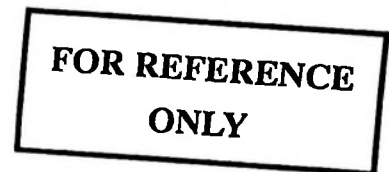


**ASSESSMENT OF FOREST CONDITIONS, THREATS AND MANAGEMENT
EFFECTIVENESS IN THE CATCHMENT OF MALAGARASI-MUYOVOZI
WETLANDS, URAMBO DISTRICT, TANZANIA**



BY

HERIBERTH JOSEPH ADAM HAULLE



**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN
FORESTRY OF SOKOINE UNIVERSITY OF AGRICULTURE
MOROGORO. TANZANIA**

2007

ABSTRACT

This study assessed the forest conditions, threats and management effectiveness of selected catchment forests of Malagarasi-Muyovozi wetlands in Urambo District, Tanzania, particularly Mpanda Line Forest Reserve. The level of disturbance was obtained through disturbance assessment methodology while threats through threat reduction assessment tool. The World Commission on Protected Areas tracking tool assessed management effectiveness and socio-economic factors was obtained through structured questionnaires. The results showed that forest disturbance for both trees and poles in the three strata were significantly different ($p < 0.05$). The forest disturbance as well as the use intensities were highest in the open woodlands followed by closed woodlands and wooded grasslands, implying high human impacts in the open woodlands. The threat reduction assessment index was 16%, indicating that the reserve is highly threatened. Major threats were wildfires, illegal logging, overgrazing, and encroachment. The management effectiveness assessment score was 28% implying that the reserve is poorly managed and therefore it stands a chance of losing its status as biodiversity conservation and wetland catchment area if the situation is not attended adequately. Lack of clear reserve boundaries, management plan, secured funding, adequate law enforcement, appropriate and well-trained staff and local community involvement were the major shortfalls. Socio-economic factors that significantly influence human disturbance in the reserve include age, ethnicity, and demand for forest products and services. A number of conservation initiatives were revealed, which may contribute in reducing the threats facing the reserve and increasing the management effectiveness. Contribution of Sustainable and Integrated Management of the Malagarasi-Muyovozi Ramsar Site Project, Ugalla Community

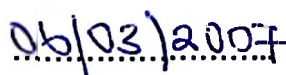
Conservation Project, Robin Hurt and Safaris Company and Friends of Urambo and Mwanihala was acknowledged. It is recommended that a management plan, land use plans, and collaboration between local communities and the government are pertinent to the conservation of the catchment and maintenance of local livelihood benefits.

DECLARATION

I, HERIBERTH JOSEPH ADAM HAULLE do hereby declare to the Senate of Sokoine University of Agriculture that the work presented here is my own original work, and has not been submitted nor is it concurrently being submitted for a higher degree in any other University.


.....

Heriberth Joseph Adam Haulle
(MSc. Forestry)

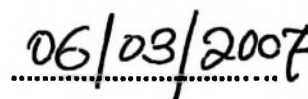

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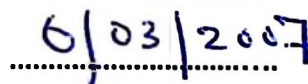
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ACKNOWLEDGEMENT

I am highly indebted and have a profound appreciation to Professor P.K.T. Munishi and Professor S.S. Madoffe, my Supervisors for their outstanding advices, tireless guidance and their moral support throughout this study. Special thanks are due to the Permanent Secretary, Ministry of Natural Resources and Tourism, my employer who granted me a study leave and financed my study.

I am very grateful to the staff of Urambo District Council, particularly the DFO, Mr. S. Makaka and Mr. F. Nkolle (DAFO-Lumbe) for their encouragement and cooperation during data collection. Others are Mr. G. Mwigu a TAFORI technician at Tabora centre, Drivers S. Kaswiza and E. Mwami from the RFO and ICRAF Tabora offices respectively and Mr. G. Male of Tabora Lands College for supporting and assisting me during the field work. I am also indebted to the management of SIMMORS, RFO and TAFORI for their logistical support and allowing me to access information relevant to this study. My thanks are also due to the villagers who spared their valuable time to discuss and work tirelessly with me especially Mzee S. Tuguru and T. Mwigu my key informants.

Last but not least, I am very grateful to my lovely wife, Agnetha and our children Joseph, Heribert, Geoffrey and Gloria who showed tolerance/patience and love and gave me tireless encouragements throughout my study. This study was conducted under very harsh and difficult conditions which involved crossing over a dangerous and rough Kalimanzovywe hill along the Ugalla River and working in an environment where coming across wild animals like elephants and lions were the order of the day. I thank the Almighty God for giving me the courage and strength as all went well eventually.

DEDICATION

This dissertation is dedicated to my beloved late parents; my father Joseph Sangilambwani and my mother Imakulata Anthony Kingwana, who laid the foundation for my education.

“May the Almighty God rest their souls in eternal Peace! Amen.”

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ABBREVIATIONS AND SYMBOLS

ANOVA	-	Analysis of Variance
CBBP	-	Cross Border Biodiversity Project
CBFM	-	Community Based Forest Management
DAFO	-	Divisional Assistant Forest Officer
DFO	-	District Forest Officer
DIA	-	Disturbance Assessment
FAO	-	Food and Agriculture Organisation
FBD	-	Forestry and Beekeeping Division
FORCONSULT	-	Forestry Consultancy at Sokoine University of Agriculture
FUM	-	Friends of Urambo and Mwanihala
GEF/UNDP	-	Global Environment Fund/United Nations Development Programme
IIED	-	International Institute for Environment and Development (UK)
IRA	-	Institute of Resource Assessment (University of Dar es Salaam)
IUCN	-	World Conservation Union
JFM	-	Joint Forest Management
LSD	-	Least Significant Difference
MEA	-	Management Effectiveness Assessment
MNRT	-	Ministry of Natural Resources and Tourism
NGOs	-	Non – Governmental Organizations
PFM	-	Participatory Forest Management
PLUM	-	Participatory Land Use Management

RAMSAR Site	-	A Wetland of Local and International Importance
SIMMORS	-	Sustainable and Integrated Management of the Malagarasi-Muyovozi Ramsar Site
SUA	-	Sokoine University of Agriculture
TAFORI	-	Tanzania Forestry Research Institute
TRA	-	Threat Reduction Assessment
UCCP	-	Ugalla Community Conservation Project (by AFRICARE)
UNEP	-	United Nations Environment Programme
VEC	-	Village Environmental Committee
VEO	-	Village Executive Officer
VGS	-	Village Game Scout
VLUM	-	Village Land Use Management
WCED	-	World Commission on Environment and Development
WCPA	-	World Commission on Protected Areas
WMA	-	Wildlife Management Area
WRI	-	World Resources Institute
WWF	-	World Wide Fund for Nature

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Wetlands are among the most productive ecosystems in the world, compared to rain forests and coral reefs (Sipple, 2003). Wetlands are the home of a wide variety of plants and animals. Freshwater ecosystems, when scored on the area they cover and the number of species they harbour, are in fact the most species-diverse habitats on earth (IUCN, 2002; Sipple, 2003). Sipple (2003) further argued that physical and chemical features such as climate, topography (landscape shape), geology, nutrients, and hydrology (the quantity and movement of water) help to determine the plants and animals that inhabit various wetlands. Wetlands in Texas, North Carolina, and Alaska, for example, differ substantially from one another because of their varying physical and biotic nature.

Wetlands were once considered useless, disease-ridden places (e.g. malaria, bilharzia and yellow fever) that were to be avoided, though it is recently becoming clear that wetlands provide numerous ecological functions and products needed by human society. This biological diversity is attractive as well as useful to humanity. Wetlands sustain thousands of communities with a wide range of direct products, such as drinking water, fish, shellfish, game meat (deer, crocodiles, birds, etc.), food, fruits, resins, timber for building, wood as fuel, reeds for thatching and weaving, fodder for animals, fibers for textiles, medicines, dyes and tanning (IUCN, 2002; Sipple, 2003) and it is often the poorest societies who depend directly on their products. According to IUCN (2002), different ecosystems provide an estimated US \$ 33 trillion per year to societies, of which an

estimated 26% comes from freshwater ecosystems. Ecologically wetlands provide many benefits to society - such as fish and wildlife habitats, natural water quality improvement, floodwaters conveying and storage, shoreline erosion protection, opportunities for recreation and aesthetic qualities appreciation, as sites for educational research, as locations of important historic and archaeological sites, and natural products for our use at little or no cost (Sipple, 2003).

Wetlands are also complex and ecologically sensitive environments that are intrinsically linked to the catchments in which they occur. They play an important role in buffering inputs from the basin catchments. Altering the wetland environment through cultivation, for example, has potential impacts across the wetland and the associated downstream areas (Masiyandima, 2004). The result is the degradation of wetland ecosystems that not only occur in the core wetland areas but also in upper catchments that are integral part of the system (MNRT, 2004). As such, agricultural production in wetlands has traditionally been considered an antithesis to the conservation of wetlands. Degradation of these wetland catchments has a big negative impact on the wetlands in terms of pollution, sedimentation and reduction of wetland sizes. Already 50% of the world's wetlands have been lost in the past century and also one third of the world's major river/lake basins have lost 75% of their original forest cover (IUCN, 2002). The degradation of wetlands put the livelihoods of many communities and the biological diversity at risk (MNRT, 2004). Over 800 freshwater species worldwide are now threatened with extinction (IUCN, 2002) due to destruction of wetlands. The affected fauna and flora habitats have progressively become surrounded by different land uses.

Recent surveys indicate that changes in forest cover and land use have a direct and enormous effect on wildlife, water quality, climate and carbon cycling (Inan and Erdin, 2004). FAO (1999) defined land use changes as the dynamics of arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. The forest ecosystem is threatened constantly by both human impacts like forest fires, air pollution, poaching, clearing for agricultural uses, illegal cutting, over-harvesting of non-timber products and also natural phenomena like storms and droughts. The monitoring and control of this dynamically structured forest ecosystem give the best usage possibilities for the sustainable operation and protection of forest resources (Inan and Erdin, 2004). However, forest ecosystems are complex in composition, structure, and function, reflecting wide variations in environmental conditions on both local and regional scales, and varied histories of natural and human disturbance. Normally the level of disturbance is regarded as the measure of the forest conditions, which alter canopy cover. This complexity makes an assessment of forest conditions challenging. In reality, all forests are dynamic, although the rate, spatial and temporal distribution of change varies widely from region to region (Ceres, 2002).

Moreover, we have limited understanding of how human activity has influenced ecosystem function and its relationship to biodiversity or, conversely, the influence of biodiversity loss on ecosystem function. By undertaking research we have yet to develop management systems that effectively conserve or improve inland water biodiversity values at scales ranging from river catchments to the continent. Identification of the key threatening processes for freshwater biodiversity and how they act to threaten biodiversity

are essential ingredients in any management system designed to conserve or improve inland water biodiversity values (Georges *et al.*, 2001).

Almost 10% of the Tanzania's surface area is covered by wetlands (Hongo & Masikini, 2002; IUCN, 2005). Research has provided empirical evidence that wetlands are among the most productive ecosystems in Tanzania (Hongo & Masikini, 2002). The contribution of wetlands to the livelihoods of rural households living around them in terms of direct cash income and contributions to food security is enormous and very important. For example, in Zambia and Tanzania, annual incomes from wetlands can be as high as US \$1000 per household (or 90% of the total household income), with high variation across sites and households (Morardet, and Koukou-Tchamba, 2004). Moreover Morardet & Koukou-Tchamba (2004) and IUCN (2005) observed that, many households utilize wetlands in coping strategies during time of food scarcity. However, wetlands in Tanzania suffer from over-extraction of fresh water, overuse of their resources, drainage, pollution and deforestation (Doody and Mesaki, 2003; MNRT, 2004). Tanzania and the world at large are thus experiencing a serious water crisis due to rampant destruction of ecosystems such as forests, wetlands and soils that capture, filter, store and distribute water. According to Ramsar (2002a) a holistic river/lake basin and ecosystem approach is the response to managing water and wetland resources sustainably.

Currently Tanzania has four sites designated as wetlands of international importance, with a total area of 4 868 424 ha. Rufiji-Mafia-Kilwa Marine Ramsar Site, designated in 2004 is located in Coast and Lindi Regions, covering an area of 596 908 ha; Kilombero Valley Flood plain, designated in 2002 is in Morogoro Region, covering an area of 796 735 ha;

Lake Natron Basin, designated in 2001 is in Arusha Region, covering an area of 224 781 ha; and the giant Malagarasi-Muyovozi wetlands, designated in 2000 is located in Kigoma, Shinyanga, Rukwa and Tabora Regions and covers an area of 3 250 000 ha (Ramsar, 2004; WI, 2004). Since 2001 with the assistance of DANIDA, the government of Tanzania is implementing a project for Sustainable and Integrated Management of the Malagarasi-Muyovozi Ramsar Site (SIMMORS) to consolidate and improve the conservation of the wetland ecosystem and improve the livelihoods of communities living within and around the wetland areas (IRA, 2001).

1.2 Problem Statement and Study Justification

The Malagarasi-Muyovozi wetlands present one of the most important ecosystems in Eastern and Southern Africa (IRA, 2001). Like other wetlands in the world, Malagarasi-Muyovozi wetland is a highly vulnerable ecosystem. The rich and distinct biodiversity of the wetlands is under multiple threats including loss of habitat to human settlement, agriculture (e.g. tobacco cultivation) and overgrazing, illegal fishing, poaching and tree cutting, mining, introduction and spread of alien invasives, pollution, altered fire regimes and land clearing. Population growth of both human and livestock (including the influx of refugees and pastoralists) has increased the demand for resources such as land. This has resulted into pressure on the protected areas and subsequently changed land use patterns, and in turn negatively affected the ecosystem and its biodiversity as well as the well-being of the people. WRI *et al.* (1992) argued that increased demand for resources, which emanates from increased human population, has made resource use in rural areas unsustainable.

Among the major problems/predicaments identified in the management of Malagarasi-Muyovozi wetlands include; deforestation and degradation of the wetland catchments a process that leads to erosion and sedimentation of the wetlands with consequences on water quality, quantity and ecosystem integrity. Unplanned human related activities, lack of basic information and public awareness of their values, functions and products as well as management aspects may have caused these problems. In order to address these issues seriously, there is a need for undertaking studies to establish quantitative baseline information on the status of these wetlands, major threats and their management that can be used in measuring changes in the wetland ecosystem and its catchments over time in the course of its management. Such information will benefit different people and institutions interested in wetland and local livelihoods and form a basis for undertaking proper management of the wetland ecosystems aimed at improving the conservation and sustainable use of resources, so that these ecosystems meet the needs of human society and make a great contribution to the conservation of biological diversity and water.

1.3 Objectives of the Study

1.3.1 Overall objective

The overall objective of this study was to assess the conditions, utilization threats and management effectiveness of the selected catchment forest of the Malagarasi-Muyovozi wetlands in Urambo district.

1.3.2 Specific objectives

The specific objectives of this study were to:

- (i) Assess human induced disturbance and utilization threats in the selected catchment forest,
- (ii) Assess management effectiveness and conservation initiatives of the wetland catchment forest,
- (iii) Assess the socio-economic (livelihoods) factors and their roles in influencing the utilization of the catchment forest resources.

1.4 Hypotheses

This study was testing the following hypotheses:

- (i) The catchment forests of the Malagarasi-Muyovozi wetland ecosystem are significantly disturbed by humans,
- (ii) There are some efforts taken to reduce threats on the Malagarasi-Muyovozi wetland catchment forests,
- (iii) The management of the Malagarasi-Muyovozi wetland catchment forests is significantly effective in conserving biodiversity and water resources.

1.5 Limitations of the Study

The following were observed as limitations during the study:

- (i) Identification and clear distinction of the vegetation types especially between open woodland and closed woodland was a big problem. This was aggravated by abrupt change from one stratum to another (i.e. fragmentation of the closed woodland stratum) within a short distance as a

result of vegetation degradation. This could make great difference in the data collected, however, vegetation zoning assisted in overcoming this problem.

- (ii) Some socio-economic data depended on the respondent's memory and willingness to say the truth. For example, although the information about household income per year may not be very realistic since it relied on farmers' memory and willingness to tell the truth only, it may provide the general picture of the income status of the households in the study area.
- (iii) Data management at the various levels of administration from the village to district level is very poor indeed. Hence the household figures for example; should be taken as mere indicators of what exists in the villages.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The Ecology and Nature of Wetland Resources

The ecological character of a wetland is "the sum of the individual biological, physical, and chemical components of the wetland ecosystem, and their interactions, which maintain the wetland and its products, functions, and attributes". Change in ecological character is "the impairment or imbalance in any biological, physical, or chemical components of the wetland ecosystem, or in their interactions, which maintain the wetland and its products, functions and attributes" (Ramsar, 2002b).

Wetland is a general term used to describe areas which are neither fully terrestrial nor fully aquatic (semi-aquatic), that is either inundated or saturated by water for varying periods of time during each year, and that supports aquatic vegetation which is specifically adapted for the water saturated soil conditions (Ramsar, 2002b). Furthermore, Ramsar (2002b) argued that wetlands are dynamic areas, open to influence from natural and human factors which impact or alter the development of the ecosystems. In order to maintain their biological diversity and productivity (i.e. their 'ecological character'), and to permit the wise and sustainable use of their resources by people, it is important to ensure that both external natural and human-induced factors and their influence on the site are taken into account.

Wetland ecosystems are adapted to the hydrological regime and are vulnerable to change. For most wetlands, direct rainfall provides only a small proportion of the water regime,

with the primary source being rivers or aquifers. Successful management of wetland sites therefore requires maintenance of these sources of water. Insufficient water reaching wetlands, due to climate change, land use change, abstractions, storage and diversion of water for public supply, agriculture, industry and hydropower, are all major causes of wetland loss and degradation. A key requirement for wetland conservation and wise use is to ensure that adequate water of the right quality is allocated to wetlands at the right time (McNeely, 1995).

Although the roles and functions of wetland ecosystems are well known to relevant authorities and that the detrimental ecological implications brought about by the loss of these habitats have been well documented and recommendations for action been given, the wetlands have remained vulnerable due to land use changes in the areas adjacent to them (Acharya, 2000).

2.2 Forest Management and its Related Problems in Tanzania

Tanzania is predominantly a land-based economy, which is largely dependent on the exploitation of the natural resources, particularly land, forests and water, and that agriculture forms the basis for economic development of the country. Tanzania covers an area of 942 800 km², out of which about 6% is covered by water bodies while forest and woodland resources occupy about 38.8 million hectares which is about 41% of total land area (MNRT, 2002). The area occupied by forest reserves is estimated to be about 13 million hectares out of which only a total of 1.6 million hectares (about 12% of the total land area) has been designated as catchment forests (MNRT, 1998a) and 9.2 million hectares of the total forested and woodland designated as Ramsar site/wetlands. In terms

of ownership, Tanzania's forests are classified as government (central and local) forests, general land forests, community/village, and private forests. Before independence, the forest cover was more than 50%, which gradually decreased to 45% in late 1970's and about 30% to date (Luoga *et al.*, 2000a).

Many of the gazetted forest reserves containing naturally occurring species are important catchment areas. They are managed for both conservation and production purposes and the larger part are miombo woodlands. These reserves are very valuable for the country in terms of soil, water and biodiversity conservation, and for sustainable production of valuable timber, fuel wood and non-timber products (MNRT, 1998a).

Tanzania like other developing countries is experiencing a high rate of deforestation which is estimated at 91 200 ha per annum (FAO, 2001; MNRT, 2002). Most of the forests both central and local government reserves, have become highly encroached and degraded as a result of poor control, shortage of manpower, corruption, retrenchment of staff, and financial constraints (Kajembe and Kessy, 2000). These problems have ultimately caused rampant pit sawing, animal hunting, and honey collection with poor techniques led to forest fires. Also overgrazing, charcoal making, cutting of trees for building materials, annual fires and forest reserves encroachment for settlement and agricultural expansion, became the major threats to Tanzanian forests. Because of human activities on some of these forest reserves and the general land, the species composition of the woody vegetation has changed drastically.

According to Frontier-Tanzania (2001a) for example, pressures on natural resources included establishment of teak plantations that have replaced the miombo woodland, timber logging of *Milicia excelsa*, increased livestock rearing in the floodplains and wetlands, wildlife hunting and over fishing in the Kilombero River Valley. Moreover, human activities in the reserves have been fuelled by increased demand for land for agriculture, increased requirement for forest products and services which is parallel to the increase in population estimated at a rate of 2.8% per annum (MNRT, 1998a). A survey done by Hall and Rodgers (1986) in the Kimboza, Pande and Pugu forest reserves found that, more than 50% of the poles in the easily accessible areas have been cut for different uses. Also in Pugu forest reserve alone, plant species disturbances through human activities were found in 75% of the sampled areas (UNEP, 1996).

