maker, and Weighted Goal Programming (WGP), based on a simultaneous consideration of goals and minimization of the sum of weighted undesired deviations from the targets. The sequential consideration of goals in lexicographic goal programming provides a high probability of the last goals becoming redundant. In this paper, WGP was chosen so that the goals of the different stakeholders could be considered jointly, thus avoiding giving preference to one goal to the detriment of the other.

However, WGP requires a large amount of data from the decision makers, and in this case mainly the households. Such data is used for determining the objectives, targets, weights, and priorities, in addition to estimating the technical coefficients of the decision variables. This is a particularly important limitation in developing countries where planning in subsistence farming is made difficult by lack of farm records and where lack of co-ordination between agriculture and forestry is likely to reduce the reliability of information provided by the decision makers. However, Rehman and Romero (1993) argue that WGP can be applied under such situations because sensitivity analysis can be used to generate information and reduce the amount of data needed from the decision maker. In fact, the method has been applied in Mozambique looking at impact of social forestry in a regional model (Nhantumbo *et al.* 2001).

The WGP model serves as a tool for enhancing planning by providing for the possibility to evaluate various options or scenarios through sensitivity analysis of variables of choice. This is the main thrust of developing these models in the three districts of central Mozambique: to provide alternative means for rural development planning.

3. SOCIO-ECONOMIC CHARACTERISTICS OF THE STUDY SITES

The study sites include the two central provinces of Manica and Sofala selected due to their richness in both the miombo woodlands, and the productive forests and protected areas. In addition, both are along the development corridor (Beira) creating opportunities for development as well as threats since the market for forest products (especially in the towns of Beira and Chimoio) is likely to increase. Further, Beira town is the second largest market for wood for energy and light construction. Manica is a supplier to this market even though at a relatively small scale. Chimoio however, just like any other town in Mozambique, consumes large amounts of firewood. This results from the low purchasing power of alternative sources of energy such as gas and electricity.

The major difference between the two provinces lies in the type of transportation means employed. In Manica there is predominance of use of bicycles. In Sofala, on the other hand, middlemen in the market channel use lorries, and appear to benefit more as demonstrated by a survey done during the study.

3.1 Nature of the households used in the modeling exercise

The household characteristics provide the context under which the results presented in the next section should be understood and discussed.

Table 1. Characteristics of the household

	Size of family		No. of years in the area	Years of education	Dependency ratio
	Male	Female			
Dondo	3	3	6.3	2.8	0.17
Nhamatanda	3	4	5.6	2.1	0.2
Gondola-Manica	3	3	12.3	3.4	0.22

Table 1 indicates that all the three sites have approximately the same size of family and almost a gender balance, except Nhamatanda. There are more children in the household, and this increases the dependency rate as the very young do not engage in agriculture, and if they do, their contribution would be relatively small. Much as Dondo and Gondola-Manica have the same household size, the latter had a higher number of dependants. The population is relatively young and the elderly do not appear as a significant dependant group in the household.

Another important feature of the households is their relative stability in the area, and this is illustrated by the number of years that they have stayed in the study sites. The inhabitants of Manica have been in the area even before the end of the country's civil war in 1992. On the other hand, those of Dondo and Nhamatanda could have experienced the severe effects of the civil war as reflected in their fairly recent resettlement in these two areas.

The scarcity of forest resources in Nhamatanda could also be an indication that this area might have been the main source of fuelwood and construction material for Beira town, even though the population in this area was very mobile. In fact, the people who temporarily resettled largely engaged themselves in harvesting the forest as a ready source of income because agriculture was not always the best strategy during the war. This was because they risked being expelled by soldiers from the area before the crops matured. The soldiers later harvested the crops.

As is the case in practically all rural communities in Mozambique, the adult literacy rate in the study sites was observed to be very low. This could potentially influence opportunities for the socio-economic development of the households.

3.2 Land acquisition

Open access to land still dominates the mode of land acquisition in all study sites. Despite the fact that traditional leadership and local government structures are informed on the intention of opening new land, or harvesting the forest, there was no indication that this is an institutionalized practice. Clearing the forest, inheriting or even purchasing land are the main forms of acquiring land for agriculture and residence. Purchasing land is an interesting feature since the Mozambican Land Law of 1997 does not recognize the existence of land markets, however reality on the ground seems to indicate the contrary. The Land Law opens an opportunity for community land delimitation and the issuing of a land use certificate. However, it was noted during the field surveys that the inhabitants in all sites had failed to take advantage of getting certificates for their land, largely because rural communities have partially or completely not been educated on this legislation. This is compounded by the absence

of external facilitators who could assist those who are aware of the legislation to go through the required procedures for acquiring land titles.

3.3 Economic activities

Agriculture, sale of forest products, and some livestock rearing were observed as the main activities undertaken in the three sites. Charcoal was the main forest product that provided employment and income to the households. As far as agriculture is concerned, all sites produce maize and sorghum. However, rice production was only observed in Dondo, while Gondola-Manica was the only study area that produced beans. The absence of beans in the other two study sites raises concerns on the sufficiency of protein foods in the households. The cropping systems include mono-cropping (maize or rice) and mixed cropping.

3.4 The household goals

Multiobjective programming is based on the analysis of tradeoffs amongst different goals (objective plus the target) set by the decision maker, in this case the household. The interviewees in the three sites articulated the household objectives and priorities (Table 2).

Table 2. Household goals (percentage of households interviewed)

Goal	Study site			Priority
	Dondo	Nhamatanda	Gondola-Manica	
Food security	83	73	77	First
Higher income	70	71	67	Second
Environmental protection	73	93	81	Third

However, the targets had to be derived by the researchers. For example, the food security target was derived using the standard FAO nutrition requirements for people of different gender and age. This, together with the size and composition of the household, determined the minimum household nutritional requirements. The income target was determined through linear programming (LP), which allows the analysis of the farm organization and resource constraints to derive the maximum return. Finally, the environmental protection target can be interpreted in various ways, but taking into account that the main environmental concern in the area is due to forest exploitation. First, one could set the exploitation of the forest at allowable cut level. The second option would be to enforce the payment of fees or royalties to achieve some desirable level of harvest. The royalty approach was employed because it was easier to get data. In order to use the allowable cut approach one would require data on the inventory of the forest and growth rate of the various tree species, information that was not available.

In all sites, the household activities and farm organization are managed in ways that seek first to satisfy the family food requirements through allocation of resources (land and labor) to crop production. This is what one would expect from any rural household in Mozambique and elsewhere in Southern Africa.

The bigger the experience with forest resource scarcity, the more sensitive people tend to be towards conservation of the environment as a goal. The decreasing number of households stating this as a goal illustrated such behavior; being highest for Nhamatanda, less for Gondola-Manica and least in Dondo.

4. MAIN FEATURES OF THE MODEL

A generalized weighted goal programming methodology of relevance to the miombo woodlands has been developed by Nhantumbo and Kowero (2001) and the model described in this paper is developed along the same lines. Therefore this section will not dwell on the details of the definition and mathematical expression of constraints, activities, and goals. However, the matrix in Table 3 illustrates the general structure of the model, while Annex 1 presents details on one of the models employed in this study. The other models were structured in a similar way.

Table 3. Planning matrix

	Agricultural activities					Forestry activities		Labor			Sign	RHS
	P	S	B	C	S	P	S	M	F	Ch		
Objective	Minimize positive and negative deviations from the weighted goals											
Land	d											X ha
Labor	d							s	s	s	<=	0
Crop production	s	d	s	d	d						<=	0
Forestry						s	d	d	d	d	<=	0
Consumption	s							d	d	d	<=	0
Food security goal	Normalized supply							Normalized demand			=	100
Income goal	Normalized supply and demand										=	100

P=Production, S=Selling, B=Buying, C=Consumption, M=men, F=women, Ch= children, d=demand, s=supply, RHS=Right hand side.

It is important to highlight some of the decision variables, constraints, and the objective function. As mentioned earlier the household activities revolve around agriculture, forest products, and livestock. However, the latter was excluded from the model since there were no large numbers of livestock, such as goats and cattle, that could take significant labour away from other activities for grazing and that would also produce significant quantities of milk and meat for consumption or sale for cash. Therefore, the model included only activities revolving around agriculture and forest products. The decision variables for each included production, consumption, selling, buying (to supplement deficits), storing food produce from one season to the other, and labor allocation for the different activities.

The main constraints included land for the different crops and cropping systems. The yield for each crop was reconciled with the decision variables for selling and buying. The allocation of produced food (in kilograms) was tied to the energy and

protein supply by each of the crop types and the total demand for the same from the household. Another dimension was that the dietary mix as defined by the eating habits was included in the model so that not only the more nutritious products could be consumed but also the habits defined by the culture and level of wellbeing could also be reflected. Labor demand for each activity was limited by the maximum labour available and capacity for hiring it. The constraints were based on a simple principle; that is, the resource demand should not exceed the supply.

The models were run as LP and GP. In the first case, the problem aimed at maximizing the total gross margins according to the set of activities undertaken and resource constraints. This was a single maximization problem. However, as stated earlier the objective of the study was to evaluate options or opportunities for satisfying the different household goals taking into account the different priorities accorded to them (Table 2). Hence the use of WGP was an imperative. Nevertheless, the two methods were complementary in this exercise with LP employed to determine the minimum target for the income goal.

5. MODEL RESULTS

5.1 Linear programming results

Based on the data collected in 1999/2000, the maximum income that the household was likely to earn is shown in the Table 4.

Table 4. Income for the typical household (US$/year)

Site	Gross margin	Disposable income per capita
Dondo	264	44
Nhamatanda	243	40
Gondola-Manica	143	27

It is evident that the level of poverty in the study sites is very high considering that the target household incomes are lower than the average per capita GDP of US$280 for Mozambique. The household disposable incomes are even more distressing, despite the fact that they are net of food requirements since some constraints are built into the model to ensure that the household gives priority to its consumption before selling any food. Even though the per capita income is a distorted measure of distribution of wealth in the country, the reality shows that people in some parts of the country live far below the poverty line. Mozambique has 70% of its people in absolute poverty and the two provinces included in this study are among the poorest areas. The study results demonstrate the severity of poverty in the study sites. This underlines the need to correct the imbalances in resources/wealth distribution not only in the study sites but also throughout the country.

The disposable income when compared with the total land available for agriculture in the three sites (Table 5) on one hand, and the opportunity for harvesting forest resources on the other, would indicate that the forest is a potentially important source of cash for the rural family. Therefore, any restrictions in form of enforcement of allowable cut or introduction of fees is likely to take the households to lower levels of

income than the current. This would be contrary to the government policy of poverty reduction. However, the tradeoff in the medium and long term is that the economic basis for the household could be lost as a result of depletion of the natural forest resources. This is the dilemma that the policy maker will have to face in devising measures to sustain the natural forest resources while at the same time alleviating rural poverty using the same resources.

In addition, the results indicate that in Gondola-Manica the preference was for intercropping, which is good in terms of replenishment of the soil fertility through leguminous crops. However, it could in fact be responsible for the relatively low production of each of the crops compared to monocropping, making the produce primarily for consumption with little or no marketable surplus.

Table 5. Land allocation (ha) in the LP model

Crop	Study site		
	Dondo	Nhamatanda	Gondola-Manica
Maize	0.78	0.9	-
Rice	0.64	-	-
Maize & sorghum	0.58	1.7	1.64
Maize & beans	-	-	0.89
Total agricultural cropland	2	2.6	3.5
Forest area harvested	1.71	0.89	0.61

The model provides the shadow prices of key resources such as land and labour (Table 6). It is apparent from the high shadow prices that land is a limited or scarce resource in Dondo and Nhamatanda. The typical household would increase the total gross margin if it expanded the current land for agriculture marginally, i.e., by a hectare. However, this would clearly not be the best option for Gondola-Manica where agricultural intensification would perhaps be a better option for improving productivity and eventually the well being of the household.

The analysis of labor demonstrates that this is also a critical production factor, especially in Gondola-Manica where US$545 could be gained if an extra adult labor (one manday) could be brought into the household at a price of US$2 (i.e. the shadow price of labour in this site).

Table 6. Shadow price of land and labor (US$)

Site	Land (ha)	Labour (mandays)	Rise in household income by one additional adult
Dondo	102	1.11	288
Nhamatanda	93	0.83	168
Gondola-Manica	0	2	545

While land could be limiting in Dondo and Nhamatanda, labor availability would be decisive in Gondola-Manica.

The level of sales shows further evidence of the relevance of the woodlands as a source of income particularly through making and selling charcoal, with as much as 12.5 tones sold per household in Dondo in a year (Table 7). Gondola-Manica households appear to trade more in agricultural produce than those in Dondo and Nhamatanda, though the total sales revenue were meager due to the low prices of these products. Meeting food requirements was the most important objective of production. Table 7 also indicates the level of consumption necessary to meet the FAO nutritional standards.

Table 7. Crop utilization (kg/season)

Site	Crops	Selling		Buying		Consumption		Storage
		Dry	Wet	Dry	Wet	Dry	Wet	Dry to wet
Dondo	Maize	0	98	0	0	472	470	698
	Rice	0	0	0	0	151	151	186
	Sorghum	92	0	0	0	38	38	57
	Charcoal	2500	10 000					
Nhamatanda	Maize	132	0	0	692	648	653	0
	Sorghum	0	0	0	0	142	138	178
	Charcoal	2250	4750	-	-	-	-	-
Gondola- Manica	Maize	619	0	0	0	500	505	634
	Sorghum	92	0	0	0	158	154	193
	Beans	0	48	0	0	26	25	78
	Charcoal	1500	2000					

These results demonstrate what would be the main farm organization if the household were to pursue an income maximization objective. However, as stated earlier, the households are rarely driven by only one objective; they seek a compromise solution between various goals. The following section presents the results of a weighted goal programming model that harmonized the attainment of the three goals on these three sites.

5.2 Weighted Goal Programming results

5.2.1 Base run results

The Weighted Goal Programming model is based on information from the decision maker on the objectives, targets, and priorities to allow calculation of different weights and coefficients. These are then used to evaluate the farm organization and especially how the goals could be satisfied given the farm constraints and a range of activities.

Table 8. shows the comparative results of the three sites.

Table 8. Achievement of goals

Sites	N_1	P_1	N_2	P_2
Dondo	0	10.6	0	0
Nhamatanda	0	2.3	0.2	0
Manica-Gondola	0	3.15	0	0

NB: N_1 and P_1 are negative and positive deviations from the food security goal while N_2 and P_2 are the respective deviations from the income goal.

While the income goal is exactly satisfied in both Dondo and Gondola-Manica (N_2 and P_2 are both zero), in Nhamatanda this is slightly underachieved. In all the three sites there is an overachievement of the food security goal. This means that the households strive to satisfy the minimum food requirements with their production, even though income for other needs is limited. However, there is also some indication that not always the households take such precaution preferring to sell the produce during the harvesting (dry) season and purchase food in the wet season. This producer behavior is responsible for seasonal famine. Besides the need for immediate cash, it was observed that poor storage in the study sites contributes to that farmer's decision.

Table 9 shows that in looking for a compromise solution between the goals of the typical household, there is a change in allocation of land to different crops compared to the maximization situation in Table 5.

Table 9. Land allocation (ha) in the goal programming model

Crop	Study site		
	Dondo	Nhamatanda	Gondola-Manica
Maize	1.3	0.9	-
Rice	0.34	-	-
Maize & sorghum	0.36	1.7	1.64
Maize & beans	-	-	0.89
Total agricultural cropland	2	2.6	3.5
Forest area harvested	2.2	0.93	0.61

In addition, as far as utilization of crops is concerned the consumption does not vary significantly, except in the case of Nhamatanda where less maize is consumed in the wet season (result of higher level of sales in the dry season), hence the need for compensation with sorghum. This apparent stability of the solution results from the fact that restrictions on the energy and protein requirements have been incorporated in the two models.

With respect to use of forest resources the Dondo households will harvest two and three times the forest area that will be harvested by households in Nhamatanda and Gondola-Manica respectively. This will result in the production, in Dondo, of two and four times more charcoal as will be produced in Nhamatanda and Manica respectively

Table 10. Crop utilization (kg/season) for the goal programming model

Site	Crops	Selling		Buying		Consumption		Storage
		Dry	Wet	Dry	Wet	Dry	Wet	Dry to wet
Dondo	Maize	0	0	0	0	472	469	589
	Rice	0	0	128	0	151	151	157
	Sorghum	25	0	0	0	38	38	52
	Charcoal	2500	10 000					
Nhamatanda	Maize	948	0	0	692	648	574	728
	Sorghum	0	0	0	0	142	220	279
	Charcoal	2250	4750	-	-	-	-	-
Gondola-Manica	Maize	633	0	0	12	500	505	619
	Sorghum	92	0	0	0	158	154	193
	Beans	0	48	0	0	26	25	78
	Charcoal	1500	2000					

(table 10). Like in the LP solution, households in Dondo will remain more forest dependent as compared to those in the other two sites.

5.2.2 Policy experiments/sensitivity analysis

Sensitivity analysis enables one to develop scenarios to guide policy analysis and choice. The analysis illustrates how much the current farm organization may be positively or negatively affected by policies and other external factors to the typical household. We evaluated the potential impacts of macroeconomic and sectoral policies in the following areas that appeared to be relevant to the study areas: labour availability, technological change in agriculture, trade in agricultural products, and forest royalties. This choice was based on literature, questionnaire interviews, reconnaissance surveys and participatory rural appraisal (PRA).

The objective of creating scenarios through sensitivity analysis is to provide the decision maker with information and a range of options to guide policy implementation by gauging potential effects on the household and its forest resources. The yardstick for analysis of the effectiveness of government policy would in this case be the poverty reduction through improvement of household incomes, food security and sustainable supply of forest products.

(a) Labour availability

Health related problems, especially those associated with malaria and HIV/AIDS, affect labour supply for various activities, generally constraining the ability of the family to explore a wide range of economic opportunities for generation of household income and subsequent improvement of the living standard. Labour supply could be affected by sickness, attending the sick, death, and attending funerals. The latter is especially important for the rest of the community who have to show solidarity with the family of the diseased, in fact farming is not done for two to three days according to the local customs. This implies that the frequency of death will severely affect the economy of the household and that of the community as a whole.

In addition, strict labour laws on child labour can affect labour supply. Nevertheless these are not enforced in Mozambique and particularly in the study sites where children either go to school after undertaking some farming tasks or even drop out of school to

help with farming. Emigration of the rural youth to urban centers in search of jobs also reduces household labour. Further, immigration into the household of relatives retrenched from jobs in urban areas increases household labour.

In Dondo the results indicate that when there was no adult male labour in the household the solution was infeasible, unless there was a possibility of hiring male labour. As Table 11 shows there are negative deviations in both food security and income goals. In the latter case the shortage of cash is more dramatic if the female labour is absent as it affects the crop production. Forest for charcoal and this could cause even greater deforestation that, depending on amount of labour hired, could lead to charcoal production over an area of 12 ha per annum for the typical household. Not all trees in a given area are used for producing charcoal, hence the possibility of making a choice over such an extented area, if there are no restrictions on forest access.

When the household had no adult female labour, even when some could be substituted for by the available child labour, the result was a complete disruption of the household production system. This means that the household has to hire adult female labour, or the man should change his activities and allocate more labour into food production or increase income from harvesting and sale of forest products in order to purchase food to maintain the food security of the household. Further, land is allocated only for pure maize and intercropping of maize and sorghum in respectively 0.24 and 0.22 ha which is far less use of the land available. This is the situation when a female adult is absent, probably due to death. On the contrary, when there is no adult male in the family the land cultivated is slightly higher, being respectively 0.78 and 0.21. In both cases, the solution is infeasible and rice is not cultivated possibly because labour for the crop is not available given that rice cultivation is labour intensive.

Table 11. Achievement of goals given changes in labour supply (Dondo)

Labour scenarios	N_1	P_1	N_2	P_2
No adult male and no hiring	10	0	91	0
No adult female and no hiring	10	0	185	0

The change in labour availability also changes dietary habits (Table 12). For example, when an adult female is absent in the family, there is less consumption of maize, and rice then becomes an important source of energy. In total the typical family would acquire (purchase) 800 kg of rice per year for consumption.

The situation in Nhamatanda and Manica-Gondola was also dramatic since there was insufficient surplus adult female labour to undertake the male activities when the model was run without adult male labour. When the model was run without adult female labour the results indicated that there was no surplus male labour to carry out adult female activities.

The implication of these two scenarios is that labour substitution within the households in these sites appear to be difficult especially in extreme situations when a household looses an adult male or female. Even when substitution was possible through labour hired into the household, it appeared not to be allocated primarily to maize production (the staple food) thus creating an infeasible solution.

Table 12. Crop utilization (kg/season) (Dondo)

	Crops	Selling		Buying		Consumption		Storage
		Dry	Wet	Dry	Wet	Dry	Wet	dry to wet
Base	Maize	0	-	0	0	472	470	589
	Rice	0	0	128	0	151	151	157
	Sorghum	25	0	0	0	38	38	52
No man and no hiring	Maize	0	0	0	0	427	358	443
	Rice	0	0	231	0	115	115	116
	Sorghum	0	0	0	0	29	39	38
No woman and no hiring	Maize	0	0	0	0	175	175	216
	Rice	0	0	800	0	462	335	338
	Sorghum	0	0	0	0	31	31	41

The main finding is that absence of an adult member of the family (either man or woman) adversely affects the ability of the household to meet its food requirements and satisfy its income goal. This also results into putting less land under crops, and therefore there will be less pressure on the forests if this loss cannot be compensated for through labour hiring into the household.

(b) Technological changes and natural disasters

Technological changes in agriculture can increase crop yields (through improved seed, efficiency in use of labour, etc.) and reduce crop losses through improved harvesting methods and better crop storage facilities. Increase in crop production and productivity is one of the government strategies for national socio-economic development highlighted in both the poverty reduction strategy programme (PRSP) and the Agricultural Sector Investment Program (PROAGRI). However, observations in the field indicate that there are no viable extension services to supply subsidized inputs such as improved seed, fertilizers and even equipment. Therefore, the changes assumed here are based on the household's own efforts to improve production.

Also, in relation to crop production we evaluated the effect of natural calamities, especially their potential impact on household welfare. Data was collected just after a drought and the interviewees reported low yields as a result; however during that same year (2000) the reverse happened – excessive rains and massive floods. Such effects are simulated through estimated decreases in crop production.

Improvements in crop yields simulated at 25% or 50% would appear to have little impact on the level of deviation from the goals. This was due to the fact that there was an internal land reallocation that maintained the base solution (Table 13). However, when there was a modest decrease in yields by 25%, the impact was significant with the negative deviation of income (N_2) ranging from 37% for Nhamatanda to an infeasible solution in Gondola-Manica. This could be explained by the fact that the farm performance was lower in Gondola-Manica making household livelihood strategies more sensitive or vulnerable (table 10).

However, as compared with the base results in Table 9, cropland in Dondo declined slightly from 2 to 1.9 and 1.59 hectares with crop productivity increase. The implication is that productivity increase can reduce cropland area and therefore deforestation in the area. However, it has been observed that increased crop productivity has indeterminate effects on forest resources. For example, Katila (1995) argues that marginal productivity of land can encourage deforestation while Jones and O'Neill (1995) reported that increased farm productivity was associated with less forest clearing in the Brazilian Amazon. Also Godoy *et al.* (1997) report that in Honduras indigenous farmers with higher rice yields cleared less forest each year. In the case of Dondo, the forest area to be cleared when crop productivity was increased by 25% remained unchanged. However, when crop yield was increased by 50% cropland area declined while forest area to be cleared increased. The implication is that since these are subsistence farmers, they will get their food from less cropland but will increase forest harvesting for household income because prices of forest products are relatively better than those from agricultural crops. So a crop yield increase that occurs in areas with low crop output prices might not reduce deforestation, especially when the prices of forest products are relatively better.

Table 13. Land allocation (ha) due to yield increase in Dondo

Crop	Yield increase (%)	
	25%	50%
Maize	1.22	1.07
Rice	0.34	0.34
Maize & sorghum	0.43	0.18
Maize & beans	-	-
Total agricultural cropland	1.9	1. 59
Forest area harvested	2.2	5.22

In addition, field observations indicated a precarious storage system where crops are lost due to a variety of plagues. When crop storage loss was estimated at 5% there was no significant change in the base solution, however when crop losses were increased by 15% a moderate reduction in household income, ranging from 5 to 6%, was observed.

The results demonstrate that extension services that result into increases in crop yields and reduction in crop storage losses would be beneficial to the local communities. However, this assumes that these communities have the means to purchase seeds and other inputs. PROAGRI program contemplates both research on the appropriate technologies and extension services that will facilitate the achievement of these aspirations.

(c) Trade in agricultural products

Trade in agricultural products was evaluated. However, the conduct and outcome of trade depend on a number of factors ranging from the quality of the produce to availability of adequate road infrastructure and transportation means to local and distant markets. Access to distant markets was minimal in the three sites.

Crop price increases were expected to augment the positive deviation of the income goal (P_2). This was not the case as shown in Table 14. We have used results from Dondo to illustrate this.

Table 14. Achievement of goals with output price increases in Dondo

Sites	Price increase	N_1	P_1	N_2	P_2
Dondo	25%	0	0	10.6	0
	50%	10	0	10.6	0

Land allocation to crops responds marginally to the change in the prices as shown in Table 15. Also the forest area to be harvested remains relatively unchanged.

Table 15. Land allocations (ha) with price increase in Dondo

Crop	Price increase	
	25%	50%
Maize	0.92	0.9
Rice	0.34	0.34
Maize & sorghum	0.28	0.3
Maize & beans	-	-
Total agricultural cropland	1.54	1. 54
Forest area harvested	2.4	2.41

However, with an output price increase of 25 and 50% there was no change in consumption patterns in all the three sites. Table 16 illustrates the situation for Dondo. Crop prices were observed to be very low and minimally affected sales volumes.

Table 16. Crop utilization (kg/season) in Dondo

	Crops	Selling		Buying		Consumption		Storage
		Dry	Wet	Dry	Wet	Dry	Wet	Dry to wet
Base	Maize	0	0	0	0	472	470	589
	Rice	0	0	128	0	151	151	157
	Sorghum	25	0	0	0	38	38	52
25% yield increase	Maize	0	0	0	0	472	470	579
	Rice	0	0	148	0	151	151	178
	Sorghum	0	0	0	0	38	38	50
50% yield increase	Maize	0	0	0	0	472	470	579
	Rice	0	0	127	0	151	151	156
	Sorghum	6.9	0	0	0	38	38	51

The implication is that with increase in output prices where market infrastructure is poor, as is the case in these sites, food and income needs will be met from less cropland (Table 15). The small marketable surplus does not appreciably change traded volumes in the small local markets. Further, it is common practice that the family will

consume the crops that have lower output prices and sell the rest. Such action could affect the satisfaction of dietary requirements and consequently the food security. In addition, this also implies that increasing the price alone for the basic products might not be a sufficient policy measure to improve the household livelihood, but introduction of other cash crops will be required to diminish the risk of malnutrition due to dietary imbalances.

(d) Forest fees

One of the ways the Government of Mozambique could arrest deforestation is to make forest products expensive. Introducing and enforcing fees on roundwood used for making charcoal can do this. However, it is also interesting to evaluate a situation in which fees on forest products are imposed with the possibility of agricultural land expansion offsetting the loss in benefits/income from forest harvesting.

(i) Imposition of forest fees for producers

The current fees for harvesting wood for charcoal are very small, only US$ 0.192 per cubic meter. This compares unfavourably with what it takes to raise the forest to maturity. An upward revision of such fees is therefore desirable, but can the rural households afford to pay such fees? We use the results from Dondo (Table 17) to illustrate the answer.

Table 17. Effect of forest fees in the household goals in Dondo

Fees	N_1	P_1	N_2	P_2
Enforcement*	0	10.6	5.2	0
Increase 10%	0	10.6	5.8	0
Increase 50%	0	10.6	5.9	0
Increase 100%	0	10.6	11	0

*Currently the producer (typical household) does not pay any royalties for harvesting forest products, if such situation was changed, that is the household pays current fees, then the impact on the goals is shown in the first row.

The results demonstrate that the introduction of fees will have a negative effect on the farm income by reducing it by 5.2, 3.3 and 0.14% for respectively Dondo, Nhamatanda and Gondola Manica. The negative effect is higher in Dondo (Table 17) where the household economy relies significantly on sale of forest products. Such dependency decreases progressively as we move to Gondola-Manica where the forest has already been depleted, making the households rely more on agriculture and other activities. Assuming that the fee undervalues the forest resources, its doubling can penalize households in Dondo and Gondola-Manica by reducing by as much as 11% and 0.41% of their incomes respectively.

Another remarkable finding is that despite the proposed increase in fees, the model indicated that households would not be deterred from continuing to harvest the same volume as before. There was also no change in agricultural land allocation patterns. This result is indicative of the few livelihood support options available to households in these areas. Men are supposed to be employed in income generating activities while women usually engage in production of food for consumption and other reproductive obligations.

(ii) Imposition of forest fees and relaxation of constraint on land
In Nhamatanda and Gondola-Manica labour has been demonstrated as the decisive factor for expanding farm area. With additional labour supply in these two sites cropland area will expand, for example, through shifting cultivation where this is possible, or expansion of the household agricultural land in the same areas (if fallow land is available). When the model was simulated with an imposition of fees on forest products, but with a relaxation of the land constraint, the results for Dondo indicated that more land would be allocated to rice production to compensate for loss in forest based revenues. The driver of such behaviour is the high price of rice relative to that of other agricultural and forest products. Nevertheless, further field surveys are required to establish the availability of land suitable for rice production; otherwise, this solution will be unrealistic.