Problems of forest management in Tanzania today largely sprung from institutional arrangements (Mung'ong'o *et al.*, 1995; Kajembe *et al.*, 2000) and are related to shift in decision making about land and other natural resources related issues from the local to national levels. Kajembe *et al.* (2003a) argued that before the colonial era, the elders were responsible for guiding the society, and regulations governing the management of natural resources were based on customary laws. The tribal rules and regulations regulated land uses and enforced cultivation regulations. According to FAO (1990), those rules were "fairness ethics" and did not require formal enforcement since they were embodied in the cultures of all people. Some of the rules were so fundamental, and appeared to be taken by granted as inviolable and were widely respected by all people (Otieno, 2002).

Luoga *et al.* (2005) shared the views that the forests were largely intact and consumption was confined to domestic use only. Nduwamungu (1996) pointed out that, centralized management systems provide legal protection for forest reserves, but it does not affect protection as illegal harvesting continues in the reserves. Furthermore, with state forest management, the commercial use of forest resources has been found to be unsustainable as it has resulted in the depletion of the most saleable species from the forests (Luoga *et al.*, 2000b; 2002). Therefore, poor natural resource management has been attributed to a large extent to intrusive state policy which are said to interfere with local and traditional institutions that include norms and procedures that shape people's action (Fisher, 1993). Many policy studies gave disappointing results of forest conservation policies especially in developing countries (Kajemba *et al.*, 2003a) and therefore many scholars and practitioners have shifted their focus away from state-centered policies towards solutions at local levels (Gibson and Becker, 2000).

2.3 Resource Use Conflicts, Poverty Reduction and Conservation Challenges

In many parts of the world, sustainable use and management of forests, inevitably face challenges that involve conflicting interests and needs of the people. Buckles and Rusnak (2004) highlighted that in most cases communities are aware of the importance of natural resources on meeting their immediate needs as well as those of their children, but are faced with obstacles in maintaining or developing sustainable management of these resources. Lea *et al.* (2005) pointed out that, poverty has become the central concern for development agencies, and because many of the areas that are most important for conserving biodiversity are occupied by poor people, or have poor people living around them, the complex relationship between poverty (need for livelihood enhancement) and

protected areas can no longer be ignored. In such a situation Madoffe *et al.* (2006) argued that, there are serious conflicts between the use of the ecosystem by the local people to meet their requirements for income and food production and the sustainability of the forest resource with its unique biodiversity of flora and fauna.

Blomely (2003) explained that there are conflicts between the resource-poor households, national, and international interests on biodiversity. Depending on the importance and conservation priority versus exploiting the resources, the communities may be denied regular access and user rights of key biodiversity and services found in the protected areas. Ongugo and Njuguna (2000) argued that, recent interest in the social and biophysical variables affecting forest conditions have focused on population growth and economic activities as social driving forces that contributed to the negative impact on forest biological diversity and environmental condition. These have inevitably caused the destruction of habitat and thus the reduction of biodiversity.

Environmental problems hit the poor hardest and constitute a significant cause of poverty and decline in livelihoods. Human activities, including agriculture and settlements, have seriously damaged the ecosystems related directly and indirectly to water and have contributed, for example, to the loss of about 50% of the world's wetlands during the 20th century and one third of the world's major river/lake basins have lost 75% of their original forest cover (IUCN, 2002). Ramsar (2002a) argued further that, the tropical mountain forests are disappearing faster than any other kind of forest. This reduces water quality and quantity thus, increasing conflicts over human uses. Some people fear that protecting the environment may hinder development, while more and more evidence shows that

environmental protection and development are mutually reinforcing. Sustainable development as defined by WCED (1987) is the development that meets the needs of the present without compromising the ability of the future generations to meet their needs. In this re-orientation, the protected areas and forest reserves are viewed as part and parcel of the surrounding communities providing them with the main resource base for their existence. Sustainable development therefore means recognizing and integrating these environmental values and services into development plans and activities (IUCN, 2005). Thus Luoga (2000) argued that, the biggest challenge of resource conservation is the trade-off between meeting present needs through agricultural production and exploitation of forest based products and the longer-term conservation of resources.

2.4 Linkages of the Forest Conditions and Socio-Economic Factors

Both macro and microeconomic changes have played fundamentally important role in the way land-use practices influence forest cover. Thus, various methodologies have been in use in finding the link between human socio-economic factors to land use practices for a better understanding of the causes, processes and impacts of forest cover changes. For example, quantitative botanical sampling techniques by Mwasumbi *et al.* (1993) have been used to determine vegetation communities in Pande and Kiono in coastal Tanzania. Seven species-associations and four sample-associations were recognised. Undisturbed forest supports six species-associations, which are rich in plant species of restricted distribution, and these differ between the sites studied. Heavily disturbed forest supports one species-association composed of more generalist forest species and this association is similar between sites. Variation in vegetation types of undisturbed forests appears to be caused by

edaphic conditions, rainfall and degree of exposure. Variation in the vegetation of disturbed forests appears to be controlled by the intensity of forest disturbance.

Heavy human disturbance of coastal forests reduces their biodiversity values as plant-diversity and the habitats of rare plant species are lost. Similarly Ndziku (2002) reported that, the Maasai Mara National Reserve in Kenya has since 1970 lost 50-80% of its wildlife species due to the spread of commercial cultivation, which has converted critical areas such as migration routes and calving grounds to mechanized agriculture.

Also according to GEF/UNDP (2004), a more community-oriented threat reduction assessment (TRA) methodology piloted by Cross Border Biodiversity Project (CBBP) at the Longido site in Monduli District in Tanzania, has received positive feedback from Longido Village Environment Committee (VEC) members who were involved in the entire TRA process. The VEC members noted that the TRA process also served as an effective springboard to discuss the condition of Longido Forest Reserve within their community and this has influenced both positive and negative changes to the forest. Further involvement of forest-adjacent communities in the TRA process could also help to maintain community interest in forest conservation into the future. Cross Border Biodiversity Project hopes that the TRA tool will become a routine activity in monitoring forest condition even after the project lifetime has ended. Also CBBP targets forests move towards the development of a Joint Forest Management paradigm, where TRA could become even more valuable as a cost-effective conservation-monitoring tool easily implemented by combined Forest Division/village assessment teams.

This methodology has also been used with success at Ol Doinyo Orok – Namanga Hill Forest and Taita Hill Forests in Kenya, Chome, Eastern Arc Mountains and Kitumbeine Forest Reserves in Monduli, Tanzania and Sango Bay Forest/Wetland in Uganda (Persha, 2004). The TRA is thus, a monitoring tool and its primary use is to help project teams judge the state of threats to biodiversity over time at project sites with respect to human socio-economic and cultural activities, and by association, the strengths and weaknesses of project activities.

On the other hand, using a management effectiveness-tracking tool over a period of five years, WWF scientists have been able to analyse the strengths and weaknesses of almost 200 forest protected areas in 34 countries worldwide (WWF, 2004). The results show that while performance on issues such as the establishment, demarcation and resource inventories of protected areas is acceptable, relations with local communities and indigenous people, planning and monitoring, law enforcement and lack of funding are recurrent problems in the surveyed areas. According to WWF (2004) for example, only 12% of these areas have an approved management plan. The report, also warns that poor governance and law enforcement which results in sanctions upon violation of laws not being applied, reduces the motivation of rangers and encourages illegal acts by criminal groups such as those involved in illegal trade of rare species. It further stresses that inadequate funding results in understaffing and lack of capacity, which make protected areas vulnerable to problems as they arise thus, paving a way for human activities to undermine its biological wealth.

According to IIED (1994), the main driving forces behind biodiversity loss arise from human activities and can be distinguished in terms of proximate and ultimate causes. A proximate cause refers to the direct over exploitation of species, for example, through hunting, fishing, collection of firewood etc, and the direct impacts of ecosystem degradation or destruction that leads to species loss, for example, through habitat alteration and conversion (McNeely, 1994). Ultimately causes refer to the economic and social factors that lie behind the economic activities that lead to the direct depletion of the species, destruction and degradation of their habitats. These underlying causes include the scale and growth of human population, culture and ethics, economic incentives and institutions.

2.5 Conservation and Management Initiatives on Forest Resources undertaken by Different Institutions in Tanzania

Protected areas around the globe i.e., national parks, wildlife reserves, forest reserves, and biosphere reserves will prosper only if the public, the private sector, and the full range of government agencies support them. Yet such support is unlikely unless society appreciates the importance of protected areas to its own interests, and protected areas are well managed and contribute to the national welfare in a cost-effective way (McNeely, 1995). However, as earlier said in Tanzania for example, the government has failed to provide adequate protection and management of the forest estates because of declining budgets and retrenchment of workers leading to rampant forest degradation and deforestation (MNRT, 1998a; Kajembe and Mgoo, 1999).

Most development professionals are currently in favour of making the people living adjacent to forests the guardians of the forest resource in the neighbourhood and this has led to emergence of Participatory Forest Management (PFM) strategy (Kajembe *et al.*, 2003b) and Wildlife Management Areas (WMAs) in wildlife protected areas (MNRT, 1998a, 1998b). PFM or Collaborative Forest Management (CFM) entails two concepts, Joint Forest Management (JFM) and Community-Based Forest Management (CBFM) (Dubois, 1999; Kajembe and Kessy, 2000). PFM is basically a common property regime. In JFM, the government is the owner but shares duty and benefits with local communities while in CBFM, local communities are both owners and duty bearers (Wily, 1998). Joint Forest Management “allows” forest adjacent communities to use certain areas or products, which tend to increase, rather than decrease policing functions and burdens of the state (Wily, 1998). Communities are considered as “rightful beneficiaries” than as “logical source of authority and management”. In such collaboration particular emphasis is placed on the need to link planning for protected areas with surrounding land uses. These resource users have important “indigenous knowledge” about the species, but more importantly, they are critical actors in both extraction and monitoring (Peters, 1994). Thus WRI *et al.* (1992) suggested that local people must be involved in the planning and management of the protected areas.

To support the need for community involvement the Wildlife Policy of Tanzania (1998b) and National Forest Policy (MNRT, 1998a) respectively state clearly that it is the determination of the Tanzanian Government to involve local communities in biodiversity conservation by making people living adjacent to natural resources the guardians of these resources. This collaboration is believed to be the best option, the most viable, effective,

and long lasting way in addressing and solving the above problems of forest degradation in order to improve forest conservation and sustainable management at lower management costs (Kajembe *et al.*, 2003b). This option stemmed from the need to better target people's needs, incorporate local knowledge, and to ensure equitable sharing of benefits between government and communities. The burden of policing by the government would fall out and the foresters would become technical advisers and not policemen. In India, JFM with its focus on meeting needs of the poor is the centrepiece of the new forest policy and the government circular (Uma *et al.*, 1994).

However, there are problems and challenges on implementing JFM, and these include; gap between policy and practice, clear definition of rights and responsibilities, poor understanding of the community's incentive structure, difficulty in defining community's benefits and costs from forest management. Others include; poverty, capacity building and change on institutional set up to take full responsibilities for JFM and for sustainability of people-centered management of natural resources (Kajembe *et al.*, 2004a). They further argued that the call for sustainable biodiversity conservation through community participation as said earlier will be effective if efforts are taken to reinforce, encourage and further develop local practices and traditional institutions that are already consistent with biodiversity conservation.

Currently, a number of Tanzanian government forest reserves have initiated participatory forest management and are at various stages of JFM. These include among others Gologolo, Kipumbwi, Handeni hill, Kilindi, Shagayu, Maffi hill and Amani Nature Reserve (ANR) in Tanga Region, Udzungwa in Iringa Region, Ufiome in Arusha Region,

Nkweshoo in Kilimanjaro Region, Kitulanghalo in Morogoro Region and Urumwa in Tabora Region (Kajembe and Kessy, 2000; Wily and Mbaya, 2001; Iddi, 2002; Kajembe *et al.*, 2004a). Examples of forests under CBFM include Duru-Haitemba in Manyara Region, Mgori in Singida Region and part of South Ruvu forest reserve in Coast Region (Wily and Mbaya, 2001). Nonetheless, it appears that more incentives are needed to persuade local communities from degrading or destroying the co-managed forest reserves (Kajembe *et al.*, 2004a). Various stages of JFM and CBFM include formulation of Joint Forest Management, Village Forest Management Area Plans and Village Bylaws for JFM and CBFM implementation.

A study carried out in Duru-Haitemba revealed that, CBFM had a positive impact on resource base and people's livelihoods. The forest is healthier than before and people are satisfied with the products they collect from the forests. On the other hand, the impact of JFM at Kwizu Forest Reserve has not yet produced desirable results since illegal activities are still rampant and apparently, forest exploitation has increased instead of decreasing (Kajembe *et al.*, 2004b).

CHAPTER THREE

3.0 MATERIAL AND METHODS

3.1 Study Site

3.1.1 Location and size

Malagarasi-Muyovozi wetland is located in northwestern Tanzania in the administrative regions of Kigoma, Rukwa, Shinyanga and Tabora. It lies between 3° 15' S to 6° 10' S and 30°40' E to 32° 30' E, and at between 800 m to 1600 m above mean sea level with an average of 1200 m above mean sea level (Ramsar, 1999, 2004; IRA, 2001; WI, 2004). This study was conducted in Urambo District of Tabora region at Mpanda Line Forest Reserve, which is one of the catchment forests for the wetland (Fig.1&2). Mpanda Line Forest Reserve is a central government forest reserve gazetted in 1955 and covers an area of 422 400 ha which includes a portion of Ugalla Game Reserve. The forest reserve serves both productive and protective functions. Mpanda Line Forest Reserve lies between Ugalla Game Reserve, North Ugalla Forest Reserve, Ugalla River and Lake Sagara which ultimately joins Malagarasi River (Fig. 1).

The Malagarasi river basin that forms the Malagarasi-Muyovozi Ramsar Site is a drainage basin for Lake Tanganyika, providing one third of the waters going into the lake. The basin has five main rivers, the Malagarasi, Moyowosi, Kigosi, Gombe and Ugalla, which drain an area of 9.2 million ha (about 30% of the Lake Tanganyika catchment system) thus forming a vast and complex riverine floodplain wetland. A large proportion of the wetland (approximately 200 000 ha) is within the game reserves of Kigosi, Ugalla, Moyowosi and game controlled areas of Gombe and Luganzo. Also a small part is comprised of forest

reserves of Ulyankulu, North Ugalla and Mpanda Line and the community land, as well as lakes Sagara and Nyamagoma and other small rivers. The area is considered of high conservation value and falls within the RAMSAR convention proclaimed Wetland of International Importance (IRA, 2001). The wetland area is 3.25 million ha and during the dry season the site covers 250 000 ha, together with permanent papyrus of swamps of about 200 000 ha with large peripheral floodplains that fluctuate widely on a yearly basis depending on the amount of rainfall, but up to 1.5 million ha (Ramsar, 1999, 2004; WI, 2004).

3.1.2 Climate

The climate of the area is tropical in nature, characterized by the interaction of the southwest monsoon winds as well as the southeast and northeast trade winds. The average annual rainfall for the area ranges from 800 to 1000 mm, peaking in November to December and April to May with marked year-to-year variations. Temperatures can range from 12 - 15⁰ C in July/August to 32 - 35⁰ C in August/September (Ramsar, 1999).

3.1.3 Biodiversity

The Malagarasi-Muyovozi Ramsar Site has unique and high levels of biodiversity of international importance. It displays a diversity of high quality habitats of large numbers of reptiles, birds and mammal species categorised as 'threatened' and other fauna like waterfowl (water birds) and fish. There are 56 fish species, which are not found elsewhere in the world, while *Pollimyrus nigricans* and *Bryconaethiops Boulengeri* are two of the rare fish species and about 51 fish species live in river Malagarasi without moving out (Ramsar, 1999, 2004). The area also supports resident bird species of special conservation

importance such as the whale-headed or shoebill stork (*Balaeniceps rex*) and the wattled cranes (*Bugeranus carunculatus*), which are listed in the IUCN Red Data Book as threatened birds (IUCN, 2004). Others are *Ardea goliath* and *Egretta alba*. There are several hundreds of forest bird species in the ecosystem such as eagles, parrots, doves and owls, among others.

The wetland provides an important dry season refuge and feeding area for migratory animals including many water birds and large mammal species. For example, it is one of the few sites in Tanzania that sitatunga (swamp antelope) (*Tragelaphus spekei*) occurs within a protected area and possibly one of East African largest protected populations. The African elephant (*Loxodonta africana*) and *Crocodylus cataphractus*, listed in the IUCN Red Data Book as 'vulnerable' (IUCN, 2004) are at present in small numbers and particularly favour ground water forest habitats. Other large fauna associated with the wetlands include the mammals *Hippopotamus amphibious*, *Syncerus caffer*, *Redunca sp.*, *Damaliscus korrigum*, *Equus burchelli*, *Kobus defassa*, *Panthera leo*, crocodile (*Crocodylus niloticus*) and the raptors (*Haliaeetus vocifer*, *Gypohierax angolensis*, *Pandion haliaetus* and *Circus ranivorus*) (Ramsar, 1999, 2004).

The Ramsar site is also a region of considerable plant diversity and mainly dominated by miombo woodlands, specifically *Brachystegia spiciformis*, *Julbernardia globiflora* and/or *Isobertlinia spp.* trees with abundant growth of papyrus and several grass species e.g. *Vossia spp.* in associated swamps (Ramsar, 1999, 2004). The core permanent swamp area (1060 m elevation) is dominated by *Cyperus papyrus* and associated species including *Vossia cuspidata*, *Leersia hexandra* and *Oryza barthi*. All the headwater streams have

associated gallery forest or woodland, with trees, which include *Acacia spp.*, *Combretum spp.*, *Borassus aethiopium* and *Phoenix reclinata*. The regularly flooded areas support grasses such as *Hyparrhenia ruffa* and *Echinochloa pyramidals*. The outer skirts of the wetland are covered by some economically important trees species of the miombo woodlands, namely *Pterocarpus angolensis*, *Azelia quanzensis*, *Swartzia madagascariensis*, *Isobertinia sp.* and *Brachystegia spiciformis*.

3.1.4 Population and economy of adjacent communities

Tabora region is among the fastest growing population in Tanzania. According to the National Bureau of Statistics (2002), Urambo district population is estimated at 369 329 people with a growth rate of 3.8% far above the national average growth rate of 2.8%. The local communities living in Urambo district as well as those living around the Mpanda Line Forest Reserve are agrarian societies whereby agriculture plays an important role in the economy. Besides agriculture, lumbering, fishing, subsistence hunting, beekeeping, and livestock keeping form important economic activities in the district.

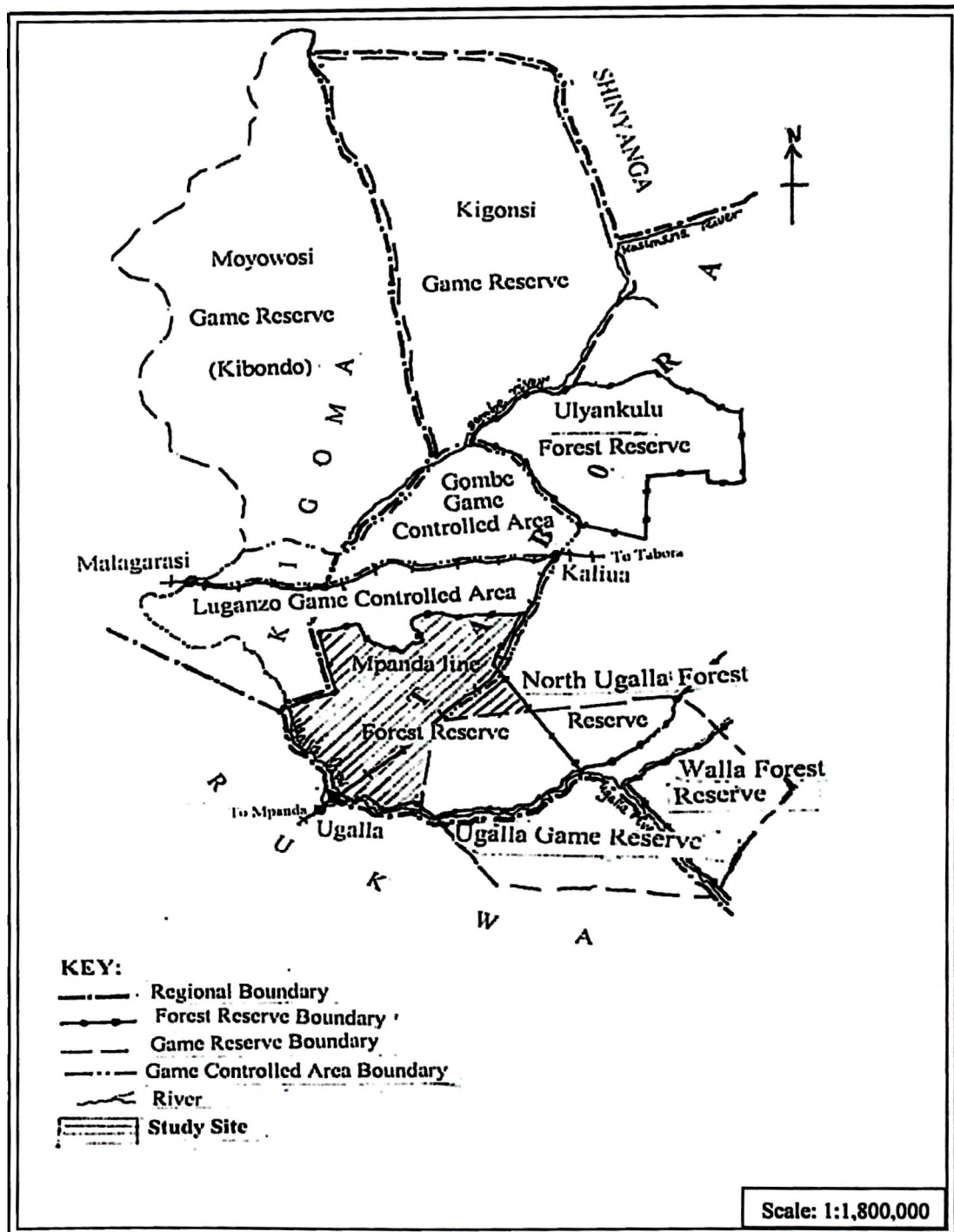


Figure 1: Location of Mpanda Line Forest Reserve in Malagarasi-Muyovozi wetland map, Urambo District, Tanzania

Source: SIMMORS (2005)

3.2 Sampling Procedures

3.2.1 Stratification of the study area

Based on the vegetation types as recognized from existing maps of the wetlands, followed by preliminary ground truth survey, the forest reserve was stratified into three miombo vegetation strata namely closed/dense woodlands, open woodlands and wooded grasslands to strategically identify representative sample sites/units (Fig. 2). The stratification was aimed at getting parts of the woodland that are more or less homogenous. Phillip (1983) argued that a stratum does not have to be a single consolidated area but may consist of separate parts as long as the identity is defined without ambiguity. The criteria used to determine the vegetation strata was tree density for which over 75%, 20-75% and below 20% represented closed woodlands, open woodlands and wooded grasslands respectively.

3.2.2 Sampling for vegetation survey

In order to cover the whole area of the forest reserve which is about 374 800 ha (after removing the portion of Ugalla Game Reserve), systematic sampling design was adopted. The forest reserve was post-stratified to sub-divide it into three strata as explained under part 3.2.1 above. The size of each plot was 0.02 ha (10 x 20 m) and using a sampling intensity of 0.001%, this gave about 187 plots for the whole forest.

The estimated area of each stratum/sampling unit was; 90 326.8 ha for closed/dense woodlands, 242 120.8 ha for open woodlands, and 42 352.4 ha for wooded grasslands. The sampling units were allocated to each stratum proportional to size of stratum. This gave the number of sampling units to be 45, 121, and 21 for closed/dense woodlands, open woodlands and wooded grasslands respectively.

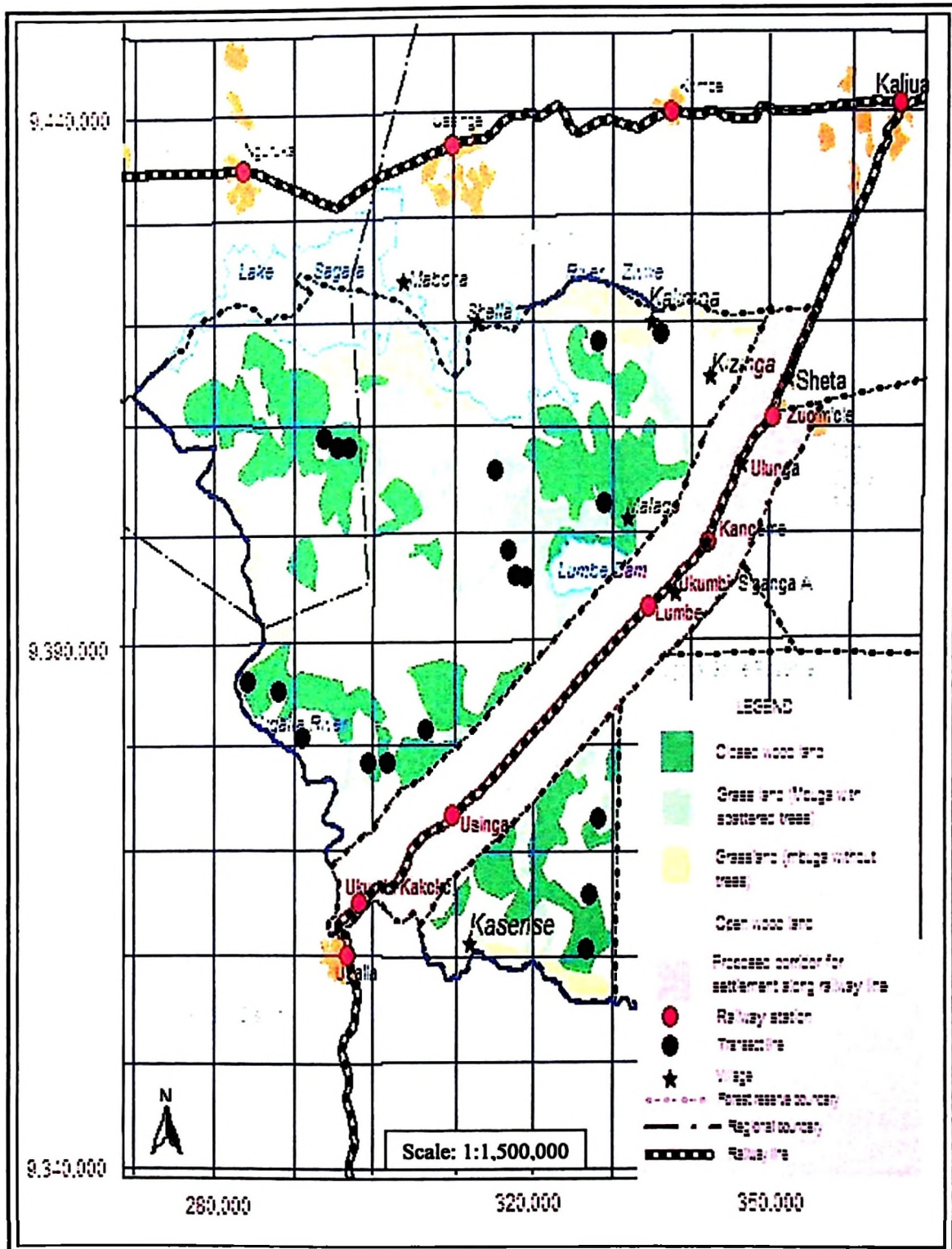


Figure 2: Vegetation stratification and transect line location map for Mpanda Line Forest Reserve, Urambo District, Tanzania

3.2.3 Sampling for socio-economic survey

The sampling unit of the study was the household. In this study a household is defined as a group of people who eat in a common pot and usually share a dwelling house and may cultivate same land. They recognize the authority of one person, the household head who is the ultimate decision-maker for the household (Poate and Daplyn, 1988 as cited by Kajembe, 1994). Two wards and two villages from each ward were purposively selected based on their accessibility, potentiality and proximity to the forest reserve. Ukumbi Siganga ward was selected among the Mpanda railway line wards while Ussinge was among the wards bordering the forest reserve on the northern side. A random sampling method was used in selecting the households for interview in each village using the village register as a sampling frame.

Forty and 30 households were selected from Ukumbi Siganga A and Lumbe villages in Ukumbi Siganga ward respectively. On the other hand 30 households were selected each from Shella and Maboha villages in Ussinge ward. On average about 6.4% (130 households) of the 2,033 total households were selected for interview. This is based on Boyd *et al.* (1981) that, in socio-economic studies, a random sample should at least constitute 5% of the total population for it to be representative.

3.3 Data Collection

Both primary and secondary data were collected. The study was conducted in three phases. In phase one reconnaissance survey was conducted to provide a general picture of the research area through a rapid assessment. During this survey the study villages were selected, the questionnaires were pre-tested, the vegetation strata were identified and it

also involved carrying out training to the field team. Phase two involved the actual collection of the vegetation information in the identified strata, while phase three was based on threat reduction, management effectiveness and socio-economic assessments.

3.3.1 Primary data

3.3.1.1 Data on vegetation structure

The key interest of this survey (that can be repeated either as a whole or in part to determine changes over time) was to assess the forest conditions in order to obtain baseline information on the levels of disturbance, the types and intensity of threats facing the forest and management effectiveness undertaken for the forest reserve under study (Persha, 2004; Madoffe and Munishi, 2005). These variables (disturbance, threats and management effectiveness) were assessed as follows:

(i) Disturbance assessment (DIA)

Disturbance assessment was done using a methodology that has previously been used by Frontier-Tanzania and FORCONSULT in the forest areas within the Eastern Arc (GEF/UNDP, 2004; Madoffe and Munishi, 2005) with some modifications. The same pattern of transect lay out used by FORCONSULT (i.e. with the distance between transect lines being 200 m) was adopted, however the East–West orientation of the transect lines was not observed due to the location of the strata in respect to the edge of the road in the reserve (i.e. the starting point of the transect line). Also a plot size of 20 x 10 m was used instead of 50 x 10 m and the plots were laid with an interval of 100 m in between (Fig. 3). Limitation of time and funding necessitated these modifications and also the interval between the plots assisted in covering a bigger portion and thus being able to get details of

the status of the vegetation within each stratum. Nineteen transects were laid and distributed to cover most of the ecological zones of the forest.

The intensity of pole cutting and logging in the forest reserve which determines the level of disturbance was assessed along the 10 m wide strip (5 m on either side of the 20 m transect line- forming a rectangular plot) through the forest. The plots were located systematically running from the edge of the road/path within the forest reserve with the first starting point selected randomly in each stratum. The plots were measured using a measuring tape. The first and last point of each transect line were geo-referenced using a GPS and the direction of the transect line determined using a compass to allow transects to be relocated in the future.

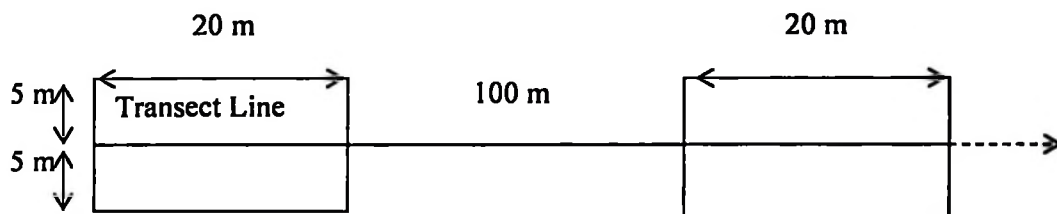


Figure 3: A plot for forest disturbance assessment

A team of 6 people were used for the transect method (one recorder, one direction finder, two chain men and two walkers, one on each side of the strip). The data was recorded separately for each 20 m transect section, to permit a variety of later analysis.

In each plot along the transect line the following data were recorded; number of live, naturally dead, cut (old and new/fresh) trees and poles. A tree was defined as any standing woody plant with a straight stem of at least 3 m and with a diameter (dbh) over 15 cm,

while a pole was defined as any standing woody plant with a straight trunk of at least 2 m in height and with a diameter (dbh) of 5 - 15 cm. Blackened stumps were considered as old cuts while pale stumps were new cuts. Also diameter of all cut trees and poles measured at the cut point and live trees/poles at breast height were taken. With the assistance of two local key informants and one research technician from Tanzania Forestry Research Institute (TAFORI) Tabora centre, species of the standing trees/poles and their uses were identified in the field by their scientific and vernacular names. For unidentified species in the field, voucher specimens were collected for later identification by qualified botanists at TAFORI (Tabora) and/or SUA. Identity of the cut and dead trees/poles were also determined whenever possible.

(ii) Threat reduction assessment (TRA)

The TRA approach used was based on that described by Salafsky and Margoluis (1999 as cited by Persha, 2004, Madoffe and Munishi, 2005). The concept behind this approach is that the kinds of threats, and seriousness of each threat, vary in and around project forests by location. Particular threats also have different levels of scope, impact and urgency in different places in and around the forest. In order to take into account these differences, the threats were divided into two equally weighted categories - forest interior threats and forest edge threats and their assessments were carried separately and then combined into a final threat reduction index.

Two villages of Ukumbi Siganga A and Lumbe were involved in the assessment of threats in the forest reserve. From each village, representatives of the Village Environmental Committee (VEC), the Village Game Scouts (VGS) and elders worked with the foresters

to form a team which was involved in the TRA survey process. The team used a combination of a number of different methodologies to assess threat levels including simple systematic walking transect (i.e. disturbance transects), along random walks in the forest and along existing paths within the forest to give better information on areas of highest human activity/impact. All major direct threats to the resource (i.e. 5 each for forest interior threats and for forest edge threats) to the biodiversity of the forest present and observed during the survey were identified by the survey team and discussions with local people/ward/district government officials.

(iii) Management effectiveness assessment (MEA)

Management effectiveness assessment approach followed the World Commission on Protected Areas (WCPA) 'framework' for assessment of the effectiveness of management practices in protected areas and protected area systems (Hockings *et al.*, 2000; Persha, 2004; Madoffe and Munishi, 2005). This tool composes of a set of questions that address the different steps and stages or elements of management necessary to achieve the objectives of management of the area for which it was established. The steps reflect the context of existing values and threats, the planning, allocation of resources (inputs), management actions (processes), products and services (outputs) and impacts or outcomes.

The assessment was done in the office by the District Forest Officer (DFO) and his assistants who have enough knowledge of the forest reserve. The tracking tool has two sections; the data sheet section containing detailed key information on the site, its characteristics and management objectives and an overview of WWF/World Bank involvement. Section two is the assessment form which is sub-divided into three; the main

part of the assessment form with a series of 30 questions that were answered by assigning a simple score ranging between 0 (poor) to 3 (excellent). A series of four alternative answers were provided against each question for assessors to make judgments as to the level of score given. There were also six supplementary questions which elaborate on key themes in the previous questions and provide additional information and points. The comments box next to each question allowed qualitative judgements to be justified by explaining why they were made and ranged from personal opinion to reference documents. Then for each question long-term management needs were identified to further relevant adaptive management of the forest reserve.

3.3.1.2 Socio – economic data

Socio-economic survey was conducted to collect information with regard to socio – economic aspects of the communities surrounding the catchment forest reserve. This involved investigating the livelihood systems of the people as related to utilization of wetland and forest resources. For example, land use and tenure systems, economic activities (e.g. agriculture, lumbering, hunting, beekeeping, grazing, and fishing), income levels, forest products and their uses, tree species preferences, local people's perceptions on forest conservation and management aspects, institutional roles and trends in management of the forest resources. Conservation institutions working in the area were also contacted for additional information.

The socio-economic information was collected through structured questionnaire (open and close ended). In order to triangulate information given through questionnaire, to cross-check respondents' answers and to obtain information that may not be covered by the

questionnaire, focus group discussion (using a check list) and participant observation were used (Kajembe and Luoga, 1996).

(i) Structured questionnaire

This entailed open and close – ended questions for collecting data from the households. The questionnaires were pre-tested during the reconnaissance stage to check if the respondents understand them well and they address issues under investigation. Most of the questions were responded and therefore little modifications were made to the original questionnaire.

(ii) Focus group discussion

A checklist was used to guide discussions with key informants (or focused group). A key informant is an individual who is accessible, willing to talk and has great depth of knowledge about the issues in question. Key informants are not only members of the clientele, but are most often informed outsiders (Mettrick, 1993). For this study discussions were conducted with SIMMORS Project Management, District Forest Officer, Divisional Forest Officer, Village Environmental Committee Members, Ward and Village Executive Officers, and some elders.

(iii) Participant observation

This is one of the techniques used by researchers on arriving to a community in order to overcome problems of orientation. The researcher tries to be part of the community being studied (Kajembe and Luoga, 1996). Much information can be obtained simply by observing what goes on. What farmers say and what they do may not necessarily coincide;

they may sometimes report the standard practice in the neighbourhood rather than what they themselves do. Observing operations in the field gives an opportunity to discuss with the farmer what, why, where, when and how things are done. It is always essential to keep ones eyes open when visiting the farm and to check what you are told against what you see (Mettrick, 1993). Curiosity, willingness to learn from other people and ability to adapt to their rhythm and life style (Martin, 1995) were the main tools used. This information was compared with the one obtained through a structured questionnaire and focus group discussion. At times, this resulted into a more complete understanding of both the individual elements and the whole social system. In other situations, new questions about life in the study area emerged which necessitated further investigation.

3.3.2 Secondary data

Secondary data included other research findings and experiences from different case studies related to the assessment of forest conditions. These were collected through literature search of activity reports on programmes/projects in the district, regional government and project offices, different publications, journals and visiting websites to form an overview and identify information gaps.

3.4 Data Analysis

Both qualitative and quantitative methods of data analysis were employed in this study. Data collected from different sources were coded in a form suitable for addressing research questions and the method of analysis to be employed and analysed as follows:

3.4.1 Vegetation data

3.4.1.1 Stem numbers (N) and basal area (G) per ha

Microsoft excel software package was used to analyse quantitative data for various forest parameters. Summaries of the basal area and number (density) of the live trees and poles, naturally dead trees and poles, new/fresh cut trees and poles, and old blackened cut trees and poles were computed for each plot and used to estimate the basal area (G) and number of stems per hectare i.e. density (N) in each stratum. One-way analysis of variance (ANOVA) was used to compare the levels of disturbance between the strata and the pair of means that showed significant difference were separated using Least Significant Difference (LSD) test at 5% level of significance (Jayaraman, 2000). The value of LSD was calculated using the following formula:

$$LSD_{\alpha} = (t_{v, \alpha}) (S_d)$$

Where;

$$S_d = \sqrt{S^2 (1/r_i + 1/r_j)} = \text{the standard error of the mean difference,}$$

$$t_{v, \alpha} = \text{the Student's t value, at } \alpha \text{ level of significance and } v \text{ degree of freedom for error,}$$

$$S^2 = \text{the error mean square in the analysis of variance,}$$

$$r_i \text{ and } r_j = \text{the number of replications of the } i^{\text{th}} \text{ and } j^{\text{th}} \text{ treatments,}$$

$$d_{ij} = y_i - y_j = \text{the mean difference between the } i^{\text{th}} \text{ and } j^{\text{th}} \text{ treatment,}$$

∴ If the absolute value of d_{ij} is greater than the LSD value, the i^{th} and j^{th} treatments are declared to be significantly different at the α level of significance and vice versa.

3.4.1.2 Resources utilization pressure

Utilization pressure of forest resources was determined in order to know the intensity in utilizing the resources and the current status. According to Madoffe and Munishi (2005) the use intensity (i.e., utilization pressure) was computed using the following formula:

$$U = R/S \times 100\%$$

Where;

U = use intensity (%),

R = recently cut trees and poles (number of trees/poles per ha),

S = stocking (density- total number of stems per ha).

3.4.1.3 Trees species checklist

A cumulative list of species was compiled and triangulated with established checklist (Brenan & Greenway, 1949; Mbuya *et al.*, 1994). All species with diameter (at dbh) ≥ 5 cm encountered in the plots of disturbance assessment were grouped as trees and poles, identified and categorized according to the stratum they occur in the forest and their usefulness was also indicated.

3.4.2 Threat reduction assessment index

The TRA approach involved generation of a “Threat Reduction Index” [(Raw Score/Total Ranking)*100]. The survey team together with other members of the VEC and VGS were involved in this process in a classroom session. The threats which were identified during the survey process were then ranked based on a set of pre-determined criteria: area referring to the percentage of the habitats in the site that the threat affected; intensity

referring to the impact of the threat within a micro-site – has the threat completely destroyed the habitat in a small locality, or has it only caused minor changes; and urgency referring to the immediacy of the threat – will the threat occur in the near future or in so many years in the future. As there were 5 threats identified in the forest interior, then the highest ranked threat for each criterion received a score of 5, and the lowest ranked threat received a score of 1. The same was done for the forest edge threats. The degree of progress made towards reducing each threat (by first defining what “100% threat met” means for each threat), was assessed as percent threat met. This information was then used to compute the final TRA Index. The TRA Index indicates the extent at which the threats to a target conservation area have been reduced as a result of project interventions (Persha, 2004; Madoffe and Munishi, 2005).

3.4.3 Management effectiveness

Management effectiveness was obtained by analysing the final total of the scores from completing the assessment form, which was calculated as a percentage of the total maximum scores from those questions that were relevant to the forest under study.