6. CONCLUDING REMARKS

6.1 On methodological issues

(a) The data used to develop the model varied significantly in terms of its accuracy depending on the level of literacy of the respondent and also on accuracy in measuring some parameters like crop yields and labour allocation. Even the selling and buying prices varied.

(b) It was clear from the early stage of sampling that it would be difficult to obtain objective and quantified data for elicitation of targets for the goals stated by the decision makers. Therefore, the approach was to use available technical information to translate the concept of food security into a measurable target, such as the minimum calorific requirement, and use LP model to establish the maximum income that the household could derive from its activities given the resource constraints. The environmental goal was difficult to formulate so a proxy was used. The imposition of forest fees was viewed as one way to regulate harvesting, and through such regulation one could implicitly influence deforestation as well as protect the environment. However, the results indicated that this was not an effective way of regulating woodland harvesting. This means that effective control of deforestation would have to include measures other than those prescribed by the forest policy alone. A better proxy could have been the allowable cut but this pre-supposes the availability of inventory data and information on the growth of all the tree species, both of which were not available.

6.2 On results

(a) The use and management of forest resources cannot be seen in isolation of the rest of economic opportunities in the household such as agriculture, fishing, brewing beer, livestock rearing, and others. These contributions were also investigated and the results indicated that agriculture and forest harvesting are the main sources of livelihoods for the communities in the three sites.

(b) Harvesting forest products was observed to be the most profitable off-farm activity. Imposition of fees on forest products that households harvested, expansion of agricultural land, and increase in crop output prices cannot, in isolation, change the current pattern of the household economy in the three sites. Provision of extension services and inputs for improved agricultural production will complement efforts in

regulating harvesting of the forest and materialize in a significant impact on household livelihoods and the forest condition. This underlines the relevance of an integrated development approach for rural areas.

(c) The challenge of diseases like malaria and HIV-AIDS on household economy were demonstrated and the results were dramatic. In short any socio-economic policies that do not address this issue are likely to fail because scarcity of labour will hamper their implementation.

(d) The current model gives a static snap shot of the policy impact on the household. In other words, the model is not dynamic. Despite this limitation the potentialities of the model have been illustrated and it is up to decision and policy makers to decide whether this is a useful planning instrument. A dynamic model could be constructed through recursive or multiperiod programming in which the results for one year would feed into the following year. This would be possible if forest planning was well organized and data collection were available. There is need for a more systematic collection of information to establish trends for a dynamic model. Otherwise, the current framework can be used to simulate the impact of few crucial policies on an annual basis, hence giving a short-term indication of the likely outcomes and allow for incorporation of new strategies. Since central government planning is done during the middle of the year (under PROAGRI), it is therefore possible to experiment with this approach. This will strengthen the current practice in which the national agricultural programme, PROAGRI, is implemented by provincial administrations that have to draw plans for subsequent years without first analyzing the likely impact or performance in the preceding years. This makes planning a partial/incomplete exercise.

(e) The discussions emanating from the demonstration of the models and their results to various fora confirmed that the model results concurred with what other people, i.e. the audience, considered the likely behaviour in the study sites. However, some wanted to see an extension of the model to include non-timber forest products (NTFPs) since these products play an important role in both food security and household incomes. The researchers observed in the field that data for this component could not be fully obtained through a spot survey, but there was need for continuous observation during the different seasons to gauge objectively (and quantify) the role of NTFPs in the household economy. Despite the efforts made by researchers to collect data on NTFPs, the information collected was insufficient and of poor quality and therefore not included in the current model.

(f) The model can be scaled up by extending it to the provincial administrative level, making it a regional or provincial model that incorporates the various activities in each of forest types or agro-ecological zones and link the supply from each of the zones to the main consumer market. This has been tested in Maputo province of Mozambique (Nhantumbo *et al.* 2001) as a more comprehensive planning instrument and at a higher level.

(g) Finally, GIS techniques can provide more illustrative results that are simple to understand and interpret by both the decision maker at farm level and the policy maker. This will bring in another dimension of programming which is fundamental, the interaction with the main actors or interested parties. This would be particularly useful if planning were at provincial or regional level.

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ANNEX 1. A WEIGHTED GOAL PROGRAMMING MODEL FOR ONE OF THE SITES

LINGO software was used.

! The Objective function is to maximise the total gross margin in a Linear Programming Model,;

!In the Goal Programming, however, the farmers look for a compromise solution between food security and income generation, the respective weights are 0.67 and 0.33 and are normalized;

!The objective of the farmers is to simultaneously minimize negative deviations from the food security and income goals;

[Objective] Min= 0.016*n1 + 0.121*n2;

!Land Constraints;
!GrRc is the amount of land allocated to rice;
!GrMz is the amount of land allocated to maize:
!GrMzSgh is the amount of land allocated to growing a mixed (inter) crop of maize and sorghum;

[LandT]GrRc + GrMz + GrMzSgh <= 2;
[LandRc]GrRc <= 0.34;
[LandMz]GrMz >= 0.78;
[LandMzSgh]GrMzSgh <= 0.88;

!Production and utilization;
!The coefficients correspond to the current yield per ha;
!SgMzD, SgMzW, SgRcD, SgRcW, SgSghD, SgSghW represent the quantity of crops (Maize, Sorghum and rice) sold respectively in the dry (D) and wet (W) seasons;
!BgMzD, BgMzW, BgRcD, BgRcW, BgSghD, BgSghW represent buying of maize and sorghum to supplement the internal production, this represents the household deficit;
!MzCsD, MzCsW, RcCsD, RcCsW, SghCsD, SghCsW are variables representing consumption of maize, rice and sorghum during the dry and wet seasons;
!StMzD, StRcD, StSghD are variables showing the transfer of stored produce from the dry season to the wet season, the assumption being that the harvesting takes place at the begining of the dry season. The coefficient reflects the losses that occur during the storage due to insects, rats, etc.;
!MzSd, RcSd, SghSd are variables representing the quantity of seed stored from the harvest;

[MzPrUse]-901*GrMz - 800*GrMzSgh + SgMzD + StMzD - BgMzD + MzCsD <= 0;
[MzUseW]-0.85*StMzD + SgMzW - BgMzW + MzCsW + MzSd <= 0;
[RcPrUse]-531*GrRc + SgRcD + StRcD - BgRcD + RcCsD <= 0;
[RcUseW]-0.99*StRcD + SgRcW - BgRcW + RcCsW + RcSd <= 0;
[SghPrUse]-320*GrMzSgh + SgSghD + StSghD - BgSghD + SghCsD <= 0;
[SghUseW]-0.85*StSghD + SgSghW - BgSghW + SghCsW + SghSd <=0;

[AccMzD]SgMzD >= BgMzD;
[AccMzW]SgMzW >= BgMzW;
![AccRcD]SgRcD >= BgRcD;
![AccRcW]SgRcW >= BgRcW;
[AccSghD]SgSghD >= BgSghD;
[AccSghW]SgSghW >= BgSghW;

!Labour demand for the household;
!The household members include men-M, women-W, Children in a working age including both boys-Cbw and girls- Cgw and other children - C;
!The coefficients represent the labour allocation for the different activities - cropping (labour contributed per ha by the different members of the household), charcoal production in the dry and wet season (ChPrD and CHPrW), harvesting of firewood and poles for household consumption (FwCs, PlCs respectively), Domestic activities - DoA;

[Malabour]42*GrMz + 42*GrRc + 46*GrMzSgh + 45*ChPrD + 45*ChPrW + PlCs - 312*M - HrMl - 66*W<= 0;
[WomLabour]33*GrMz + 40*GrRc + 51*GrMzSgh + 90*DoA + 2*ChPrD + 2*ChPrW + 1.5*FwCs - 187.5*W <= 0;
[Boylabour]14*GrMz + 1.5*FwCs - 104*Cbw <= 0;
[Girlabour]15*GrMz + 90*DoA + 1.5*FwCs - 117*Cgw <= 0;
[AccDomA]DoA=1;

!Size of the household;
!Variables for household composition: M for men, W for women, CbW for children (boys) and CgW for children girls both in working age while C denotes both girls and boys before they reach the age of helping their parents;

[NoMan]M = 1;
[NoWoman]W = 1;
[Noboyswg]Cbw = 1;
[Nogirlswg]Cgw=1;
[Nochildren]C=2;

!Utilization of forest products for energy and construction;
!For - is a variable representing the quantity of forest harvested to produce charcoal for commercial purposes, firewood and poles for consumption;
!ChPrD and ChPrW are the number of kilns of charcoal produced in the dry and wet seasons;
!SgChD and SgChW sales of charcoal in the dry and wet seasons;
!FwCs and PlCs represent the amount of firewood and poles that the typical household consumes per day;

[ChPr]-47*For + 15*ChPrD + 15*ChPrW + FwCs + PlCs <= 0;
[ChUseD]-ChPrD + SgChD <=0;
[ChUseW]-ChPrW + SgChW <=0;
[NoKilnsD]ChPrD >=1;
[NoKilnsW]ChPrW >=1;

```
[FwCons] FwCs >=5;
[PolesCons]PlCs >=0.6;

!Energy requirement;
!MzCsD, MzCsW, RcCsD, RcCsW, SghCsD, SghCsW represent the quantity of different crops consumed by the household and by season, according to the calories and protein provided by each kg of crop and according to the household minimum requirements per year as established by FAO;
[EnergyD]-3.450*MzCsD - 3.350*RcCsD - 3.350*SghCsD + 538.752*M + 428.22*W + 475.8*Cbw + 385.764*Cgw + 217.221*C <= 0;
[EnergyW]-3.450*MzCsW - 3.350*RcCsW - 3.350*SghCsW + 535.808*M + 425.88*W + 473.2*Cbw + 383.656*Cgw + 216.34*C <= 0;
[ProteinD]-100*MzCsD - 70*RcCsD - 95*SghCsD + 10.431*M + 10.431*W + 13.542*CbW + 12.078*Cgw + 3.66*C <=0;
[ProteinW]-100*MzCsD - 70*RcCsD - 95*SghCsD + 10.371*M + 10.374*W + 13.468*CbW + 12.012*Cgw + 3.64*C <=0;

!Diet balance;
!The diet balance illustrates the fact that the crops included in the model are consumed at different proportions, this avoids the possibility of obtaining unrealistic consumption of only crops that have the highest energy and protein levels. Eating habits are therefore factored into the model;

[MzBalD]-3.450*MzCsD + 0.33*(538.752*M + 428.22*W + 475.8*CbW + 385.764*Cgw + 217.221*C)<=0;
[MzBalW]-3.450*MzCsW + 0.33*(535.808*M + 425.88*W + 473.2*CbW + 383.656*Cgw + 216.34*C)<=0;
[RcBalD]-3.35*RcCsD + 0.224*(538.752*M + 428.22*W + 475.8*CbW + 385.764*Cgw + 217.221*C)<=0;
[RcBalW]-3.350*RcCsW + 0.224*(535.808*M + 425.88*W + 473.2*CbW + 383.656*Cgw + 216.34*C)<=0;
[SghBalD]-3.35*SghCsD + 0.056*(538.752*M + 428.22*W + 475.8*CbW + 385.764*CgW + 216.34*C)<=0;
[SghBalW]-3.350*SghCsW + 0.056*(535.808*M + 425.88*W + 473.2*CbW + 383.656*CgW +216.34*C)<=0;

!Demand for seed;
!MzSd, RcSd and SghSd are quantities of seed of maize, rice and sorghum, respectively, necessary for the cultivated land;
[SdMz]19*GrMz + 18.7*GrMzSgh - MzSd = 0;
[SdRc]12*GrRc - RcSd = 0;
[SdSgh]18.7*GrMzSgh - SghSd =0;

![Food security]3.450*MzCsD + 3.450*MzCsW + 3.350*RcCsD + 3.350*RcCsW + 3.350*SghCsD + 3.35*SghCsW + n1 - p1 = 4 080.335;
!Definition of the food security goal, the RHS shows the absolute target in terms of energy required per year;
```

![Income] Max = 0.12*SgMzD + 0.16*SgMzW + 0.243*SgRcD + 0.25*SgRcW + 0.16*SgSghD + 0.18*SgSghW - 0.13*BgMzD - 0.17*BgMzW - 0.29*BgRcD - 0.293*BgRcW - 0.18*BgSghD - 0.19*BgSghW + 44*SgChD + 47.5*SgChW + n2 - p2 =271.74;
!The income goal has been defined using the information in the expression above, which has been used when the program was run as LP which maximizes the gross margin. This was also important for defining the income target whose deviation is minimised in the goal programming. The coefficients are prices of selling and buying of the different household products;
!Food security goal normalized using percentage normalization;
!n1 and p1 are negative and positive deviations from the food security goal;
[FSecurity]0.0845*MzCsD + 0.0845*MzCsW + 0.0821*RcCsD + 0.0821*RcCsW + 0.0821*SghCsD + 0.0821*SghCsW + n1 - p1 = 100;

!Percentage normalization of the income goal;
!n2 and p2 are negative and positive deviations from the income goal;
[Income]0.0442*SgMzD + 0.059*SgMzW + 0.0894*SgRcD + 0.0919*SgRcW + 0.059*SgSghD + 0.0662*SgSghW - 0.0478*BgMzD - 0.0626*BgMzW - 0.1067*BgRcD - 0.108*BgRcW - 0.0662*BgSghD - 0.0699*BgSghW - 0.367*HrMl + 16.19*SgChD + 17.48*SgChW + n2

20.

Policy impact on woodland resource management, use and conservation in Mozambique: A case study of selected sites in Dondo, Nhamatanda, Gondola and Manica districts

G. Mlay, M. Falcao, I. Nhantumbo and G. Kowero

ABSTRACT

Forest resources play an important role in the economy of Mozambique. They are a significant source of livelihood and food security for rural people. The high rate of deforestation, estimated at 4.2% per year, coupled with land degradation, has been demanding a re-evaluation of the institutions and policies which guide the exploitation and conservation of forest resources. Management arrangements and policies that will meet the needs of stakeholders and at the same time guarantee a sustainable use of the forest resources are complex to devise.

A case study of three sites in the provinces of Manica and Sofala was carried out to analyse (a) the impact of alternative management regimes on the incomes of miombo woodlands users and on woodlands conservation, and (b) the impact of sectoral and extrasectoral policies on incomes for miombo users and woodland conservation under different management regimes. A system dynamics model, MIOMBOSIM, based on game theory and implemented in Powersim, was used for the study.

The results show that regulated management regimes incorporating social concerns or incorporating social and environmental concerns are potentially more beneficial to the household sector than the open access situation. The open access situation is the most beneficial management option for the private sector. Extrasectoral policies intended to promote agriculture have mixed effects on forest development. Modest agricultural price and productivity increases would increase agricultural production through area expansion. Reduction in land clearing for agriculture is only achieved when extrasectoral policies lead to large productivity increases in agriculture.

Key words: Sectoral and extra sectoral policies, management regimes, stakeholders, benefits, system dynamics, Mozambique.

1. INTRODUCTION

Mozambique has been implementing economic reforms in the context of structural adjustment programs since 1987. The pace of reforms accelerated after the signing of a peace agreement between RENAMO (an opposition movement in the country's post-independence civil war that later became a political party) and the government in 1992, followed by multiparty elections in 1994. The reforms have included currency devaluation with subsequent liberalization of the exchange rate, markets, prices and trade. Other measures include increased privatisation, fiscal retrenchment and domestic credit contraction. The implementation of these policies hinges mainly on the dominant role of market forces in guiding economic activities, with government's role directed at creating enabling conditions (infrastructure and market development, regulations and laws to protect property rights and enforcement of contracts, fiscal incentives, public investment in research, etc.).

Although the economic reforms have led to impressive macroeconomic performance as exemplified by a real GDP average annual growth rate of about 8% between 1996 and 1999, an annual growth rate of agricultural production of about 14%, and a reduction of annual inflation from 70.2% in 1994 to 6.2% in 1999, Mozambique continues to be one of the poorest countries in the world. According to a report on poverty assessment in Mozambique about 71.2% of the rural population and 62% of the urban population are below the poverty line (Ministry of Planning and Finance *et al.* 1998). Given that 70.4% of the population lives in rural areas poverty is essentially a rural problem.

The impressive performance of the agricultural sector has come about mainly from area expansion and not from an increase in productivity. The average yields of the main food crops (maize, rice, cassava, and beans) are about half those of sub-Saharan Africa. According to the results of the national household survey carried in 1996/97 by the National Institute of Statistics, only about 20% of the rural households used purchased seeds, none used fertilizer and only 18% of the households had access to technical assistance in the community. These statistics indicate that the present growth performance of agriculture cannot be sustained (since it is based on mining the land/soil) without the use of high productivity technologies that are environmentally friendly.

The Government of Mozambique recognizes that rapid broad based economic growth is necessary to reduce poverty. In this connection, agriculture (which supports the majority of the population) has to play a key role, with emphasis on use of more productive technologies that are environmentally friendly. The high incidence of poverty, and agricultural production characterized by low input use and extensive land use are, two characteristics that favour deforestation and land degradation. As pointed out by Vosti and Witcover (1996), poor households have a short time horizon in which natural resource mining may be the only alternative to meet the short term goals of food and livelihood security. In Mozambique, it is estimated that 4.2% of forest cover is lost annually, the principal causes being conversion of forest land to agriculture, tree felling for energy (charcoal and fire-wood) and construction material. Inadequate agricultural practices based on slash and burn methods, and exploitation of non-wood products using uncontrolled fires, often lead to the destruction of large tracts of forests.

In order to contain the adverse effects of economic development on the environment, the macroeconomic policy reforms have been accompanied by reform or formulation of sectoral policies and instruments to match economy wide policies. The

key policy documents relevant to forest management include the agricultural policy and strategy for implementation (Ministério da Agricultura e Pescas 1995), the land law of 1997 (AR1 1997), the trade policy and strategy (Governo de Moçambique 1999), forest and wildlife policy of 1997 (AR2 1997), food security and nutrition strategy (Governo de Moçambique 1998), the national agricultural development program (Governo de Moçambique 1998), and the action plan for the reduction of absolute poverty (Governo de Moçambique 2001).

While land continues to be publicly owned the land, law recognises land use rights under customary law, and has provision for right of occupancy (through title deeds) at community level. The drawing of benefits is guaranteed by the land law, which provides a legal framework of right of occupancy of land at community level. The current forest and wild life policy also provides for a greater role for local community participation in natural resource management. According to Kant and Nautiyal (1993), a cross section study of 28 countries in Africa, Asia and Latin America showed that the main cause of deforestation in these areas is not over exploiting for supply to industry, but the inability of forest owners (often the state) to exclude various user groups from the resource which in theory is under a well defined property regime, leading to resource exploitation in an open access context. The high cost of monitoring coupled with low budgets means that in practice, monitoring and enforcement of government regulations is lax and hence ineffective. The recent interest in promoting community based forest management arrangements is seen as a more promising management alternative to the centralised arrangement.

Although broad policy statements and instruments for the implementation of community based forest management policies are in place in Mozambique, empirical support either to predict their impact or to fine-tune them to reflect the local environment is lacking. This is particularly important given the conflicting objectives of the different actors involved and the trade offs imputed by the extrasectoral policies which impact on the forest sector. The forest and wildlife policy provides for private sector logging under concession arrangements, while the land law allows for the communities to enter into partnership arrangements with the private sector in the exploration of land under community management. These policy provisions create opportunities for cooperation between the private sector and communities in managing the forest. What incentives will promote cooperation and at what level? How will the cooperation impact on community and private sector income and on the woodland resources? These are but a few of the many unknowns.

This paper presents results from a study carried out in Mozambique in the districts of Nhamatanda and Dondo in Sofala province, and those of Gondola and Manica in Manica province. The study was undertaken with the general objective of analysing the impact of selected policies on the incomes of users of miombo woodlands and on the conservation status of the woodlands. The miombo woodland is the most extensive forest formation in Mozambique and is characterised by tree species of *Brachystegia* and *Julbernadia*.

Specifically, the study evaluated the potential impact of five alternative miombo woodland management regimes on incomes of miombo users and on woodlands condition as well as the likely impact of some sectoral and extrasectoral policies on incomes of miombo users and woodlands conservation under the same management regimes. In this way the study sought to predict the impact of the broad government policies on

local communities and their environment thus providing an opportunity to fine-tune these policies for maximum impact.

The rest of the paper is organized as follows: section 2 presents a brief review of modelling experiences in forest management, section 3 presents the methodology, while the main results are discussed in section 4. Section 5 presents the summary and main implications of the results on the welfare of rural communities and the forest condition.

2. A BRIEF OVERVIEW OF MODELLING IN FOREST MANAGEMENT

The review focuses on the modelling procedures used to study forest development problems; less emphasis is given to the underlying causes of these problems. These have been reviewed in many studies, including those reported by Mlay *et al.* (2003), Kaimowitz and Angelsen (1998), and Angelsen and Kaimowitz (2001).

Deforestation has serious negative effects on land degradation, climate and biodiversity. In the recent past there has been a rapid growth of studies at micro, meso and macro levels to try to understand and quantify the impact of the underlying causes of deforestation with a view to improving policy formulation and implementation. Kaimowitz and Angelsen (1998) present a rich review of economic models of tropical deforestation, covering studies conducted at micro (household and firm), meso (regional) and macro (national and cross country) levels. Further, Angelsen and Kaimowitz (2001) present a good account on agricultural technologies and tropical deforestation.

The micro level modelling has used household models of two types namely: open economy type models which treat all prices as being exogenous, and Chayonavian models assuming some markets are imperfect or incomplete or absent, leading to inseparability of production and consumption decisions. The empirical implementation of the conceptual models has taken the form of regression analysis, mathematical programming and simulation. These models have been used to study the impact on deforestation of input and output prices, risk, wage rates, off-farm employment land tenure and transport costs.

Regional or meso level models are either spatial or non spatial. The spatial models based on geo-referenced variables can predict where deforestation can occur. The majority of these models use multivariate logit or probit analyses. The non-spatial models are based on regression analysis, and can be used to study the effects of agricultural prices, population growth, transport costs, income and credit on deforestation.

The macro level models are of the general equilibrium type, and their popularity has been promoted for the following reasons (Kaimowitz and Angelsen (1998): they make some prices endogenous, they explore how some underlying variables help to determine decision parameters thus providing an important link to macroeconomic variables and policy instruments, and finally they include the interaction between different sectors and markets. The analytical implementation has mainly been by Computable General Equilibrium Models (GCE). The GCE models have been used to study the impact on deforestation of devaluation, trade liberalisation, export taxes, subsidies to industry, public expenditure, subsidies to agriculture, land taxes and technology (in agriculture and forestry). Trade and commodity models linking production,

consumption and trade have been used to study the impact of currency devaluation, population growth, export taxes, wage rates and fertilizer prices on deforestation (Kaimowitz and Angelsen 1998, Pandey and Wheeler 2001).

The choice of modelling approach depends on the research questions and resource availability for implementation. While the models reviewed above address forest development issues at micro, meso and macro levels, they don't provide answers to management issues where potential conflicts exist between stakeholders. Models based on game theory seem promising. White (2000) provides a detailed review of game-theoretic analysis of common property resources. With the exception of fisheries (see Sumaila 1999), the empirical application of game theoretic models for other renewable resources has been limited. McCarthy (2000) presents a single period theoretical model to analyse the effects of production risk on the use of common pool rangelands. The comparative statistic results show that: (a) under a cooperative regime herders are better off in terms of welfare and production as production risk decreases. Stock levels increase as production risk decreases; (b) although under a non-cooperative regime stock levels increase with a decrease in production risk, profit may actually decline; and (c) total stock levels are higher under non-cooperation than under cooperation. According to McCarthy (2000), groups undertake cooperation to the extent that the benefits from cooperation outweigh the costs of making and enforcing agreements. As such, members will weigh the costs and benefits when choosing the level of cooperation.

Unsustainable exploitation of natural forest, land and other resources under open access, stemming from ineffective regulatory instruments (because of high costs of enforcement and conflict between national level objectives on one hand and local needs and objectives on the other) has seen a growing interest in promoting the participation of local communities in joint management programmes. Examples in the region include CAMPFIRE (Community Areas Management Program for Indigenous Resources) in Zimbabwe, largely involving local communities in wildlife ranching; the ADMADE programme (Administrative Management Design for Game Management Areas) of Zambia, another wildlife management initiative with local communities (Forests, Trees and People Newsletter 1991); and Village Natural Resource Management Committees in the Malawi. Other initiatives include Trusts, Conservancies, and Associations as found in Botswana, Namibia, and some villages in Tanzania (e.g. Duru-Haitemba). According to Kant and Nautiyal (1993), joint forest management programmes will only be successful if they include the rights and obligations of both partners, and if the sharing of benefits is perceived to be fair.

Kant and Nautiyal (1993), using a bilateral monopoly gaming approach, show the necessary community share of annual benefits from forest resources to maintain community interest in cooperation with a forest owner in joint forest management. This model is, however, limited in that it does not take into account other employment opportunities opened to local communities (agriculture, off-farm employment). Cardenas *et al*. (2000) examined the effects of external institutions, like rules and regulations imposed from outside the community, on behaviour under an experimental setting. The subjects for the experiment were drawn from rural households who depended heavily on local forests for wood products, and the exploitation of these products affects other aspects of their livelihood adversely (water quality and fish population). The experiment involved the allocation of a given endowment of time between collection of firewood from the forest and providing labour to an unrelated market. They found that when subjects do not face external restrictions and cannot

communicate with each other (non-cooperation), their decisions tended to be neither Nash-based strategies[1] nor efficient choices, but somewhere between these extremes. In the absence of regulations, but with communication (cooperation), the subjects made more efficient choices. With external regulations subjects made choices closer to their pure Nash strategies. Consequently, average individual payoffs were lower than in the absence of regulation, and much lower than the payoffs of those subjects who were simply allowed to communicate with each other (cooperation), despite the fact that the regulatory institutions were designed to induce more efficient choices. Their results show that local environmental policies that are moderately enforced are ineffective, and can do more harm than good in comparison to allowing individuals collectively to confront local environmental dilemma without intervention. The reason for the poor performance of external control is that it crowded out group-regarding behaviour in favour of greater self-interest.

3. METHODOLOGY

3.1 The model

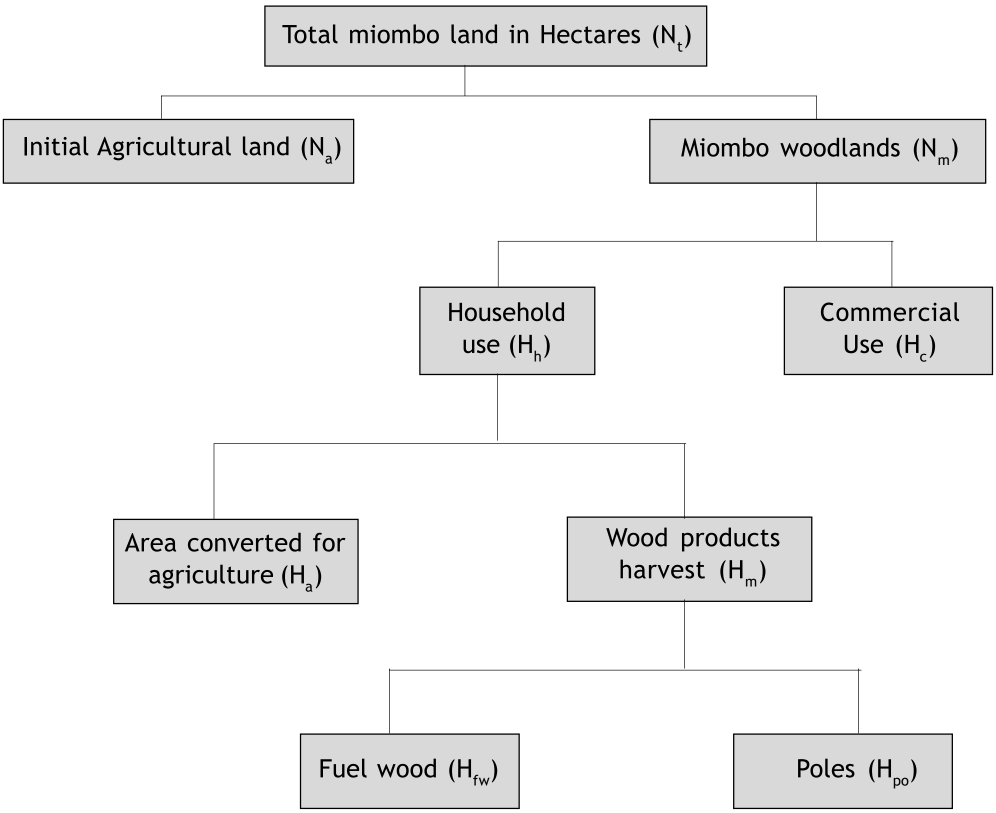
A system dynamics model, MIOMBOSIM, which is based on game theory, is used in this paper. The conceptual model adapted here is presented in detail in Sumaila *et.al.* (2001). Three groups of stakeholders are identified, namely the government, the private (commercial) sector and the local community. The government's interest in miombo woodlands is based on maximizing society-wide benefits that include environmental protection (biodiversity conservation, protection of catchment areas, mitigation of land degradation and climatic changes), direct economic benefits and social benefits (e.g. preservation of settlement patterns in rural areas). The community's interest in miombo woodlands is based on the benefits that can be derived from wood and non-wood products harvested for consumption and sale, while the private sector's interest is based on the income derived from woodland harvesting, processing and sale activities. Under the existing Mozambican legislation, the land belongs to the state (owner) and the communities and the private sector enjoy user rights as per regulations mandated by the government. Partial enforcement of these regulations has resulted in the woodlands being under open access and therefore overexploited. This has potential for conflicts among the stakeholders due to their divergent objectives. While the private sector carries out selective logging, the household harvesting activities are non-selective, leading to destruction of valuable timber species. In addition, harvesting under concession[2] denies communities legal access to these areas. In the absence of enforcement capacity, these areas will continue to be exploited by communities as if under open access, and this could lead to losses of valuable timber species that have been legally allocated to the concession owner. These conflicts provide a basis for considering cooperation between the private sector and the local communities. A summary of the model that depicts this behaviour is presented in Annex 1. However, the logic leading to the development of the model is described in Figure 1.