3.4.4 Socio – economic data

3.4.4.1 Descriptive and inferential statistics

Quantitative data from household surveys were processed and analysed using Statistical Package for Social Sciences (SPSS). Most of the analysis under quantitative data falls under the domain of “descriptive statistics”. Descriptive statistics (statistical data about the distribution, central tendency and dispersion of responses) was summarized and presented as figures, frequency tables and cross- tabulations. Cross tabulation is both a powerful way

of communicating information and the commonest form of data presentation (Casley and Kumar, 1988). The function of the second domain “inferential statistics” was to provide an idea about whether the patterns described in the samples were likely to apply in the population from which the samples were drawn (de Vaus, 1986, as cited by Mbwambo, 2000) by developing a logistical regression model.

Logistic regression is useful for situations in which one wants to predict the presence or absence of a characteristic or outcome based on values of set of predictor variables. It is similar to a linear regression model but it is suited to models where the dependent variable is dichotomous, while the independent variables can be interval level or categorical. The logistical regression coefficients can be used to estimate odd ratios for each of the independent variable in the model. In this study the logistic regression analysis established a relationship (Whitehead, 1998; Pampel, 2000) between dependent variable i.e. existence of human disturbance in the reserve and independent variables i.e. socio-economic and demographic factors (i.e. age, gender, marital status, education level, ethnicity (tribe), duration of stay in the village, farm size, and demand of forest products and services) as follows:

$$Y_i = \frac{1}{1 + e^{-Z}}$$

Where:

Y_i = the i^{th} probability of event to occur for the dependent variable (existence of human disturbance in the catchment forest a binary/dichotomous variable with value of 1 if there are disturbances on the reserve and 0 if other wise),

Z_i = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e_i$ (the linear combination),

Z_i = the i^{th} observed value of the independent variables,

β_0 = constant term of the model without the independent variables (intercept),

β_1 to β_n = independent variables coefficients estimates from the data,

e = is a natural logarithm base approximately 2.718,

i = 1, 2, ..., n ; where n is the total number of variables,

X_1 to X_n = independent variables (socio-economic and demographic factors),

X_1 = age of respondents in years,

X_2 = gender (male vs female) – dummy variable,

X_3 = ethnicity (native tribes vs immigrants) - dummy variable,

X_4 = marital status (married vs not married) – dummy variable,

X_5 = duration of stay in the village (≤ 10 years vs > 10 years) – dummy variable,

X_6 = education level (formal vs non formal) – dummy variable,

X_7 = farm size in hectares,

X_8 = demand of forest products and services - dummy variable.

The probability of an event not to occur was estimated as:

Prob (No event) = 1 - Prob (Event).

The hypotheses tested were;

$H_0: \beta = 0$ (implying that the regression coefficients are equal to zero and thus there is no correlation between human disturbance in the catchment forest (dependent variable) and socio-economic and demographic factors (independent variables));
against,

$H_1: \beta \neq 0$ (implying that the regression coefficients are not equal to zero and thus there is

either a positive or a negative correlation between human disturbance in the catchment forest reserve and the socio-economic and demographic factors).

H_0 : will be rejected only where $p < 0.05$.

To test whether the regression coefficients are significantly different from zero, the Wald statistic (or t-value) that asymptotically follows a Chi-squared distribution in large samples (Gujarati, 1995) was used. The Wald statistic is distributed as Chi-square with degree of freedom (df) equal to the number of constrained parameters (r). With single parameter, the Wald statistic is simply the square of the ratio. The odds ratios represented by $\text{Exp}(\beta)$ from logistic regression analysis were used in explaining the likelihood of occurrence or non-occurrence of human disturbance in the catchment forest reserve in the study area under specified socio-economic and demographic factors.

To assess the goodness of fit of the regression model to the data, the model Chi-square as suggested by Pampel (2000) was used and was tested at 5% probability level. Chi-square measures how well the independent variables affect the outcome of dependent variable. Also -2 log likelihood (-2LL) which indicates that the model fits the data reasonably well, and the overall percentage of correct predictions where the bigger the percentage the better the model were used.

Proper interpretation of logistic regression results involved looking at Wald statistic (t-value) to see whether the effect of a particular independent variable is statistically significant, sign of effect of the logistic regression coefficient (β) to see whether the increase in independent variable increased or decreased the probability of success (in this

case occurrence of human disturbance in the catchment forest reserve), magnitudes of the similarly measured variables to determine which of the independent variables seem to have a greater impact on the human disturbance in the catchment forest, and the $\text{Exp}(\beta)$ to see how much a 1- unit increase in X_i changes the odds of success (this is because the odds of success is not the same as probability of success).

3.4.4.2 Content and structural – functional analysis

The qualitative data and information was analysed using the content and structural analysis techniques. Content analysis method was used to analyse in detail the components of verbal discussions held with key informants and open-ended questions whereby recorded dialogue with respondents were broken down into smallest meaningful units of information or themes and tendencies. This helps the researcher in ascertaining values and attitudes of the respondents (Kajembe, 1994). Since most of the data were categorical, interpretation was done using frequencies, cross tabulations and percentages. Structural functional analysis was used to explain the way social factors relate to each other within a social system and to the physical surrounding. This type of analysis helps the researcher to distinguish between manifest and latent functions. Manifest functions are “those consequences which are intended and recognized by actors in a system”. Latent functions are “those consequences which are neither intended nor recognized” (Thomlinson, 1965 as cited by Kajembe and Luoga, 1996).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Vegetation Structure of the Woodlands in the Catchment

In general timber harvesting is prohibited in protective forests for water catchment and biodiversity purposes, while sustainable controlled harvesting may be allowed in production forest reserves and in general land. However, in order to establish strategies for managing the natural resources and bring about sustainable timber harvesting, knowledge of the growing stock is a prerequisite. This study concentrated on estimating basal area and density of the stand and tree species composition in order to know the status of the available resources in the catchment forest reserve.

4.1.1 Basal area (m^2/ha)

The average stand basal area of the catchment forest reserve was estimated at 13.2 ± 0.6 (SE) $\text{m}^2 \text{ha}^{-1}$. This result is comparable to the results obtained in other studies in miombo woodlands. Frost (1996) observed that generally in the miombo ecoregion the stand basal area varies between 7-19 $\text{m}^2 \text{ha}^{-1}$ in dry miombo and up to 22 $\text{m}^2 \text{ha}^{-1}$ in wet miombo; Nduwamungu and Malimbwi (1997) reported a basal area of 10.4 $\text{m}^2 \text{ha}^{-1}$ at Kitulanghalo in Tanzania; and Nduwamungu (2001) reported 10.9 $\text{m}^2 \text{ha}^{-1}$ in Kilosa, Tanzania. Mean basal area per ha was significantly ($p < 0.05$) lower in the wooded grasslands (10.1 ± 1.4 (SE)) $\text{m}^2 \text{ha}^{-1}$ than in the closed woodlands (15.2 ± 1.3 (SE)) $\text{m}^2 \text{ha}^{-1}$ (Table 1).

Table 1 **Mean stand parameters in three different vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania**

	Vegetation Stratum	Mean	Std. Dev.	Std. Error	95.0% Confidence Level	Min	Max
Basal area (m ² /ha)	Wooded grassland	10.1	6.5	1.4	2.9	1.7	25.6
	Open woodland	12.9	7.1	0.7	1.3	1.3	47.7
	Closed woodland	15.2	8.7	1.3	2.6	0.5	53.3
	Average	13.2	7.6	0.6	1.1	0.5	53.3
Density (stems/ha)	Wooded grassland	771	511	112	233	200	2250
	Open woodland	579	256	23	46	50	1450
	Closed woodland	667	302	45	91	100	1450
	Average	622	310	23	45	50	2250

The significant difference between wooded grasslands and closed woodlands could probably be due to soil characteristics and the water logged nature of the wooded grassland stratum. This stratum is within the floodplain woodlands characterized by seasonal/intermittent freshwater marshes/pools on inorganic soils; including freshwater swamp forest, seasonally flooded forest, and wooded swamps (Ramsar, 2004; WI, 2004) with most trees growing on ant hills. Some of the tree species growing here could not be found in the other two strata and are comparably smaller in diameter. Basal area showed no significant difference ($p>0.05$) between wooded grasslands and open woodlands and between open woodlands and closed woodlands; probably due to destruction of the closed woodlands caused by uncontrolled annual wildfires and illegal harvesting of trees making it undistinguishable from the open woodland stratum.

4.1.2 Density (stems/ha)

On average the stand density was estimated to be 622 ± 23 (SE) stems ha^{-1} . This result is comparable to the results obtained in other studies carried out in various miombo woodlands. Chidumayo (1993) obtained 750 stems ha^{-1} in Zambia; Frost (1996) observed that generally in the miombo ecoregion the stand density ranges from 380-1 400 stems ha^{-1} ; and Nduwamungu and Malimbwi (1997) reported 691 stems ha^{-1} at Kitulanghalo in Tanzania. Density was significantly ($p < 0.05$) higher in the wooded grasslands (771 ± 112 (SE)) stems ha^{-1} than the open woodlands (579 ± 23 (SE)) stems ha^{-1} (Table 1). No significant difference in density was observed between wooded grasslands and closed woodlands and between open woodlands and closed woodlands ($p > 0.05$). These signify the impact of human disturbance in the open and closed woodlands. Human disturbance threatens the sustainability of the ecosystem of the catchment and thus the reduction of the biodiversity of the wetland resources.

4.1.3 Trees species composition

A total of 79 tree species belonging to 31 different families were identified (Appendix I). Twenty eight (28) species were obtained in the wooded grasslands, 67 in the open woodlands and 65 in the closed woodlands. Twenty five (25) tree species were common in the three strata. Tree species uses were also indicated based on the experience of key informants (tree identifiers) and according to Brenan & Greenway (1949) and Mbuya *et al.* (1994) checklist. This new checklist was later cross referenced with that mentioned by respondents during the socio-economic survey on tree species preferences for different uses.

4.2 Human Induced Disturbance and Utilization Threats in the Catchment Forest

The communities living adjacent to this catchment reserve depend on the forest for timber, building poles, firewood for household use and for curing tobacco, forest land for agriculture and settlement, fodder for animal feeding, medicine, honey collection and fruits. These forest resources are exploited unsustainably and compounded with bush fires leading into resource destruction and ultimate degradation.

4.2.1 Human induced disturbance in the catchment forest

4.2.1.1 Disturbance in the three vegetation strata

An assessment of forest disturbance showed an average removal (both dead and cut trees) of 114 stems ha^{-1} equivalent to a basal area of $4.8 \text{ m}^2 \text{ ha}^{-1}$. In the wooded grasslands a total of 171 stems ha^{-1} were sampled, of which 140 stems ha^{-1} (82%) were alive (Table 2). In this stratum dead trees averaged 26 stems ha^{-1} (15%). There were no new cut trees but old cuts were 5 stems ha^{-1} (3%). Also in the same stratum a total of 676 poles ha^{-1} were sampled in which 636 were live poles ha^{-1} (94%), 38 dead poles ha^{-1} (6%) and no new cut poles. Old cut poles were 2 poles ha^{-1} (0.4%) (Fig. 4 a & b). A detailed account of the types and levels of disturbances in the study forest is given in Appendix II.

In the open woodlands 272 stems ha^{-1} were sampled of which 203 stems ha^{-1} (75%) were alive. In this stratum, there were more old cut trees which averaged 27 stems ha^{-1} (10%), while dead trees and new cut trees had 21 stems ha^{-1} (8%) each. A total of 436 poles ha^{-1} were sampled in this stratum with 376 live poles ha^{-1} (86%), 35 dead poles ha^{-1} (8%), 19 new cut poles ha^{-1} (4%), and 7 old cut poles ha^{-1} (2%).

Dead trees recorded the highest disturbance level of 24 stems ha^{-1} (9%) in the closed woodland stratum where a total of 266 stems ha^{-1} was sampled with 219 stems ha^{-1} (82%) identified as live trees. This was followed by new cut trees which averaged 12 stems ha^{-1} (5%) and the least was old cut trees with an average of 10 stems ha^{-1} (4%). The total poles sampled in this stratum were 497 ha^{-1} of which 453 poles ha^{-1} (91%) were identified as live. Dead poles showed the highest level of disturbance with an average of 40 poles ha^{-1} (8%), followed by new cut with an average of 3 poles ha^{-1} (0.7%) with no old cut poles.

Table 2: Forest disturbance in three different vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania

Vegetation Stratum	Type of Product	Transect length (m)	Total area (ha)	Stocking (stems per ha)	Live % of total	Avg. live per ha	Dead % of total	Avg. dead per ha	New cut % of total	Avg. new cut per ha	Old cut % of total	Avg. old cut per ha
Wooded Grassland	Trees	420	0.4	171	82	140	15	26	0	0	3	5
	Poles	420	0.4	676	94	636	6	38	0	0	0.4	2
Open woodland	Trees	2420	2.4	272	75	203	8	21	8	21	10	27
	Poles	2420	2.4	436	86	376	8	35	4	19	2	7
Closed woodland	Trees	900	0.9	266	82	219	9	24	5	12	4	10
	Poles	900	0.9	497	91	453	8	40	0.7	3	0	0

4.2.1.2 The level of forest disturbance between the three vegetation strata

(i) Comparison between dead, new cut and old cut trees and poles

Disturbance in the three strata in terms of both trees and poles (i.e., dead, new cut and old cut stems) showed statistically significant difference ($p < 0.05$) between strata (Table 3). Least significant difference test at 5% level of significance to compare the difference in disturbance for trees showed a significantly higher disturbance for dead (9 ± 3 (SE)) stems ha^{-1} in wooded grasslands than for dead (2 ± 0 (SE)) stems ha^{-1} in open woodlands. Furthermore, the dead (9 ± 3 (SE)) stems ha^{-1} in wooded grasslands had a significantly higher disturbance than the dead (4 ± 1 (SE)) stems ha^{-1} in closed woodlands. Similarly the dead stems ha^{-1} in closed woodlands had a significantly higher disturbance than that for the open woodlands. For the new cut trees the open woodlands (2 ± 0 (SE)) stems ha^{-1} showed a significantly higher disturbance than the wooded grasslands (0 ± 0 (SE)) stems ha^{-1} . Furthermore the closed woodlands (2 ± 0 (SE)) stems ha^{-1} had a significantly higher disturbance than the wooded grasslands (0 ± 0 (SE)) stems ha^{-1} . No significant difference ($p > 0.05$) was observed in new cut trees between open woodland and closed woodland strata. Old cut trees showed no significant difference ($p > 0.05$) between the three vegetation strata.

Similarly for the poles the dead (13 ± 8 (SE)) stems ha^{-1} in wooded grasslands had significantly higher disturbance than the dead (4 ± 1 (SE)) stems ha^{-1} in open woodlands. The dead (13 ± 8 (SE)) stems ha^{-1} in wooded grasslands also had a significantly higher disturbance than the dead (7 ± 2 (SE)) stems ha^{-1} in closed woodlands. Whereas the dead stems ha^{-1} in open woodlands showed a significantly lower disturbance than that of the closed woodlands. For the new cut poles the open woodlands (2 ± 2 (SE)) stems ha^{-1}

showed a significantly higher disturbance than the wooded grasslands (0 ± 0 (SE)) stems ha^{-1} . No significant difference ($p > 0.05$) was observed in new cut poles between wooded grasslands and closed woodlands as well as between open woodland and closed woodland strata. Equally old cut poles showed no significant difference ($p > 0.05$) between the three vegetation strata.

Table 3: Mean forest disturbance parameters in three different vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania

Type of Product	Vegetation Stratum	Dead		New cut		Old cut	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
Trees	Wooded grassland	9 a ¹	3	0 a	0	2 a	2
	Open woodland	2 b	0	2 b	0	3 a	0
	Closed woodland	4 c	1	2 bc	0	2 a	0
Poles	Wooded grassland	13 a	8	0 a	0	1 a	1
	Open woodland	4 b	1	2 b	2	1 a	0
	Closed woodland	7 c	2	1 ab	0	0 a	0

¹a = Means with same letter are not significant different while those with different letters indicate significant differences ($p \leq 0.05$) between the strata

Between strata the densities of new cut and old cut trees are significantly higher in the open woodlands followed by closed woodlands and are lowest in the wooded grasslands. Whereas, the density of dead trees is higher in the wooded grasslands followed by closed woodlands and is lower in the open woodlands. Within strata old cut trees are higher in the open woodlands while dead and new cut trees are the same (Fig. 4 a). For poles the

densities of new cuts and old cuts are relatively higher in open woodlands, with no old cuts in the closed woodlands and no new cuts in the wooded grasslands. Within strata dead poles are higher in the open woodlands, followed by new cuts while old cuts are the lowest (Fig. 4 b).

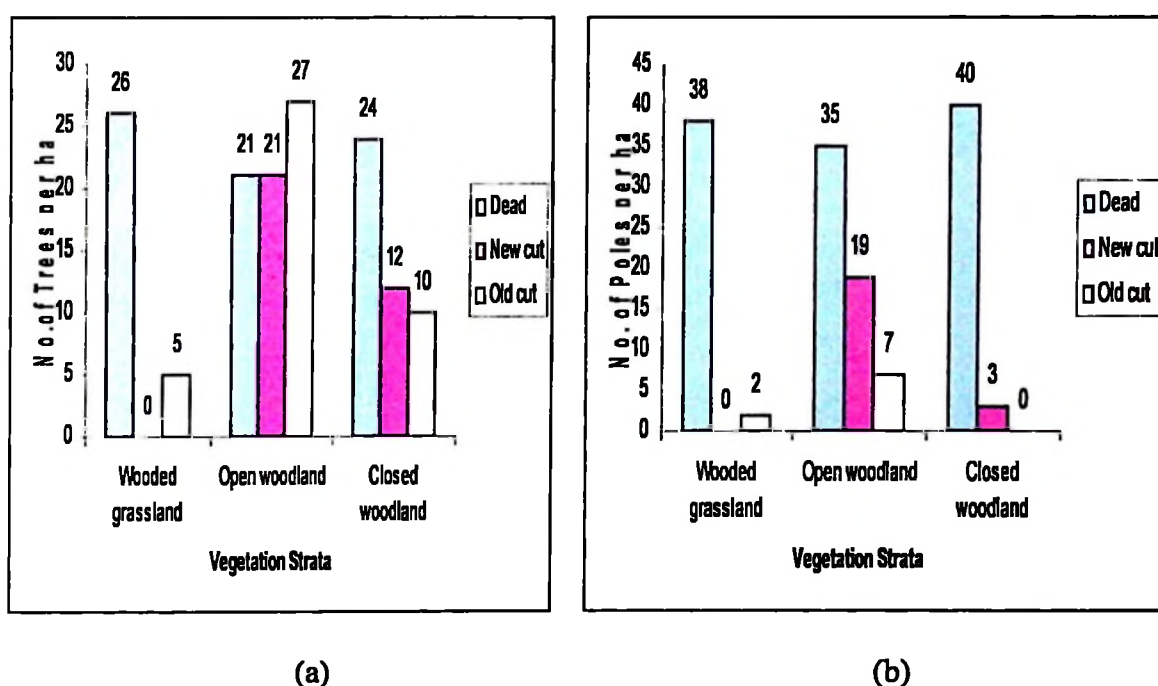


Figure 4: Levels of forest disturbance for (a) trees and (b) poles within the three different vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania

These results imply that there were higher extraction rates in the past for trees while the current extraction for poles seems to be higher than in the past. Significant difference in the poles could be due to the fact that most of the big extractable tree species have been significantly reduced and current extraction is taking place in trees with dbh less than 25 cm. Moreover, poles are easily broken by animals like elephants than big sized trees and

they are easily destroyed by annual wildfires. Most of the dead trees and poles are a result of disturbance caused by wildlife especially elephants that break them while feeding on them. Wildlife have preferences on the tree species they feed on and thus causing enormous destruction to them (Plate 1). Elephants play a pivotal role in the ecosystem. They break down and push over trees and shrubs, often transforming relatively dense woodlands into more open wooded grasslands with scattered tall trees, low-growing shrubs and resprouting trees.



Plate 1 Tree debarked by elephants in Mpanda Line Forest Reserve, Urambo District, Tanzania

Some trees and poles die naturally by drying out as a result of aging or natural disturbances like wind fall, while others die due to attack by pests and diseases e.g. heart rot. On the other hand, most of the new and old cut trees and poles are a result of illegal

timber harvesting, construction poles, and firewood collection. A study by Mutangah (2005) at Kakamega forest in Kenya found out logged stumps diameter for timber as small a 20 cm, while less than 20 cm were harvested as poles for construction. Also Frontier-Tanzania (2002) reported the death of poles and timber trees in Mgambo to be likely and directly influenced by the high levels of fire disturbance in the forest reserve.

(ii) **Comparison of overall disturbance between the three vegetation strata**

The overall mean number of stems (trees and poles) removed (dead or cut) were compared statistically between the strata and results showed significant difference ($p < 0.05$) between strata for the poles but not with the trees (Table 4).