3.2 Decision making by household and commercial sectors

The decision rules following the game theoretic games are summarised in Figure 1. It is assumed that at any time, t, there is a fixed woodland area (N_t) available to the

communities from which the land area N_a is put under agriculture and N_m is the remaining area under miombo woodlands. The household and commercial sectors have to decide on how to use the land area N_m hectares that are under miombo woodlands. The commercial sector's decision is a one step process involving the determination of area H_c to harvest annually in order to maximize the sum of discounted net benefits. For the household sector, the decision making is a three-stage process. The criterion at each stage is to maximize utility over time. In the first stage a decision is made on how much of the area presently under miombo they should use (H_h) in order to maximize their utility over time. In the second stage a decision is made on how much of the miombo area to be used by households should be cleared for agriculture (H_a) and how much should be used for harvesting miombo wood products (H_m). For the area to be harvested of miombo wood products, the third stage involves its allocation between poles, H_{po}, and fuelwood, H_{fw}, the two main products from the woodlands.

Figure 1. Steps in decision making by the household and commercial sectors



The allocation process is driven by relative prices as shown in equations 1, 2 and 3.

$$H_a = \frac{P_a H_h^*}{P_a + (P_{fw} + P_{po})} \tag{1}$$

$$H_{fw} = \frac{P_{fw} H_m}{P_{fw} + P_{po}} \tag{2}$$

$$H_{po} = \frac{P_{po} H_m}{P_{fw} + P_{po}} \tag{3}$$

Where: H_h^* = miombo woodland area to be exploited by the household sector
H_a= area to be converted to agriculture
H_m= miombo woodland area to be exploited for wood products (H_m=H_h^*-H_a)
H_{fw} = miombo woodland area to be exploited for fuelwood
H_{po} = miombo woodland area to be exploited for poles
P_a= revenue per hectare of agricultural products
P_{fw} = price per hectare equivalent of fuelwood
P_{po}= price per hectare equivalent of poles

3.3 The game theoretic models

Three principal game theoretic models were employed, namely a command model, a cooperative model and a non-cooperative model. In all models, the maximization of the objective function was over labour since this is the main variable factor in miombo harvesting activities. Each model is briefly described. For definition of symbols see Annex 1.

a) Command model

This model relates to a 'regulator' such as a central or local government, in that ownership and decisions are centralised. In this model, society-wide net benefits are maximized through the choice of the amount of labour to be used by the private and the household sectors in each year over the planning horizon of the model. The harvesting technologies used by both sectors are labour intensive and therefore the amount of labour to be used defines the volume of wood products to be harvested by each sector.

$$\underset{L}{\text{Max}} \sum_{t=1}^{T} \left[B_t\right] \rho_{t-1} = \sum_{t=1}^{T} \rho_{t-1} [B_c(H_{c,t}) + B_h(H_{h,t}) + B_s(\theta_c H_{c,t}, \theta_{h,t} H_{h,t}) - \phi B_e(H_{c,t} + H_{h,t})]$$

subject to: (4)

$N_t = sN_{t-1} + K_t - H_{c,t} - H_{h,t}$

$L_t = L_{m,t} + L_{a,t} + L_{n,t} + L_{of,t}$

where: L_t = total labour available to both household and private sectors at time t.
$L_{m,t}$ = Labour used for harvesting miombo wood products at time t.
$L_{a,t}$ = Labour used in agriculture at time t.
$L_{n,t}$ = Labour used in converting miombo woodland to agriculture at time t.
$L_{of,\,t}$ = Labour used for off-miombo, off agriculture activities at time t.
s = Natural regeneration rate of the woodlands

Depending on the values assigned to parameters θ_c, θ_h, ϕ different scenarios of the command model can be examined. In this paper we look at three scenarios,

namely the scenario in which the regulator (government) is concerned with both social and environmental benefits but favouring or giving more weight to the household sector (θ_c=0, θ_h = 1 and ϕ=1) (scenario 1), the scenario in which only environmental benefits are considered (θ_c=0, θ_h =0 and ϕ=1) (scenario 2), and the scenario that considers only social benefits but favouring the household sector (θ_c =0, θ_h=1 and ϕ=0) (scenario 3).

These three scenarios represent the range of management options that central and local governments normally employ to manage the natural woodland resources. The first scenario corresponds to an advocated option in natural forest conservation that allows limited or controlled exploitation, like in water catchment forest areas that border villages. The second scenario represents a strict biodiversity conservation thrust as usually found in protected areas for important biodiversity, like heritage sites. The third scenario is largely found in most woodlands in the region that are technically under government control, but due to inadequate resources for their management they have almost become open access woodlands.

b) Cooperative model

In some situations some households indulge in commercialisation of the woodland products. Under such a situation, these households could form a 'commercial sector', while those that use the woodland products for own consumption would constitute the 'household sector'. This way one could map and monitor the development of commercial activities at the household level.

In this model it is assumed that the household and commercial sectors have an incentive to cooperate through joint maximization of their discounted net benefits.

$$\underset{L_h, L_c}{Max} \sum_{t=1}^{T} [\alpha \rho_{c,t-1} B_{c,t} + (1-\alpha)\rho_{h,t-1} B_{h,t}],\ 0 \leq \alpha \leq 1$$

subject to:

$$N_t = sN_{t-1} + K_t - H_{c,t} - H_{h,t}$$

$$L_t = L_{m,t} + L_{a,t} + L_{n,t} + L_{of,t}$$

The value assigned to the parameter will reflect the relative weight given to their individual benefits under cooperative management. When is assigned a value of 1, full weight is given to the commercial sector's benefits and a value of 0 corresponds to full weight being given to the household sector's benefits. The value of between the two extremes will permit both sectors to participate in miombo activities, thus the parameter is a measure of their preferences.

c) Non-cooperative model

In this model it is assumed that the two stakeholders (commercial and house hold sectors) operate in the woodlands independently without taking into account the interest of other stakeholders. This model mimics the open access situation, currently the dominant arrangement under which miombo woodlands are being exploited in many parts of Mozambique.

The constrained maximization problem of each stakeholder is as:

(i). Household sector

$$\underset{L_h}{\mathrm{Max}} \sum_{t=1}^{T} \rho_{h,t-1} B_{h,t}$$

subject to:

$$N_t = sN_{t-1} + K_t - H_{c,t} - H_{h,t}$$

$$L_t = L_{m,t} + L_{a,t} + L_{n,t} + L_{of,t}$$

(ii). Commercial Sector

$$\underset{L_c}{\mathrm{Max}} \sum_{t=1}^{T} \rho_{c,t-1} B_{c,t}$$

subject to:

$$N_t = sN_{t-1} + K_t - H_{c,t} - H_{h,t}$$

$$L_t = L_{m,t} + L_{a,t} + L_{n,t} + L_{of,t}$$

Simulation of the models is based on the numerical approach similar to that applied in Sumaila (1995) using system dynamics simulation package Powersim.

3.4 Questions to be addressed

On the basis of the participatory rural appraisal (PRA) and survey results from the study sites the following were identified as the main problems that could be solved with appropriate policy instruments.

a) Inadequate agricultural practices involving use of uncontrolled fires in land clearing and exploitation of non-wood products (honey and wild game).
b) Low or non-use of improved inputs (fertilizers and improved seeds) the result of which is area expansion to increase production or shifting cultivation to maintain reasonable yields.
c) High post-harvest losses of agricultural crops.
d) Incomplete or absent markets for agricultural inputs and products, as a result of poor rural infrastructure.
e) Limited or lack of alternative employment opportunities.
f) Various fees/prices for exploitation of forest products do not reflect their economic values. Cuco (1994) noted that stumpage/royalty fees range from US \$1.20 per m^3 for second-class species to US \$3.60 per m^3 for precious species.
g) Incomplete property rights on land, with consequent absence of internalisation of the externalities that arise from the exploitation of forest resources. The ineffective enforcement of existing regulation favours the utilization of woodland resources as if under open access conditions.

In addressing the above problems, simulation experiments under the five specified alternative management options were made within the context of the following

categories of policy instruments (more details in section 4.2):

a) Policy instruments to create rural markets and improve incentives of market participants: mainly through agricultural input and output prices. For example, we employed a 25% and a 75% increase in agricultural output prices.
b) Policy instruments to promote the use of improved technologies in agricultural and charcoal production: largely through reducing post-harvest losses and increasing crop yields. We experimented with a 25% and a 75% increase in crop yields.
c) Sectoral policies aimed at forest or biodiversity conservation: mainly through fees or royalty charges on the forest products exploited. We experimented with a 30% increase in various fees charged for exploiting forest products for sale.

Table 1. Baseline data

Item	Units	Study site		
		Nhamatanda	Dondo	Gondola-Manica
Average farm size	ha	2.0	2.6	3.5
Discount factor ( )		[0.909;0.89]	[0.909;0.89]	[0.909;0.89]
Household labour efficiency parameter (q_h)		[0.1;0.05]	[0.1;0.083]	[0.1;0.03]
Forest area for community (N_t)	ha	12 000	14 500	25 000
Existing agricultural land (N_a)	ha	4997.2	1890.2	8355
Conversion cost miombo	\$ per m^3	0	0	0
Wage rate (w)	\$ per year	303.72	303.72	303.72
Average price of standing miombo (P_{ave})	\$/m^3	19.30	15.40	11.55
Price of fuel wood (P_{fw})	\$/m^3	3.17	3.06	3.3
Price of poles (P_{po})	\$/m^3	5.2	5	5.4
Purchased inputs		0	0	0
Regeneration (s)		0.012	0.012	0.012
Revenue from agriculture (P_a)	\$/ha	206.03	253.66	134.5
Subsistence income (I_h)	\$	1 095 156	734 561	1 099 930
Survival rate (s)		0.92	0.92	0.92
Social concern parameter ( )		0 or 1	0 or 1	0 or 1
Total potential labour per household	mandays	1273	986	1565
Total labour in the community	mandays	2 446 706	716 822	3 735 655
Parameter to labour cost function (v)		0.5	0.5	0.5
Standing volume of wood (K_t)	m^3/ha	38	47	40
Number of habitants per site		13 454	4 362	14 322
Harvesting cost by commercial sector	\$/m^3	9.75	7.8	5.85
Efficiency parameter for labour for commercial harvesting (q_c)	-	0.05	0.083	0.3
Potential area for commercial harvesting	ha	8 935	1 234	7 282

3.5 Data used

The data used to run the base models are presented in Table 1. The data were obtained from a field survey conducted in 2000 and supplemented with data from secondary sources.

4. RESULTS AND DISCUSSION

4.1 Basic simulation results

The basic results are presented under three categories of management regimes, namely:

a) A scenario in which a central or local government (regulator) determines the annual harvesting levels by household and commercial/private sectors in order to maximize society-wide benefits, which include the direct economic benefits, social benefits and environmental benefits (Command model).
b) A scenario in which the household and commercial/private sectors decide, of their own free will, to cooperate on the harvesting levels for each sector in order to maximise their joint net benefits (Cooperative model).
c) A scenario in which the household and commercial/private sectors act independently, each setting its level of harvesting to maximize own benefits (Non-cooperative model).

4.1.1 Effect of private sector participation (commercialisation) on household benefits

The relative weight assigned to each sector in the cooperative game is reflected by the preference parameter whose value varies from 0 (giving all weight to the household sector) to 1 (giving entire weight to the commercial/private sector). Figures 2 to 4 present the results. These results are compared with those obtained from the non-cooperative model. The top curve (Total household benefits) represents the combined benefits from woodlands and agriculture.

The joint discounted net benefits from woodland products are highest when the private sector or commercialisation is given maximum preference and they are least when total weight is given to the household sector. Given that, in practice, these benefits are not redistributed between the participating sectors, these extreme levels of existence are not practical and therefore define the outermost limits for both sectors; that is, in practice, the private sector and households coexist between these two extremes. It is therefore the responsibility of the decision maker to decide on the appropriate weight to give to each sector and taking into account the monetary benefits, employment creation and eventual forest condition, among others.

In the Dondo site, which is more endowed with miombo woodlands than the other two sites, there is a clear declining trend of household sector discounted net benefits from woodland products and a rising trend of commercial sector discounted net benefits from woodland products as the level of private sector participation or commercialisation increases. The rate of decline slows down when the preference level is between 0.4 and 0.7. The household sector net benefits from combined agriculture and forest activities (the top curve) are also sensitive to changes in preference parameters, showing that forest activities contribute a pronounced share to households' total benefits.

The household sector's net befits from the combined forest and agriculture activities are insensitive to changes in preference parameters in the case of the Nhamatanda

Figure 2. Effect of variation of preference parameter on the stakeholders' net benefits in Dondo

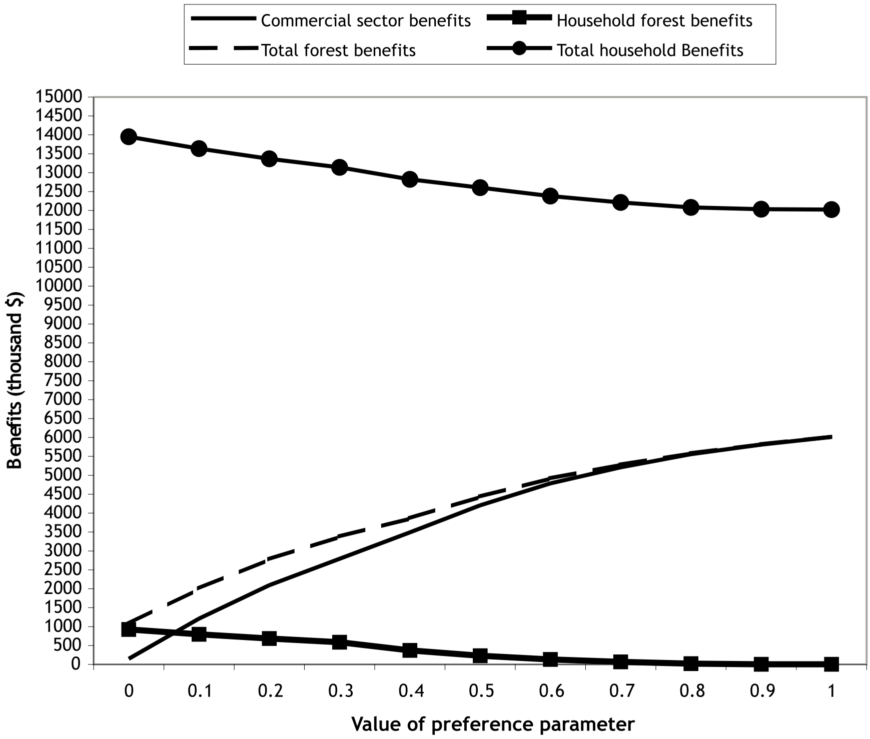


Figure 3. Effect of variation of preference parameter on the stakeholders' net benefits in Nhamatanda

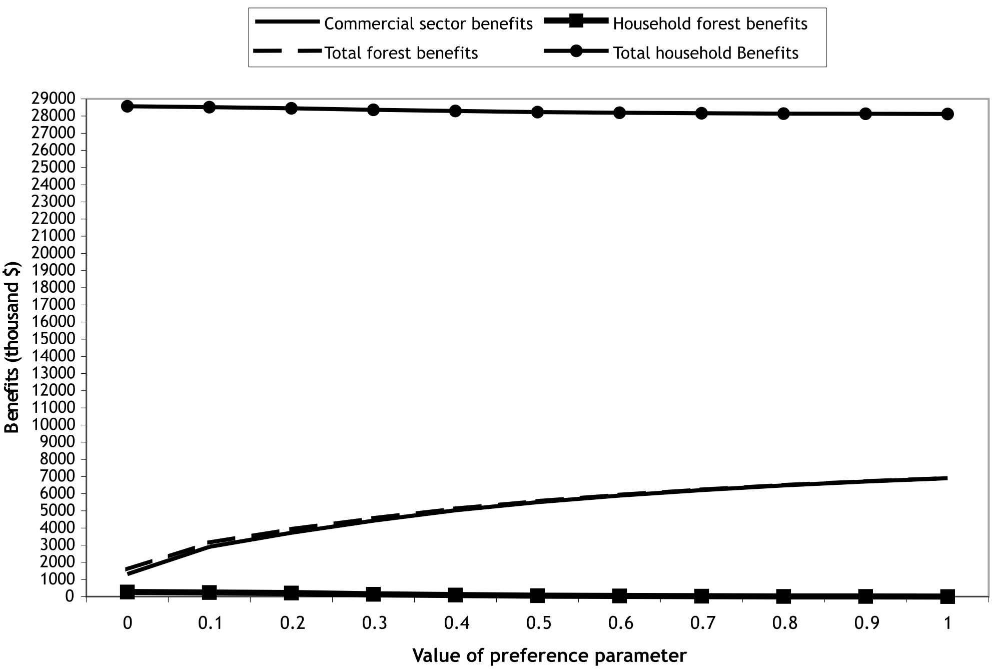
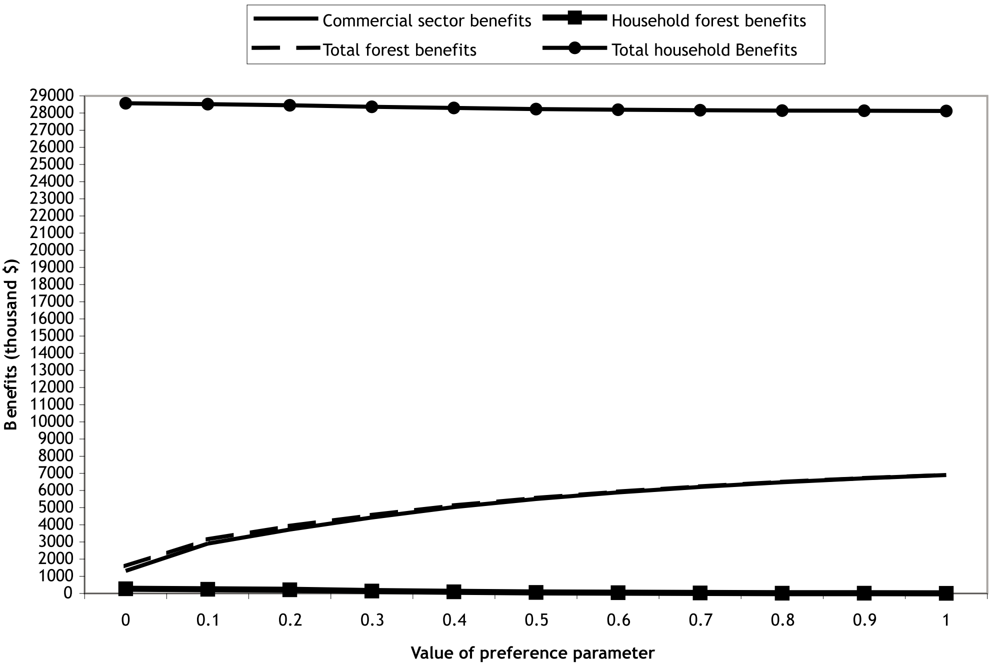


Figure 4. Effect of variation of preference parameter on the stakeholders' net benefits inGondola-Manica



and Gondola-Manica sites, as can be seen from the top curves in Figures 3 and 4. This is because these two sites have few forest resources and the products derived from them make a small contribution to total household net benefits. In these two sites, using income from the woodlands as a strategy (incentive) to households to conserve the forests would most probably be less effective as compared to Dondo. Therefore another strategy has to be devised.

4.1.2. The impact of management regimes on the well-being of stakeholders and on woodland resources

This section will first present the results on comparative analysis of the five management regimes with particular emphasis on their impact on the well-being of stakeholders and on the forest resources. We analyse how alternative management regimes influence the benefits accruing to the stakeholders and how these translate to volume of wood products harvested, labour employment opportunities for miombo activities and the state of forest resources. Given that currently the miombo woodland resources are principally exploited under open access, the non-cooperative model will be used as a reference point in comparing the management alternatives.

4.1.2.1 Impact on stakeholders' net benefits

The effects of management regime on discounted total benefits from miombo activities vary in terms of quantity and distribution between the two sectors (Table 2). The difference in discounted net benefits between the two sectors reflects the difference in harvesting efficiency and market values of the products harvested.

Table 2. Effect of management regime on discounted benefits from sale of woodland products ('000 US $)[a]

Study site	Management regime	Sector		All
		Commercial	Household	
Dondo	Command with social	3578.95 (3)	410.33 (1)	3989.28 (3)
	Command with environment	3227.31 (4)	21.45 (5)	3248.76 (4)
	Command with social & environment	2877.04 (5)	272.77 (2)	3149.81 (5)
	Cooperative	4206.65 (2)	228.65 (3)	4435.30 (2)
	Non-cooperative	5752.07 (1)	87.59 (4)	5839.66 (1)
Nhamatanda	Command with social	3069.08 (3)	180.53 (1)	3249.61 (3)
	Command with environment	2471.97 (4)	0.18 (5)	2472.15 (4)
	Command with social & environment	2267.12 (5)	113.93 (2)	2381.05 (5)
	Cooperative	3440.88 (2)	84.12 (3)	3525.00 (2)
	Non-cooperative	4543.65 (1)	44.99 (4)	4588.64 (1)
Gondola-Manica	Command with social	5409.64 (3)	90.35 (1)	5499.99 (3)
	Command with environment	4035.49 (5)	24.86 (4)	4060.35 (5)
	Command with social & environment	4041.64 (4)	44.83 (3)	4086.47 (4)
	Cooperative	5506.10 (2)	61.54 (2)	5567.64 (2)
	Non-cooperative	6871.26 (1)	20.90 (5)	6892.16 (1)

[a] *Fugures in parentheses are the rankings of the management regime in terms of benefits derived by stakeholders*

(a) The commercial sector

For the three study sites, the highest discounted net benefits to the commercial sector would be consistently obtained under the non-cooperative management regime, i.e. under an open access situation. Since the non-cooperative regime is the most beneficial to the commercial/private sector, the sector would not welcome government intervention or cooperation with government or local communities unless the intangible benefits and the penalties for non-compliance exceed the additional benefits emanating from cooperation. The cooperative regime would be the second best option, followed by the command regime incorporating social concerns. Therefore if the aim is to promote private sector involvement in woodland management and use, then the open access (non-cooperative regime) situation or the status quo would be the most appropriate approach to the private sector.

(b) The household sector

The management regime that would lead to the highest discounted net benefits from woodland products to the household sector would be the command regime incorporating social concerns. The benefits accruing to the household sector under this regime would be more than 300% higher than those that would be obtained under the non-cooperative regime or open access situation for the three sites. In the case of Dondo and Nhamatanda, the regulated regime incorporating social and environmental benefits would be the second best option, followed by the cooperative regime. For the Gondola-Manica site, the cooperative regime would be the second best alternative followed by the regulated regime incorporating environmental benefits. The regulated option for environmental reasons would be least beneficial to the household sector in Dondo and Nhamatanda and it would be second least beneficial in Gondola-Manica. The non-cooperative arrangement would be least attractive for communities in Gondola-Manica. The conclusion is that if decision makers or rural planners put more weight on rural household welfare, then the command regimes (social and social + environmental concerns) appear to be the most appropriate management regimes for the woodlands, followed by the cooperative regime. The open access situation or status quo (non-cooperative regime) would appear to be very disadvantageous to local communities.

(c) The combined household and commercial sectors

For both the household and commercial sectors, if the objective is to maximize discounted net benefits from miombo wood products without considering their distribution between the two sectors, then the non-cooperative arrangement or status quo would be most attractive in all three sites, followed by the cooperative and then command with social concerns regimes. The command management incorporating social and environmental benefits would provide the least potential discounted net benefits from miombo wood products in Dondo and Nhamatanda, while the command arrangement incorporating environmental benefits would be the least attractive management option in Gondola-Manica.

However, since the bulk of the benefits flow into the commercial sector, the combined total benefits for the two sectors follow the trend of the commercial sector benefits (Table 2). Decision makers would be advised, to the extent possible, to make site-specific decisions on the management regimes. For example, it would appear that in Nhamatanda and Gondola-Manica, where few forests remain, giving households more weight than the commercial sector in forestry would be reasonable. This would then lead to the recommendation of the command regime incorporating social concerns as being more appropriate. In Dondo, where forest resources abound, private/commercial sector initiatives alongside household welfare concerns could be promoted or given more weight than in Nhamatanda and Gondola-Manica. Under such a situation the cooperative regime or command regime with social concerns would appear to be more relevant. In both situations neither sector would realise the potential maximum benefits dictated by the best management option, the non-cooperative regime or the status quo; one sector loses while the other gains, depending on the weight we attach to either of the two sectors.

(d) Combined agricultural and woodland benefits

In terms of total household benefits (from miombo products and agriculture) the command regime incorporating social concerns would be the best for all the three sites (Table 3).

In the case of Gondola-Manica, there was a switch in ranking between the command arrangement incorporating environmental concerns and the non-cooperative arrangement with the latter occupying the last position and the former occupying the fourth position. The Dondo site, which is more endowed with forest resources, has the highest net benefits per capita while the Nhamatanda site, which has suffered most from deforestation, has the least net benefits per capita.

Table 3. Effect of management alternatives on household sector total benefits and annual total benefits per capita[a]

Study site	Management regime	Total benefits in US $ '000	Annual per capita net benefits US $
Dondo	Command with social	13100.20 (1)	60.07 (1)
	Command with environment	12024.80 (5)	55.13 (5)
	Command with social &environment	12621.50 (2)	57.87 (2)
	Cooperative	12604.20 (3)	57.79 (3)
	Non-cooperative	12273.60 (4)	56.28 (4)
Nhamatanda	Command with social	26193.50 (1)	38.94 (1)
	Command with environment	25739.70 (5)	38.26 (5)
	Command with social & environment	26004.80 (2)	38.66 (2)
	Cooperative	25975.30 (3)	38.61 (3)
	Non-cooperative	25879.30 (4)	38.47 (4)
Gondola-Manica	Command with social	28298.20 (1)	39.52 (1)
	Command with environment	28136.30 (5)	39.29 (5)
	Command with social & environment	28167.00 (3)	39.33 (3)
	Cooperative	28231.90 (2)	39.42 (2)
	Non-cooperative	28148.50 (4)	39.31 (4)

[a] *Fugures in parentheses are rankings of the management regime in terms of benefits derived by stakeholders.*

The average volume harvested annually and potential for labour employment that would lead to maximum discounted benefits under each management arrangement exhibit trends corresponding to those of benefits derived from these products.

These results seem to suggest that the two regulated (command) management arrangements that emphasise social and social plus environmental concerns (followed by the cooperative management regime) are potentially beneficial to local communities and the private sector. The failure by governments to guarantee a flow of such benefits (in the form of investment in economic and social infrastructure) to communities leaving in the proximities of forest resources has contributed to the poor performance of central or local government regulated management regimes. Therefore, decentralization of forest resource management to local levels with in built mechanisms for benefit sharing between the regulator (central or local government) and the communities has the potential to improve the welfare of the communities and the condition of woodlands. Some central or local government influence is still possible and desirable. This can be done through forestry extension agents who can raise and sustain in the local communities the awareness of the social and environmental values of the woodlands, thus facilitating their consideration in woodland management regimes that the communities might eventually evolve.

The other alternative is a partnership arrangement between the commercial sector and local communities (cooperative) in managing and harnessing forest resources in areas in the proximity to these communities. The current land law and forest and wildlife management policy provide a legal basis for putting such arrangements into practice.

4.1.2.2 Impact of different management regimes on forest resources

Incomplete property rights, poor agricultural practices and policy failure in internalising the externalities arising from the exploitation of forest resources have contributed to high rates of deforestation and land degradation. The weak institutional capacity to enforce existing legislation on use of forest resources has led to their utilization under open access. Table 4 presents a summary of the impact of different management regimes on the relative area of standing miombo and relative forest area converted to agriculture using the non-cooperative management regime (status quo) as a reference. At the steady state, the standing forest area at the end of the simulation period (relative to that of the non-cooperative management regime) would be highest under the command regime incorporating environmental concerns, followed by the command regime incorporating social and environment benefits, cooperative regime, command regime incorporating social benefits and lastly the non-cooperative regime. This trend is observed in all sites.

In all sites, the deforestation would be highest under open access (i.e. non-cooperative situation). At the end of simulation period only about 20% of the initial area will remain forested in the Dondo site (which is currently the most forested of the three sites), 26% in the Nhamatanda site and 25% in the Gondola-Manica site. As

Table 4. Relative area (in %) of standing miombo and that converted to agriculture[a]

Site	Management regimes	Relative area of standing miombo	Relative area converted to agriculture
Dondo	Command with social concern	141.19 (4)	385.06 (1)
	Command with environment	193.85 (1)	10.02 (5)
	Command with social & environment	175.03 (2)	221.06 (2)
	Cooperative	151.10 (3)	202.74 (3)
	Non-cooperative	100.00 (5)	100.00 (4)
Nhamatanda	Command with social	147.70 (4)	318.79 (1)
	Command with environment	175.90 (1)	0.28 (5)
	Command with social & environment	174.16 (2)	187.92 (2)
	Cooperative	148.87 (3)	159.42 (3)
	Non-cooperative	100.00 (5)	100.00 (4)
Gondola-Manica	Command with social	167.37 (4)	335.02 (1)
	Command with environment.	201.81 (1)	52.37 (5)
	Command with social & environment	195.32 (2)	82.95 (4)
	Cooperative	168.34 (3)	225.23 (2)
	Non-cooperative	100.00 (5)	100.00 (3)

[a] *The non-cooperative arrangement is used as a base for comparison and the figures in parenthesis are rankings of the management regimes*

expected, the regulated (command) system incorporating only environmental concerns would lead to least deforestation in all three sites, but it is the option least attractive to the household and commercial sectors in terms of incomes/benefits.