Table 4: Overall mean number of forest disturbance in three different vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania

Type of Product	Vegetation Stratum	Mean ²	Std. Dev.	Std. Error	95.0% Confidence Level	Min	Max
Trees	Wooded grassland	10 a ¹	8	4	19	2	17
	Open woodland	7 a	3	1	2	2	11
	Closed woodland	7 a	3	1	4	3	12
Poles	Wooded grassland	14 a	15	9	37	5	31
	Open woodland	6 b	6	2	4	2	21
	Closed woodland	7 bc	4	2	4	3	13

¹a = Means with same letter are not significant different while those with different letters indicate significant differences ($p \leq 0.05$) between the strata

²Mean = Number of Dead, New cut and Old cut trees and poles ha⁻¹

For the poles a LSD test at 5% level of significance to compare the difference in disturbance between the strata showed a significantly higher disturbance in the wooded grasslands (14 ± 9 (SE)) stems ha^{-1} than in the open woodlands (6 ± 2 (SE)) stems ha^{-1} . Furthermore, the wooded grassland (14 ± 9 (SE)) stems ha^{-1} showed a significantly higher disturbance than the closed woodlands (7 ± 2 (SE)) stems ha^{-1} . The poles showed no significant difference ($p > 0.05$) between open woodlands and closed woodlands.

Generally in the three strata the highest disturbance for both trees and poles were observed in the open woodland followed by closed woodland and the least was in wooded grassland (Fig. 5). This is probably due to the fact that most of the extractable tree species for timber and poles are found in the open and closed woodland strata. Frontier-Tanzania (2002) found out in Mgambo forest reserve that pitsawing is largely confined to the riverine and lowland forest habitats where the few large trees remain in small relatively undisturbed areas.

Field observations revealed that the highest disturbances were on the northern part of the catchment reserve, followed by the central part and the southern part was the least. In the northern part of the reserve few wild animals were found. However, livestock grazing (in Lumbe dam and the floodplains of lake Sagara and Zivwe river), and encroachment for settlement and agriculture were rampant in these areas. Both new and old platform and pit sawing structures, timber extraction of even small sized trees, and log off cuts (*mbilimbi*) harvesting was common. Other disturbances observed included tree debarking for beehives making and ropes, track and foot paths, fires, and farm land preparation as well as pole cutting for construction of houses and livestock sheds (*boma*) (Plates 2 to 5).

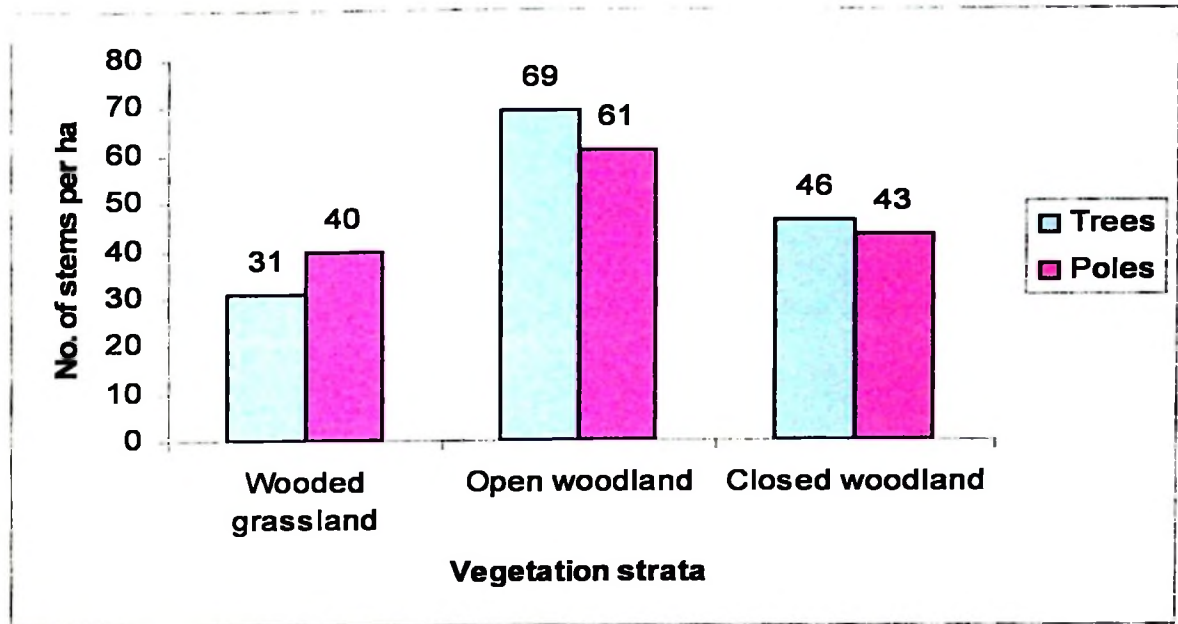


Figure 5: Levels of forest disturbance for trees and poles within the three vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania

The central and southern part of the reserve had big numbers of different wild animals and is the area of concentration for protection within the Luganzo Game Controlled Area. Yet the central part exhibits rampant timber and log off cuts (*mbilimbi*) harvesting, fires, tree debarking for beehives making and felling of trees for honey collection (Plates 2, 4b & 5). Towards the southern part except near Kasense fishing camp, little disturbances were observed in terms of timber and poles extraction especially areas adjacent to the Ugalla Game Reserve as it has an additional protection influence from the Game Reserve. However, away from the Game Reserve timber and poles extraction, beekeeping activities, and fires were common. Mutangah (2005) in Kakamega forest, Kenya found out both large and small trunk stumps left after large trees and poles harvesting, tree branch cuttings from standing trees, and platform and pit sawing structures. The research further

observed other disturbance indicators including; charcoal kilns, firewood collection for domestic use, stem debarking for medicinal use or for fibre or both, honey gathering from crevices or holes in tree trunks, and tracks of both vehicle and human footpaths.

Similar studies by Frontier-Tanzania (2001b, 2002); Madoffe and Munishi (2005); Burgess *et al.* (2005); and Madoffe *et al.* (2006) reported that in spite of management and conservation efforts from various institutions; fires, agriculture encroachment, illegal logging, pole cutting, hunting, and medicinal plant collection were still threatening most parts of the Eastern Arc Mountains (EAMs). These activities could lead to further fragmentation of this important ecosystem. Forest fragmentation is considered to be one of the major sources of biodiversity loss (Newmark, 1998).

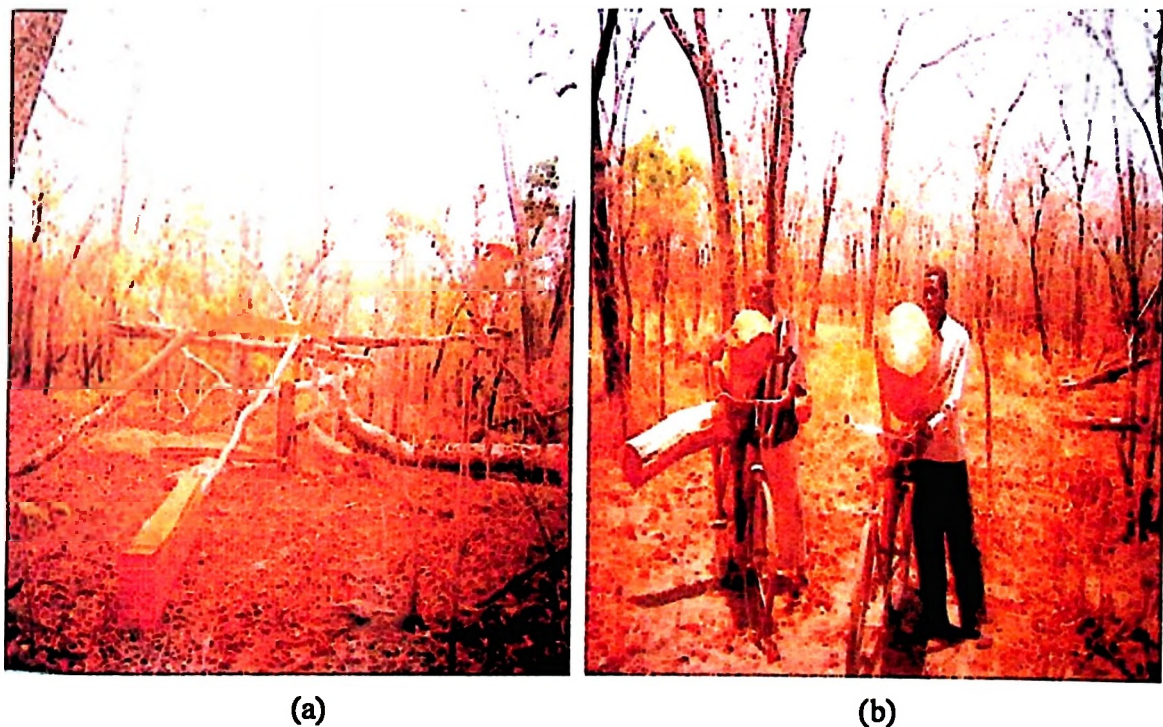


Plate 2: Illegal (a) timber extraction and (b) log off cuts (*mbilimbi*) collection in Mpanda Line Forest Reserve, Urambo District, Tanzania

4.2.1.3 Forest utilization pressure

(i) Utilization pressure in the three vegetation strata

A total stocking of 171 trees ha⁻¹ and 676 poles ha⁻¹ in the wooded grassland stratum was surveyed (Table 5). Extraction was very low in this stratum as observed in old cut stems with a use intensity of 3% for trees and 0.4% for poles. In the open woodland stratum with a stocking of 272 and 436 stems ha⁻¹ of trees and poles respectively, use intensity was found to be higher in old cut trees (10%) than in new cut trees (8%). Use intensity for poles was higher in new cuts (4%) than in old cuts (2%). The closed woodland stratum with a stocking of 266 and 497 stems ha⁻¹ of trees and poles respectively, had a higher use intensity of new cut stems for both trees (5%) and poles (0.7%) than in old cut stems. In this stratum only old cut trees with no poles were observed with a use intensity of 4%.

Table 5: Percentage of forest utilization pressure in three different vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania

Vegetation Stratum	Type of Product	Density (stems/ha)	Average new cut per ha	Use intensity (%)	Average old cut per ha	Use intensity (%)
Wooded grassland	Trees	171	0	0	5	3
	Poles	676	0	0	2	0.4
Open woodland	Trees	272	21	8	22	10
	Poles	436	19	4	5	2
Closed woodland	Trees	266	12	5	8	4
	Poles	497	3	0.7	0	0

(ii) Comparison of utilization pressure between the three vegetation strata

Use intensity in the three strata in terms of both trees and poles cutting (i.e. new cut and old cut) showed statistically significant difference ($p < 0.05$) between the strata (Table 6). Least significant difference test at 5% level of significance to compare the difference in use intensities for trees between strata showed a significant lower use intensity in the wooded grasslands (2 ± 1.7 (SE)) % than the open woodlands (5 ± 0.7 (SE)) %. Further the open woodlands had higher use intensity (5 ± 0.7 (SE)) % than the closed woodlands (3 ± 0.3 (SE)) %. No significant difference ($p > 0.05$) was observed in use intensity for trees between wooded grassland and closed woodland strata.

Table 6: Mean percentage of use intensity in three different vegetation strata in Mpanda Line Forest Reserve, Urambo District, Tanzania

Type of Product	Vegetation Stratum	Mean ³	Std. Dev.	Std. Error	95.0% Confidence Level	Min	Max
Trees	Wooded grassland	2 a ¹	2.9	1.7	7.2	0	5
	Open woodland	5 b	2.3	0.7	1.7	1	8
	Closed woodland	3 ac	0.8	0.3	0.9	2	4
Poles	Wooded grassland	1 a	1.2	0.7	2.9	0	2
	Open woodland	3 b	4.8	1.5	3.4	0	16
	Closed woodland	1 ac	0.6	0.2	0.6	0	1

¹a = Means with same letter are not significant different while those with different letters indicate significant differences ($p \leq 0.05$) between the strata

³Mean = Percentage of New cut and Old cut trees and poles

Similarly the results for the poles showed a significant lower use intensities in the wooded grasslands (1 ± 0.7 (SE)) % than the open woodlands (3 ± 1.5 (SE)) % and also a higher use intensity for the open woodlands (3 ± 1.5 (SE)) % than the closed woodlands (1 ± 0.2 (SE)) %. No significant difference ($p>0.05$) was observed in use intensity for poles between wooded grassland and closed woodland strata. Furthermore, there was no significant difference ($p>0.05$) in use intensities between new cuts and old cuts within the three vegetation strata.

These results revealed that there is more extraction in the open woodlands followed by the closed woodlands and the wooded grasslands is the least (Fig 6 a), implying high human impacts in the open and closed woodlands than in the wooded grasslands. Old cut extraction seems to be high however; the current trend is towards new cut extraction of poles as most of the big sized preferred trees have already been cut (Fig 6 b). These results are comparable to those observed by Frontier-Tanzania (2005) in Uluguru North Forest Reserve where there has been a decrease over time in timber resource extraction, while more poles are being cut now and is more prevalent on the western side of the reserve where access is easier. Similar results were observed by Madoffe *et al.* (2005) who found out that there are over 10 times more old cut than new (less than 6 months old) cuts in the EAM forests. Mialla *et al.* (2004) argued that timber cutting is declining following exploitation done in the past, but pole cutting seems to be leading in terms of the rate of tree cutting in the forest. They further noted other forest disturbance as those associated with excessive tree cutting and uprooting of some trees (e.g. *Zanthoxylum chalybeum*) in search of medicinal plants, which currently do fetch market within and outside the

country. This has led to extinction of some of the species and change in forest species composition.

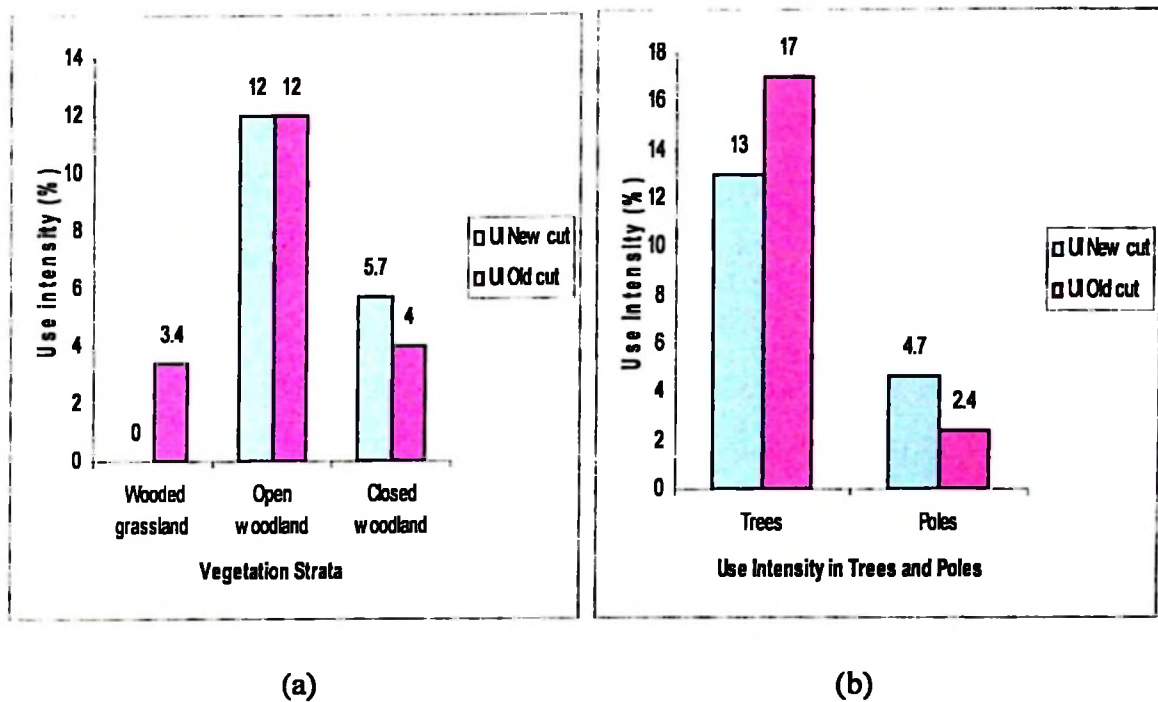


Figure 6: Mean percentage of use intensity between (a) the three vegetation strata and (b) trees and poles in Mpanda Line Forest Reserve, Urambo District, Tanzania

4. 2.2 Utilization threats facing the catchment forest

An analysis of the threats facing the catchment forest reserve showed that the TRA Index for the reserve is 16% (Table 7). During this study eight (8) main threats were identified as both forest edge (5) and forest interior threats (5). A detailed account of the types and intensity of the threats facing the study forest is given in Appendix III. According to Persha (2004); and Madoffe & Munishi (2005), the lower the TRA percentage the higher the threats and vice versa. Given this low TRA Index it seems that the reserve is highly

threatened (Madoffe and Munishi, 2005). This signifies that little efforts have been taken by the management to reduce threats on the Malagarasi-Muyovozi wetland catchments specifically in Mpanda Line Forest Reserve. A similar study by Madoffe and Munishi (2005) in the EAMs revealed that most of the forests had TRA ranging between 30 – 39% indicating that most of the forests are highly threatened.

(i) Bush fires: Bush fires appear to be the most serious threat in the forest edge and forest interior respectively. Accidental bush fires occur normally during land preparations late in the dry spell and sometimes they result into enormous damages like burning houses and other properties as many of the farms are near household premises. Most of the forest interior fires are accidentally caused by hunters, pitsawers, honey collectors and herdsmen while a bigger part are intentional both to improve the quality of grazing grass, and to attract wildlife for hunting causing a dramatic decline in tree cover. DANIDA (1999) reported that almost all fires within the wetland ecosystem are the result of human activities. The findings on arson fires are in line with those reported by Goodman (2003) in KwaZulu-Natal protected areas caused by the local communities. Similar studies by Frontier-Tanzania (2001b, 2002); Madoffe and Munishi (2005); Burgess *et al.* (2005); and Madoffe *et al.* (2006) observed that deliberate and accidental fires were the most significant threat to some of the EAM forests especially in some of the drier parts where grasslands intermingle with forests.

Controlled burning in Luganzo Game Controlled Area where Mpanda Line Forest Reserve falls in has been one of the main sources of fires to the reserve and has been causing extensive damage to forests thus a threat to the catchment ecosystem. Elsewhere similar

studies reported frequent fires as a big threat affecting the protected areas ecosystems and their biodiversity (UWA, 2002; KNP, 2003; SENAPA, 2004). Mialla *et al.* (2004) noted that grazing in Monduli-Mlimani catchment especially during dry periods was also associated with wildfires to stimulate succulent grass and eradication of pests thus affecting the forest cover. Nsolomo and Chamshama, (1990) argued that, despite the fact that quantified information on the losses of forest biodiversity that is caused by wildfires is not available; the loss is no doubt significant. They further asserted that fire damage to vegetation is of a higher magnitude than damage caused by pit sawing or fuelwood and pole cutting in the forests.

(ii) **Illegal timber harvesting:** Timber harvesting appears to be the most serious threat in the forest interior. Traders in forest products, timber being the most traded product (other products include fish, honey and bees wax, and wild meat) started to build temporary shelters around railway station staff quarters along the Mpanda railway line. As business progressed these people went on to construct permanent houses and more people were attracted. This move resulted into expansion of the railway stations into the current villages within the reserve. The readily availability and easy means of transportation through the railway line to outside markets especially to Mwanza, Musoma, DSM, and Arusha has also contributed to the expansion of business on forest products. Preferred timber species of mninga (*Pterocarpus angolensis*), mkora (*Afzelia quanzensis*) and kasanda (*Swartzia madagascariensis*) are now hard to find in the forest reserve, and harvesting has turned up into small sized immature trees and other lesser known tree species of mtundu (*Brachystegia spiciformis*), mgando mkalati (*Burkea africana*), mgando kaguha (*Albizia antunesiana*) and others.

Table 7: Forest threats in Mpanda Line Forest Reserve, Urambo District, Tanzania

Forest location	Direct Threats	Total Ranking	% Threat Met	Raw Score	TRA Index (%)
FI1 ⁴	- Fire (accidental/intentional)	12	10	1.2	
FI2	- Timber harvesting	12	15	1.8	
FI3	- Hunting	4	30	1.2	
FI4	- Encroachment	6	20	1.2	
FI5	- Grazing	11	15	1.7	
Sub-total		45		7.1	15.7
FE1 ⁵	- Fire (accidental)	12	15	1.8	
FE2	- Grazing	11	15	1.7	
FE3	- Fishing	3	50	1.5	
FE4	- Firewood collection (tobacco curing)	12	10	1.2	
FE5	- Tree/Pole cutting	7	15	1.1	
Sub-total		45		7.2	16
Total		90		14.3	15.8

⁴FI = Forest interior threats (i.e., those which occur inside closed forest more than 100 m from the forest edge),

⁵FE = Forest edge threats (i.e., those which occur within 100 m from the forest edge, and in the forest perimeter zone)

The pattern of decrease in stocking of timber species which are more valuable in the market conforms to the optimum foraging theory that depicts that human foragers as actors maximize their net rate of return per unit of foraging time (Smith, 1983 as cited by Kajembe *et al.*, 2004). The resource switch can further ascertain the optimum foraging concept as people now obtain timber from formerly lesser-utilised tree species. Several scholars have also shown that most subsistence use of resources is sustainable as opposed to the commercial harvesting that always attracts invaders and normally results into overexploitation of the preferred species (Gibson and Becker, 2000; Luoga *et al.*, 2002).

Both fresh and old pit and platform saws, living camps, track and foot paths, cut trees and timber planks were observed in the reserve an indication that illegal harvesting was still going on (Plates 2 to 5) though the study was conducted when there was a country wide ban on timber harvesting.

Occurrences of fresh and old pitsawing sites and footpaths were also reported by Frontier-Tanzania (2001b, 2002, 2005) in Amani Nature, Mgambo Forest, and Uluguru South Forest Reserves respectively. Kajembe *et al.* (2004b) reported that in Kwizu Forest Reserve, illegal harvesting and grazing are not uncommon. A study by Chizyuka (2006) indicated that logging and forest conversions for agriculture are key drivers to the disappearance of Malawi's forests and deterioration of the country's national parks. This has led into increasing deforestation rates and unsustainable exploitation of non-timber forestry products.

(iii) **Overgrazing:** Grazing is becoming a big problem now both on the edge and in the interior part of the reserve especially on the central and northern part. These areas are heavily used for livestock grazing during the dry season, where large herds of cattle are grazing in the floodplains of Lumbe Dam, Lake Sagara and Zivve River, with a detrimental effect to the catchment environment (Plate 3 a). Overgrazing could lead to habitat degradation and loss of preferred species. The dam which used to have water all year round is now seasonal while the size of Lake Sagara has been greatly reduced and the river is also seasonal and hard to trace during the dry season as a result of siltation (Plates 3 b). Frontier-Tanzania (2001a) noted that increased livestock rearing in the floodplains and wetlands was one of the pressures on natural resources in the Kilombero

River Valley. Similarly Frontier-Tanzania (2002); Madoffe and Munishi (2005) noted significant grazing pressure in most of the EAM forests, while UWA (2002) noted in boundary patches of the Bwindi Impenetrable National Park in Uganda. Hongo and Masikini (2002) experienced a high influx of immigrant pastoral herds from drought prone districts to Magu district causing soil erosion, loss of vegetation cover and deforestation and ultimately leading to pollution of lake Victoria along the Speke gulf.

In this study it was noted that bird species known as kong'whani - wattled cranes (*Bugeranus carunculatus*) and bungunusu - shoebill stork (*Balaeniceps rex*) are hardly seen at Lumbe dam due to scarcity of food. These bird species might become extinct as this is the only place where they are found in Tanzania (Makaka S.S. pers comm. 2005). A survey by IRA (2001) also noted very few shoebills in other areas of the wetlands. These bird species are of special conservation importance listed in the IUCN Red Data Book as threatened birds (IUCN, 2004). As indicators, birds may detect aspects of wetland landscape condition that are not detected by other indicator groups and particularly the connectivity between wetlands at large spatial scales (DWAF, 2004). Thus, if their habitats are disturbed they may move away indefinitely. Though grazing pressure seemed seasonal with migratory pastoralists, this study witnessed a shift into permanent dwellings in the reserve, where a big number of the livestock grazers have constructed permanent houses and livestock sheds as well as farmlands.

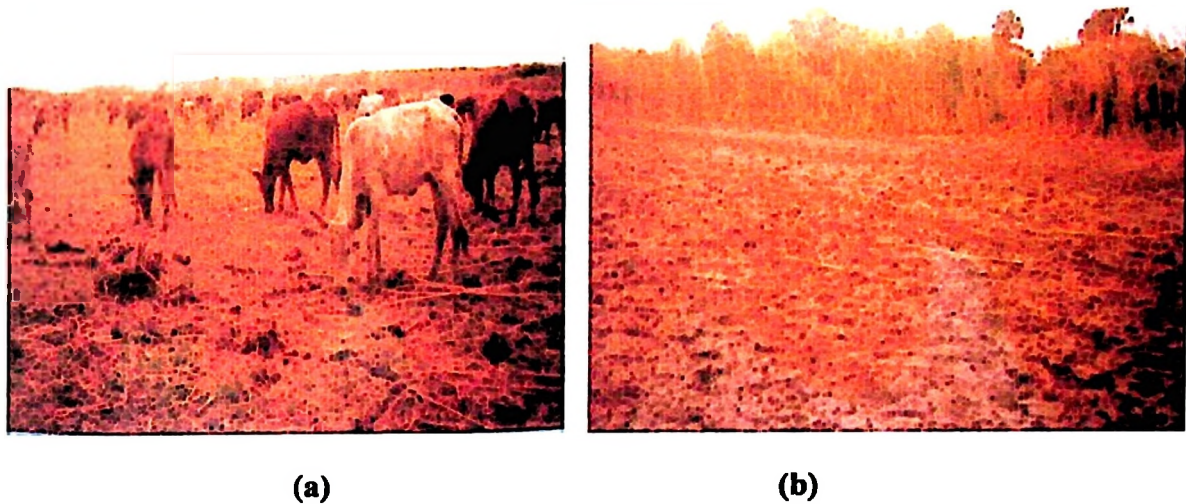


Plate 3: (a) Overgrazing in the floodplains of Lake Sagara (b) siltation of the lake in Mpanda Line Forest Reserve, Urambo District, Tanzania

(iv) Encroachment: Encroachment for settlement and cultivation is another threat to the interior part of the reserve. In spite of the government's effort to establish a corridor of 5 km on both sides of the Mpanda railway line (about 86.05 ha) to accommodate the highly expanding populations in the railway line stations who had already encroached a bigger part of the reserve, there is still encroachment on the northern part at Kizinga and Kalimba sub villages (Refer to Fig. 2). The encroachment takes the forms of tree cutting for firewood to cure tobacco, opening new farms, timber harvesting, rope production, and building materials (Plates 4 a & b). For example, due to the spread of diseases such as nematodes, cultivation of tobacco demands a new farm after every 2-3 years of cultivation this encourages shifting cultivation and thus loss of forest cover. In Zimbabwe tobacco growing has led to large losses of woodland, both for land and fuelwood. These losses are

increased by a need for fresh land each year to avoid risk of root-knot nematodes, as well as for curing the tobacco, which is often carried out using charcoal (Misana *et al.*, 1996).

These findings are consistent with the study by Mahinya (2005) in the same wetland who observed that shifting cultivation is still a major form of crop production. Tree ring barking for land preparation, and for beehive making were common (Plates 5 a & b). DANIDA (1999) argued that human impact in this wetland is increasing rapidly as the human population grows through high birth rates, and local and refugee migration. Whereas the extra demands for food for the refugees in the camps around the site has led to intensified cultivation of forest land and wetlands in surrounding areas, and to increasing fishing and poaching pressure in the reserves. Farming practices cause siltation and pollution of the rivers and lakes which affect the primary production and the growth of the fish.

According to DANIDA (1999) the Ministry of Water identified the Malagarasi River System as one of three river basins in Tanzania with significant agrochemical pollution. These human activities result into deforestation and ultimately to catchment ecosystem degradation. A similar study by SENAPA (2004) at Serengeti National Park reported encroachment for cultivation by local communities as a big threat to the park. Frontier-Tanzania (2005) reported that encroachment into Uluguru North forest reserve for farming and firewood collection is still taking place though at a lower intensity than it is in Uluguru South.

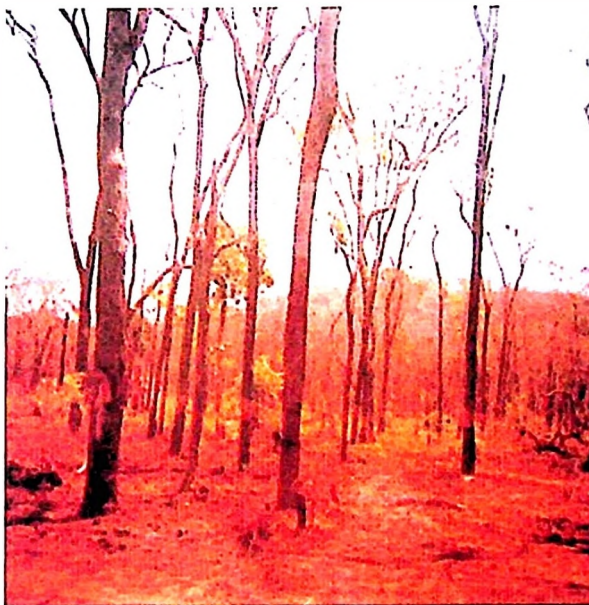


(a)

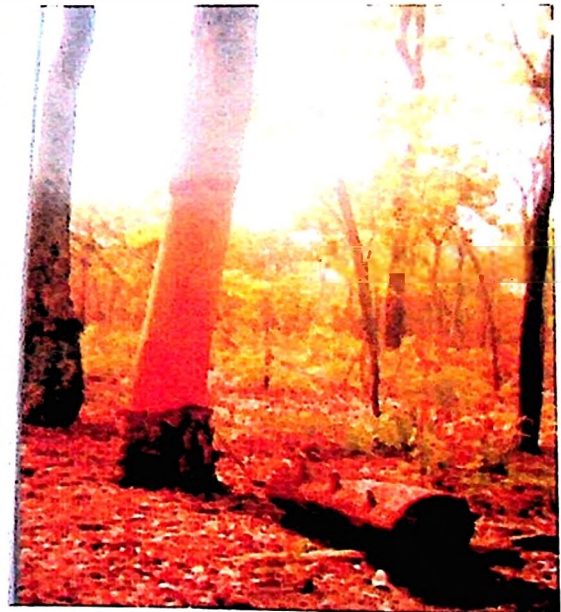


(b)

Plate 4: Tree cutting for (a) house construction and (b) timber in Mpanda Line Forest Reserve, Urambo District, Tanzania



(a)



(b)

Plate 5: Tree ring barking for (a) land preparation and (b) beehives making in Mpanda Line Forest Reserve, Urambo District, Tanzania

(v) Illegal hunting: Illegal hunting for wild meat is no longer becoming a big threat to the ecosystem as it is at least controlled now after the introduction of a patrol unit by one Tourist Hunting Company, Robin Hurt and Cullman Safaris, though both old and recent carcasses could be found in the interior forest during the study. Key informants reported that poaching especially for elephant tusks is still going on though to a small extent by armed refugees' gangs coming as far as from Katumba in Mpanda District. According to DANIDA (1999) heavy levels of poaching have been recorded in the area over the past 20 years and populations of some species of large mammal have been significantly reduced. IRA (2001) reported that at least 70% of the poaching activities in the wetland were done during the wet season unlike other places, possibly because more patrols are conducted during the dry season when roads are passable than during the wet season when most of the areas are inundated and impassable. In another study, Goodman (2002) reported that illegal hunting of rhino and elephant for horn and ivory by sophisticated and organized poaching gangs has to a large extent been contained in South Africa and in KwaZulu-Natal in particular. However, poaching especially of black rhinos and elephants, is a continuing problem and has resulted in severe losses of animals, despite extensive protection efforts in the miombo ecoregion (Misana *et al.*, 1996). For example, according to government figures Zimbabwe may have lost as much as 80 percent of its black rhino population due to poaching in 1992 alone. On the other hand, illegal hunting of antelope in the protected areas for meat is very extensive. A study by Frontier Tanzania (2001b, 2002) in Amani Nature Reserve and Mgambo Forest Reserve observed animal traps close to village boundaries signifying illegal hunting for meat. High poaching incidences by local communities for domestic consumption and for income were also reported by TRAFFIC (2000) in Zimbabwe, UWA (2002) in Bwindi Impenetrable National Park, Uganda; KNP

(2003) in Kaziranga National Park, India; and by SENAPA (2004) in Serengeti National Park, Tanzania. This could be a big threat to the biodiversity sustainability of the ecosystems.

(vi) Illegal fishing: Over fishing was one of the major economic and subsistence activities in river Ugalla, Lumbe dam, and Lake Sagara that could pose a threat to the ecosystem. Fishing is licensed in the game reserve and game controlled areas, but enforcement is minimal and the proximity of the railway in the central part of the Ramsar site is stimulating a commercial market and consequent overexploitation of the resource. According to DANIDA (1999) the Ramsar site is included in a list of nine heavily exploited or over-exploited fishery areas in Tanzania. However, it is no longer a big threat as a result of environmental awareness creation campaigns and regular patrols. Illegal and improper fishing practices including the use of nets with very small mesh sizes, as well as the use of explosives and chemicals for fishing, which destroy the aquatic fauna and other resources of the wetlands, have stopped. Fishing seems no longer a lucrative business as a result of siltation of the lake, dam, and rivers and thus drying in most part of the year and due to previous years' excessive fishing. During this survey holes were seen in Lumbe dam where people were looking for kambale (*Clarias mossambicus*) and kamongo (*Protopterus aethiopicus*) fish which bury themselves in the mud during dry season and come out when there is enough water. This method and intensity of fishing appear to decrease the population of these fish species consequently could lead to their extinction.

Another study by Frontier-Tanzania (2001a) noted that over fishing was one of the pressures on natural resources in the Kilombero River Valley. In India KNP (2003)

reported illegal fishing by villagers in numerous “beels” at the Kaziranga park. This survey witnessed a dry river Ugalla with some patches of water ponds which have also been invaded by alien species (i.e. water hyacinth) where fishing is on going with cultivation of vegetables, maize, beans and other crops on the river floodplains. The once existed big fishing camps within the forest reserve like Msindeni (at lake Sagara) and Kasense (at river Ugalla) are no longer in place and/or have been reduced to very small sizes due to lack of sufficient fish population left. Outside the reserve the fishing camps have now turned into villages; like Shella and Maboha villages. The fishermen have become farmers while others have resorted into illegal timber harvesting. Similar findings were reported by IRA (2001) in this wetland.

(vii) Illegal firewood collection: Firewood collection for curing tobacco is one of the biggest threats to the forest edge of the reserve. Decline of business in forest products has caused people to turn into permanent settlements and start cultivating cash crops, tobacco being one among them thus causing deforestation. FRMP (1996) revealed that on average 18 m³ of wood from live trees is used to cure 1000 kg of tobacco. However, firewood collection for household use may not be regarded as one of the major sources of deforestation and biodiversity loss in the area as local people collect dry wood in favour of green wood. Luoga *et al.* (2000a) argued that generally collection of firewood for household use is not a major cause of deforestation as dead branches; naturally dying trees and unused materials from trees that are harvested for other purposes are collected.

On the other hand charcoal making is still at a very low scale and in most cases is for household use. However, with the current decline in timber and other forest products

trade, the local people might turn into charcoal business as a coping strategy for their livelihoods. Charcoal production in gazetted forests is illegal and its production is unsustainable and inefficient. Using miombo trees to make charcoal a kiln efficiency of 11-30% was obtained (Malimbwi *et al.*, 2004). In the process, large areas of forests are cleared just to access the few trees available and also to provide space to build the kilns. The results therefore are massive forest destruction, loss in biodiversity, frequent forest fires, soil erosion and poor forests among others (Njuguna and Ongugo, 2004). Malimbwi *et al.* (2004) argued that there is a need to explore desirable ways of kiln preparation and carbonization since there is a room to maximize charcoal kiln efficiencies and thus reduce the forest degradation.

(viii) Illegal trees/poles collection: Collection of trees/poles as building materials was common on the forest edge. Big hips of poles as leftovers were seen along the paths/roads during the survey in the southern part of the reserve. Here poles were used to build temporary huts at Lufira camp for tourist hunters. In the north, poles were widely used for house construction by encroachers and cattle grazers as well as for making livestock enclosures. The current move of the Local Government Council to encourage the use of earth bricks for house construction may reduce pole cutting in the forest reserve. Hall and Rodgers (1986) noted that more than 50% of the poles in the easily accessible areas in the Kimboza, Pande and Pugu forest reserves have been cut for different uses. Similarly Frontier-Tanzania (2001b, 2002); Madoffe and Munishi (2005) noted that, tree and pole cutting was intensive along some of the EAM forests border areas within proximity of villages.

4.3 Management Effectiveness and Conservation Initiatives of the Catchment

4.3.1 Management effectiveness of the catchment forest

All questions in the WCPA tracking tool were relevant to the forest reserve under study. The management effectiveness in this study ranged between 15 – 30% with mean score of 28% (Appendix IV). The higher the percentage the more effective (strong) is the management and vice versa (Hockings *et al.*, 2000; Madoffe and Munishi, 2005). According to Hockings *et al.* (2000) and Madoffe & Munishi (2005), percentage score ranking given in this catchment forest reserve is poor. This indicates that the catchment forest reserve is not well managed and therefore it stands a chance of losing its status as biodiversity conservation and wetland catchment area if the situation is not adequately attended (Madoffe and Munishi, 2005). This poor management could have been contributed by lack of resources (i.e. funds, personnel and equipment) making it hard for the forest officers to implement, supervise and monitor management activities. These findings are consistent with DANIDA (1999) argument that many exploitative activities in the Ramsar site are uncontrolled, due to lack of resources of the management agencies. Chizyuka (2006) indicated that the plight of Malawi's forests is exacerbated by a poor management regime on the part of the forest authorities. Management of forests is either very low or non-existent. The vulnerability of important forests in Malawi stems from inadequate law enforcement, consumption demands on forestry products, staffing problems and high levels of poverty among the general population.

This study identified 13 most important key issues to the management of the catchment forest reserve out of the 30 main issues used to evaluate the management effectiveness by the WCPA tracking tool (Table 13). The rest of the issues are considered as supportive to

the key issues as they have minimum impact to the management of the catchment forest reserve. A summary of the present status of the catchment forest reserve is given below as reflected in Table 13 as well as in Appendix IV.

(i) Protected area boundary demarcation: Although the boundary of the reserve is known by the management authority and local residents it is not appropriately demarcated. Ownership to any important resource entails identity of the resource, which includes boundary demarcation. In Uluguru North Forest Reserve, Frontier-Tanzania (2005) observed that lack of clear forest boundaries, especially on the eastern side has implications in encroachments. Findings from KwaZulu-Natal indicated that some of the protected areas had no clear boundary demarcation while others have boundaries but not appropriately maintained (Goodman, 2003). In the study area this has resulted into encroachment into the reserve, thus forcing the government to excise part of the reserve and provide a corridor (with an estimated area of about 86.05 ha) along the Mpanda railway line for people to settle (Refer to Fig. 2). Boundary resurveying and demarcation for the established corridor is being facilitated by SIMMORS project through Village Land Use Management (VLUM) programme.

(ii) Management plan: Management plan is an important tool for both short and long term forest activities. Unfortunately, the forest reserve has no management plan, a situation that makes most activities happen on an irregular or *ad hoc* basis. A management plan is very helpful in identifying clearly the expected outcomes and impacts from the management of the area and one can make future projections of resource needs. For example, management of the wetland resources against fires, poaching, encroachment,

lumbering, fishing, grazing, invasive species, is thus neither planned nor coordinated together by the conservators. This calls for an integrated management approach for the wetland resources to reverse the current bad state of the wetland ecosystem and deterioration of the biodiversity values. A study by Madoffe and Munishi, (2005) in some EAM forests reported similar findings. These results are consistent with Goodman (2003) argument that despite the long tradition (30 yrs) of protected area management planning in the organisation, the majority of protected areas (54%) in KwaZulu-Natal did not have current management plans and for only 15% of protected areas were current and complete management plans available.

Similarly, according to WWF (2004) only 12% of the 200 forest protected areas in 34 countries worldwide surveyed have an approved management plan. Clearly this is a critical weakness with respect to management effectiveness and requires urgent attention. According to Goodman (2003) one might expect that, better planning of protected areas and greater inputs into protected area management would result in better practices or higher standards of implementation. As a starting point for the reserve a harvesting plan has been prepared following a country wide move on carrying out stock inventory of the forest resources on identified potential forest reserves. Also Tabora region has been included in the catchment forest programme by Forest and Beekeeping Division (FBD) and Mpanda Line Forest Reserve is among the forests in the region which has been proposed to be included in this programme, where management plan will be an important management tool.