In terms of benefits for both commercial and household sectors, the command regimes incorporating social and environmental plus social concerns appeared favourable, and they would also appear to be a reasonable choice when consideration is given to the relative area of standing miombo in the long term. However, with the exception of the command regime with environmental concerns, the other two variants of the command regime (social and social + environment) would appear to be associated with relatively more area under woodlands converted to agriculture. But this is the price or trade-off for improving overall household benefits.

4.1.2.3 Implications of alternative management regimes

The alternatives analysed for managing miombo woodland resources reflect either on-going practices or practices in the early stages of being introduced. The experience of centrally regulated regimes has not been effective in redressing deforestation and land degradation. Although governments have the obligation to defend society-wide interests in natural resource conservation and use, experience shows that the policies adopted and instruments used for their implementation have been ineffective. The fact that social benefits implied by central government are not felt at grass-roots level gives an incentive for non-compliance, which in turn is facilitated by lack of institutional and financial capacity for enforcement.

The fact that the regulated (command) management regimes (central or local government) that take into account social needs or both social and environmental needs are potentially more beneficial to the household sector than when forests are exploited as in open access, suggests that if these benefits were to flow to the local communities, non-compliance could be minimized. This can be guaranteed under decentralized management with local community participation but with clear definition of the benefit sharing arrangement. The cooperative arrangement that already has a legal support for property rights protection needs to be promoted. Though this was ranked as second best, it would appear to be the best management regime for all sites because it has better potential than the command management regimes to allow for all the benefits to remain with the principal stakeholders the local communities and private sector.

4.2 Policy impact on stakeholders' benefits, wood products harvested and on the miombo woodlands under alternative management regimes

In this section we analyse the potential impact of sectoral and extrasectoral policies on the benefits of stakeholders' utilisation of woodland resources and the consequent impact on the resource. The extrasectoral policies considered here are those that influence agricultural performance, because of its central role in the livelihood and food security of rural communities, and because that agricultural activities are one of the main causes of deforestation. The sectoral policies considered here are those related to different types of fees charged for exploiting forest resources.

4.2.1 Increase in fees charged on forest products

An increase in various fees charged on forest products can be viewed as a means of raising public revenue and, at the same time, as a policy instrument to influence the exploitation of forest resources through its taxation effects on users benefits. The potential impact of a 30% increase in various fees charged on commercialised wood products on stakeholders' benefits, labour employment opportunities in forest activities and forest resources was analysed. Particular attention was paid to the interaction between the management regimes and the increase in fees. Table 5 presents a summary of the results on the benefits to the household and commercial sectors.

(a) Potential effects on the commercial sector

An increase in fees under ceteris paribus conditions is expected to reduce incomes to the commercial sector, but this could be to different magnitudes depending on the woodland management regime. A 30% increase in various fees charged on wood products would lead to a reduction in discounted net benefits to the commercial

Table 5. Potential effects of a 30% increase in fees on stockholders' benefits (US $'000)[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial -	3615.41(1)	2527.82(2)	2076.86(3)	1815.23(4)	1593.22(5)
	forest benefits	*(-37.1)*	*(-39.9)*	*(-42.0)*	*(-43.7)*	*(-44.6)*
	Household	125.94(4)	277.72(3)	558.76(1)	35.28(5)	361.05(2)
	forest benefits	*(43.8)*	*(21.5)*	*(36.2)*	*(64.5)*	*(32.4)*
	Household	1244.40(4)	12733.80(3)	13371.70(1)	12038.80(5)	1285.60(2)
	total benefits	*(1.4)*	*(1.0)*	*(2.1)*	*(0.1)*	*(1.9)*
	Household	57.04(4)	58.39(3)	61.31(1)	55.20(5)	58.95(2)
	benefits per capita[c]	*(1.4)*	*(1.0)*	*(2.1)*	*(0.1)*	*(1.9)*
Nhamatanda	Commercial-	2901.97(1)	2140.06(2)	1912.63(3)	1323.86(4)	1209.71(5)
	forest benefits	*(-36.1)*	*(-37.8)*	*(-37.7)*	*(-46.5)*	*(-46.6)*
	Household	55.23(4)	122.53(2)	200.06(1)	0.107(5)	114.62(3)
	forest benefits	*(22.8)*	*(45.7)*	*(10.8)*	*(-13.0)*	*(0.6)*
	Household	25935.70(4)	26050.30(2)	26170.80(1)	25739.70(5)	26048.00(3)
	total benefits	*(0.2)*	*(0.3)*	*(-0.1)*	*(0.0)*	*(0.2)*
	Household benefits	38.55(3)	38.72(2)	38.90(1)	38.26(4)	38.72(2)
	per capita[c]	*(0.2)*	*(0.3)*	*(-0.1)*	*(0.00)*	*(0.2)*
Gondola - Maniaca	Commercial -	4416.56(1)	3469.73(2)	3396.00(3)	2262.38(4)	2254.45(5)
	forest benefits	*(-35.7)*	*(-37.0)*	*(-37.2)*	*(-43.9)*	*(-44.2)*
	Household	28.35(5)	77.62(2)	102.66(1)	38.95(4)	54.66(3)
	forest benefits	*(35.7)*	*(18.0)*	*(13.6)*	*(56.3)*	*(21.9)*
	Household total	28183.10(4)	28284.40(2)	28368.00(1)	28149.10(5)	28192.10(3)
	benefits	*(0.1)*	*(0.2)*	*(0.3)*	*(0.1)*	*(0.1)*
	Household	39.36(4)	39.50(2)	39.61(1)	39.31(5)	39.37(3)
	benefits per capita[c]	*(0.1)*	*(0.2)*	*(0.3)*	*(0.1)*	*(0.1)*

[a] The figures in italics represent changes (in%) from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b]NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.
[c]US $ per year

sector of more than 35% under all management regimes. The largest reduction is observed under the command regime with environmental and social concerns, where the discounted net benefits relative to base scenario would be reduced by 45% in Dondo, 47% in Nhamatanda and 44% in Gondola-Manica. These results conform to a priori expectations since the social concern component is in favour of the household sector, meaning that in addition to the restriction on harvesting implied by taking up environmental concerns, the commercial sector is indirectly penalised by the social consideration that favours free access to the woodlands by the household sector for its needs. The discounted net benefits would appear to be least sensitive (smallest reduction relative to base results) to fees increase under the non-cooperative regime. However, the net benefits in relation to base results would be reduced by 37% in Dondo and 36% in both Nhamatanda and Gondola-Manica. This would imply that an open access situation would be conducive to increased harvesting and commercialisation to offset/contain the loss in volume of revenue due to an increase in royalty fees. Comparing the discounted net benefits under alternative management options the same ranking is maintained as in Table 2 (basic results) in the case of Dondo and Nhamatanda. The results therefore indicate that the commercial sector benefits would be very sensitive to modest changes in royalty charges and that the non-cooperative regime (an open access situation) followed by the cooperative regime would offer the best opportunities to cushion some of this impact through increased harvesting.

(b) Potential effects on household sector forest benefits

The imposition of royalty fees without an increase in the sales price of forest products is expected to reduce commercial harvesting of the woodlands, thus releasing labour that could possibly be engaged in agriculture and increase household benefits (Table 6). The results for the Dondo and Gondola-Manica sites show an increase in discounted total household benefits under all management arrangements (Table 5) as compared to basic results (Table 2). In Nhamatanda, all but the command regime with environmental concerns show an increase in total household benefits relative to the base results, with the highest values being attained under a cooperative regime. The same trend is maintained with respect to discounted net forest benefits that would increase appreciably, but from the insignificant changes in total household benefits this means that in value terms the forest benefits are relatively small. The observed increase in household discounted net forest benefits from miombo activities would be obtained as a by-product of land conversion to agriculture (agriculture becomes relatively more beneficial than miombo activities) through the sale of forest products harvested from the converted land. More labour would be available for household activities due to a decline in demand by the commercial sector as indicated in Table 6.

When the management regimes are compared after an increase in royalty fees, the same ranking as in the base scenario is maintained in terms of discounted forest benefits to the household sector in all sites. This would imply that a royalty fee increase policy would not influence the relative suitability of the five management regimes in the three sites when the development goal is to sustain or increase household benefits. The best forest management regime per site, as indicated by the base results, could therefore continue to be maintained under such circumstances.

(c) Potential impact on combined agricultural and woodland benefits to household sector
The overall potential impact of royalty fee increase on total household benefits from agriculture and forest activities appears to be small, less than 0.5% for both Nhamatanda and Gondola-Manica and between 1 and 2% for Dondo (Table 5). The substitution effects resulting from changes in relative net prices can explain this apparent lack of sensitivity. The benefits from crops on the expanded agricultural land coupled with benefits derived from miombo products harvested and sold from the converted land would be more than sufficient to compensate for the modest increase in royalty fees charged on any commercialised forest product. This result implies that the royalty fees charged are too low to affect the total household income. Again, the relative ranking of the management regimes in terms of discounted total household benefits has been maintained as in the basic results. In all sites the command regime incorporating social concerns continues to have the highest potential total household benefits.

d) Potential impact on labour employment and on woodland resources
An increase in fees has the potential to reduce labour employment by the commercial sector under all management regimes because commercial harvesting would become less profitable. However, the degree of responsiveness in the reduction of labour employment potential would be dependent on the forest management regime. As it can be seen in Table 6, the largest reduction in labour employment potential for commercial activities relative to basic results would be achieved under the command management regime that emphasizes social and environmental concerns in Dondo and Gondola-Manica and the command management regime that emphasizes environmental concerns in Nhamatanda. The least reduction would be achieved under the cooperative management regime in Dondo and the command management regime with social concerns in Nhamatanda and Gondola-Manica.

When the management regimes are compared, in terms of their ranking, with the base results, Dondo and Gondola-Manica maintain the same rankings. For the Nhamatanda site, a switch in ranking occurs between the command-social and command-social-environment management regimes.

Labour employment behaviour in the household sector when fees for woodland products are increased would appear to be opposite to that of the commercial sector, with the exception of the command-environment regime in the Nhamatanda site. As explained earlier, the potential for increased profitability of agriculture relative to forest activities would create a demand for more labour for land conversion to agriculture. This labour would be withdrawn from the less profitable commercial sector. As in the case of commercial labour employment, the degree of responsiveness to a fees increase would be dependent on the forest management regime and study sites. When the management regimes are ranked in terms of the level of labour employment potential by the household sector, Dondo and Gondola-Manica maintain the same rankings, in which the command management regime that provides for environmental concerns would appear to have the highest potential for labour employment (i.e. would release most labour), followed by the non-cooperative management regime. In the case of the Nhamatanda site, the cooperative management regime would have the highest potential, followed by the non-cooperative management regime.

An increase in fees has often been argued to have potential to promote forest or biodiversity conservation. The impact of increased fees on biodiversity conservation would be most pronounced under the two command management regimes that

incorporate environmental concerns in all sites (Table 6), as seen from the proportion of woodland stock left standing at the end of the simulation. These management options would lead to the highest area of standing miombo woodlands in all sites at the end of the simulation period. However, in both Nhamatanda and Gondola-Manica the non-cooperative regime would also lead to the same conclusion, apparently from the reducing pressure now experienced on these resources. The forest royalty fee increase would be least effective in mitigating deforestation under the cooperative regime and the command with social concerns regime in all three sites. These results seem to suggest that the management options that will minimize conflicts between multiple objectives will be between these two extremes.

4.2.2. An increase in agricultural output prices by 25% and 75%

Policies leading to an increase in agricultural output prices are intended to stimulate improvement in agricultural production and consequently improve rural incomes and food security. The impact of price increases on agricultural production will be constrained by the resources and production technologies, at least in the short run.

Table 6. Potential effects of a 30% increase in fees on labour employment and woodland conservation[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest labour (Proportion)	0.481(1) *(-15.2)*	0.294(2) *(-13.3)*	0.201(3) *(-17.6)*	0.167(4) *(-31.1)*	0.129(5) *(-32.5)*
	Household forest labour (proportion)	0.110(4) *(25.9)*	0.132(3) *(16.8)*	0.320(1) *(17.7)*	0.005(5) *(54.3)*	0.134(2) *(25.2)*
	Standing miombo woodlands (% of initial area)	24.17(5) *(17.4)*	32.71(3) *(5.1)*	29.58(4) *(1.7)*	46.89(1) *(17.4)*	43.64(2) *(21.6)*
Nhamatanda	Commercial forest labour (Proportion)	0.440(1) *(-10.2)*	0.290(2) *(-9.4)*	0.233(3) *(-7.2)*	0.012(5) *(-93.5)*	0.107(4) *(-33.95)*
	Household forest labour (Proportion)	0.104(4) *(15.7)*	0.126(2) *(22.3)*	0.257(1) *(8.9)*	0.000(5) *(-0.35)*	0.108(3) *(4.9)*
	Standing miombo woodlands (% of initial area)	29.37(5) *(14.2)*	44.83(2) *(5.9)*	39.23(4) *(3.3)*	50.45(1) *(11.51)*	44.65(3) *(12.02)*
Gondola-Manica	Commercial forest labour (Proportion)	0.606(1) *(-13.9)*	0.403(2) *(-12.2)*	0.386(3) *(-12.1)*	0.188(4) *(-32.6)*	0.185(5) *(-33.2)*
	Household forest labour (Proportion)	0.095(4) *(14.7)*	0.113(2) *(11.9)*	0.185(1) *(10.8)*	0.018(5) *(26.8)*	0.103(3) *(11.7)*
	Standing miombo woodlands (% of initial area)	22.75(5) *(25.7)*	35.12(3) *(15.3)*	34.66(4) *(14.4)*	54.04(1) *(23.3)*	45.02(2) *(27.3)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b] NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.

(a) Potential effects on stakeholders' benefits

The results on the potential effects of an increase in agricultural/crop output prices on stakeholders' benefits are presented in Tables 7 and 8. When agricultural prices increase, keeping other factors constant, forest activities will become less profitable relative to agriculture, causing a shift of more labour to agriculture. It is therefore expected that the benefits to the commercial sector will decline. In the case of the household sector, benefits from forest activities can actually increase as a result of the revenue obtained from the sale of wood products obtained in the process of land conversion to agriculture. However, our results show that the theoretical predictions are not always achieved, since these are constrained by initial land productivity and forest endowment (which are site specific) and forest management regime. The initial land productivity and forest endowment will influence the level of price changes at which a switch from forest activities to agriculture would occur.

Further, in this and other sections caution should be exercised in interpreting the magnitudes of percentage changes that might appear to be very high or very small, because these changes are related to the initial conditions. For example, an increase in benefits from US$1 to US$2 would represent a very big percentage change while in real monetary values the change would appear small, while a benefit change from US$100 to US$110 will represent a small percentage change but a higher monetary value change.

(i) Potential impact on commercial sector benefits

The commercial sector forest benefits would appear to be insensitive to increases in agricultural prices by 25% and 75%. At the 25% crop output price increase the changes in commercial forest benefits in relation to the base scenario would be less than 1% in all study sites and under all management regimes (Table 7). The highest change at the 75% crop output price increase would be achieved in Dondo under the command-environment management regime with a 4.28% decline in benefits relative to the those in the base results (Table 8).

The results also show a mixed effect (indeterminate) of price increase on benefits, depending on substitution effects resulting from changes in relative net prices, the goal of each management regime, and site specific initial conditions. For example, in Dondo, an increase in commercial forest benefits is predicted under the non-cooperative management regime and a decline is also predicted in all other regimes when there is a 25% crop output price increase. When the crop output price is increased to 75%, a decline is predicted under all management regimes. In the case of Nhamatanda, at the 25% crop output price increase commercial forest benefits are predicted to go up under the non-cooperative, cooperative and command-social regimes and would decline under the command-environment and command-social-environment regimes. At the 75% crop output price increase, the benefits under the cooperative regime would decline while the other management regimes would maintain the same pattern observed under 25% crop output price increase. Similar results are also observed for the Gondola-Manica site.

With 25 and 75% crop output price increases the ranking of the forest management regimes in terms of potential to improve commercial sector benefits appears to remain the same as in the base results in all study sites. The non-cooperative management regime continues to be the most profitable in all sites, while the command regime with environment and the command with social concerns would be least in all sites

Table 7. Potential effects of a 25% increase in crop output prices on stakeholder's benefits (US $ '000)[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest benefits	5758.77(1) *(0.1)*	4185.18(2) *(-0.5)*	3563.07(3) *(-0.4)*	3212.10(4) *(-0.5)*	2859.38(5) *(-0.6)*
	Household forest benefits	90.28(4) *(3.1)*	235.86(3) *(3.2)*	433.14(1) *(5.6)*	27.80(5) *(29.6)*	283.35(2) *(3.9)*
	Household total benefits	12823.0(4) *(4.5)*	13169.6(3) *(4.5)*	13701.7(1) *(4.6)*	12568.0(5) *(4.5)*	13191.8(2) *(4.5)*
	Household total benefits per capita[c]	58.79(4) *(4.5)*	60.38(3) *(4.5)*	62.82(1) *(4.6)*	57.62(5) *(4.5)*	60.49(2) *(4.5)*
Nhamatanda	Commercial forest benefits	4557.46(1) *(0.3)*	3443.53(2) *(0.1)*	3075.87(3) *(0.2)*	2459.45(4) *(-0.6)*	2265.78(5) *(-0.1)*
	Household forest benefits	39.58(4) *(-12.0)*	86.96(3) *(3.4)*	182.75(1) *(1.2)*	1.77(5) *(1173.4)*	123.57(2) *(8.5)*
	Household total benefits	34109.2(4) (4)*(31.8)*	34248.6(3) *(31.9)*	34523.4(1) *(31.8)*	33945.5(5) *(31.9)*	34291.0(2) *(31.9)*
	Household total benefits per capita[c]	50.70(4) *(31.8)*	50.91(3) *(31.9)*	51.32(1) *(31.8)*	50.46(5) *(31.9)*	50.98(2) *(31.9)*
Gondola – Maniaca	Commercial forest benefits	6875.17(1) *(0.1)*	5505.90(2) *(-0.0)*	5409.37(3) *(-0.0)*	4030.03(5) *(-0.1)*	4048.49(4) *(0.2)*
	Household forest benefits	12.23(5) *(-41.5)*	60.33(2) *(-2.0)*	87.14(1) *(-3.5)*	25.48(4) *(2.5)*	36.46(3) *(-18.7)*
	Household total benefits	35228.9(4) *(25.2)*	35341.6(2) *(25.2)*	35421.0(1) *(25.2)*	35224.8(5) *(25.2)*	35249.6(3) *(25.2)*
	Household total benefits per capita[c]	49.20(4) *(25.2)*	49.35(2) *(25.2)*	49.46(1) *(25.2)*	49.19(5) *(25.2)*	49.22(3) *(25.2)*

[a] *The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.*
[b] *NC = Non-cooperative, COOP=Cooperative, CM-S=Command Social, CM-E=Command Environment, CM-SE=Command social and environment.*
[c] *US $ per year*

(ii) Potential impact on household sector benefits

Increasing agricultural output prices by 25 and 75% would increase household discounted net forest benefits under all forest management regimes in Dondo, while in Nhamatanda a decline would be realized under the non-cooperative management regime. There would be a decline in Gondola-Manica under all forest management regimes except under the command regime incorporating environmental/biodiversity concerns (Tables 7 and 8). However, the overall impact of a 25% crop output price increase on annual total benefits per capita in the household sector would be positive, ranging from slightly above 4% in Dondo, to 25% in Manica-Gondola and 32% in Nhamatanda, with small differences between forest management regimes (Table 7). On the other hand the potential effect of a 75% crop output price increase on total benefits per capita in the household would be large, ranging from 47% in Dondo to 75% in Gondola-Manica and 85% in Nhamatanda, with minor differences between forest management regimes within a study site (Table 8).

Table 8. Potential effects of a 75% increase in crop output prices on stakeholders' benefits

Study site	Variable	(US $ '000)[a] Management regime[b] NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest benefits	5737.33 (1) *(-0.26)*	4134.24(2) *(-1.73)*	3551.57(3) *(-0.77)*	3089.05(4) *(-4.28)*	2797.29(5) *(-2.77)*
	Household forest benefits	107.98(4) *(23.28)*	295.45(3) *(29.21)*	522.28(1) *(27.23)*	79.06(5) *(268.58)*	370.87(2) *(35.96)*
	Household total benefits	17968.0(4) *(46.40)*	18483.6(3) *(46.65)*	19224.7(1) *(46.75)*	17668.3(5) *(46.65)*	18549.7(2) *(46.97)*
	Household total benefits per capita[c]	82.38(4) *(46.40)*	84.75(3) *(46.65)*	88.15(1) *(46.75)*	81.01(5) *(46.65)*	85.05(2) *(46.97)*
Nhamatanda	Commercial forest benefits	4560.64(1) *(0.37)*	3440.52(2) *(-0.01)*	3087.43(3) *(0.60)*	2432.82(4) *(-1.65)*	2258.62(5) *(-0.37)*
	Household forest benefits	41.29(4) *(-8.22)*	96.81(3) *(15.01)*	199.51(1) *(10.51)*	7.71(5) *(5446.86)*	148.04(2) *(29.94)*
	Household total benefits	47744.1(4) *(84.49)*	47949.3(3) *(84.60)*	48328.5(1) *(84.51)*	47528.9(5) *(84.65)*	48026.0(2) *(84.68)*
	Household total benefits per capita[c]	70.97(4) *(84.49)*	71.28(3) *(84.60)*	71.84(1) *(84.51)*	70.65(5) *(84.65)*	71.39(2) *(84.68)*
Gondola—Maniaca	Commercial forest benefits	6880.9(1) *(0.14)*	5515.16(2) *(0.16)*	5414.7(3) *(0.09)*	4022.45(5) *(-0.32)*	4047.54(4) *(0.15)*
	Household forest benefits	5.02(5) *(-75.98)*	60.55(2) *(-1.61)*	86.95(1) *(-3.76)*	29.62(4) *(19.15)*	40.49(3) *(-9.68)*
	Household total benefits	49307.4(5) *(75.17)*	49473.8(2) *(75.23)*	49587.4(1) *(75.23)*	49317.3(4) *(75.28)*	49406.0(3) *(75.40)*
	Household total benefits per capita[c]	68.86(5) *(75.17)*	69.09(2) *(75.23)*	69.25(1) *(75.23)*	68.87(4) *(75.28)*	68.99(3) *(75.40)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b] NC = Non-cooperative, COOP=Cooperative, CM-S=Command Social, CM-E=Command environment, CM-SE=Command social and environment.
[c] US $ per year

As explained earlier the increase in household forest benefits resulting from crop output price increases would result from sale of forest products obtained when converting the forest to cropland (Tables 9 and 10). Such forest benefits would be higher at the 75% than at the 25% crop output price increase, probably because with a 75% crop output price increase more forest land would be converted to cropland (Table 10), a process that would be accompanied by more saleable forest products from the converted land.

The ranking of the forest management regimes in relation to household forest benefits has been maintained as in the base results in all sites. The same appears true in the case of total household benefits from agriculture and forest activities, with the exception of Gondola-Manica, where a switch occurs between non-cooperative and command-environment. The implication could be that the relative suitability of the forest management regimes to individual sites does not appear to be sensitive to or influenced by fairly significant rises in crop output price.

(b) Potential effects on forest or biodiversity conservation

Table 9 shows that a 25% crop output price increase would have an insignificant effect on the area of standing miombo at the end of the simulation period in all three sites when compared to base results. The results are mixed, with both decreases and increases in deforestation. For example, in Dondo, a small decline relative to the base results (less than 1%) is observed under non-cooperative, command with environmental/ biodiversity concern, and command with social concern management regimes. A potential increase in deforestation of less than 1% is indicated in Gondola-Manica under all management regimes.

When the management regimes are ranked in terms of the percentage of standing miombo at the end of the simulation period, the command regime with environmental concerns occupies the first position and the non-cooperative regime occupies the last

Table 9. Potential effects of a 25% increase in crop output prices on woodland conservation[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest labour Proportion)	0.570(1) *(0.5)*	0.335(2) *(-1.2)*	0.243(3) *(-0.4)*	0.227(4) *(-0.4)*	0.190(5) *(-0.5)*
	Household forest labour (Proportion)	0.089(4) *(1.3)*	0.112(2) *(-0.9)*	0.274(1) *(0.7)*	0.004(5) *(27.3)*	0.108(3) *(0.9)*
	Standing miombo (% of initial forest area)	20.46(5) *(-0.6)*	31.22(3) *(0.3)*	29.12(4) *(0.2)*	39.82(1) *(-0.2)*	35.93(2) *(-0.3)*
	Land converted to agriculture (ha)	29.09(4) *(2.3)*	58.80(3) *(2.0)*	113.25(1) *(3.4)*	3.70(5) *(29.8)*	64.70(2) *(2.9)*
Nhamatanda	Commercial forest labour (proportion)	0.492(1) *(0.4)*	0.321(2) *(0.3)*	0.253(3) *(0.8)*	0.186(4) *(-0.5)*	0.162(5) *(0.0)*
	Household forest labour (Proportion)	0.078(4) *(-12.5)*	0.099(3) *(-4.0)*	0.230(1) *(-2.5)*	0.000(5) *(1191.8)*	0.103(2) *(0.0)*
	Standing miombo (% of initial forest area)	25.98(5) *(1.0)*	38.35(3) *(0.2)*	38.05(4) *(0.2)*	45.17(1) *(-0.2)*	44.78(2) *(0.0)*
	Land converted to agriculture (ha)	18.09(4) *(0.3)*	31.33(3) *(8.9)*	63.38(1) *(10.2)*	0.29(5) *(545.9)*	38.25(2) *(12.8)*
Gondola-Manica	Commercial forest labour (Proportion)	0.700(1) (-0.6)	0.460(2) (0.2)	0.440(3) (0.2)	0.278(4) (-0.4)	0.277(5) (0.0)
	Household forest labour (Proportion)	0.070(4) *(-15.4)*	0.099(2) *(-2.4)*	0.164(1) *(-1.8)*	0.014(5) *(-1.4)*	0.088(3) *(-4.9)*
	Standing miombo (% of initial forest area)	18.25(5) *(0.8)*	30.52(3) *(0.2)*	30.33(4) *(0.1)*	36.59(1) *(0.2)*	35.43(2) *(0.2)*
	Land converted to agriculture (ha)	9.82(3) *(-0.9)*	24.80(2) *(11.1)*	37.01(1) *(11.5)*	5.78(5) *(11.4)*	8.87(4) *(7.9)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.

[b] NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.

position in all three sites. Nhamatanda and Gondola-Manica have maintained the same rankings as in the base run results.

Producer price increase appears to have the potential to promote forest conversion to agriculture under all management regimes in all three sites except under the non-cooperative regime in Gondola-Manica, where a small decline (less than 1%) is observed in relation to base results, implying that the crop output price increase would not necessarily be accompanied by an increase in deforestation. The response to price increase, in percentage terms, in forest conversion to agriculture is more pronounced under the command regime incorporating environmental benefits in the case of Dondo and Nhamatanda (29.8% and 545.9% respectively, relative to base results) and the non-cooperative regime in Gondola Manica (36% relative to base results). However, in absolute terms, the land area values involved would be very small despite the extremely high percentage changes associated with some management regimes in the tables, and this is also influenced by the initial conditions. Also, the physical area converted to cropland would be higher under the command management regime with social concerns while the command regime with environmental/biodiversity concerns hold potential for least forest area conversion. The model's prediction conforms to Barbier's (2000) observation that in low input agriculture, an increase in output prices will promote area expansion instead of intensification, at least in the short run. Although land conversion has been demonstrated to be responsive to modest price increase, its impact on deforestation would be insignificant largely because the areas involved are small, reflecting the low efficiency implicit in the hand tools used for forest conversion as well as, probably, inadequate adult male labour in the household. Normally men undertake the laborious task of clearing forests when opening new farms.

The impact of a 75% increase in producer price has maintained the same trend of deforestation observed under a 25% price increase (Table 10) in all sites and under all forest management regimes. The rate of deforestation under all forest management regimes has maintained its insensitivity to price changes, from the 25% to the 75% producer price increase. Much as forest conversion to agriculture shows a large percentage increase in comparison to the base results, in absolute terms the change in actual forest area converted to cropland would be small. Again, adult labour and technological constraints would indicate that the response of area converted to agriculture as a result of price increase has little impact on deforestation.

When the management regimes are ranked in terms of the area of standing forest at the end of the simulation period, the command-environment regime occupies the first position, while the non-cooperative regime (implicit of status quo) occupies the last position in all study sites. The results suggest that a compromise between conservation and profit will be found between these two extreme management regimes.

When the alternative forest management regimes are compared with the current practice (non-cooperative regime), they all appear to be better alternatives for forest resource conservation.

If the policy objective is also to improve the forest benefits of rural households, the command regime incorporating social concerns, the command regime incorporating both social and environmental concerns and the cooperative management regime constitute the best three forest management regimes for the study areas. It therefore appears that the government, as well as the local communities, have important roles to play in managing these resources, and that the advocacy on government devolution of management of these resources to local communities might not be appropriate to all natural forests.