(iii) Staff numbers and training: The staff numbers are inadequate for critical management activities of the catchment. Successful execution of management activities such as planning, law enforcement, supervision, monitoring, needs sufficient and well trained staff. The forestry sub sector in the district has seven staff and only one is stationed at Lumbe as a Divisional Assistant Forest Officer (DAFO) responsible for Mpanda Line as well as North Ugalla Forest Reserves and other general land forests in the Ukumbi Siganga division. On the other hand staff training and skills was low relative to the needs of the protected area. Madoffe and Munishi (2005) observed that, in the EAMs all forests have either inadequate number of staff or below optimum level which contributes to poor management in most of these forests. Also training of staff was either low or adequate but could be further improved to fully achieve the objectives of the management.

Similar studies elsewhere (UWA, 2002; KNP, 2003; SENAPA, 2004) reported that currently, staff manpower (especially the rangers/ant poaching unit) was still not sufficient, given the sizes of the parks, some with inadequate training and skills thus affecting law enforcement efforts. In such a situation the reserve is poorly managed with a lot of encroachment, illegal harvesting, and other illegal human activities, resulting into degradation of the catchment resources and loss of its biodiversity. Introduction of Participatory Forest Management (PFM) programme like Joint Forest Management (JFM) as well as Wildlife Management Areas (WMAs), recruitment, and training of Village Game Scouts (VGS) who will participate in the conservation and management of the reserve could help to change the current bad status of the catchment forest reserve in the study area.

Table 8: Selected critical management issues for the Mpanda Line Forest Reserve, Urambo District, Tanzania

Issue	Score⁶
1. Protected area boundary demarcation	2
2. Management plan	0
3. Staff numbers and training	1
4. Law enforcement	1
5. Current budget	0
6. Education and awareness programme	2
7. Involvement of local communities	0
8. Equipment	1
9. Access assessment	1
10. Resource inventory	1
11. Monitoring and evaluation	1
12. Commercial tourism and hunting	0
13. Economic benefit assessment	3

⁶ Scores: 0 = poor, 1 = fair, 2 = good, and 3 = excellent

(iv) **Law enforcement:** The District Forest Officer's (DFO) office has major deficiencies in staff capacity/resources to enforce forest reserve legislation and regulations (e.g. lack of skills, no patrol budget). Kajembe *et al.* (2004b) reported that in Kwizu Forest Reserve, law enforcement is generally constrained by the extremely low capacity of the district council and finances. Adequate capacity for law enforcement by the staff is vital to the protection of the reserve and conservation of its biodiversity. The inadequacy in capacity has resulted into rampant illegal activities in the reserve with detrimental effects to the catchment forest. Gibson *et al.* (2004) as cited by Banana *et al.* (2004) argued that the regularity of law enforcement is the most important factor in determining forest conditions. Furthermore WWF (2004) warned that, poor governance and law enforcement which results in sanctions upon violation of laws not being applied reduces the motivation of

rangers and encourages illegal acts by criminal groups such as those involved in illegal trade of rare species.

(v) Current budget: The reserve does not have a regular budget for its activities, however, SIMMORS has set aside Tshs. 15 000 000/= to facilitate boundary demarcation of the corridor through VLUM programme. The availability of funds and financial management is a prerequisite for effective and efficient execution of planned activities. Forest and Beekeeping Division (FBD) remits funds to the reserve through the Regional Forest Officer (RFO) but they are inadequate and not consistent. The inadequacy of funds coupled with its irregular flows explains why the forest reserve is poorly managed in the study area. A similar study by Madoffe and Munishi (2005) in the EAM forests observed that most of the forests had either no budget or it was inadequate for basic management needs.

Elsewhere UWA (2002) and KNP (2003) reported that funds were inadequate and untimely released making law enforcement and other operations in the parks ineffective. Banana *et al.* (2004), WWF (2004), and Chizyuka (2006) further stressed that inadequate funding results in understaffing and lack of capacity to implement management plans, monitoring and law enforcement which make protected areas vulnerable to problems as they arise thus, paving a way for human activities to undermine its biological wealth. These issues need urgent attention.

(vi) Education and awareness programme: Although there was a planned education and awareness programme in the study area there were still serious gaps. Conservation

education and awareness creation to the local communities adjacent to the forest is considered as an important tool for forest management and conservation (FBD, 2001; Madoffe and Munishi, 2005). In the study area SIMMORS and Ugalla Community Conservation Project - UCCP (AFRICARE) projects support and facilitate these awareness and training programmes of the VEC and the VGS. Capacity building of stakeholders is critical to achieve effective management and protection of the catchment and wetland resources. Moreover, improved and informed decision making and implementation of decisions with regard to the ecosystem management must be underpinned by the necessary skills, tools, technical knowledge and science. Goodman (2003) in KwaZulu-Natal observed that, the level of outreach and education programmes on restoration and prevention were not consistent with the degrees of pressures and threats experienced by protected areas. This has resulted into ecosystem degradation and loss of some important biodiversity.

(vii) Involvement of local communities: The local communities living adjacent to this catchment forest reserve have no input into decisions relating to its management. Involving local communities in decision making motivates conservation because the communities will feel that the forest belongs to them (FBD, 2001; FORCONSULT, 2003; Madoffe and Munishi, 2005). Meinzen-Dick and Knox (1999) as cited by Banana *et al.* (2004) claimed that participation in decision-making is the most critical form of participation in natural resources management. Most of the forests in the EAMs either don't involve the local communities or the communities have some discussions relating to management but no direct involvement in the resulting decision (Madoffe and Munishi, 2005). Goodman (2003) argued that this should be recognised as an important weakness in management

effectiveness since; improved communication with local communities is likely to lead to a much better understanding of the value of the protected area, a greater degree of participatory management and acceptance of the protected area and hence improved management effectiveness. Supporting these arguments Banana *et al.* (2004) emphasized that, lack of participation by local communities in decision-making is often cited as the explanation for inadequate monitoring and enforcement of harvesting regulations and the decline in stocking of trees used for commercial wood products.

Madoffe *et al.* (2006) further argued that one could not overlook the role of human being in forest degradation and therefore the need for involvement of the rural community in natural resources management. As poverty and population growth are the main force behind forest degradation, people's participation could be an important tool in the reduction of the losses. Kaboggoza (2000) commented that communities living in proximity to natural resources such as forest and wildlife will continue to rely (legally or illegally) on them for their livelihood and for economic survival. Thus, Chizyuka (2006) argued that such communities need support to develop a general appreciation for natural resource conservation, as they are looking for solutions to meet their basic food and income requirements. KNP (2003) and SENAPA (2004) reported that poor collaboration and involvement of local communities has resulted into high poaching and encroachment rates in Kaziranga National Park, India and Serengeti National Park, Tanzania respectively. Introduction of Joint Forest Management (JFM), Community Based Forest Management (CBFM) and Wildlife Management Areas (WMAs) programmes could be an entry point for participation in decision making by the local communities in this catchment forest reserve and its adjacent general forest areas and thus enhance mutual collaboration.

(viii) Equipment: There was some equipment and facilities but they are wholly inadequate. The DFO has only one vehicle and three motor cycles but only one motor cycle was running for the whole district. Effective and efficient implementation of working plans need adequate and well maintained equipment and facilities among other things. These results are comparable to those obtained by UWA (2002) in Bwindi Impenetrable National Park in Uganda; and KNP, (2003) in Kaziranga National Park in India who reported that equipments were inadequate, and this also applied to the infrastructure and funds constraints preventing regular maintenance. Goodman (2003) in KwaZulu-Natal reported that, there is widely expressed opinion, that the maintenance and care of equipment and infrastructure is substandard, thus posing a serious threat to the sustainability of current levels of management inputs by the organisation.

(ix) Access assessment: Protection systems are only partially effective in controlling access or use of the reserve in accordance with designated objectives. Madoffe and Munishi (2005) argued that access to the forest encourages destruction of varying magnitude and one way of reducing this happening is through the issuing of permits, patrolling and monitoring. Due to the nature of the terrain (relatively flat) and proximity to human settlements, with multiple access points the catchment forest reserve has been subjected into high levels of illegal exploitation because it is difficult for the DFO to adequately monitor all access points and control unauthorized entry to the forest. Also some customers are not trustful and thus always this result into under licensing. Inadequacy in resources hinders the effectiveness in the protection systems of the reserve. Moreover, the reserve is not accessible by road from the district headquarters in most part of the year after the rain season rendering regular and frequent patrols by the DFO

impossible. Madoffe and Munishi (2005) reported that most of the forests in the EAMs had either partially or moderately effective protection systems in controlling access or use of the reserve in accordance with designated objectives. It is envisaged that with the introduction of a PFM programme, access/use issues in the catchment forest will be developed in a collaborative manner and thus reduce illegal activities.

(x) Resource inventory: Information on the critical habitats, species and cultural values of the catchment forest is not sufficient to support planning and decision making. One of the management objectives of the wetland is to ensure that biological diversity is adequately conserved. However, the various surveys and research work carried in the wetland were not specific to Mpanda Line Forest Reserve. IRA (2001) concurs with the need for a detailed and exhaustive inventory of the existing natural resources in the wetland. To establish active strategies in the management of natural resources Malimbwi and Zahabu (2000) argued that, there is a need to know what is in the forest reserve in terms of vegetation and other biodiversity. It is not possible to achieve sustainable forest management if the forest resource status (both qualitative and quantitative) is thus not known. Goodman (2003) on a similar issue in KwaZulu-Natal reported that although most respondents felt that there were up-to-date natural resource inventories in place almost 40% felt that these were inadequate for their protected areas thus, calling for more efforts to address this need.

(xi) Monitoring and evaluation: There was no good monitoring and evaluation systems for the forest reserve instead only some *ad hoc* monitoring and evaluation with no overall strategy and/or no regular collection of results was done. Similar findings were obtained in

the EAM forests by Madoffe and Munishi (2005). They further argued that monitoring and evaluation ensures that management obstacles are discovered and solutions sought promptly. Banana *et al.* (2004) concurs with these findings and urged that, due to reduced monitoring and law enforcement caused by lack of manpower in the DFO's office together with the perverse incentives for local councillors to protect forest resources, one would anticipate widespread illegal harvesting of forest products and degradation of the resource.

(xii) Commercial tourism and hunting: Mpanda Line Forest Reserve is also a Game Controlled Area (i.e. Luganzo Game Controlled Area). However, there is little or no contact between managers and tourism operator's management using the forest reserve. That is to say, the two management regimes have neither common objectives nor collective efforts on protecting the reserve. For example, although the hunting company contributes also to the protection of the forest reserve through overcoming illegal harvesting and fishing, the confiscated products are taken under their custody contrary to the forest law (MNRT, 1998a) which requires that the produce be handed over to the forest department thus causing conflict of interest between them (Makaka, S.S. person comm. 2005). IRA (2001) reported that the hunting companies demand exclusive rights to the area although the policy states that such blocks should include other uses. This has raised bitter complaints from other natural resource users like pastoralists, foresters and agriculturalists. Such situation tends to demoralize other stakeholders from participating in the management of such resources, and thus threatens the integrity of the wetland catchment environment.

(xiii) Economic benefit assessment: There is a significant or major flow of economic benefits from activities in and around the forest reserve to local communities. The forest reserve is surrounded by villages which were not there before its gazettelement. These villages are an outcome of human economic activities in the reserve like lumbering, fishing, honey and bees wax collection, poaching and tobacco growing. With the introduction of a hunting block in the reserve, the local communities earn income through participation in tourism activities as labour force during the hunting season. Also the 25% of the retention fund from the hunting fees (in Wildlife Division) is allocated back to the villages surrounding the protected area, through Local Authority for protected area protection and other village development programmes. A similar study by UWA (2002) Bwindi Impenetrable National Park in Uganda reported that all rangers are employed from the areas surrounding the park. Furthermore, the park administration has initiated other relationships including community tourist camp for community income, and revenue sharing scheme.

4.3.2 Conservation initiatives and their impact in the catchment forests of Malagarasi-Muyovozi wetland ecosystem

It was apparently obvious from the socio-economic survey that there had not existed any specific traditional resource management initiative in the area. This is from the fact that the villages have been established in the cause of development in forest products business along the Mpanda railway line and from fishing activities along lake Sagara, Lumbe dam, and Ugalla river, where many of the inhabitants are not natives. However, a number of organisations with conservation initiatives on the catchment of the wetlands were identified during this study. These organisations include; SIMMORS project, Ugalla

Community Conservation Project (UCCP-AFRICARE), Robin Hurt and Cullman Safaris Hunting Company, and Friends of Urambo and Mwanihala (FUM). Wells and Brandon (1993) argued that the goal of many conservation projects is to “enhance biodiversity conservation through approaches that attempt to address the needs, constraints and opportunities of local people” by involving them as active partners.

SIMMORS project is supporting and facilitating the formation of cooperative groups with small projects in fisheries, beekeeping and agricultural sectors and provides modern beekeeping/fishing gears as well as farm inputs on soft loan basis. These projects are meant to improve the income of the individuals as well as their livelihood and thus reduce environmental degradation and poverty. The loan is returned to respective village governments after a year and is used as a revolving fund to other members. SIMMORS also facilitates VLUM programmes in the villages as well as awareness education and training to VEC and VGS on natural resource conservation and sustainable management. Village land use management is meant to institute adoption of proper land use plans by the local communities thus reducing disturbance to the adjacent forest reserve and to the lake. The project facilitates the resurvey and demarcation of the corridor along the Mpanda railway line as well as shifting of settlements to a distance of 500 m from the shores of lake Sagara in Maboha and Shella villages. The project also supports the Local Government by constructing Ward offices where all district ward staff are accommodated and provided with a motor cycle under the supervision of Ward Executive Officer (WEO) of that particular ward.

Robin Hurt and Cullman Safaris Company has patrol crews which significantly reduce illegal human activities causing disturbance to the catchment ecosystem. The Tourist Hunting Company supports the villages in other socio-economic activities by facilitating the construction of primary school class rooms and teachers' houses, dispensaries, drinking water wells and roads/paths. Furthermore, 25% of the hunting fee paid by the company to the Wildlife Division is sent back to the district and later to the villages for development projects.

Ugalla Community Conservation Project supports the training of VGS and basic data collectors in the villages. Another organization called Friends of Urambo and Mwanihala which is coordinated by the district planning office facilitates communities around the catchment reserve in awareness education to fight bush fires through meetings, workshops and provision of posters, brochures and leaflets. It also facilitates the rehabilitation of village dispensaries and schools. These conservation initiatives are likely to play a major role in future conservation of the Malagarasi-Muyovozi wetland ecosystem.

Over 56% of the respondents indicated appreciation of the presence of different conservation organizations working for forest/environment conservation in the area (Table 9). Conversely a good proportion of the respondents (40%) showed to be less involved in the general decision making concerning the management of the reserve. The village governments, the VEC, and the VGS have no say in the management of the catchment forest. Apparently this is a big weakness not only for this forest reserve but for many other reserves in the region and in the country as well. According to Paulo (2004) village governments play the role of initiating environmental committees while the

communities themselves ensure that all activities related to conservation are performed through their VECs. Such community institutions have strong potential to overcome the force that drives individuals to overuse natural resources (Mbwambo, 2000). Lewis (1997) argued that, lack of real involvement of local communities in planning and management of protected areas results into resource use conflicts. This is because the needs of local communities are not addressed as the decisions on planning and management of protected areas is reached without their involvement. He further stressed that lack of involvement of local community can also lead to unequal distribution of the resources thereby generating conflicts among resource users. The compounded effect is deforestation and forest degradation.

The respondents had also some comments or suggestions on the improvement of the present state of the reserve (Table 9). Their suggestions ranged from involvement of the local community (29%), strengthened government efforts to protect the forest reserve (21%), need for conservation awareness among the local communities through education (12%), and to train and empower VEC and VGS on environmental protection (5%). A similar trend was also observed in a study by Luoga (2000) who found less than half of the respondents suggesting the government to place more emphasis on law enforcement and that local people should be involved in the utilization and safeguarding the resources. A proportionally high percentage on the issue of local people involvement in the decision making and overall management of the reserve in this study is an indication of environmental conservation awareness, concern and willingness to change attitude towards sustainable resource use and its management by the local people. This is inline with the wildlife and forestry policies of 1998 which emphasize the need for active and

effective community participation in conservation and management of the natural resources. Kajembe *et al.* (2003b) argued that collaboration with local communities is believed to be the best option, the most viable, effective, and long lasting way in addressing and solving the problems of forest degradation in order to improve forest conservation and sustainable management at lower management costs.

Under this collaboration the VEC and VGS are expected to contribute to reduced forest disturbances through regular patrols in the catchment forest reserve. Alternative source of poles and firewood can be obtained from adjacent forests within the corridor proposed for CBFM where a strip of 1 km is left for this purpose, while communities are encouraged to establish and maintain their own woodlots (*Ngitiri*). The catchment forest reserve is also earmarked under the JFM programme as a measure towards sustainable forest management. This initiation may raise awareness of the local communities towards forest conservation. A WMA programme in the area can be among the ways of ensuring sustainable management and utilisation of the wildlife resources by the local communities in the Game Controlled Area. Villagers in Monduli-Mlimani catchment forest, Monduli district argued that since the start of the JFM programme there was an improvement in forest cover. Grazing and forest fire incidences are currently under control (*Mialla et al.*, 2004). Experience from west Bengal, India, showed that when forest staff collaborated with rural communities, they overcame some of the problems of forest management, from being degraded through overgrazing and tree cutting, the forestlands began to regenerate dramatically. As the forest cover increased, conflicts between foresters and communities decreased (*Joshi*, 1998).

Table 9: Local people awareness and perception on conservation initiatives in Malagarasi-Muyovozi wetlands, Urambo District, Tanzania

Information/issue	% of respondents in each village				Overall % of respondents (N = 130)
	Maboha (n = 30)	Shella (n = 30)	Lumbe (n = 30)	Ukumbi Siganga A (n = 40)	
Appreciation on conservation initiatives					
Yes	100	50	83	8	56
No	0	7	10	5	5
Not applicable	0	43	7	87	39
Local people involvement in conservation initiatives					
Involved	33	20	70	8	31
Not involved	67	80	20	5	40
Not applicable	0	0	10	87	29
Views/suggestions on the management of the catchment forest					
Frequent seminars to create awareness to the local people	17	20	13	0	12
Government should intensify protection of the reserve	57	10	23	0	21
Train and empower VEC and VGS on environmental protection	0	0	17	2	5
Involve local people in the management of the reserve	20	70	27	8	29
Not applicable	6	0	20	90	34

4.4 Socio-Economic Factors and their Roles in Influencing the Utilization of Catchment Forest Resources

4.4.1 Socio-economic factors influencing human disturbance in the catchment forest

The findings on forest disturbance and utilization threats discussed in the previous sections are the outcomes in most cases of the uncontrolled and unregulated utilization of resources in the cause of improving the livelihoods of the local communities and thus poverty reduction. Coupled with ineffective management as earlier discussed, resource destruction

with ultimate ecosystem degradation will apparently be evident. Birdlife International, (2005) argued that natural resources are the basis for development, but to genuinely alleviate poverty they must be managed sustainably so that they can continue to form part of the complex web that supports all life on earth. Socio economic factors play an important role in resource utilization and management while improving the livelihood of the local communities. When not well controlled these factors cause unsustainable resource utilization resulting into its destruction and loss of biodiversity.

To establish the likelihood of the socio-economic factors influencing human disturbance in the catchment forest, factors were entered sequentially in the logistic regression model, checked and the insignificant factors were removed from the prediction model. The socio-economic factors observed to have a profound influence on the utilization of the catchment and thus cause human disturbance in the reserve include; age, gender, ethnicity, marital status, education level, duration of stay in the village, size of the land holdings, and demand of forest products and services.

4.4.1.1 Statistically significant socio-economic factors

Of the eight factors studied only three factors; age, ethnicity, and demand for forest products and services were statistically significant in influencing forest disturbance.

(i) Age of respondent: The influence of age on forest disturbance was statistically significant ($p < 0.05$). This implies that old aged household heads contribute significantly to the chances of reducing forest destruction in the catchment forest. The “age” of the respondent shows a negative logit coefficient (-0.041), which implies that an increase in

one older person decreases the odds ratio of forest disturbance in the reserve by a factor of 0.960 (Table 10). As a matter of fact increase in the age of the household head increases the chances of reducing the forest disturbance than young members can do. Elders have accumulated a lot of traditional knowledge and experience on natural resources management and they have that sense of ownership and feel responsible for the sustainable conservation and management of the resource. However, young and middle aged people are active and energetic in providing labour force which can be invested in the exploitation of the forest resource among other activities. Their interest is to get quick gains rather than attaining long term objectives of sustainable resource use and conservation. They are thus tempted to encroach the reserve in order to collect different products to meet their immediate needs.

The age of interviewees varied from 21 to over 71 years, with most (68%) of the respondents having the age between 31 to 60 years while elders (above 60 years) accounted to 23% of the total population sampled (Table 11). Kessy (1998) argued that forests have both cultural and utilitarian benefits to local communities. It is believed that different age groups respond differently towards existence of the forest and its importance/uses. Older people are more open minded and often express the need to have the forest conserved, unlike the youths whose major interest is to create economic benefits out of the forest (Mbwambo, 2000).