Table 10. Potential effects of a 75% increase in crop output prices on labour employment and woodland conservation[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest labour (Proportion)	0.563(1) *(-0.70)*	0.332(2) *(-2.06)*	0.243(3) *(-0.41)*	0.218(4) *(-4.39)*	0.185(5) *(-3.14)*
	Household forest labour (Proportion)	0.084(4) *(-3.43)*	0.113(3) *(0.0)*	0.271(1) *(-0.39)*	0.011(5) *(258.73)*	0.119(2) *(11.22)*
	Standing miombo woodlands (% of initial forest area)	20.7(5) *(0.50)*	30.8(3) *(-1.03)*	29.0(4) *(-0.40)*	39.1(1) *(-2.16)*	35.5(2) *(-1.45)*
	Land converted to agriculture (ha)	32.7(4) *(14.987)*	67.4(3) *(16.89)*	128.3(1) *(17.13)*	10.1(5) *(254.03)*	78.68(2) *(25.15)*
Nhamatanda	Commercial forest labour (Proportion)	0.497 (1)*(1.43)*	0.321(2) *(0.32)*	0.255(3) *(1.59)*	0.181(4) *(-3.21)*	0.162(5) *(0.0)*
	Household forest labour (Proportion)	0.070(4) *(-22.12)*	0.094(3) *(-8.45)*	0.224(1) *(-5.10)*	0.002(5) *(6787.2)*	0.107(2) *(3.88)*
	Standing miombo woodlands (% of initial forest area)	26.1(5) *(1.37)*	38.5(3) *(0.5)*	38.0(4) *(-0.08)*	45.0(1) *(-0.53)*	44.7(2) *(-0.13)*
	Land converted to agriculture (ha)	18.7(4) *(3.60)*	34.01(3) *(18.25)*	69.6(1) *(20.97)*	1.2(5) *(2461.25)*	44.19(2) *(30.35)*
Gondola-Manica	Commercial forest labour (Proportion)	0.706(1) *(0.28)*	0.461(2) *(0.43)*	0.441(3) *(0.46)*	0.278(3) *(-0.36)*	0.277(5) *(0.0)*
	Household forest labour (Proportion)	0.056(4) *(-32.08)*	0.095(2) *(-6.44)*	0.160(1) *(-4.19)*	0.015(5) *(7.25)*	0.087(3) *(-5.53)*
	Standing miombo woodlands (% of initial forest area)	18.3(5) *(1.16)*	30.5(3) *(0.12)*	30.3(4) *(0.07)*	36.5(1) *(0.02)*	35.4(2) *(0.26)*
	Land converted to agriculture (ha)	9.65(4) *(-2.62)*	28.02(2) *(25.53)*	42.5(1) *(28.04)*	7.2(5) *(39.11)*	19.9(3) *(142.1)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b]NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.

4.2.3 Impact of an increase in crop yields by 25% and 75%

Modest crop yield increases of 25% through improved agronomic practices appear to have the potential to improve total household benefits per capita in all study sites and under all management regimes (Table 11).

This improvement in benefits would be accompanied by increased forest conversion to agriculture in all sites and under all management regimes (Table 12). An exception is observed in the case of the cooperative model in Nhamatanda, where a 5% decline in land conversion to agriculture is predicted. A reduction of about 2% is also observed in Gondola-Manica under the non-cooperative regime. The modest increase in crop yield (or reduction in post-harvest crop losses) would not be sufficient to cover household consumption and income needs, hence the continued increase in deforestation or forest conversion into cropland.

Table 11. Potential effects of a 25% increase in crop yields on stakeholders' benefits (US $ '000)

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial	5743.69(1)	4160.07(2)	3556.73(3)	3138.99(4)	2829.02(5)
	forest benefits	*(-0.1)*	*(-1.1)*	*(-0.6)*	*(-2.7)*	*(-1.7)*
	Household	103.13(4)	271.29(3)	483.37(1)	55.82(5)	333.26(2)
	forest benefits	*(17.7)*	*(18.7)*	*(17.8)*	*(59.3)*	*(22.2)*
	Household	15625.6(4)	16062.3	16706.8(1)	15337.9(5)	16104.0(2)
	total benefits	*(27.3)*	(3)*(27.4)*	*(27.5)*	*(27.6)*	*(27.6)*
	Household total	71.64(4)	73.65(3)	76.60(1)	70.33(5)	73.84(2)
	benefits per capita[c]	*(27.3)*	*(27.4)*	*(27.5)*	*(27.6)*	*(27.6)*
Nhamatanda	Commercial	4557.78(1)	3459.26(2)	3078.67(3)	2457.85(4)	2265.26(5)
	forest benefits	*(0.3)*	*(0.5)*	*(0.3)*	*(-0.6)*	*(-0.1)*
	Household	40.5(4)	68.97(3)	183.39(1)	2.23(5)	124.78(2)
	forest benefits	*(-10.0)*	*(-18.0)*	*(1.6)*	*(1504.3)*	*(9.5)*
	Household	34851.7(4)	34944.7(3)	35272.0(1)	34683.1(5)	35036.2(2)
	total benefits	*(34.7)*	*(34.5)*	*(34.6)*	*(34.8)*	*(34.7)*
	Household	51.81(4)	51.95(3)	52.43(1)	51.56(5)	52.08(2)
	total benefits per capita[c]	*(34.7)*	*(34.5)*	*(34.6)*	*(34.8)*	*(34.7)*
Gondola-Maniaca	Commercial	6881.22(1)	5506.13(2)	5409.2(3)	4029.18(5)	4044.52(4)
	forest benefits	*(0.1)*	*(0.0)*	*(-0.0)*	*(-0.2)*	*(0.1)*
	Household	12.09(5)	62.31(2)	87.06(1)	25.35(4)	36.43(3)
	forest benefits	*(-42.1)*	*(1.3)*	*(-3.6)*	*(2.0)*	*(-18.7)*
	Household	35165.7(4)	35283.5(2)	35357.7(1)	35161.9(5)	35186.5(3)
	total benefits	*(24.9)*	*(25.0)*	*(25.0)*	*(25.0)*	*(24.9)*
	Household total	49.11(4)	49.27	49.38	49.10	49.14
	benefits per capita[c]	*(24.9)*	*(25.0)*	*(25.0)*	*(25.0)*	*(24.9)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b]*NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.*
[c]*US $ per year*

On the other hand, a 75% yield increase would reduce forest conversion to agriculture in Gondola-Manica site under all management regimes (Table 14). In the case of Dondo, land conversion to agriculture would increase under all management regimes, although the increase is smaller than at the 25% price increase with the exception of the three command regimes, which show an increase in forest conversion to agriculture of 12.2%, 157%, 16.4% respectively in comparison to the basic scenario. The results indicate that for the Dondo and Gondola-Manica sites, a high yield increase in agriculture has the potential to reduce deforestation through land conversion to agriculture. In the case of Nhamatanda, land conversion to agriculture declines by 6.2% under the non-cooperative regime and increases under the remaining management regimes (Table 14).

Total household net benefits per capita per year would improve significantly in all sites and under all management regimes in comparison with the base results (Table 13). The improvement in net benefits would range from about 64% in Dondo to slightly above 100% in Nhamatanda. A big improvement in crop yields would appear to significantly

Table 12. Potential effects of a 25% increase in crop yields on employment and woodland conservation[a]

Study sites	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest labour	0.585(1)	0.335(2)	0.242(3)	0.221(4)	0.187(5)
	(Proportion)	*(-0.3)*	*(-1.2)*	*(-0.8)*	*(-3.1)*	*(-2.1)*
	Household forest	0.087(4)	0.114(3)	0.273(1)	0.008(5)	0.115(2)
	labour (proportion)	*(-0.3)*	*(0.9)*	*(0.4)*	*(58.4)*	*(7.5)*
	Standing miombo	20.6(5)	30.8(3)	29.0(4)	39.4(1)	35.6(2)
	woodlands (% of initial forest area)	*(0.2)*	*(1.0)*	*(-0.1)*	*(-1.3)*	*(-1.3)*
	Land converted	31.58(4)	64.26(3)	122.47(1)	7.22(5)	72.94(2)
	to agriculture (ha)	*(11.0)*	*(11.5)*	*(11.8)*	*(53.3)*	*(16.0)*
Nhamatanda	Commercial	0.495(1)	0.322(2)	0.253(3)	0.186(4)	0.162(5)
	forest labour	*(1.0)*	*(0.8)*	*(0.8)*	*(-0.5)*	*(0.0)*
	Household	0.079(4)	0.097(3)	0.230(1)	+0.000(5)	0.103(2)
	forest labour	*(-11.7)*	*(-5.9)*	*(-2.5)*	*(1573.2)*	*(0.0)*
	Standing miombo	25.9(5)	38.5(3)	38.0(4)	45.2(1)	44.8(2)
	woodlands	*(0.7)*	0.4(3)	*(+0.0)*	*(-0.2)*	*(+0.0)*
	Land converted	18.36(4)	27.40(3)	63.76(1)	0.36(5)	38.62(2)
	to agriculture	*(1.8)*	*(-4.7)*	*(10.9)*	*(699.5)*	*(13.9)*
Gondola-Manica	Commercial	0.704(1)	0.460(2)	0.439(3)	0.278(4)	0.277(5)
	forest labour	*(0.0)*	*(0.2)*	*(-0.0)*	*(-0.4)*	*(0.0)*
	Household	0.070	0.099	0.164	0.014	0.088
	forest labour	*(-15.0)*	*(-2.2)*	*(-1.8)*	*(-1.4)*	*(-4.9)*
	Standing miombo	18.2(5)	30.5(3)	30.3(4)	36.6(1)	35.5(2)
	woodlands	*(0.4)*	*(0.2)*	*(0.1)*	*(0.2)*	*(0.4)*
	Land converted	9.74(3)	25.46(2)	36.95(1)	5.75(5)	8.79(4)
	to agriculture	*(-1.7)*	*(14.1)*	*(11.3)*	*(10.8)*	*(6.9)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b] *NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.*

increase household food self sufficiency and incomes to the extent that demand for new cropland (excised from the woodlands) would decline, resulting in a decreased rate of forest conversion to cropland.

At 25% and 75% crop yield improvements, the effect on commercial forest benefits would be insignificant (Table 11) largely because of insignificant labour mobility between commercial and household consumption activities. However, the results on household forest benefits would be significant and direction of change indeterminate (Table11).

In terms of the well-being of rural households, the command regime with environmental concern is the only option that would leave the households worse off in relation to the current management practice (open access), with the command regime with social concerns as the best. It would appear than crop yields would have to increase considerably before conversion of woodlands to cropland could be reversed. Only in Gondola-Manica and with crop yields of 75% could forest conversion be reversed (and under all the five management regimes); the other sites would probably need higher crop yields for woodland conversion to stop. These results suggest that policy

Table 13. Potential effects of a 75% increase in crop yields on stakeholders' benefits (US $ '000)[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest benefits	5764.82(1) *(0.2)*	4171.89(2) *(-8.3)*	3564.51(3) *(-0.4)*	3141.93(4) *(-2.6)*	2827.52(5) *(1.8)*
	Household forest benefits	90.47(4) *(3.3)*	264.81(3) *(15.8)*	467.48(1) *(13.9)*	55.37(5) *(158.1)*	326.48(2) *(19.7)*
	Household total benefits	20169.7(4) *(64.3)*	20707.0(3) *(64.3)*	21479.1(1) *(64.0)*	19840.6(5) *(65.0)*	20746.3(2) *(64.4)*
	Household total benefits per capita[c]	92.48(4) *(64.3)*	94.94(3) *(64.3)*	98.48(1) *(64.0)*	90.97(5) *(65.0)*	95.12(2) *(64.4)*
Nhamatanda	Commercial forest benefits	4573.5(1) *(0.7)*	3460.86(2) *(0.6)*	3093.9(3) *(0.8)*	2459.13(4) *(-0.6)*	2274.56(5) *(0.3)*
	Household forest benefits	31.53(4) *(-29.9)*	79.7(3) *(-5.2)*	165.03(1) *(-8.6)*	1.88(5) *(1252.5)*	118.31(2) *(3.8)*
	Household total benefits	52709.5(4) *(103.7)*	52917.8(3) *(103.7)*	53302.7(1) *(103.5)*	52497.9(5) *(104.0)*	52974.1(2) *(103.7)*
	Household total benefits per capita[c]	78.36(4) *(103.7)*	78.66(3) *(103.7)*	79.24(1) *(103.5)*	78.04(5) *(104.0)*	78.75(2) *(103.7)*
Gondola-Manica	Commercial forest benefits	6886.44(1) *(0.2)*	5522.18(2) *(0.3)*	5426.98(3) *(0.3)*	4054.58(5) *(0.5)*	4062.12(4) *(0.5)*
	Household forest benefits	0.01(5) *(-100.0)*	37.67(2) *(-38.8)*	55.37(1) *(-38.7)*	10.69(4) *(-57.0)*	16.67(3) *(-62.8)*
	Household total benefits	49168.7(3) *(74.7)*	49286.7(2) *(74.6)*	49372.5(1) *(74.5)*	49152.6(4) *(74.7)*	49146.1(5) *(74.5)*
	Household total benefits per capita[c]	68.66(3) *(74.7)*	68.83(2) *(74.6)*	68.95(1) *(74.5)*	68.64(4) *(74.7)*	68.63(5) *(74.5)*

[a] *The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.*
[b]*NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.*
[c]*US $ per year*

intervention leading to only moderate crop productivity improvement might not lead to natural resource conservation, but at a high level of productivity increase, forest conservation could be promoted.

4.2.5 A simultaneous increase in agricultural producer prices and royalty fees

On one hand, an increase in producer prices promotes agricultural expansion, while on the other hand, an increase in royalty fees discourages exploitation of forest products. This interaction is felt by household sector, which performs both activities, while the commercial sector perceives the direct impact of royalty fees increase, and possibly an indirect impact of increases in crop output prices through labour supply reduction.

Table 14. Potential effects of a 75% increase in crop yields on labour employment and woodland conservation[a]

Study Site	Variable	Management Regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest labour (Proportion)	0.569(1) (0.4)	0.337(2) (0.6)	0.243(3) (-0.4)	0.222(4) (-2.6)	0.187(5) (-2.1)
	Household forest labour (Proportion)	0.080(4) *(-8.1)*	0.112(3) -0.9(2)	0.270(1) *(-0.7)*	0.008(5) *(156.5)*	0.113(2) *(5.6)*
	Standing miombo woodlands (Percent of initial forest area)	20.61(5) *(0.1)*	30.98(3) *(-0.5)*	29.17(4) *(0.3)*	39.34(1) *(-1.4)*	35.78(2) *(-0.8)*
	Land converted to agriculture (Ha)	29.99(4) *(5.5)*	54.21(3) *(11.3)*	122.90(1) *(12.2)*	7.26(5) *(154.7)*	73.16(2) *(16.4)*
Nhamatanda	Commercial forest labour (Proportion)	0.498(1) *(1.6)*	0.324(2) *(1.3)*	0.255(3) *(1.6)*	0.186(4) *(-0.5)*	0.163(5) *(0.6)*
	Household forest labour (Proportion)	0.066(4) *(-27.1)*	0.091(3) *(-11.5)*	0.221(1) *(-6.4)*	+0.000(5) *(1172.4)*	0.099(2) *(-4.0)*
	Standing miombo woodlands (Percent of initial forest area)	26.17(5) *(1.8)*	38.54(3) *(0.7)*	38.19(4) (0.5)	45.17(2) *(-0.2)*	44.79(1) *(0.2)*
	Land converted to agriculture (Ha)	16.92(4) *(-6.2)*	31.77(3) *(10.5)*	66.26(1) *(15.2)*	0.31(5) *(599.3)*	39.87(2) *(17.6)*
Gondola-Manica	Commercial forest labour (Proportion)	0.704(1) *(0.0)*	0.462(2) *(0.7)*	0.443(3) *(0.9)*	0.280(4) *(0.4)*	0.278(5) *(0.4)*
	Household forest labour (Proportion)	0.053(4) *(-36.1)*	0.090(2) *(-11.2)*	0.157(1) *(-6.0)*	0.006(5) *(-59.0)*	0.077(3) *(-16.8)*
	Standing miombo woodlands (Percent of initial forest area)	18.36(5) *(1.4)*	30.63(3) *(0.5)*	30.32(4) *(0.1)*	36.84(1) *(0.9)*	35.35(2) *(0.9)*
	Land converted to agriculture (Ha)	6.89(3) *(-30.5)*	20.2(2) *(-9.5)*	31.56(1) *(-4.9)*	2.44(4) *(-53.0)*	0.33(5) *(-95.9)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b] *NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.*

A 30% increase in royalty fees and a 25% increase in crop output prices were evaluated simultaneously. In the Dondo and Nhamatanda sites, the household discounted net benefits from wood products and total net benefits per capita per year would increase under all management regimes in relation to base results (Table 15). In the case of the commercial sector, the discounted net forest benefits would decline under all management options. Land conversion to agriculture resulting from improved terms of trade (emanating from the increase in agricultural prices with a re-enforcement effect coming from the royalty fees increase) would appear to be responsible for the

Table 15. Potential effects of a 30 % increase in fees and 25% increase in agricultural products prices on stakeholders' benefits (US $ '000)[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest benefits	3608.85(1) *(-37.3)*	2518.23(2) *(-40.1)*	2077.68(3) *(-41.9)*	1804.66(4) *(-44.1)*	1585.50(5) *(-44.9)*
	Household forest benefits	130.67(4) *(49.2)*	293.08(3) *(27.7)*	576.85(1) *(40.6)*	43.25(5) *(101.6)*	377.79(2) *(38.5)*
	Household total benefits	12998.9(4) *(5.9)*	13306.4(3) *(5.6)*	13970.7(1) *(6.6)*	12580.8(5) *(4.6)*	13442.0(2) *(6.5)*
	Household total benefits per capita[c]	59.60(4) *(5.9)*	61.01(3) *(5.6)*	64.06(1) *(6.6)*	57.68(5) *(4.6)*	61.63(2) *(38.5)*
Nhamatanda	Commercial forest benefits	2899.04(1) *(-46.2)*	2153.26(2) *(-37.4)*	1913.27(3) *(-37.7)*	1317.47(4) *(-46.7)*	1206.49(5) *(-46.8)*
	Household forest benefits	56.32(4) *(25.8)*	100.46(3) *(19.4)*	206.17(1) *(14.2)*	3.80(5) *(2633.8)*	127.51(2) *(11.9)*
	Household total benefits	34196.6(4) *(32.1)*	34282.5(3) *(32.0)*	34620.6(1) *(32.2)*	33947.6(5) *(31.9)*	34354.4(2) *(32.1)*
	Household total benefits per capita[c]	50.83(4) *(32.1)*	50.96(3) *(32.0)*	51.47(1) *(32.2)*	50.46(5) *(31.9)*	51.07(2) *(32.1)*
Gondola-Manica	Commercial forest benefits	4423.66(2) *(-35.6)*	5524.66(1) *(0.3)*	3398.43(3) *(-37.2)*	2259.71(4) *(-44.0)*	2259.18(5) *(-44.1)*
	Household forest benefits	18.39(5) *(-12.0)*	50.77(2) *(-17.5)*	100.78(1) *(11.5)*	42.38(3) *(70.5)*	41.70(4) *(-7.0)*
	Household total benefits	35269.50(2) *(25.3)*	28214.7(5) *(-0.1)*	35570.8(1) *(25.2)*	5240.7(4) *(25.3)*	35268.6(3) *(25.2)*
	Household total benefits per capita[c]	49.25(2) *(25.3)*	239.40(5) *(-0.1)*	49.59(1) *(25.5)*	49.21(4) *(25.3)*	49.25(3) *(25.2)*

[a] *The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.*
[b]*NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.*
[c]*US $ per year*

increase. The increase in net benefits from wood products would come from the wood obtained in the process of land conversion to agriculture. In the Gondola-Manica site, an increase in total household benefits would materialize under the three management variants of command model, while a decline is predicted cooperative model.

With regard to the policy impact on the forest resource, it is observed that in all three sites, the percentage of standing woodland would increase in relation to the base results (Table 16). This improvement would basically be due to a significant decline in exploration by the commercial sector. The observed large percentage increase in land conversion to agriculture would, however, translate to a small land area largely due to constraints on availability of household male labour for forest clearing and the rudimentary technology for the job (mainly hand tools).

As compared to Table 9, more land would be converted to cropland (Table 16) due to the increased labour availability that would result from decreased commercial

Table 16. Potential effects of a 30 % increase in fees and 25% increase in agricultural products prices on labour employment and woodland conservation[a]

Study site	Variable	Management regime[b]				
		NC	COOP	CM-S	CM-E	CM-SE
Dondo	Commercial forest	0.479(1)	0.292(2)	0.202(3)	0.156(4)	0.129(4)
	labour (Proportion)	*(-15.5)*	*(-13.9)*	*(-17.2)*	*(-31.6)*	*(-32.5)*
	Household forest	0.110(4)	0.133(3)	0.321(1)	0.006(5)	0.137(2)
	labour (Proportion)	*(25.9)*	*(17.7)*	*(18.0)*	*(91.1)*	*(28.0)*
	Standing miombo	24.20(5)	32.66(3)	29.46(4)	46.78(1)	43.68(2)
	woodlands	*(17.5)*	*(4.9)*	*(1.3)*	*(17.2)*	*(21.2)*
	(Percent of initial forest area)					
	Land converted	49.26(4)	83.38(3)	163.09(1)	6.81(5)	103.88(2)
	to agriculture (Ha)	*(73.2)*	*(44.6)*	*(48.9)*	*(139.0)*	*(65.2)*
Nhamatanda	Commercial forest	0.440(1)	0.292(2)	0.233(3)	0.122(4)	0.107(5)
	labour (Proportion)	*(-10.2)*	*(-8.7)*	*(-7.2)*	*(-34.8)*	*(-33.9)*
	Household forest	0.098(4)	0.119(2)	0.252(1)	0.001(5)	0.111(3)
	labour (Proportion)	*(8.8)*	*(15.5)*	*(6.8)*	*(3012.8)*	*(7.8)*
	Standing miombo	29.61(5)	40.79(3)	39.39(4)	50.38(1)	50.15(2)
	woodlands	*(15.1)*	*(6.5)*	*(3.7)*	*(11.3(1)*	*(12.0)*
	(Percent of initial forest area)					
	Land converted	28.40(4)	42.78(3)	83.10(1)	0.70(5)	49.71(2)
	to agriculture (Ha)	*(57.4)*	*(48.8)*	*(44.5)*	*(1459.0)*	*(46.6)*
Gondola-	Commercial	0.608(1)	0.461(2)	0.387(3)	0.188(4)	0.186(5)
Manica	forest labour	*(-13.6)*	*(0.4)*	*(-11.8)*	*(-32.6)*	*(-32.8)*
	(Proportion)					
	Household	0.084(4)	0.095(3)	0.182(1)	0.018(5)	0.097(2)
	forest labour	*(1.2)*	*(-6.0)*	*(9.0)*	*(33.3)*	*(5.0)*
	(Proportion)					
	Standing miombo	22.82(5)	30.65(4)	34.67(3)	45.02(2)	45.13(1)
	woodlands	*(26.1)*	*(0.6)*	*(14.5)*	*(23.3)*	*(27.7)*
	(Percent of initial forest area)					
	Land converted	17.87(3)	20.39(2)	54.81(1)	10.6(5)	14.22(4)
	to agriculture (Ha)	*(80.3)*	*(-8.6)*	*(65.1)*	*(104.2)*	*(73.0)*

[a] The figures in italics represent changes in% from the corresponding base results, and the figures in roman parentheses are the ranking of the management regimes.
[b]*NC = Non-cooperative, COOP=Cooperative, CM-S=Command social, CM-E=Command environment, CM-SE=Command social and environment.*

activities. The combined policy strategy (forest fees/royalty and crop output price increases) also has potential to improve forest conservation, as illustrated by the greater area of standing miombo woodlands that is predicted to be there at the end of the simulation period (Table 16) as compared with a policy strategy that relies only on increasing forest fees (Table 9).

The simultaneous increase in crop yields and royalty fees demonstrated similar behaviour to that observed for the price-royalty fees combination. While the commercial

sector's net benefits were predicted to decline, those of the household sector would increase. In relation to base results, the percentage of standing forest at the end of simulation period was predicted to improve in all sites and under all management options. As expected, labour employment for miombo activities by the commercial sector was observed to decline and only increase in the household sector.

5. SUMMARY AND IMPLICATION OF THE RESULTS

1. The results show that improvement in the well-being of woodland dependent households and resource conservation can be achieved with sound management practices. These results show that the command regime incorporating social concerns and the command regime incorporating social and environmental concerns have the potential to provide higher benefits to the household sector than the open access regime. The command management regime incorporating social concerns has the potential to raise discounted net benefits from wood products by over 300% in all three sites relative to the non-cooperative management regime. In the case of the command arrangement incorporating social and environmental concerns, this increase would range from slightly over 100% in Gondola-Manica to about 200% in Dondo. This means that command management regime incorporating social concerns and the command regime incorporating social and environmental concerns have the potential to improve the well-being of the rural communities and encourage forest conservation only if these benefits were actually felt at the community level.

   The results on the cooperative management regime show that both the local communities and the commercial sectors could gain under this arrangement. Although the commercial sector will have to forgo some direct benefits in favour of the household sector, the cost saving emanating from the reduction of conflicts between the two sectors might induce this cooperation. In the case of Mozambique, where the land law permits the communities to enter into partnership with private sector in managing and using natural forest resources the results show that such cooperation is potentially beneficial to local communities if properly implemented, and further, this could be the best option given that the benefits arising from the command model do not actually reach the other stakeholders.
2. Sectoral policies in the form of fees charged on various forest products manifest their impact on the forest resource mainly through commercial sector activities in the form of a reduction of harvesting activities, when there is no compensation in the form of an increase in sales price. In the case of the household sector, short-term compensation would be achieved through land clearing for agriculture. The reduced employment resulting from reduced private sector activities could have negative ramifications for rural development, if complementary policies are not put into place to create alternative employment opportunities. Promotion of small-scale rural agro processing industries through public investment in rural roads, electricity and water infrastructure and tax incentives are potential intervention measures to create rural employment alternatives.
3. The extrasectoral policies, particularly those directed at promotinge agricultural production, have both positive and negative effects on forest development. Our results show that modest price and productivity increases in agriculture

would not encourage significant woodland clearing for cropland. Reduction in land clearing for agriculture would be achieved only if improvement in agricultural production technology leads to a large increase in productivity. Further, the impact of these policies on the forest resources and the welfare of stakeholders would be influenced by the management regime in place.

4. The impact of management regime and/or policy intervention on the welfare of stakeholders and on the forest resource will depend on the amount of natural resource endowment and the initial economic conditions on the ground. While the general direction of policy or institutional change can be predicted, the actual impact will depend on the initial conditions, which are site specific. In addition, the results show that there is no management regime capable of satisfying all goals; that is, a trade-off between goals is necessary.

ENDNOTES

1. Nash based strategies, are the choices made such that each player's strategy is an optimal response to the opponents' strategies.
2. Concession is the right of use of land under specified conditions and period.

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ANNEX 1. SOME MIOMBOSIM COMPONENTS FOR MOZAMBIQUE

A. Household Sector

A non-separable household model is assumed since the communities operate in an environment with incomplete markets. A representative household is assumed to maximize utility derived from income (I) and leisure ($T=L^{max}-L$)

$$U(I,\ T)=(I-I^{min})\ +v(L^{max}-L) \qquad (1)$$

where:

I=gross income of the household
I^{min}=subsistence consumption
L^{max}=Maximum labour available from the household
L=labour used by household in activities undertaken
 , are parameters of the utility function

The shadow wage (z) is obtained by total differentiation of the utility function and is presented in equation 2.

$$z = z(I,L) = -\frac{U_T}{U_I} = \frac{v\beta(I - I^{min})^{1-\alpha}}{\alpha(L^{max} - L)^{1-\beta}} \qquad (2)$$

The allocation of labour is made such that the marginal return to labour is the same across all activities and equal to the shadow wage. The production activities performed by the households are divided into three categories, namely: agriculture, harvesting of miombo wood and non-wood products and off-farm/off-miombo employment. For this model non-wood products have been excluded for lack of data. Wood products included are poles, firewood and charcoal (energy). The gross income and labour utilization are presented in the accounting equations 3 and 4 respectively

$$I_h=I_m+I_a+I_{of} \qquad (3)$$

$$L_h=L_m+(L_a+L_n)+L_{off} \qquad (4)$$

where:
h=household, a=agriculture, off=off-farm/off-miombo, n=new converted land. L_n =labour required for converting land to agriculture and L_a =labour required to cultivate land currently under agriculture.

i. Income from agriculture and decision to convert miombo woodlands to agriculture

In the model the income from agriculture is a sum of the income from the different agricultural enterprises practiced by a typical household as described in the descriptive results (Mlay *et al.* 2003). Optimal use of purchased inputs (where applicable) is determined from an additive production function presented in equation 5.

$$x=a+bl+cf^{d} \quad (5)$$

where: x =crop yield per hectare, l=labour requirement per hectare and f=purchased input per hectare and a, b,c, and d are parameters to be estimated.

Optimal input use is derived from first order conditions of gross margin maximization. On the basis of optimal quantities of purchased inputs and corresponding yields, net income from agriculture can be obtained on the basis of equation 6.

$$I_a=(P_a x-P_a f)H_a \quad (6)$$

Labour to be employed in agriculture is obtained by equation 7.

$$L_a=lH_a \quad (7)$$

where H_a is total land under agriculture, which is equal to the sum of the initial land under agriculture (H_i) and new land converted to agriculture (H_c).

The decision on whether to convert miombo woodlands to agriculture is made by comparing the net benefits from a hectare converted to agriculture (B_a-zl_c) with benefits from miombo wood products per hectare (B_m)

where:

$$B_a=P_a x-P_f f-zl \quad (8)$$

The conversion cost should be convex in land cleared to reflect increased labour as distance increases from the homestead. A convex labour function as presented in equation 9 is used.

$$l_c = gH_n^{\tau} \quad , \quad \tau > 1 \quad , g>0 \quad (9)$$

where H_n= new land converted to agriculture, l_c=labour requirement per hectare and and g area parameters

The total labour required to convert land to agriculture is given by equation 10.

$$L_n = \int_0^{H_n} gx^{\tau} dx = g\frac{1}{\tau+1}H_n^{\tau+1} \quad (10)$$

If B_a-zl_c>B_m for all positive values of H_n land will be converted to agriculture. If B_a-zl_c< B_m then no conversion will take place. Conversion of miombo woodlands to agriculture will continue until B_a-zl_c=B_m.

It should be noted that in the conversion process there are one-time benefits coming from the wood cleared (if it is used for poles, energy) which are accounted for in the model.

ii. Miombo activities

The households are assumed to harvest wood products for energy (firewood and wood for charcoal making) and building poles. The gross income from miombo activities would be given by equation 11.

$$I_m = P_{ave} H_m \tag{11}$$

where H_m is the volume of miombo wood harvested for poles and fuel (firewood and charcoal) and P_{ave} is a weighted price of the two products

The allocation of the total volume between energy (H_{fw}) and poles (H_{po}) is given by equations 12 and 13 respectively.

$$H_{fw} = \frac{P_{fw} H_m}{(P_{po} + P_{fw})} \tag{12}$$

$$H_p = \frac{p_{po} H_m}{(P_{po} + P_{fw})} \tag{13}$$

The volume of miombo products to be harvested by the household sector depends on the volume of standing miombo (N) and labour allocated for this activity (L_m). A Cobb-Douglass function as presented in equation 14 is used to depict the functional relationship.

$$H_m = q_h N^{\mu} L_m^{\psi} \quad 0 < \mu < 1,\ 0 < \psi < 1 \tag{14}$$

where q_h is the household efficiency parameter, μ and ψ are partial elasticities of production.

iii. Off farm/off-miombo activities

The income from off-farm/off-miombo activities depend on the wage rate (w) and labour allocated to these activities (L^{of}) as depicted by equation 15.

$$I^{of} = wL^{of} \tag{15}$$

B. Commercial Sector

The commercial sector component of the model is simpler than the household sector since it involves only one activity logging. The decision here is how much miombo to harvest each year in order to maximize total discounted benefits. The harvesting and net benefit functions for the commercial sector are presented in equations 16 and 17 respectively.

$$H_c = q_c N^{\mu} L_c^{\psi} \;; \quad 0 < \mu < 1,\ 0 < \psi < 1 \tag{16}$$

where q_c is the harvest efficiency parameter for the commercial sector. Since the harvesting process is semi mechanized, the private sector efficiency parameter is larger than that for the household sector.

$$B_c = p_c H_c - kL_c \tag{17}$$

where k=is the wage rate exogenously determined, p_c price of a cubic meter of logs.

The labour used by the commercial sector is part of the labour available from the household sector.

C. Institutional Component

As was pointed out earlier, in Mozambique land belongs to the state and its use and the resources therein is regulated by the government to maximize society-wide benefits, which include direct economic benefits, social benefits (B_s) and environmental benefits (B_e). The problem the government or regulator faces is to determine the volume of miombo to be harvested by each sector in each year in order to maximize society-wide objectives.

Defining B_h as household private net benefits and B_c as commercial sector private net benefits, the social (s) and environmental (e) benefits (B) can be presented as follows:

$$B_s(\theta_c H_c, \theta_h H_h), \tag{18}$$

$$\phi B_e(N - H_c - H_h) \text{ or } \phi B_c(H_c + H_h)$$

Where: (19)

$$\frac{\partial B_s}{\partial (N - H_c - H_s)} > 0 \text{ or } \frac{\partial B_s}{\partial (H_c + H_h)} < 0$$

Where:

a) $_h$ $_c$ are parameters reflecting the social preference of the society given to a participant in harvesting miombo wood products. The parameters take a value of 0 if there is no social preference and 1 if there is social preference. In the model $_h$ is assigned a value of zero and $_c$ is assigned a value of 1 indicating that the household sector is given social preference in harvesting miombo wood products.

b) ϕ is a parameter to capture society-wide concern about environment. It is assigned a value of 1 if the society cares about the environmental benefits and 0 otherwise.

D. Miombo woodland dynamics

The ecology of miombo is represented by a regeneration equation (equation 20), where a constant annual regeneration rate is assumed and miombo stock equation (equation 21). The two equations are presented below.

$$R_t=K_t \tag{20}$$

$$N_t=sN_{t-1}+R_t-H_{c,t}-H_{h,t}; \tag{21}$$

N_o is the initial stock of miombo woodlands, s is the survival rate.
For the implementation of the model, area under miombo and average volume per hectare of wood products were used.

21.

A system dynamics model for management of miombo woodlands in two communal areas of Zimbabwe

C. Sukume and E. Guveya

ABSTRACT

This paper reports results on the use of a systems dynamic model of woodland management (MIOMBOSIM) to two communities in communal areas of Zimbabwe – one abundant and the other less abundant in woodlands resources. The relatively well-endowed community borders the Mafungautsi Forest Reserve in Gokwe. The less endowed site was Mutangi in Chivi area. The objective of the modelling exercise was to simulate the effects over time of changes in agricultural and other economic policies on how local communities use woodlands under an open access regime and under institutional constraints imposing biodiversity concerns.

The simulations point to the following basic conclusions: a) rate of deforestation is higher in resource abundant areas; b) enforcing biodiversity requirements in a resource abundant area reduces deforestation at a lower cost in terms of loss in household benefits from woodland use compared to a resource poor area; c) increase in agricultural crop output price increases deforestation; d) decline in crop yields reduce deforestation; and e) increases in agricultural input prices and decrease in the income for basic needs produced indeterminate impacts on deforestation.

Key words: Woodlands, system dynamics, communal area, Zimbabwe.

1. INTRODUCTION

The total surface area of Zimbabwe is about 39 million hectares of which 41% is occupied by woodlands (Chipika and Kowero 2000). Close to a quarter of these woodlands consists of miombo woodlands, an African woodland dominated by *Brachystegia* species, either in pure stands or in association with *Julbernadia* and/or

Isoberlinia species (Chipika and Kowero 2000). The woodlands provide the bulk of the forest products required by the rural populace as well as serving the wood resource needs of many urbanites.

History and recent social changes have had a significant impact on the plight of miombo woodlands in Zimbabwe. Segregatory policies during pre-independence period led to the majority indigenous people being confined to agro-ecologically poor and crowded areas known presently as communal areas. The continually growing pressure for cultivation land and pastures has led to massive degradation of miombo in the communal areas. Deteriorating economic conditions especially during the 1990s, which led to massive retrenchments of workers, escalating cost of living and removal of government subsidies (Chipika and Kowero 2000) added to the burden of communal areas. The traditional role of communal areas being places of last refuge has meant that most retrenched workers come into these areas, worsening the impact on the woodland resources and the economic conditions of the households.

The above factors tend to encourage people to increase reliance on the woodlands for additional agricultural and pasture land. They could also provide an incentive to rural communities to increase harvesting of the woodlands for products for sale to supplement incomes. These and other activities have potential for deforestation and/or degradation of the woodlands. In Zimbabwe, we would expect factors affecting agriculture to have a particularly significant impact on woodland degradation. Unlike in countries such as Tanzania and Mozambique where a well-developed commercial market for charcoal exists, most woodland use in communal areas of Zimbabwe is in the form of wood for domestic use and clearing for agricultural production. Campbell *et al.* (1993), based on analysis of aerial photos, note that most deforestation is largely due to land clearing for cultivation.

The miombo in communal areas is used and managed under weak common property arrangements. In recent years, concerted effort has gone into attempts to strengthen management regimes for these woodlands (for example CAMPFIRE)[1] as a way of conserving and unlocking latent non-exploitative benefits from the woodlands. Designing institutions and strategies to protect these resources requires tools that can mimic the implications of alternative management regimes and policies.

The main problem in the woodland areas is one of reconciling the interests of key stakeholders. The local communities would want to continue relying on the woodlands for the many needs already mentioned. At the same time society in general is interested in sustained supply of goods and services of a public good character that can only be safeguarded if environmental protection measures guide management of the woodlands. All these demands have to be met in an environment of rapidly changing socio-economic policies that guide economic development in Zimbabwe.

In this paper, we develop and test a simulation model of miombo woodland management adapted from a generalised community miombo woodlands management model developed by Sumaila *et al.* (2001), on communities in Gokwe and Chivi. The model demonstrates the potential impacts of key sectoral and macroeconomic policies on local community benefits derived from the woodlands as well as potential environmental implications. This way the model serves as a potentially useful tool for rural development planning as specific hypotheses associated with the policies can be evaluated.

The paper is organised as follows. The next section provides a description of the two communities of Gokwe and Chivi that were the basis of the study. It is followed by an overview of the Sumaila *et al.* (2001) conceptual framework as well as modifications

made to adapt the model to the prevailing situations at the project sites. Section 4 presents the data used to run the model while section 5 presents and discusses simulation results of impacts of different policy scenarios and management regimes. The last section gives a summary of major conclusions from the study.

2. DESCRIPTION OF STUDY SITES

The two districts, Chivi and Gokwe, within which the study sites are located, were purposely selected as they have differing agricultural potential, and settlement history. In Chivi, Mutangi, a dam catchment area was selected while in Gokwe, villages within a radius of about 30km from the Mafungautsi state forest were selected. Mutangi is 6 km on a gravel road from the main tar road running through Chivi business centre. The site is 80 km from Masvingo town and 19 km from Chivi business centre.

Chivi communal area, the major part of Chivi district, covers 3534 km^2. Its administrative centre is Chivi business centre, an old settlement established in the early part of the 20th century. Chivi was settled by its forefathers in the mid 19th century. At the turn of the century the estimated population of Chivi district was only around 15 000 (Scoones *et al.* 1996). By 1930 the population had grown to an estimated 28 500, in part due to population movements in the reserves brought about by the implementation of the Land Apportionment Act of 1930 which set aside large tracts of land for the exclusive use of white settlers. Census figures in 1962, 1969 and 1982 showed district populations of 57 220, 80 580 and 103 656, respectively (CSO 1985). The 1992 census shows a total population for Chivi district of 157 428, with a growth rate of 1.98% and a population density of 44.5 people per square km. Campbell *et al.* (2001) calculated population densities at 58.2 people/km^2 for Mutangi.

Long-term mean annual rainfall at Chivi business centre is 545 mm (1913-2001). On average, 89% of this annual rainfall is received during the summer rainy season from November to March. However, rainfall amount, intensity and distribution are highly variable, and inter-annual variation is large (Campbell *et al.* 2002). The long-term mean has a standard deviation of 207 mm or coefficient of variation of 38 per cent. Droughts are recurrent in the region, and the most recent in 1991/92 was the worst on record, when only 83 mm of rain fell in the district. The rainfall average in Mutangi is 550 mm. Mutangi is a dam catchment utilised for irrigation, fishing, and water supply for domestic and livestock use by the local community. The soils are very poor and the area is very prone to droughts. Due to high population pressure, woodlands are being cleared for arable land, and to meet firewood and construction wood needs of the community.

The dominant vegetation in Mutangi is the woodland that forms an enclave of approximately 360 square kilometres surrounded by about five villages who share it (Campbell *et al.* 2002). The top three dominant tree species found in the area are *Colophospermum mopane*, *Terminalia sericea* and *Acacia tortilis*. Fruit trees also occur but are relatively scarce. Examples of the most commonly occurring fruit trees are *Diospyros mespiliformis*, *Azanza garckeana*, *Berchemia discolor* and *Ficus sycomorus*. Other forest products like honey, mushrooms, and medicinal plants also occur in the woodlands. There is very little wild game except for small animals like rabbits that can be found in some parts of the woodland. The woodland is mainly utilised as a grazing area for livestock, source of firewood, construction poles and occasionally as a source of fruits and other non-timber forest products (NTFPs).

The study area in Gokwe was one of communities surrounding the Mafungautsi state forest. Villages included in the survey are within a radius of 30 km from the western edges of the Mafungautsi state forest and about 50 km from Gokwe business centre. These communities have settled in the area for less than 70 years. The communities are still relatively sparsely settled and most areas are still covered by woodlands. Furthermore the communities have access to the Mafungautsi State Forest, a protected forest covering an area of 82 659 hectares (Vermeulen 1997). Villages located near the boundaries can access a total area of about 600 square kilometres of the forest.

Mafungautsi State Forest is entirely situated on the Mafungautsi plateau, one of the most northerly extensions of the Kalahari sands in Zimbabwe (Vermeulen 1997). The soils are dystrophic with poor water holding capacity. Mean annual rainfall for the area is around 819 mm. The forest is very dense with many tall and old trees. The dominant tree species is the *Terminalia sericea*, while important commercial timber species such as *Baikiea plurijuga* and *Pterocarpus angolensis* are also abundant. Many fruit trees can still be found within the forest. Wild game especially warthogs and antelopes still occur in large numbers in the forest. During the wet season, mushrooms sprout quite extensively in most parts of the forest. In addition, communities surrounding the forest are allowed to graze their livestock, collect dead wood and NTFPs like mushrooms, thatch and broom grass. However, the communities are not allowed to cut down trees, collect honey or hunt game.

3. CONCEPTUAL MODEL

To simulate potential impacts of different policies on woodlands use and condition, the study adopted a simulation model in Sumaila *et al*. (2001). The household is assumed to maximise utility (U (.)), which is a function of income(I) net of subsistence requirements(I^{min}) and leisure(L^{max} - L). That is

$$U(I,T) = (I - I^{\min})^{\alpha} + v(L^{\max} - L)^{\beta} \tag{1}$$

where:

I	=gross household income
I^{min}	=value of subsistence consumption
L^{max}	=maximum labour available to the household
L	=labour used by the household in all income generating activities; and
	and are parameters of the utility function.

Based on the utility specification in equation (*1*), the shadow wage (z) is obtained by total differentiation of the utility function to yield (See Sumaila *et al*. 2001),

$$z = z(I, L) = -\frac{U_T}{U_I} = \frac{v\beta(I - I^{\min})^{1-\alpha}}{\alpha(L^{\max} - L)^{1-\beta}} \tag{2}$$

The household derives income from use of labour and other resources in three principal activities – agricultural related activities (I_a), woodland related activities (I_m) and off farm and off-woodland activities (I_{of}). The gross household income (I) is thus

$$I = I_m + I_a + I_{of} \tag{3}$$

It is assumed in the model that a fixed proportion of labour available (L_{of}) is devoted to off-woodland/off-farm employment at a fixed wage rate (w):

$$I_{of} = wL_{of} \tag{4}$$

At any given time, total labour usage (L) consists of labour use in woodland activities (L_m), labour use on existing agricultural land (L_a), labour use on newly converted agricultural land (L_n) and labour use in off-woodland/off-farm activities as represented by equation 5.

$$L = L_m + L_a + L_n + L_{of} \tag{5}$$

Income from agricultural activities

Farm income per hectare is the product of yield (x) and area cropped (H_a) where yield or output, x, is a function of labour per hectare (l) and fertiliser per hectare (f):

$$x = a + bl + cf^d \tag{6}$$

where a, b, c, d are parameters to be identified using field data.

If revenue per hectare or agricultural output price is P_a and cost of fertiliser per hectare is P_f, profit maximisation implies optimal fertiliser requirement of

$$f = \left(\frac{P_f}{cdP_a} \right)^{\frac{1}{b-1}} \tag{7}$$

and income from agriculture is given by

$$I_a = (P_a x - P_f f)H_a \tag{8}$$

The implied labour, L_a, requirements for the cultivation of H_a hectares (the sum of initial agricultural land H_i plus newly converted agricultural land H_n) is assumed to be

$$L_a = lH_a \tag{9}$$

where l is labour required per hectare.

Whether or not the household expands area under agriculture and by how much will depend on the extra benefits it derives from agriculture compared to benefits from woodland activities taking into account the costs of wood clearance as well as the benefits from wood products from the clearance process.

Benefits per hectare of clearing and cultivating new land, B_a, consist of per unit land benefits from cultivating, less the costs of clearing (zl_c):

$$B_a = P_a x - P_f f - z l_c \tag{10}$$

where labour per hectare required to clear land, l_c, increases the more the household has to move to clear land. That is

$$l_c = g H_n^{\tau}, \tau > 1, g > 0 \tag{11}$$

where H_n is land cleared of woodlands and and g are parameters.

Given the specification of (11), total labour, L_n, required to clear land at any given time is

$$L_n = \int_0^{H_n} g x^{\tau} dx = g \frac{1}{\tau + 1} H_n^{\tau + 1} \tag{12}$$

If benefits from woodlands are greater than those from agriculture on converted land, no land will be converted to agriculture. However, if the reverse is true, forests will be converted to agriculture up to the point when marginal benefits from woodlands just equal marginal benefits from converted land less costs of land clearing.

Woodland activities

The products harvested from woodlands are mainly fuelwood (H_{fw}) and poles (H_{po}). Due to lack of information, non-timber forest products were not included in the calculation of net benefits from miombo woodlands. What proportion of the forest product harvested is used as poles and fuelwood was determined by the relative prices of each product. The proportion of area harvested for fuelwood, H_{fw}, was estimated as

$$\mathrm{H}_{\mathrm{fw}} = \frac{\mathrm{P}_{\mathrm{fw}} \mathrm{H}_{\mathrm{m}}}{\mathrm{P}_{\mathrm{fw}} + \mathrm{P}_{\mathrm{po}}} \tag{13}$$

where:

H_m is the total area of woodland harvested for fuelwood and poles,
P_{fw} is the price of fuelwood/firewood (these terms are used interchangeably in this text),
P_{po} is the price of poles.
Similarly for poles, H_{po}, was estimated as

$$H_{po} = \frac{P_{po} H_m}{(P_{fw} + P_{po})}, \tag{14}$$

Meanwhile, the total harvest function for woodlands was formulated as a Cobb-Douglas function of existing stocks of woodlands and labour:

$$H_m = q_h N^{\mu} L_m^{\psi}, 0 < \mu < 1, 0 < \psi < 1 \quad (15)$$

where:
N is the volume of standing woodland (stock),
μ and ψ are parameters of the harvest function, each assumed to be 0.5 in the model, q_h is the harvest efficiency coefficient, that is, the proportion of the total woodland resources that can be cleared using all the capacity available to the households in a given period.

If P_{ave} is the weighted average price of poles and fuel wood, income from wood harvested can be presented as:

$$I_m = P_{ave} H_m \quad (16)$$

Woodland growth dynamics
Given the encroachment on forests implied by the relationships in previous sections, the state of the resource stock at any given time (N_t) is postulated to depend on the stock in the previous period, its natural survival rate(s) and the regeneration (R_t) (equivalent to the volume, K_t, created in a given year) as well as the amount, H_t, harvested in the year. This is captured by the following relationships:

$$R_t = K_t \quad (17)$$

$$N_t = sN_{t-1} + R_t - H_t \quad (18)$$

Objectives in management
The most fundamental modification to the conceptual model in Sumaila, *et al.* (2001) is that we have only one player or participant group here, and that is the household. There is no commercial or private sector in the two sites. So, the model is a sole owner/player/user model, which operates basically by an assumption that the interests of the members of the group are coordinated. However, environmental concerns are incorporated to reflect the desire to guide communities towards taking care of the woodlands as reflected in the growing emphasis worldwide on communities to manage such resources sustainably. When undertaking a participatory rural appraisal (PRA) of the two sites it was observed that there were local attempts to manage the woodlands, though they were taking off fairly slowly in Chivi. Further, woodland management approaches brought to the communities by outsiders were reported as weak, irrelevant and detached from existing social structures.

Figure 1 presents the steps taken by households on these two sites in making decisions on the allocation of woodland resources to either agricultural production or woodland use. It provides guidance on how to mathematically formulate the model.

For each site and at any time *t*, there is an area Nt of woodlands, a portion of which is initially under agriculture cultivation, denoted *Na,* and area *Nm,* which remains forested and available for future use as poles, *Hpo,* and fuelwood, *Hfw,* as well as for conversion to agricultural land, *Ha.*

The communities in these two sites are assumed to seek to maximise the present value, *B*, of net benefits derived through their allocation of labour to woodland, agricultural and off-farm/off-woodland activities over time. Following the logic of Figure 1 the objective in decision making by the household is summarised by the following function:

$$\max_{L}\sum_{t=1}^{T}\rho_{t-1}[B_t]=\rho_{t-1}[B_h(H_{h,t})+\theta B_e(N_t - H_{h,t})]$$

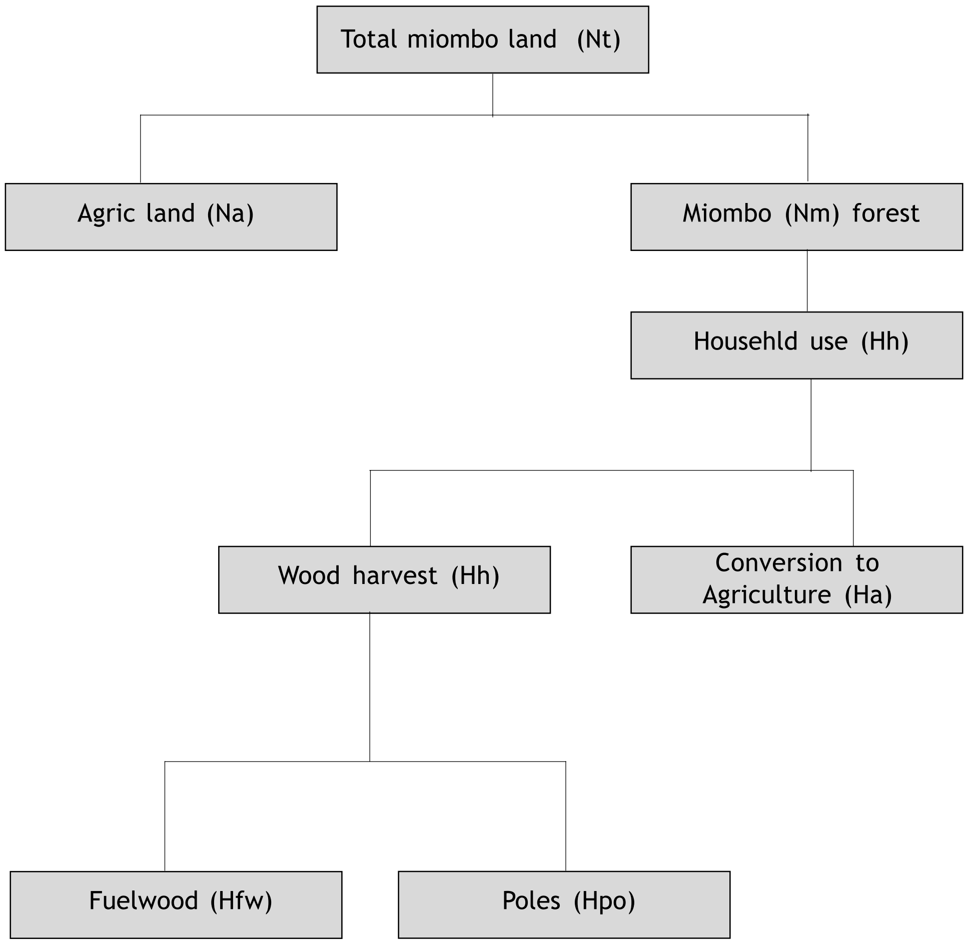
Subject to:

$$N_t = sN_{t-1}+K_t-H_{h,t} \qquad (19)$$

$$L = L_{m,t}+L_{a,t}+L_{n.t}+L_{of,t}$$

where:
B_h = benefits to households
 = discount factor
B_e = environmental benefits
θ = weight attached to woodland harvests to reflect concern for environment. θ =0 implies no environmental concern, and θ >0 implies the opposite.
and s is the survival rate of the woodlands.

Figure 1. Steps in decision making by the households in Gokwe and Chivi



In the above equations,

$$B_{h,t} = I_{m,t} + I_{a,t} - zL_{c,t} \tag{20}$$

$$B_e = B_e(N_t - H_{h,t}) \tag{21}$$

where $H_{h,t}$ is woodland susceptible to agricultural encroachment and harvesting for poles and firewood. B_e is such that

$$\frac{\partial B_e}{\partial (N - H_h)} > 0, \frac{\partial B_e}{\partial H_h} < 0$$

4. MODEL OPERATIONALISATION

To solve the above decision making model, the study uses the numerical algorithms (MIOMBOSIM) in Sumaila *et al.* (2001), which is implemented using the simulation package Powersim. Data used is based on surveys conducted in 1999 by Siziba and Mutamba (2002). The field data in this report was used to estimate the MIOMBOSIM parameters for the two sites as presented in Table 1.

In Table 1, the discount factor assumed is based on a social interest rate of 12 percent, the rate used by government for planning purposes in Zimbabwe. Based on PRA and questionnaire data about 55% of the population was active and the household

Table 1. Model data

Item	Site	
	Gokwe	Chivi
Environmental parameter ( )	1	1
Discount factor ( )	0.893	0.893
Harvest efficiency parameter (q_h)	0.133	0.0641
Off-woodland labour (proportion) (L_{of})	0.1	0.15
Average agric price/m^3 equiv (US$) ($P_{ave}$)	5.71	7.31
Wood demand/ household/per year (m3)	62	40
Fertilizer cost (US$/kg) ($P_f$)	0.14	0.10
Forest area (ha) (N_t)	42,120	5,670
Existing agric land at start of analysis (N_a)	18,323	1,042
Maximum annual labour available to household users (L) (normalized)	1	1
Number of households in the community	4,558	453
Off woodland wage for all households (US$) (w)	2,007,526	199,519
Price per m^3 of woodland firewood by the household (US$) ($P_{fw}$)	1.84	2.76
Price per m^3 of woodland poles (US$) ($P_{po}$)	1.84	2.76
Revenue from a hectare of agricultural produce (US$) ($P_a$)	285	365
Cost of seed (US$)	0.15	0.21
Subsistence income for the community (US$)	1,429,329	160,370
Woodland survival rate (s)	0.95	0.95
Total person days in community per year	4,562,558	453,453
Parameter to labour cost function of households (v)	0.5	0.5
Standing volume of wood per hectare (K_t)	50	50
Initial volume of woodland for the site (normalized)	1	1
Parameters in household cost function	0.9	0.1

size averaged 7 people in both sites. Further, it is assumed there are 260 working days in a year. The total person days per community per year is calculated as the product of the active population and the number of working days per year. Subsistence income for the community is the product of per household income and the total number of households in the community. The per-household income used is the optimal income from Linear Programming models of representative households in the two communities under study. Off-woodland wage for all households was estimated as the product of minimum commercial farm worker wage ($0.44 per day), the total active population in the community and the total working days in a year (260 days).

Wood demand per household per year was estimated as the product of average wood collected per day and the average number of days in a year the household collects wood, based on survey estimates. Siziba and Mutamba (2002) estimated that for Chivi the average household collected 0.35 m^3 per day for 116 days in a year while in Gokwe average household collected 0.43 m^3 per day for 142 days in a year. Revenue from a hectare of agricultural production was estimated as the weighted average of revenues from all crops grown by the community with proportion of area put to the different crops being used as weights. This was converted to average agricultural price per cubic metre of wood by dividing the revenue per hectare by the standing volume of wood per hectare (assumed to be 50 m^3).

5. IMPACTS OF POLICIES ON WOODLAND USE: SIMULATION RESULTS

The model allows us to answer a number of questions about the likely effects of changes in the socio-economic environment in which the Gokwe and Chivi communities under study reside. Specifically, we scrutinise the likely impacts on levels of woodland use, labour utilised in woodland related activities, household incomes, community benefits from woodlands, among others, under the following scenarios:

- Continuation of current community practices;
- Continuation of current community practices but with institutional arrangements instituted to safeguard biodiversity concerns;
- All agricultural commodity prices increased;
- Agricultural productivity reduced;
- Agricultural input prices reduced;
- Money required to satisfy subsistence income reduced and
- Wage rates in the non-woodland use sector reduced.

The justification for selecting each of these scenarios is given in the following sections.

5.1 Base case runs

Table 2 presents the base case results from the simulation runs of the model based on data for Gokwe and Chivi study areas. For both sites, the results reveal the trade-offs in the use of woodland resources for current economic gains versus conservation of the resources for biodiversity concerns. If the objective is to maximize households economic benefits without any special consideration given to environmental concerns, a net present values of US$ 2.52 million and US$ 81,000 are realised in Gokwe and Chivi, respectively. Present values are reduced to US$ 2.45 million and US$ 62,000 for

Gokwe and Chivi, respectively; when the objective is to maximize household economic benefits while protecting/conserving the environment. This represents a revenue loss of about 2.4% and 24% for Gokwe and Chivi, respectively. Gokwe borders a Government forest reserve with abundant firewood that is freely collected for household use and minimal sales at low prices. Chivi is a wood scarce area with high population pressure on land and woodland resources, thus raising the price of firewood much higher as compared to that obtaining in Gokwe (see Table 1). Therefore, financially households in Chivi could lose proportionally more than those in Gokwe if environmental conservation measures are rigorously enforced on the woodlands.

Table 2. Baseline Results of Simulations in Gokwe and Chivi

	Gokwe			Chivi		
	No-Env*	Env*	% Change	No-Env	Env	% Change
Benefits from woodlands ($'000)	2,515	2,453	-2.4	81	62	-24
Sustainable amount of woodlands	0.25	0.27	8.5	0.51	0.54	6
Labour used in woodland activities (%)	17	16	-7	5	3.2	-37
Woodland area converted to agric. land (ha/yr)	642	609	-5	19	13	-34
Average area of standing woodland (ha)	17,058	17523	2.7	3,978	4,090	2.8
Community use of woodland products (m^3/yr)	43,015	40,808	-5	1,337	888	-34
Household disposable income ($/yr)	901	896	-1	552	540	-2

*No-Env and Env indicate simulated values under respectively the 'without' and the 'with' environmental concern scenarios, and '% change' is percent difference between the two.

A measure of resource preservation is how much of the initial woodlands in the long term can be sustainably maintained based on current consumption patterns. The results again show a marked trade-off between the 'with and the 'without' environmental concerns scenarios. For Gokwe, current woodland products consumption patterns imply a long run sustained stock of a quarter of current woodland resources under the 'without' environmental concern scenario. With the environmental concern, the long-run sustainable proportion of the resources increases to about 27% of initial. For Chivi, continuing with the current consumption pattern and without environmental concerns holds potential for sustaining, in the long run, about 51% of initial woodland stock, while the proportion could increase slightly to 54% were environmental or biodiversity conservation measures adhered to. The difference between the two sites can partly be explained by the more than 50% higher per household woodland products consumption observed in the sample of households in Gokwe (see Table 1). The difference in sustained stock levels tends to indicate that households and community do adjust their consumption in response to scarcity. Gokwe households currently consume more resources because they have an abundant supply while Chivi households

used to a relatively poor resource base have adjusted their consumption downwards. The model as currently structured, however, does not allow for adjustment in demand in response to increasing scarcity.

The high woodland products consumption in Gokwe translates into a high proportion (17% and 16%) of labour used on woodland activities compared to Chivi (5% and 3.2%), both in the 'without' and 'with' environmental concern cases. Results also show that a significant proportion of woodland use in Gokwe is from agriculture encroaching into forest areas. The model predicts that 642 hectares of land on average could be converted into agricultural land each year in Gokwe as compared to only 19 hectares in Chivi, if there is free access to the woodlands or encroachment on them cannot be contained. When considerations for environmental or biodiversity conservation are taken into account Gokwe's encroachment could be reduced by 5% as compared to 34% in Chivi.

The 'without' and the 'with' environmental concern results in Table 2 indicate that for the Gokwe community, an 8.5% increase in the proportion of sustained forest resources can be realized for the loss of only 2.4 % of net benefits from the forest. However, gains in environmental benefits come at a higher cost to the Chivi community. A 6% gain in proportion of initial forest sustainably remaining comes at a cost of close to 24% loss in household economic benefits. The losses are magnified if we use the average area of standing woodlands over time as a measure of sustainability of resources. In this case the gain in resource conservation due to the incorporation of environmental concerns are 2.7 and 2.8 percent for Gokwe and Chivi, respectively.

Finally, Table 2 reports average household disposable income in the 'with' and 'without' environmental concern scenarios for the two communities. The results reflect the relative wealth of Gokwe community compared to Chivi due to the better agro-ecological endowments in the former. Using per household disposable income as a welfare measure dampens the effect of incorporating environmental concerns in woodland use decision-making. Here households' income losses at 1 and 2 % for Gokwe and Chivi, respectively, are smaller than the ecological gains in terms of both average standing woodlands and long-run sustained forest as proportion of initial forest. This means that in relative terms more is gained ecologically when environmental concerns are incorporated in the objective function than what is lost in terms of disposable income. In other words, the households lose relatively less disposable income compared to the relative gain in environmental benefits. This outcome is achieved most probably because the household cost function is endogenously determined, hence, costs (mainly labour costs) decrease enough in the 'without' scenario to bridge the gap that would have emerged as a result of the reduction in woodland harvested.

5.2 Effects of an increase in output prices

To assess the impact of general increase in output prices that could be brought about by for instance, improvement in road infrastructure, setting up of marketing infrastructure closer to the community, devaluation of an overvalued exchange rate or removal of explicit government taxes on outputs, we simulated the Gokwe and Chivi models with prices of outputs set at 25 % more than current prices. Table 3 reports the simulated outcomes as well as percent changes from the base model results obtained for the two study sites.

A priori, we would expect a general increase in output prices to increase agricultural profitability encouraging expansion of agriculture and causing deforestation. Indeed a substantial body of research shows that general increases in agricultural prices lead to deforestation. Using data from 19 Tanzanian regions Angelsen *et al.* (1999) observed a significant increase in cropped area with increases in agricultural prices. A study by Deininger and Minten (1996) using satellite imagery information from Mexico found a significant positive relationship between deforestation and agricultural price increases. Similar results were found in two separate studies on deforestation in Thailand by Cropper *et al.* (1997) and Panayotou and Sungsuwan (1994). In Zimbabwe, a study by Chipika and Kowero (2000) found a weak positive relationship between agricultural land expansion and crop price increases.

Simulation results from the two sites in this study presented in Table 3 generally agree with the above-cited findings. For Gokwe, a 25 % increase in agricultural prices has the potential to induce about 22% increase in economic benefits from woodland use under both the 'without' and 'with' environmental concern objective functions. These increases in community benefits from the woodlands translate to close to 35 % increase in per household disposable income under the two scenarios. The bulk of these benefits would come from an expansion in agricultural land. A projected 7% and 8% more land could be converted to agriculture under the 'without' and 'with' environmental concern scenario.

In terms of impact on woodland resource stock, the results from the Gokwe site imply a modest 2% reduction in the long-term sustainable standing woodlands under both the 'without' and 'with' environmental concern scenario. Thus, the cost in environmental damage would appear to be relatively small and making the inclusion of environmental concerns in managing and using the woodlands to marginally impair long term sustainability of the woodlands. Only 3.5% and 4% more household labour is diverted to the exploitation of woodland resources under the 'without' and 'with' environmental concern scenario, respectively.

Simulations of effects of general agricultural price increases for the Chivi community gave results similar to those for Gokwe with the exception being a more pronounced conservation effect compared to the Gokwe site results. The price increase is estimated to induce 26 and 28% increases in economic benefits under the 'without' and 'with' environmental concern scenarios, respectively. Under both scenarios, households are projected to gain about 40% increase in disposable income, most probably due to higher output prices obtaining in Chivi as compared to Gokwe (see Table 1). Based on the 'without' environmental concern objective function, 6% more land is converted to agriculture compared to 11% under the 'with' environmental concern scenario. Thus, taking into account biodiversity concerns into account results in 5% less converted agricultural land for no loss in individual disposal incomes. This is reflected in woodland product consumption that drops by less than 1% under the 'without' compared to 5% drop under the 'with' biodiversity concerns scenario. Consequently, only 1% (half that of Gokwe) and 6% (slightly higher than that of Gokwe) more household labour is devoted to exploiting woodlands under the 'without' and 'with' environmental concern scenarios.

In conclusion, agricultural price increases hold potential for improving livelihoods in Chivi communities more than in Gokwe. This happens through modest increases in disposable incomes, slightly higher levels of woodland products harvesting and consumption, encroachment on protected woodlands for agriculture, slight increase in

labour employment in woodland activities and overall benefits from sale of woodland products. All this comes at a negligible cost in terms of loss in woodland sustainability in the long run.

Table 3. Impacts of a 25 % increase in output prices

	Gokwe				Chivi			
	No-Env	% change	Env	% change	No-Env	% change	Env	% change
Benefits from woodlands ($'000)	3,068	22	2,999	22	102	26	79	28
Sustainable proportion of woodlands	0.25	-1	0.26	-2	0.51	0.2	0.54	-0.2
Labour used in woodland activities (%)	18	3.5	17	4	5	1	3	6
Woodland area converted to agric. land (ha/yr)	687	7	657	8	20	6	14	11
Average area of standing woodland (ha)	16,730	-2	17,188	-2	3,959	-0.5	4,065	-0.6
Woodland products used by community (m^3/yr)	43,560	1	41,716	2	1,338	0.1	928	5
Household disposable income ($/yr)	1,210	34	1,205	35	771.24	40	757	40

5.3 Effect of a loss in agricultural productivity

In general, we would expect changes in agricultural productivity to have an indeterminate direction of impact on woodland use. On one hand, an increase in productivity which does not have an appreciable impact on commodity prices and labour demand will lead to an increase in agricultural profitability and hence promote conversion of woodland to agriculture. On the other hand, yield improvements may trigger declines in prices affecting agricultural profitability reducing pressure on woodlands (Kaimowitz and Angelsen 1998). This indeterminacy of the impact of productivity on deforestation is borne out in empirical research. Studies by Deininger and Minten (1996) and Panayoutou and Sungsuwan (1994) showed that increase in agricultural yield was associated with a reduction in deforestation while studies by Angelsen *et al.* (1999) and Katila (1995) report an increase in deforestation with productivity improvement. Yet studies by Barbier and Burgess (1996) and Chakraborty (1994) showed no significant effect of yield changes on deforestation.

To assess the impact of general decline in agricultural productivity, we simulated the Gokwe and Chivi models with yields reduced by 25 %. Results in Table 4 generally support the results of studies elsewhere referred in the previous paragraph. For Gokwe, the decrease in yields are projected to induce, respectively, 22 and 23% reduction in economic benefits from miombo use under the 'without' and 'with' environmental concern objective functions. There is also a 34 % decrease in per household disposable

income under both scenarios. These are largely stemming from 10% and 11% less land converted to agriculture under the 'without' and 'with' environmental concern objective functions, respectively.

The Gokwe simulations also indicate that a 25% productivity decline has potential to boost the average area of standing miombo by 2.7 and 3.4 % under the 'without' and 'with' environmental concern scenario, respectively. The reduction on encroachment on woodlands translates to 2% and 6% less woodland use related employment under the 'without' and 'with' environmental concern scenarios, respectively.

The simulations for Chivi, a more resource poor community showed similar but more pronounced of impacts of yield decrease on woodland resource utilisation. A 25% yield decline is projected to induce 26 and 30% decrease in economic benefits from woodland use under the 'without' and 'with' environmental concern scenarios, respectively. At household level, this results in a decrease of 40% in disposable income.

There is scope for a significant reduction in pressure on the woodlands, in relation to demand for agricultural land, in Chivi as compared to Gokwe on both 'with' and 'without' scenarios. However, the trade-off for this appears to be partly reflected in 4% and 11% less woodland related employment potential under both scenarios. Because consumption is much lower under baseline conditions in Chivi compared to Gokwe (see Table 1) the effect of the agricultural yield decline on the woodlands is significantly less. About 1 % more area of woodlands under both the 'without' and 'with' environmental concern scenarios are maintained.

These results show that in both sites agricultural yield reduction could constrain deforestation. This result ought to be qualified much as logic would support that pressure on the woodlands could be alleviated if households had better incomes. However, the model does not endogenously allow for the possibility of supply induced changes in prices due to productivity changes, thus not permitting the possibility of land extensification compensating for reduced yield.

Table 4. Simulation of effects of 25% decrease in agricultural yields

	Gokwe				Chivi			
	No-Env	% change	Env	% change	No-Env	% change	Env	% change
Benefits from woodlands ($'000)	1,956	-22	1,894	-23	60	-26	43	-30
Sustainable proportion of woodlands (%)	0.25	2	0.28	4	1	0.00	0.53	-1
Labour used in woodland activities (%)	17	-2	15	-6	5	-4	3	-11
Woodland area converted to agric. land (ha/yr)	578	-10	540	-11	17	-11	11	-17
Average area of standing woodlands (ha)	17,521	2.7	18,120	3.4	4,005	0.7	4,126	0.9
Woodland products use by community (m^3/yr)	42,238	-2	39,452	-3	1,308	-2	806	-9
Household disposable income ($/yr)	593	-34	588	-34	333	-40	322	-40

5.4 Effect of an increase in input prices

Increasing the prices of inputs is likely to lead to two opposing effects (Kaimowitz and Angelsen (1998). On one hand, an increase in input prices could decrease agricultural profitability thereby decreasing the incentive for conversion of woodland to agriculture. On the other hand, subsistence farmers following a safety-first food production strategy may substitute cash inputs with land if input prices are increased and this could increase deforestation. The net effect of this price change is therefore likely to be indeterminate. In a number of CGE modelling efforts that looked at impact of lowering agricultural subsidies – which is the same as increasing input prices – this indeterminacy seems to be supported. A study by Mwanawina and Sankayan (1996) in Zambia estimated that an increase in input prices tends to increase the level of encroachment on woodlands while a similar study in Tanzania showed no effect due to input price increases. A study by Coxhead and Shively (1995) in the Philippines estimated a reduction in deforestation due to input price increases.

Other dimensions that may affect how responsive a community's woodlands use is to input price increases are the initial levels of cash inputs use and the cropping patterns. Communities in the study areas that use a lot of cash inputs and are involved in cash crops such as cotton that demand more cash inputs (fertilisers, seed agrochemicals) would tend to exhibit more inelastic response to changes in prices as compared to communities that traditionally use little bought inputs. Thus we would expect the response to be more muted in Gokwe where cotton growing is a major enterprise as compared to Chivi which is relatively more subsistence oriented.

To assess the impact of general increase in cash input prices we simulated the Gokwe and Chivi models with cash input prices increased by 25 %. Table 5 reports the changes from the base model results obtained for the two study sites. The minute changes projected in woodland use as well as inconsistent directions of impacts would tend to support the indeterminacy hypothesis. For Gokwe the 25% increase in input prices is projected to induce only 1 and 1.3% reduction in economic benefits from woodland products under the 'without' and 'with' environmental concern scenarios, respectively. Even though the projected impact is reduction on encroachment on agricultural land, the effects are almost insignificant. Close to 0.2% less land is converted to agriculture under the 'without' and 1% more in the 'with' environmental concern scenarios, respectively. Corresponding drops on woodland related employment are only 2% and 1% under the 'without' and 'with' environmental concern objective functions, respectively. The net projected impact on woodlands indicates contradictory and very insignificant effects. Though there is a projected 0.1% decrease in area of woodlands under the 'without' environmental concern scenario, the results for the 'with' environmental concern scenarios indicate a 0.4% increase in average area of woodland resources.

Results show that responses tend to be slightly larger in Chivi supporting the hypothesis that more commercialised communities are more input price inelastic. Still the results show very small changes in woodland use from the 25% input price increase in Chivi tending to support the indeterminacy hypothesis. The price increase is projected to induce only 3 and 2.5% decreases in economic benefits from woodland products under respectively the 'without' and 'with' environmental concern scenarios accompanied by loss in woodland related employment that amounts to close to 3% and 1% under the 'without' and 'with' environmental concern, respectively, as well as reductions in per household disposable income that amounts to less than 2 % in both

scenarios. Land converted to agriculture could be reduced by about 0.6% and 0.2% under the ‘without’ and ‘with’ environmental concern scenarios, respectively. Average woodland area improves by about 0.2 and 0.1 % under the ‘without’ and ‘with’ environmental concern scenarios, respectively. All these results support our earlier assertion that responses in Gokwe would most likely be more muted as compared to Chivi.

Table 5. Simulation of effects of 25% increase in agricultural input prices

	Gokwe				Chivi			
Outcome	No-Env	% change	Env	% change	No-Env	% change	Env	% change
Benefits from woodlands ($’000)	2,492	-1	2421	-1.3	79	-3	60	-2.5
Sustainable proportion of woodland	0.25	-0.4	0.27	1	0.51	0.4	0.54	0.00
Labour used on woodland activities (%)	17	-2	16	-1	5	-3	3	-1
Woodland converted to agric land (ha/yr)	641	-0.2	604	-1	19	-3	13	-0.2
Average area of standing woodland (ha)	17,043	-0.1	17,596	0.4	3,988	0.2	4,093	0.1
Woodland products used by community (m^3/yr)	43,099	0.2	40,615	-0.5	1,306	-2	888	0.1
Household disposable income ($/yr)	887	-1.6	881	-1.7	543	-1.8	531	-1.6

5.5 Effect of a decrease in subsistence income

The reduction in income necessary to meet community basic needs which can come about through lowering of consumption goods due to economic growth or improvements in social infrastructure – better roads, clinics near homesteads, more retail out lets, *etc* – lowering transactions costs, will likely have two conflicting impacts on the woodlands use. It lowers the need for agriculture to generate enough income to meet subsistence need and therefore reducing use of woodlands. On the other hand, reduction in labour demand on existing agricultural land may make more labour available for woodland related activities thus increasing pressure on the forests.

To assess the impact of such a change in the community’s economy we simulated the Gokwe and Chivi models with the subsistence parameter arbitrarily set at 25 % less than current. Table 6 reports the changes from base model results obtained for the two study sites. For Gokwe the decrease in subsistence requirements generally induced very mild impacts on woodland use. Table 6 shows that Gokwe experienced a tenth of a percent increase in economic benefits under the ‘without’ and third of a percent reduction in economic benefits under the ‘with’ environmental concern scenarios, respectively. All other indicators of woodland condition and community well being with the exception of household disposable income showed responses of less

than 1 percent. The only significant impact was on disposable income which increased by about 9% under both the 'without and 'with' environmental concern scenarios.

Similar results were observed in the case of Chivi with the exception that the impact on income in Chivi was substantially higher than in Gokwe showing an improvement in per household disposable incomes of about 16% under both scenarios.

The net results tend to support the indeterminacy hypothesis under both decision-making scenarios and in both sites.

Table 6. Simulation of effects of 25% decrease in subsistence income

	Gokwe				Chivi			
	No-Env	% change	Env	% change	No-Env	% change	Env	% change
Benefits from woodlands ($'000)	2,517	0.1	2,446	-0.3	80	-1	62	0.3
Sustainable proportion of woodland (%)	0.25	-0.4	0.27	0.8	0.51	0.2	0.54	0.00
Labour used in woodland activities (%)	17	0.00	16	-0.6	5	-1	3	0.3
Woodland converted to agric land(ha/yr)	644	0.3	607	-0.4	19	-1	13	0.3
Average area of standing woodland (ha)	17,033	-0.2	17,581	0.3	3,982	0.1	4,089	-0.01
Woodland products use by community (m^3/yr)	43,129	0.3	40,647	-0.4	1,325	-1	890	0.3
Household disposable income ($/yr)	980	9	974	9	641	16	628	16.4

5.6 Effect of a decrease in off-woodland/off-farm wage

The reduction in off-woodland wages, which can come about through poor growth in the rest of the economy, will likely increase the pressure on woodlands in order to sustain the community (Kaimowitz and Angelsen 1998). To assess the impact of such a change in the community's economy we simulated the Gokwe and Chivi models with the off-woodland wage parameter arbitrarily set at 25 % less than current. Table 7 reports the changes from base model results obtained for the two study sites.

The decrease in off-woodland wages generally induced very mild and mixed impacts on woodland use in both Gokwe and Chivi. Table 7 shows that impacts on all indicators of woodland use were 1 % or less in Gokwe under the two decision scenarios. Largest impacts of 1.2% and 1.3 % were experienced for decreases in disposable income. Similar results were observed in the case of Chivi. However, in Chivi the negative impact on disposable income at 3% under the two scenarios were more pronounced than in Gokwe.

An explanation of the mixed direction of impacts of reduction in off-woodland wages is that our model does not allow reallocation of labour between woodland/

agricultural use and off-woodland activities. Labour allocated to off-woodland activities is fixed for the community. Thus, declines in off-woodland incomes will not lead to a shift in labour into agriculture or woodland using activities. In addition, the mild impacts we observe may be partly due to the fact this source of income constitutes only a small part of the total income of the household.

Table 7. Simulation of effects of a 25% decrease in off-woodland wages

	Gokwe				Chivi			
	No-Env	% change	Env	% change	No-Env	% change	Env	% change
Benefits from woodlands ($'000)	2,520	0.2	2,441	-0.5	80.75	-0.4	60	-3.4
Sustainable proportion of woodland (%)	0.25	-0.4	0.27	1	0.505	0.00	0.54	0.2
Labour used in woodland activities (%)	17	0.00	16	-0.6	5	-1	3	-3
Woodland converted to agric land (ha/yr)	644	0.3	605	-0.7	19	-1	12	-3
Average area of standing woodland (ha)	17,023	-0.2	17,627	0.6	3,980	0.05	4,098	0.21
Woodland products use by community (m^3/yr)	43,111	0.2	40,525	-0.7	1328	-1	866	-3
Household disposable income ($/yr)	890	-1.2	884	-1.3	536	-3	523	-3.2

6. MAIN FINDINGS AND CONCLUSIONS

This paper presents and demonstrates a useful framework for analysing the impacts of policies on woodland condition and use. The findings point to the following basic conclusions:

- There is a tendency to extract more wood resources in Gokwe compared to Chivi, which, given the difference in access on the two sites, supports the notion that easy access to woodlands promotes deforestation.
- Introducing biodiversity concerns in a resource abundant area such as Gokwe could reduce deforestation at a lower cost in terms of loss in benefits from the woodlands as compared to a resource poor area such as Chivi.
- Increase in agricultural product prices has the potential to increase deforestation on both project sites. The magnitude of woodland loss, however, tends to be more in the forest resource abundant Gokwe compared to a resource poor Chivi.
- Decrease in yields could lead to reduced deforestation in both resource abundant and scarce areas. However, this result may be misleading since the model does not allow for a price response to changes in supply.
- Increase in agricultural input prices could lead to a decrease in woodland area on

both sites in the long run. However, the change in steady-state proportion of remaining woodland would appear to be indeterminate tending to support the hypothesis that there are two opposing impacts caused by input price increases – decrease in deforestation due to decline in profitability, and increase in deforestation due to substitution of land for cash inputs.

- A decrease in income required to meet subsistence needs could lead to mixed impacts on deforestation under both community profit maximisation and maximisation subject to environmental concern constraints. Though a reduction in the requirement for agriculture to meet basic needs may lead to less encroachment on forests, the labour released from existing agricultural land may promote non-agricultural forms of woodland use that exert pressure on the environment.
- Though we would expect that declines in growth in the rest of the rural economy to reduce non-agricultural wages and enhance reliance on agriculture thereby leading to deforestation, simulations in this study show mixed results. This is largely due to the structure of the model, which does not allow for a shift in labour away from off-woodland activities to agriculture.

These conclusions demonstrate the strong effect on woodland use and condition of agricultural policies and institutional arrangements protecting forests. As Zimbabwe proceeds with its second - and much expanded - phase of the land reform and redistribution exercise, it is important that issues of protection of the woodlands are not ignored. Of particular concern is the lack of consideration for development of local level institutions governing the use of forest resources in the current land redistribution exercise. The model presented here provides a tool for potential use in crafting new policies and institutions governing woodland resource use in the newly settled areas.

However, despite its robustness the model used in the current study can be improved in a number of ways. There is need to allow for price response to changing supply and demand conditions for both inputs and outputs from woodlands and agriculture. Differences in woodland product consumption between resource abundant and resource poor areas indicate the need to allow for a demand response to scarcity in the model. Finally, the model can benefit from explicit incorporation of population dynamics.

ENDNOTES

1. CAMPFIRE stands for Communal Areas Management Programme for Indigenous Resources.

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22.
Management of miombo woodlands in Malawi: An application of system dynamics modelling

R. Kachule, H. Tchale and C. Mataya

ABSTRACT

The effect of different policy changes in the forestry and agriculture sectors of Malawi were assessed using a systems dynamic model with the acronym MIOMBOSIM on three different sites, namely, Chimaliro, Dzalanyama and Mdeka. The model was applied to establish the effect of five management regimes on the welfare of the local communities and sustainability of forest resources. Five management scenarios were evaluated, namely, 'command management regime' which assumes that central, local or village government controls management of the resources; 'cooperative management regime' whereby local communities manage the resource with active cooperation among themselves; and 'non cooperative management regime' whereby stakeholders have free access to the resources without taking the interests of each other into account. The latter mimics an open access scenario. Further, the command management regime assumes that the government takes into account 'social', 'environmental', 'social and environmental' concerns of all stakeholders; thus giving us three potential management scenarios.

Results indicated that highest total monetary benefits from the woodlands to all stakeholders would be realized under the command model with social concerns in all the sites. This is contrary to expectations because current policy by the central government is to devolve management of the woodland resources to the local communities and the private sector, a move that implicitly advocates the cooperative management approach. The potential for environmental protection or biodiversity conservation in all sites would appear to lie with the command regime that emphasises environmental concerns. Increases in the price of fuelwood to 75% might not significantly influence deforestation in the three sites under all management regimes,

most probably due to the fact that labour for harvesting and transporting the product on the head or with bicycles to distant markets could be a limiting factor for households to take advantage of the high prices. Increases in fertilizer prices by 75% could result in modest increases in total household benefits in both Dzalanyama and Chimaliro, because households would harvest and sell more fuelwood to more than offset any cuts in crop production that would result from using less fertilizer. However, in Mdeka total household benefits would decline as this site is almost depleted of woodland resources that households could fall on to offset decreases in agricultural production due to low fertilizer use.

Key words: System dynamics, forest resources, households, Malawi.

1. INTRODUCTION

Malawi is a small landlocked country surrounded by Mozambique to the south, east and west, Tanzania to the north and east and Zambia to the west. It has a land area of 118,480 km^2. About 9.8 million of its inhabitants occupy a land area of 9.4 million ha. Of the total land area, agricultural land accounts for 61% while forests occupy about 38%. About 20% of the total land area is under protected forests consisting of natural forests (71%), natural grassland (15%), plantation forest area (6%), potentially agricultural land (7%) and other protected areas (1percent) (Government of Malawi 1998).

The country's forests are dominated by miombo woodlands, mainly species of *Brachystegia*, *Julbernadia* and *Isoberlinia*. Miombo woodlands account for approximately 70% of the total forest area and 97% of all forest species (Government of Malawi 1996). The distribution of the forest resources is skewed; with 50% of them in the Northern Region and the rest of the forest resources are distributed equally between the densely populated southern and central regions. Administratively, the country is divided into three regions (northern, central and southern regions) with a total of 27 districts.

The population of the country is estimated at 9.8 million with the Southern region accounting for 47%, Central region 41% and Northern region 12%. Population growth rate is estimated at 1.9% and 50% of the population is below the age of 15 years. Poverty is widespread in the country and is characterized by hunger, malnutrition, and low per capita incomes with the most vulnerable groups being women, children and the elderly. Literacy rate is estimated at 56.6% and 27.2% for men and women, respectively. Life expectancy at birth is estimated at 38.9% for women and 38.6% for men. HIV sero-prevalence rates range from 3.3% in rural areas to 30.4% in major urban centers (United Nations and Government of Malawi 1993).

The country's economy is based on agriculture which contributes about 40% of the Gross Domestic Product (GDP), accounts for about 90% of the export earnings, offers employment to almost 80% of the population and supplies over 90% of the food consumed in the country while manufacturing accounts for only 13% of GDP (Malawi Government 2001). Productivity in agriculture has remained low and about 60% of the people live below the poverty line. Unless the rate of economic growth exceeds that of population, poverty will continue to increase and exert pressure on shrinking cropland and natural resources. The result could be an ecological imbalance that has potential to adversely affect the agricultural sector, the backbone of livelihoods of rural households and the national economy.

In an effort to contain the deteriorating economic situation, Malawi has since 1981 implemented economic reforms, commonly referred to as Structural Adjustment Programmes (SAPs), in collaboration with the International Monetary Fund and the World Bank. The SAPs aimed at:

- Stabilizing the economy;
- Accelerating agricultural growth;
- Diversifying the export base;
- Increasing efficiency of export substituting enterprises and parastatals;
- Improving the mobilization and management of public resources including sustainable utilisation of natural resources to anchor the economic activities (World Bank 1994).

In line with other on-going initiatives to improve the well being of Malawians, these reforms have potential to influence the behaviour of individuals and industry in ways that could impact on the sustainability of the country's forest resources.

This study was initiated with the purpose of developing a model that would demonstrate the potential effects of selected economic reform (SAPs) and sectoral policies on the welfare of rural communities and the status of forest resources they depend on. The model was constructed to demonstrate these effects under five potential natural forest management scenarios, namely: management by government (central, local or village government), referred to as 'command regime'; management by local communities with active cooperation among themselves, referred to as 'cooperative regime'; and a situation whereby stakeholders have free access to the resources and do not take the interests of each other into account, referred to as 'non-cooperative regime'. The latter mimics an open access situation. The command management regime assumes that the regulator who controls the woodland resources (i.e. the government) would take into account social and environmental concerns of all stakeholders. This means that the regulator could give more weight to environmental concerns when managing the woodland resources, and this would give us an 'environmental scenario' as would be the case of protecting biodiversity in fragile ecosystems or managing water catchment areas. Alternatively the regulator could give more weight in managing the woodlands to the social concerns of the local communities that depend on these resources, like allowing them free access to collect firewood or perform rituals in sacred forests. This would give us a 'social concern scenario'. Further, the regulator could take into account in managing the woodlands both the social and environmental concerns, thus giving us a fifth management regime, the 'social and environmental concerns scenario'.

Policy experiments were carried out to highlight the potential effects of different policies on rural employment, household incomes, and encroachment on natural forests, and sustainability of the forest resources.

This paper is arranged as follows: section 2 describes the study sites; section 3 describes the methodology employed, section 4 presents results on baseline scenarios, section 5 presents policy experiments/sensitivity analyses, and section 6 summarises the major findings.

2. DESCRIPTION OF STUDY SITES

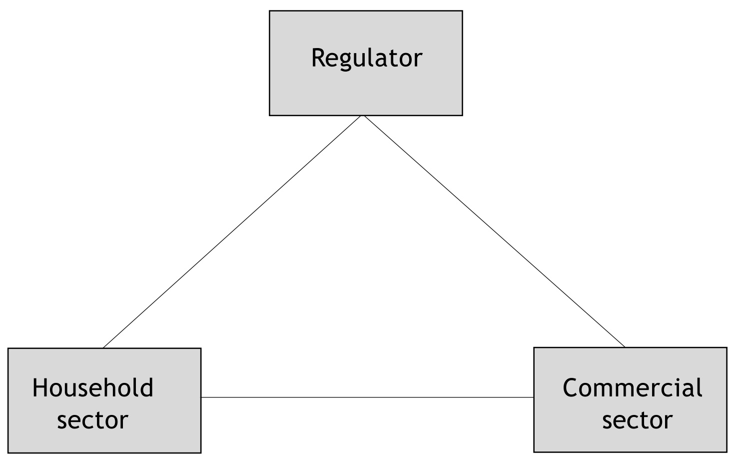
The research was conducted in three different sites bordering forest reserves namely, Chimaliro and Dzalanyama in the central region of the country and Mdeka in the Southern Region of the country. Tchale *et al.* (in this book) gives detailed description of each site, with more details on Dzalanyama found in Ngalande (1995) and that of Chimaliro in Lowore *et al.* (1995). Proximity of the area to urban centers was one of the criteria used in selecting the study sites, since this defined a gradient of accessibility to markets and other infrastructure, with those areas far from urban centers being the most deprived of these facilities. Dzalanyama and the Mdeka sites are close to the cities of Lilongwe and Blantyre, respectively, while the Chimaliro site was selected because of its remoteness.

3. METHODOLOGY

3.1 The conceptual model

The systems dynamic model follows the generic model developed by Sumaila *et al.* (2001). Two user groups of miombo woodland resources identified in the study sites belonged to the 'household sector' and the 'commercial sector'. It was necessary to disaggregate them this way so as to differentiate 'household consumption' activities as constituting a 'household sector' from those that target 'commercialisation' of forest products that is done by a few households and mainly in collaboration with middlemen, as constituting a 'commercial sector'. Otherwise in these rural areas we are principally dealing with households only. A third woodland stakeholder is a 'regulator' who influences decision-making and therefore activities of the two user groups. The regulator in this case can be the central or local government, or the village authority/ government (Figure 1).

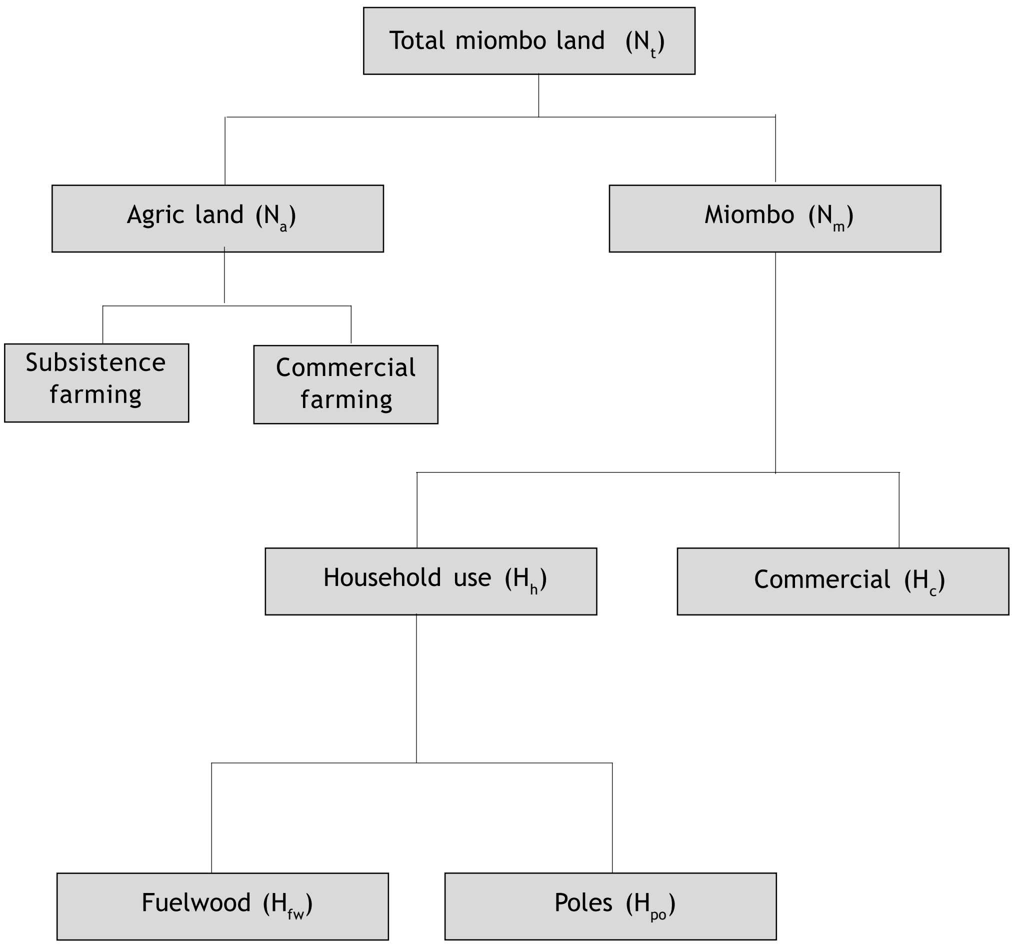
Figure 1. Main agents in the model



The logic or reasoning guiding the use of the woodland resources is illustrated in Figure 2. In any site there is an area of miombo woodland that local communities have access to, and this area is denoted as N_t. It is part of this area that has been cleared for the existing agricultural land, N_a, which is found in the site and which supports crops, livestock, habitation and other land-based household necessities. Households in the study areas have to make decisions on how to improve food availability/security and incomes.

For example, both goals and objectives could be partly achieved by encroaching on a woodland area N_m that they harvest for poles and fuelwood for both household consumption (H_h) or for sale (H_c).

Figure 2. Decision making process of the household



As mentioned earlier there is no clear demarcation between the household and the commercial sector in the sense that it is the same household members that indulge in some commercial activities based on forest products. What actually happens is that households extract firewood and poles principally for domestic use. However, because of limited alternative sources of income, the households extract more than their domestic requirements and sell the excess for cash income. This also includes charcoal in some cases. It is the selling activities of the households that basically constitute the activities of the commercial sector in this model. Commercialisation of forest products is increasingly becoming a feature of rural households and is confined to the informal sector of the economy. It is therefore important to monitor its development and contribution to household livelihoods.

Secondly households could improve food security and incomes by expanding cropland area N_a through encroachment on the woodland area N_t for subsistence and commercial farming as well as livestock husbandry.

The households implement these activities within a defined policy environment that influences decisions on crop and livestock production as well as harvesting and selling of woodland products. The policy environments and their potential impacts on the welfare of the households and sustainability of the woodland resources are explored in detail in Section 5.

3.2 The MIOMBOSIM for Malawi

3.2.1 The command model

In the command model, the regulator/government influences the behaviour of the household as to its consumption ('household sector' activities) and sales choices ('commercial sector' activities) by, for example, regulating access to and prices of woodland resources. The assumption is that the government would want the households to maximize total net benefits B_t through the choice of the amount of labour to be used in the 'commercial sector' (L_c) and the 'household sector' (L_h) activities in each year and in the time horizon, T, of the model. This is the situation that has been common in central government policies, but it was observed to be scantly demonstrated or completely absent on the ground in the study sites. The objective function is therefore presented as follows:

$$\max_{L_h, L_c} \sum_{t=1}^{T} [B_t] \rho_{t-1} \tag{1}$$

subject to the relevant ecological and household labour constraints.

and

$$B_t = B_{c,t} + B_{h,t} + \theta B_{e,t} + B_{s,t} \tag{2}$$

where:

B_t = Total benefits accruing to household and commercial sectors

B_c = Net private benefits accruing to the commercial sector from the use of woodland resources (i.e. benefits from sales of woodland products plus value

of harvested woodland products for household use. This applies to households that reported selling woodland products)

B_h = Net private benefits accruing to the household sector from the use of woodland resources (i.e. value of harvested woodland products consumed by the household. This applies to households that did not report sale of woodland products)

B_e = Environmental benefits

B_s = Benefits accruing to the whole society

θ = weight put on the harvests by the two sectors to reflect their concern for environmental protection, with a value of one indicating strict environmental or biodiversity protection and a value of zero meaning that there is no protection for environment or biodiversity, as would be the case in an open access situation. We also put weights on the harvests of the 'commercial' (H_c) and 'household' (H_h) sectors in order to incorporate social concerns.

Also,

$$\rho_{t-1} = \frac{1}{(1+r)^{t-1}}, \ \rho_0 = 1, \ t = 1,\ldots,T.$$

where is the discount factor and r is the discount rate.

The regulator therefore influences choices that reflect environmental, social or a combination of social and environmental concerns.

3.2.2 The cooperative model

Under the cooperative regime, it is assumed that there are efforts towards participatory management of the natural resources by all households either on their own or in a joint venture with the government. It is the type of management that governments are encouraging by devolving management of natural forests to local communities. We were therefore interested to find out the potential for it and its implication in all the study sites. In a cooperative management case we put weights and (1-) to respectively the 'commercial' and 'household' sector benefits as a measure of their preferences so as to maximize their combined benefits from exploiting the woodland resource (Sumaila *et al.* 2001). The objective function for the cooperative model is presented as:

$$\max_{l_h, l_c} \sum_{t=1}^{T} \left[\alpha \rho_{h,t-1} B_{h,t} + (1-\alpha) \rho_{c,t-1} B_{c,t} \right] \tag{3}$$

subject to the relevant ecological and household labour constraints.

where

B_c = Benefits accruing to the 'commercial sector'

B_h = Benefits accruing to the 'household sector'

and 1- = weight put by the commercial and household sectors as a measure of their preference in maximizing benefits from the woodland resources.

3.2.3 The non-cooperative model

In the non-cooperative model, each household aims at maximizing its own private benefits without taking into account interests of the other stakeholders. The

management problem facing 'household sector' under the non-cooperation is defined as:

$$\max_{L_h} \sum_{t=1}^{T} \left[\rho_{h,t-1} B_{h,t} \right] \tag{4}$$

subject to the relevant stock and the labour constraints.

Similarly, the non-cooperative management by the 'commercial sector' can be stated as follows.

$$\max_{Lc} \sum_{t=1}^{T} \left[\rho_{c,t-1} B_{c,t} \right] \tag{5}$$

subject to the relevant stock and the labour constraints, and
where

B_c = Benefits accruing to the 'commercial sector'
B_h = Benefits accruing to the 'household sector'

Based on the conceptual framework of the MIOMBOSIM model and the description of the study sites, it would appear that the cooperative model best describes the situation observed on the ground during data collection in Dzalanyama and Chimaliro sites while the non-cooperative model would appear to depict the prevailing situation in the Mdeka site. However for purposes of this study, policy experiments were made on the different management scenarios (command, cooperative and non-cooperative) on all the three study sites to find out what would be the outcome if each management style were applied.

All the models were solved using a software package called Powersim.

4. BASELINE DATA AND SCENARIOS

Baseline data that was used to run the models for all the three sites are presented in Table 1. This data set gave the base case scenarios, i.e., the "status quo" in all the three sites. The base case scenarios formed the basis on which policy experiments were conducted. The data was obtained from field surveys while some were computed from secondary sources.

4.1 Results of base case scenario

The base runs were made under the five different woodland management regimes, viz. command regime with social, environmental and both social and environmental concerns; cooperative management regime, and the non-cooperative management regime. These runs were made to determine, among others, the total monetary woodland benefits accruing to both the household and the commercial sectors, average woodland resources remaining at the end of the simulation period (Ave_WLR), and the employment and environmental/biodiversity conservation implications associated with the generation of these benefits, among others.

Table 1. Baseline data for the model

	Dzalanyama	Chimaliro	Mdeka
Proportion of household labour employed on existing agricultural activities (%)	0.39	0.45	0.30
Existing agricultural land, N_a, (ha)	8,000	16,300	2,800
Social concern parameter,	0.5	0.5	0.5
Cost of employing households in harvesting woodland resources (US$/m^3)	7.60	6.34	5.10
Cost of inputs including labour used by commercial sector in harvesting woodland resources (US$/ha)	75	30	90
Discount factor	[0.89;0.87]	[0.89;0.87]	[0.91;0.90]
Efficiency parameters[1]	[0.023;0.07]	[0.023;0.07]	[0.023;0.07]
Fertilizer cost (US$/kg)	10.25	10.25	10.25
Forest area, N_t, (ha)	17,110	16,000	5,000
Proportion of household labour employed for collecting firewood	0.12	0.12	0.15
Proportion of household labour employed for management and control of forest resources	.001	.001	.000
Maximum labour available normalized to 1	1	1	1
Off-miombo wage (US$/man day)	0.41	0.41	0.41
Price paid by of commercial sector for a cubic metre of firewood (US$)	5.7	5.7	5.3
Price paid by of household sector for cubic metre of firewood (US$)	3.2	2.0	4.0
Revenue per ha. of agric. land, N_a, (US$)	434.17	180.12	148.30
Seed cost (US$/kg)	3.46	5.64	2.45
Subsistence income for all households in the community (US$000)	380.25	519.02	257.95
Survival rate of the miombo woodland	0.95	0.95	0.80
Environmental concern parameter	[0;1]	[0;1]	[0;1]
Total man days in community (000' man days/year)	25317.56	18654.70	28246.76
Parameter to labour cost function	0.5	0.5	0.5
Parameters to household cost function [2]	(0.9,0.1)	(0.9,0.1)	(0.9,0.1)
Volume of firewood harvested per household/year (m^3)	10	12	10
Volume of standing miombo (m^3/ha)	80	85	60
Initial woodland resources (WLR_0) normalized to 1	1	1	1

[1]An efficiency parameter represents the efficiency with which either the household or the commercial sector is harvesting the woodland resources.
[2] The household is assumed to maximise utility (U (.)), a function of income (I) net of subsistence requirements (I^{min}) and leisure (L^{max} - L). That is:

where: $$U(I,T) = (I - I^{\min})^{\alpha} + v(L^{\max} - L)^{\beta} \quad (6)$$

I = gross household income
I^{min} = subsistence consumption
L^{max} = maximum labour available to the household
L = labour used by the household in all income generating activities; and and are parameters of the utility function.

4.2 Monetary woodland benefits

The base case scenario (Tables 2a-c) indicates that highest total benefits (for 'household sector' and 'commercial sector') would be derived under the command regime with social concerns in all the three sites.

Since some values are very small, they have been reported beyond two decimal points to facilitate comparisons because when the absolute values are aggregated for all households in all the sites, the outcome, especially in monetary terms, would probably be easily ignored in decision making.

Table 2a. Base run scenario for Chimaliro

Variable	Command management regime			Cooperative management	Non-cooperative management
	Social	Environ-mental	Social plus environmental		
Benefits to commercial sector ($000')	179	148	136	199	145
Benefits to household sector ($000')	331	109	251	246	107
Total benefits ($000')	510	257	386	446	252
Ave_WLR	0.526	0.607	0.597	0.591	0.521
Proportion of labour in commercial sector	0.0872	0.065	0.0598	0.0994	0.0642
Proportion of labour in household sector	0.232	0.0249	0.127	0.125	0.0242
Quantity harvested by household sector (000m^3)	3061	2635	2431	3632	2658
Quantity harvested by commercial sector (000m^3)	20717	3469	13836	13591	3457

Table 2b. Base run scenario for Dzalanyama

Variable	Command management regime			Cooperative management	Non-cooperative management
	Social	Environ-mental	Social plus environmental		
Benefits to commercial sector ($000')	174	145	128	191	103
Benefits to household sector ($000')	539	298	461	434	250
Total benefits ($000')	713	443	589	645	354
Ave_WLR	0.517	0.601	0.578	0.571	0.425
Proportion of labour in commercial sector	0.0857	0.0642	0.0564	0.0953	0.0564
Proportion of labour in household sector	0.237	0.0549	0.149	0.144	0.0454
Quantity harvested by household sector (000m^3)	21353	6785	6784	15671	15209
Quantity harvested by commercial sector (000m^3)	3000	2606	2290	340	2317

Table 2c. Base run scenario for Mdeka

Variable	Command management regime			Cooperative management	Non-cooperative management
	Social	Environ-mental	Social plus environmental		
Benefits to commercial sector ($000')	1.58	0.149	0.141	0.406	0.317
Benefits to household sector ($000')	38	0.0845	14.59	14.58	1.19
Total benefits ($000')	39	0.234	14.73	14.99	1.50
Ave_WLR	0.196	0.208	0.205	0.205	0.185
Proportion of labour in commercial sector	0.0162	0.00871	0.00826	0.0133	0.000186
Proportion of labour in household sector	0.0412	0.000247	0.00868	0.00854	0.000373
Quantity harvested by household sector (000m^3)	654	1.94	211.43	212.43	29.08
Quantity harvested by commercial sector (000m^3)	29	8.15	8.02	17.25	5.44

The results also show that households in the 'household sector' would derive more benefits under the same management regime in all the three sites. However, these benefits would be realized at the expense of much lower standing miombo at the end of the simulation period. In other words, these outcomes would be associated with the highest loss of biodiversity in practically all sites.

On the other hand, the commercial sector could derive more benefits under the cooperative management regime in the Chimaliro and Dzalanyama sites.

This would imply that households that engage in selling of woodland products would have more potential to trade in these products in these two sites as opposed to the woodland scarce Mdeka site. However, the central government through its Forest Department tends to discourage commercially oriented activities from the indigenous woodlands while at the same time encouraging communities' participation in management of the woodlands. In return to these efforts, households are allowed to freely harvest some of the woodland resources such as dead wood for firewood, grass, thatch and poles for house construction.

The non-cooperative regime, which mimics an open access situation, would produce the lowest total benefits in Chimaliro and Dzalanyama, while for Mdeka it would be the command model with environmental concerns. The latter management regime is implicit of strict biodiversity conservation with minimal or no harvesting of the woodlands, and therefore logically leading to minimal monetary benefits.

4.3 Labour employment potential

There appears to be a potential for households to increase their employment in woodland activities for their own consumption rather than for sale for all management regimes. However, this potential is very low for Mdeka households, ranging from zero to about 4%, while for Dzalanyama and Chimaliro, sites that are more endowed with woodland resources, the potential ranges from about 2 to 23%. The command regime with social concerns appears to offer the best opportunities for labour

employment in household activities in the woodlands while, as expected, the command regime with environmental concerns offers the least potential. The same trend was observed for monetary benefits to the households in all sites. This observation would appear to confirm that it is the households that tend to use much of the woodland resources for own consumption and probably for unreported commercialization. The commercial sector appears to be not well developed as demonstrated by its relatively low monetary benefits in all sites as well as its low potential for labour employment opportunities ranging from 6 to 10% in Dzalanyama and Chimaliro to zero to 2% in Mdeka. Probably the prevailing prices for fuelwood are not high enough to allow for significant dislocation of labour from crop production to harvesting and sale of fuelwood. Further, the woodlands do not appear to have potential for a significant alleviation of rural unemployment.

4.4 Environmental/biodiversity conservation implications

With respect to environmental benefits, i.e., proportion of woodland resources (Ave_WLR) remaining at the end of the simulation period, the command regime with environmental concern had the highest values of remaining woodland resources in all the three sites, being about 60% for Chimaliro and Dzalanyama and about 20% for Mdeka. This makes sense because Chimaliro and Dzalanyama have more woodland resources than Mdeka.

With respect to volumes of harvested wood, the commercial sector would appear to have the potential for harvesting more from the Chimaliro site as compared to the household sector. This could be attributed to the tobacco industry in the Chimaliro area whereby estate owners buy a lot of wood for use in tobacco production. In the case of Dzalanyama, the household sector would harvest more woodland resources as compared to the commercial sector, most probably due to unreported commercialization done by the household sector and perhaps as a response to woodland conservation measures implicit in the co-management efforts introduced by the Forest Department in the area; measures that would curb open commercialization of fuelwood while allowing for its harvesting for household consumption.

The woodlands are mainly encroached upon for agriculture. The three sites have an average household size of five people and a land-holding size of 1.44, 1.25 and 0.55 hectares for Dzalanyama, Chimaliro and Mdeka, respectively. The results indicate that at the end of the simulation period about 40 to 60% of the initial land under woodlands would remain in Dzalanyama and Chimaliro under all management regimes, while the proportion for Mdeka would be much lower, averaging 20% for all management regimes. Mdeka experiences more land pressure as already seen from the small average land holding size for households of similar size to the other two sites. Further, Mdeka has much less woodland cover.

It would appear that the command with social concerns and the non-cooperative management regimes have the potential to deplete the woodlands more rapidly than the other regimes. The command regime with environmental concerns appears to have the best potential for protecting biodiversity.

5. POLICY EXPERIMENTS/SENSITIVITY ANALYSIS

Some sensitivity analyses or policy experiments were run based on the results from the base scenarios. They were made based on some assumed policy changes with potential effects on the behaviour and decisions of the household and commercial sectors as they relate to the miombo woodlands. The policy simulations were based on potential increases in the prices of fuelwood and agricultural inputs, given the strong linkages between the agriculture and forestry sectors.

Results of the sensitivity analyses would help to guide policy makers on the choice of woodland management regime to adopt in order to maintain a sustainable stand of indigenous forest resources as well as to improve the welfare of the local communities that depend on these woodlands.

5.1 Potential effects of increasing the price of fuelwood

Rural and urban dwellers in Malawi depend heavily on fuelwood. However, fuelwood sources are dwindling, very fast in the south and rather slowly in the north of the country. Land clearance for agriculture and related activities in Malawi is estimated at about 48,000 hectares annually (Minde *et al.* 1997). The pressure on forests and woodlands fluctuates widely among in the three administrative regions. In the southern region that supports 50% of the population, there is little forest cover left outside forest reserves. Annual deforestation in this region has been estimated at 2,000 hectares. The highest pressure on the forests and woodlands is in the central region, which supports about 39% of the population. In this region annual deforestation has been estimated at about 32,000 hectares. In the northern region that supports about 11% of the population the pressure is less and there are more forests and woodlands. The estimated annual deforestation in this region is about 14,000 hectares (*ibid.*).

As demand for fuelwood increases its price is bound to increase. We explored the potential effect of fuelwood price increase on household consumption, commercialisation and sustainability of the woodlands.

In the more woodland rich Dzalanyama and Chimaliro areas, a modest increase in the price of firewood by 25% would produce a very insignificant effect on the woodland remaining at the end of the simulation period. This woodland area would decline by between 1 and 2% for all management regimes and would remain unchanged in the non-cooperative management regime in Dzalanyama. Further, this firewood price increase would also have a modest but indeterminate effect on commercialised fuelwood, ranging from 3 to 8% in Dzalanyama, but the changes could become more pronounced in Chimaliro, ranging from 1% (with command management regime that emphasises social concerns) to 275% under the non-cooperative management regime.

With a price increase of 50% the proportion of woodland that would remain at the end of the simulation period would not decline significantly, remaining under 2% in both Chimaliro and Dzalanyama for all management regimes. However, if prices were to increase by 75%, the decline could jump to between 1% and 3% with the exception of command with social and environmental concerns in Dzalanyama that would have a decline of 13%.

However, in the woodland scarce Mdeka, the picture would be more or less the

same, with the area of woodland remaining at the end of the simulation period declining by less than 1% when firewood prices increase by 25, 50 and 75%.

These price increases might not significantly influence deforestation in all study sites under all management regimes. Labour for harvesting and transporting the product on the head or with bicycles to distant markets could be a limiting factor for households to take advantage of the high prices. Further, firewood prices are fairly low, and increasing them modestly might not trigger a significant relocation of labour from crop production to firewood harvesting and selling.

5.2 Potential effects of increasing the price of fertilizer

The major inputs to crop production are fertilizers. These are mostly imported and their prices continue to rise. The hypothesis in this section is that increases in fertilizer prices could constrain agriculture production therefore encouraging the local communities to increase their reliance on the woodlands, a development that would increase deforestation.

The results indicate that there would be modest changes to total household benefits from woodland resources arising from increasing fertilizer prices by between 25% and 50%. When fertilizer prices are increased by 25% household total benefits could increase by between zero and 11% in Dzalanyama and 4 to 11% in Chimaliro, but decline by between 1 and 45% in Mdeka. In Dzalanyama households would harvest more wood for sale, with the non-cooperative management regime providing more flexibility in this, followed by the cooperative management regime. Both these regimes would respectively allow for a 135% and 124% increase in commercialized fuelwood. This could increase to 106% and 500% if fertilizer prices were to increase by 50%. The increases in commercialized fuelwood would more than offset decline in net revenues from crop production due to fertilizer price increases, resulting into the noted modest increases to total household benefits. The same trends are noted for Chimaliro, with the non-cooperative regime encouraging increased harvest of fuelwood by 68% and this could rise to about 184% if fertilizer prices were increased by 50%.

Mdeka is a woodland scarce area and would therefore not have the capacity to cushion a decline in total household incomes through increased fuelwood sales when fertilizer prices increase, hence the noted decreases in total household benefits to between 2 and 3% at 25 and 50% fertilizer price increases for respectively the command management regime with social and command management regime with environmental concerns. The decrease is much more pronounced to 27% and 45% for respectively the cooperative and command with social and environmental concerns regimes.

The magnitudes of the resultant changes in fuelwood harvests in the three study sites appear to be very big in some cases, but the actual volumes of fuelwood to be harvested from the woodlands would be fairly small. Since the commercialized volumes of fuelwood are a small fraction of the fuelwood for household consumption the observed potential increases in commercialized fuelwood would appear to have insignificant effects on the woodland that would remain at the end of the simulation period. In other words, the sustainable woodland resources at the end of the simulation period would remain relatively unaffected by these fertilizer price increases.

6. MAIN OBSERVATIONS AND CONCLUSION

a) The results demonstrate that the command management regime that emphasizes managing the woodlands with emphasis on social concerns would be more relevant to all the three study sites if derivation of highest total benefits to both household and commercial sectors is the criterion. The households would also derive highest benefits under this management regime in all the three sites, while the commercial sector would do better under the cooperative management regime in Chimaliro and Dzalanyama. These results would appear to contradict the logic of the present drive by central government to devolve ownership and management of the woodlands to the local communities, a move that implicitly advocates for the adoption of the cooperative management regime by the households in managing these resources. Further, the results demonstrate the relevance of continuing with government management of the woodland resources in all sites so long as the government gives priority access to the local communities (i.e. employing the command management regime with social concerns).

b) The potential for environmental protection or biodiversity conservation in all sites would appear to lie with the command management regime that emphasises environmental concerns.

c) In terms of potential for creating employment in these rural areas (or alleviating unemployment) the command management regime that emphasises social concerns would appear to be the best in all sites for household related activities. However, the cooperative management regime appears to have more labour employment potential for commercialised forestry activities. In general the potential for the forestry sector to alleviate or reduce rural unemployment in the three sites would appear to be relatively small.

d) Increases in price of fuelwood to at most 75% might not significantly influence deforestation in the three sites under all management regimes, most probably due to the fact that labour for harvesting and transporting the product on the head or with bicycles to distant markets could be a limiting factor for households to take advantage of the high prices. Further, fuelwood prices are fairly low, and modest increases in prices might not trigger a significant relocation of labour from crop production to fuelwood harvesting and selling. Another possible reason for this result is that we are dealing largely with subsistence communities and once they attain their subsistence level of income the pressure on the woodlands declines.

e) Increases in fertilizer prices by at most 75% could result in modest increases in total household benefits in both Dzalanyama and Mdeka, because households would harvest more woodland products to more than offset any cuts in crop marketable surplus that would result from using less fertilizer. However, in Mdeka total household benefits would decline as this site is almost depleted of woodland resources that households could fall on to offset revenue declines in agricultural production.

f) Much as emphasis has been on the agriculture and forest sectors, the systems dynamic model can also incorporate other sectors, like those of mining and construction to assess their impact on forest resources and welfare of rural communities.

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Policies and Governance Structures in Woodlands of Southern Africa

Southern Africa is essentially a woodland region. The woodlands are home to some of the largest herds of wildlife in the world, support a vast livestock industry, play a pivotal role in the hydrological functioning of the region, support the livelihoods of millions of people through agriculture, forest products and other services. However, there is scanty scientific information to guide their development and management. Given the numerous end uses and many stakeholders, it is not possible to rely exclusively on conventional forestry approaches and tools to manage the woodlands.

This book highlights different facets of local community governance of woodlands. The outcomes for people and forest are often dependent on local institutional arrangements (rules, regulations, organisational dynamics). The book explores the role of local institutional arrangements in woodland management, in community-based approaches and in conflict resolution.

It documents approaches and tools to reconcile the demands of the three key stakeholders on the woodlands (the local communities, government and private sector) in the framework of the three prominent rural development goals of food security, increased rural incomes and biodiversity or forest conservation. It also highlights tradeoffs between the goals and between five potential woodland management options by: (i) local communities, as a result of devolution of authority and management from central government, (ii) government but with a strict biodiversity conservation focus, (iii) government with access given to local communities for basic needs, (iv) government with a combined conservation focus and limited local community access for basic needs, and (v) perpetuating the present situation of open access.

CIFOR 1993 - 2003
Science for Forests and People

ISBN 979-3361-22-0
9 789793 361222