Table 10: Socio-economic factors influencing human disturbance in Mpanda Line Forest Reserve, Urambo District, Tanzania

Variable	β	S.E.	Wald	Df	P- value	Exp(β)	95.0% C.I. for Exp(β)	
							Lower	Upper
GENDER	0.932	0.975	0.913	1	0.339 ns	2.540	0.375	17.186
AGE	-0.041	0.081	5.423	1	0.020 *	0.960	0.927	0.994
ETHNICITY	1.374	0.497	7.634	1	0.006 *	3.949	1.491	10.463
MARITAL STATUS	0.383	0.358	1.144	1	0.285 ns	1.467	0.727	2.962
EDUCATION	0.217	0.474	0.210	1	0.647 ns	1.243	0.491	3.137
DURATION	0.283	0.592	0.228	1	0.633 ns	1.327	0.416	4.230
LAND	0.019	0.033	0.321	1	0.571 ns	1.019	0.955	1.087
DEMAND	3.559	1.094	10.577	1	0.001 **	35.137	4.114	300.133
Constant	-3.973	2.058	3.726	1	0.054 *	0.019		

-2LL (-2 Log Likelihood) = 140.156,

Model Chi-square = 38.088 ($p \leq 0.001$), (df = 8),

Overall Prediction Percentage = 70.8 %,

Number of cases = 130,

β = estimated logit coefficient,

S.E. = standard error of the coefficient,

Wald statistics = $[\beta/S.E.]^2$,

Exp(β) = "odds ratio" of the individual coefficient (probability of success/probability of failure) = e^{β} where $c = 2.71818$ and β = as defined above,

* = Statistically significant at 0.05 level of significance,

** = Statistically significant at 0.001 level significance,

ns = Statistically non significant at 0.05 level of significance,

Sig = Significance level and df = degree of freedom.

(ii) **Ethnicity:** The positive logit coefficient (1.374) of "ethnicity" of the respondent indicates that an increase in one non native respondent increases the odds ratio by a factor of 3.949 of forest disturbance in the forest reserve (Table 10). The assumption here was

that non native tribes cause human disturbance in the study area while the native tribe (Wanyamwezi) has the sense of ownership and feels responsible for the proper resource utilization and management of forest reserve, and thus they would be against any kind of forest disturbance in the reserve. The influence of ethnicity on forest disturbance was statistically significant ($p < 0.05$). This outcome implies that non natives are involved in the forest degradation.

Table 11 shows that out of twenty five identified ethnic groups in the 130 interviewed households, the native Wanyamwezi tribe account for 26% only. The impression here is that the sampled villages are inhabited with immigrants who have different culture, experience, motives and interests. It is also assumed that there has been an increase in population due to immigration as well as high internal population growth momentum, forcing people to encroach the reserve and causing forest degradation. As a matter of fact, migration increases population and demand for more resources, including erosion of traditional institutions attributed to new comers who may not have affinity to the local natural resources management systems (Mahinya, 2005). Therefore, migration may have a negative impact on the use and management of natural resources leading to the loss of the wetland ecological integrity. Luoga *et al.* (2005) found out that outsiders were not very much committed to resources conservation as opposed to the local residents in Kitulanghalo forest reserve.

(iii) Demand: The “demand” of forest products and services shows a positive logit coefficient (3.559) indicating that an increase in one unit of demand of the respondents increases the odds ratio of the forest disturbance in the forest reserve by a factor of 35.137

(Table 10). The effect of demand on forest products and services on the forest disturbance was statistically highly significant ($p < 0.001$). This would mean that there is a high demand on forest products and services in the study area resulting into forest destruction due to rampant illegal activities in the catchment reserve.

Table 11: Statistically significant respondent characteristics in villages adjacent to Mpanda Line Forest Reserve, Urambo District, Tanzania

Information/issue	% of respondents in each village				Overall % of respondents (N = 130)
	Maboha (n = 30)	Shella (n = 30)	Lumbe (n = 30)	Ukumbi Siganga A (n = 40)	
Age distribution					
21 – 30 years	7	10	10	8	9
31 – 60 years	77	73	70	63	68
above 60 years	16	17	20	35	23
Ethnicity					
Native	3	17	30	48	26
Not	97	83	70	52	74
Demand for forest products and services					
Yes	97	63	77	90	82
No	3	37	23	10	18
Response as to the importance of the forest reserve					
Receiving 25% of the tourist hunting fees	10	0	60	18	22
Reserved for the use of future generation	34	7	3	43	23
For environmental conservation	50	13	7	0	16
Provides forest products and services	3	44	7	30	22
Has no importance	3	23	7	2	8
I don't know	0	13	16	7	9
Response as to whether the forest is disturbed					
Yes	67	73	37	50	56
No	33	27	63	50	44

There is an obvious indication by 82% that there is a high demand for forest products and services (Table 11). The respondents expressed the importance of the forest reserve to the local communities' livelihood to include among other things; it is reserved for the use of

future generations (23%), the villages receive 25% of the tourist hunting fees (22%), it provides forest products and services (22%), and is for environmental conservation (16%). Mutangah (2005) carried a survey on utilisation of forest resources by the local communities in Kakamega forest, Kenya found out that almost all (98 %) of the households surveyed make the forest a very important asset to them. The researcher further argued that such a heavy dependence on the forest as a major income generating source leads to a high level of disturbance.

The awareness on the importance of the reserve was also shown by a big proportion of the respondents (56%) indicating their concern that the forest is not well managed by the government as a result of rampant disturbance in the reserve (Table 11). Respondents from both Maboha (67%) and Shella (73%) villages showed to be more concerned on the present status of the forest though they are outside and thus benefit less than it is for Lumbe and Ukumbi Siganga A villagers who are living within the reserve. Maboha and Shella villagers take themselves as caretakers of the resources in the reserve and look at all villages within the reserve along the Mpanda railway line as encroachers. On the other hand many respondents in Lumbe (63%) and Ukumbi Siganga A (50%) villages showed that there are no forest disturbance in the reserve, though there are obvious signs of forest disturbance which are likely caused by the same villages. These findings are consistent with that of Kingazi (2002) in Chome forest reserve. He reported that, though people interviewed were not explicit on the illegal activities in the forest such as pole cutting, pit sawing and hunting, field walk and long stay in the village during the research revealed the existence of such activities.

4.4.1.2 Statistically non significant socio-economic factors

Five variables; gender, marital status, duration of stay in the village, education level, and size of landholdings, were not statistically significant but they were found to be very important in contributing to forest disturbance in the study area.

(iv) **Gender:** A positive logit coefficient (0.932) of “gender” of the household head implies that an increase in one man headed household increases the odds ratio for forest disturbance in the reserve by a factor of 2.540 (Table 10). Man headed household significantly increases the destruction of the forest resources because in most cases it is the men who are involved in illegal exploitation and business on the forest products. However, the effect of gender on the odds of forest disturbance of the reserve was not statistically significant ($p > 0.05$).

About 87% of respondents randomly sampled for interview in the four villages were men (Table 12). Similar results were reported by IRA (2001) in the same wetland. These results indicate that in each village there were more male headed household, and more mature aged male respondents than females. This is attributed to the socio-cultural dimensions of the Wanyamwezi community where males enjoy more privileges than females. Among Wasukuma as it is with the Wanyamwezi, Shao *et al.* (1992) reported that, men are entitled to land ownership and cattle, and through their dominance they are traditionally decision makers in the household. Women are therefore, deprived of decision making in the household, hence their participation in this study is very small. Thus with many male members of the household (who are active and energetic age-wise) more labour will be invested in the exploitation of the forest resource.

(v) Marital status: A positive logit coefficient (0.383) of “marital status” of the household head implies that an increase in one married headed household increases the odds ratio for forest disturbance in the reserve by a factor of 1.467 (Table 10). Here it was assumed that with most of the mature male household heads married; having a number of responsibilities to accomplish, and more family demands over the use of natural resources, encroachment into the forest reserve is inevitable. However, the effect of marital status on the odds of forest disturbance of the reserve was not statistically significant ($p>0.05$).

The study found out that the sample interviewed of married household heads was higher (82%) than that of other marital status (Table 12). This could lead into encroachment in the reserve so as to meet family obligations resulting into forest destruction. Sustainable use and conservation of the forest resources to a large extent depends on the economic status of the community in question, which would ultimately determine the level of utilization and management. Socio-economic forces are tied intimately to the status of the forest. Whether sustainable forest management can compete with other, unsustainable land and resource uses depends to a large extent on whether people receive sufficient benefits from it. Widespread poverty, land pressure and unemployment, limited and insecure local production bases, often means absence of alternatives, hence community members have little choice but to over-exploit forest resources to generate sufficient subsistence, income and employment to meet their ends.

On the other hand marriage may diversify the socio-economic activities at household level due to complementarity of men and women labour roles within the household as observed by Wirth (1988). This idea is further supported by Koda (1994) who observed that by

estimation, women provide on average 60% of all farm labour force in agriculture in Tanzania while men handle other duties.

(vi) Education level: Furthermore “education level” of the respondent shows a positive logit coefficient (0.217) implying that an increase in one illiterate person increases the odds ratio for forest disturbance in forest reserve by a factor of 1.243 (Table 10). It was assumed that illiteracy was one of the causes of human disturbance in the study area. On the other hand increase in education of the household head tends to increase people’s awareness on the importance of natural resources conservation for sustainable development and also increases their willingness to participate in conservation and management of natural resource activities. This reduces the chances of involvement in destructive practices in the reserve and hence improving the conservation status of the forest as the practice imparts a sense of ownership and benefit sharing at the local level. Power and benefit sharing balances conservation and livelihood of the local communities. This in turn improves the relationship between local communities and the protected area authorities (Mayeta, 2004). The increase in level of education also increases options of respondents to meet their livelihoods. However, the influence of illiteracy (education level) on forest disturbance in the reserve was not statistically significant ($p>0.05$).

Most of the interviewed people (69%) had formal education (i.e., primary and tertiary education), with non formal (illiterate) education having 31% of the respondents (Table 12). While IRA (2001) survey report concur with these findings, an additional note was on many drop outs (i.e. a considerable number do not finish the required seven years of study as boys get employed in fishing operations while girls assist in harvesting and processing

of paddy and other crops). It is also likely that others join in illegal hunting, timber harvesting, honey collection, and encroachment for settlement and agriculture.

Table 12: Statistically non significant respondent characteristics in villages adjacent to Mpanda Line Forest Reserve, Urambo District, Tanzania

Information/issue	% of respondents in each village				Overall % of respondents (N = 130)
	Maboha (n = 30)	Shella (n = 30)	Lumbe (n = 30)	Ukumbi Siganga A (n = 40)	
Gender					
Male	83	87	83	93	87
Female	17	13	17	7	13
Marital status					
Single	10	0	0	2	3
Married	70	84	84	88	82
Divorced	3	3	0	2	2
Separated	7	13	0	3	5
Widowed	10	0	16	5	8
Educational level					
No formal education	37	30	20	35	31
Formal education	63	70	80	65	69
Duration of stay if not born in the village					
Equal and below 10 years	27	27	7	8	16
Above 10 years	73	73	93	92	84
Occupation					
Employment	3	0	0	0	1
Petty business	3	3	0	0	1.5
Agriculture	94	90	100	100	96
Fish man	0	7	0	0	1.5

As a tool of transfer of knowledge and experience, education on the other hand plays an important role in socio-economic development. Education fosters human creativity and makes people confident on their efforts to improve their lives and readiness to integrate new innovations in forest management into traditional systems of land use management. It also enables people to analyse their situations, identify problems and workout solutions, such as environmental degradation problems. Substantial formal education among the

respondents (69%) may reflect adequate awareness on the ongoing degradation of the forest. This may eventually lead into effectiveness on efforts towards conservation of forest resources and continued mitigation of land degradation, which is becoming a major threat to the sustainability of production in the study area. Maro (1995) suggested that, for sustainable changes to occur in the environment and natural resources management in Shinyanga region, emphasis must be given on education. Furthermore, Mahinya (2005) asserted that education has a positive and a direct influence on ecological integrity such that the educated community is likely to maintain ecosystem integrity through wise use of the natural resources.

(vii) Duration of residence: “Duration of stay” of the respondent in the village also shows a positive logit coefficient (0.283). This implies that an increase in one man headed household increases the odds ratio for the forest disturbance in the reserve by a factor of 1.327 Table (10). Thus increase in number of years of residence of the households in the villages adjacent to the forest reserve increases forest disturbance. Since many respondents in the study area were not natives, it was presumed that with duration of stay in the village of more than ten (10) years (84%) (Table 12), their families grow in size thus more forest products demanded from the reserve and also more land required to meet demands for the growing population. With the evidence of land shortage (Table 13) in the area people opt to encroach the reserve hence its disturbance. However, the effect of duration of residence in the area on forest disturbance in the reserve was not statistically significant ($p>0.05$).

There is a strong relationship between household size and environmental degradation. Large households tend to over-exploit forest resources in order to meet their needs while

also undermining their very sources of livelihood (IRA, 2001; Mahinya, 2005). Paulo (2004) argued that as household size increases, people become less willing to engage themselves in conservation activities. The possible reason is that people tend to focus more on activities which are directly associated with their immediate subsistence living than caring much about biodiversity conservation activities.

Table 13: Land size, soil fertility and crop production status and its improvement in villages adjacent to Mpanda Line Forest Reserve, Urambo District, Tanzania

Information/issue	% of respondents in each village				Overall % of respondents (N = 130)
	Maboha (n = 30)	Shella (n = 30)	Lumbe (n = 30)	Ukumbi Siganga A (n = 40)	
Size of cultivated land (ha)					
Below 5 ha	47	47	53	30	43
6-15 ha	47	47	34	43	42
Above 15 ha	6	6	13	27	15
Occupation					
Employment	3	0	0	0	1
Petty business	3	3	0	0	1.5
Agriculture	94	90	100	100	96
Fish man	0	7	0	0	1.5
Soil fertility status of the farm					
High	17	13	7	30	18
Moderate	50	53	57	48	51
Low	33	34	36	22	31
Experiences on decline in crop yields					
Yes	90	97	97	65	85
No	10	3	3	35	15
How soil fertility is improved					
Leave the farm fallow for some years	87	57	87	75	76
Apply manure	3	20	10	13	12
Apply chemical fertilizer	3	20	3	7	8
Do nothing	7	3	0	5	4

(viii) **Size of land holdings:** Similarly the “size of the land holdings” of the respondents showed to have a positive logit coefficient (0.019). This is to say that a single unit of land increases the odds ratio by a factor of 1.019 (Table 10). This result means that the size of the land holdings of the people around the forest determine their level of dependence on the forest land. The bigger the farm sizes and more crops owned, the more the land required. On the other hand the big farm sizes and many crops may act as alternatives to the dependency on the forests. The result however, shows that the effect of land size is statistically non significant ($p > 0.05$).

On average more people 43% own less than 5 ha of land for farming (Table 13), implying that reduced or inadequate farmland size around homesteads increases disturbance in the reserve. Mayeta (2004) reported that a decrease in farm size increases the chances of resource use conflicts and vice versa and this end into resource degradation. The high dependence on agriculture (96%) is a direct indication that there is land pressure in the sampled villages. As a result encroachment to the forest reserve has been seen as an alternative to the prevailing situation especially for Lumbe and Ukumbi Siganga A villages that are within the forest reserve. Coupled with population pressure resource use conflicts is inevitable which ultimately result into its degradation and depletion. Scholes *et al.* (1996) observed that the pressure from the growing human populations has led the conversion of miombo woodlands into unsustainable forms of land use. In the surveyed villages cash crops grown include tobacco, groundnuts, paddy, oil palm, mlonge (*Moringa oleifera*), sunflower, beans, and simsim, while food crops include maize, cassava, sweet potatoes, pigeon pea, cow pea and finger millet.

The perception of farmers on soil fertility status of the farms in the study area is between moderate 51% and low 31%, and that there are indications by a great number of respondents of a decline in crop yields 85%. To overcome problems of poor soil fertility and low crop production, about 76% of the respondents expressed that leaving the farms fallow for some years without farming for natural recovery is the best option they undertake. This is shifting cultivation which demands opening up new land by clearing the forest for cultivation after every 3-5 years of cultivating. Shifting cultivation has also been reported by IRA (2001) and Mahinya (2005) as a major form of crop production in much of the Ramsar Site. Paulo (2004) observed that the prevailing shifting cultivation in Uluguru Mountains may partly be caused by lack of improved technology in soil conservation techniques such as agroforestry and soil fertility maintenance thus resulting pressure on the forest reserves. Forest reserves are known to be virgin lands which are naturally fertile and thus attract encroachers to expand their farm lands through shifting cultivation in the cause of improving their livelihood and poverty reduction. The present poor state of the forest reserve has been contributed by this practice among other factors.

4.4.1.3 Goodness of fit and significant variables for the model

In terms of goodness of fit, the logistic regression model (LRM) fitted well to the data by 95% as shown by the significant value of 0.054 for a constant (Table 11). The overall model is also highly significant ($p = 0.001$) with a Chi-square statistics of 38.088 ($df = 8$) implying that the independent variables affected very well the outcome or dependent variable. The -2 log likelihood ($-2LL$) value of 140.156 indicated that the model fitted the data reasonably well and that the model predicts 70.8% of the responses correctly (i.e., the bigger the percentage correct predictions, the better the model). Also independent variable

coefficients with high (significant) Wald statistics indicate superior specification of the variable (Whitehead, 1998). In this case age, ethnicity and demand of forest products and services were significant in influencing forest disturbance.

Age, ethnicity and demand on forest products and services respond rationally to increase in forest disturbance in the reserve. The odds ratio of age of the respondents is 0.96 with a 95% confidence of [0.927, 0.994] and Wald statistics of 5.423 ($df = 1$). This suggests that increase in age is likely to increase the chances of an individual to reduce disturbance in the reserve while young people are more likely to disturb the forest. Similarly the “odds ratio” for ethnicity of the respondent is 3.949 with a 95% confidence interval of [1.491, 10.463] and Wald statistics of 7.634 ($df = 1$). This suggests that those who are ethnically non natives are almost 4 times more likely to cause forest disturbance in the reserve than those who are natives (the Wanyamwezi). Likewise the odds ratio of demand for forest products and services is 35.137 with a 95% significance level and Wald statistics of 10.577 ($df = 1$) suggesting that respondents with high demand on forest products and services are 35.137 times likely to cause forest disturbance than those with low demand. Since other independent variables are either insignificantly different from zero or continuous, interpretation of their magnitude has little meaning in logistic regression and thus do not have influence on forest disturbance.

Testing of the hypothesis was carried out using Wald statistic (Pampel, 2000; Powers and Xie, 2000). The Wald statistics shown in Table 10 indicate both non-zero and zero values, implying that there are some kind of interactions between the dependent and independent variables. According to Powers and Xie (2000) non-zero values for the Wald statistics

indicate presence of relationships between the explanatory variables. It can be observed from the results in Table 10 that four of the independent variables (i.e. age, ethnicity, marital status, and demand) included in the prediction model have non-zero regression coefficients. This implies the existence of a relationship between the independent (socio-economic and demographic) variables and the dependent variable (human disturbance). Based on these observations, the null hypothesis was rejected in favour of the alternative hypothesis at 5% level of significance.

4.4.2 Perceptions on the current state and condition of the catchment forest reserve

About 68% of the respondents perceived that the current condition of the forest is poor and not well managed (Table 14).

Table 14: Local people perceptions on the current state of the Mpanda Line Forest Reserve, Urambo District, Tanzania

Information/issue	% of respondents in each village				Overall % of respondents (N = 130)
	Maboha (n = 30)	Shella (n = 30)	Lumbe (n = 30)	Ukumbi Siganga A (n = 40)	
Current state of the forest reserve					
Good	7	23	33	55	32
Poor	93	77	67	45	68
Reasons for the poor state of the forest					
Inadequate management	80	30	30	28	41
Poor laws enforcement	17	43	17	10	21
Environmental degradation	3	0	20	2	6
I don't know	0	7	0	5	3
Not applicable	0	20	33	55	29
Causes of forest degradation					
Deforestation	4	17	13	32	18
Bush fires	23	17	47	17	25
Encroachment for farming and settlement	73	63	33	38	51
Overgrazing	0	3	7	5	4
I don't know	0	0	0	8	2
Noted environmental impacts					
Yes	87	67	73	50	68
No	13	33	27	50	32

While 41% attributed the poor condition of the reserve to inadequate management by the government, 21% connected it to inadequate law enforcement, and 6% due to environmental degradation. Encroachment for cultivation and settlement was mentioned as the major forest degrading activity (51%) followed by bush fires (25%), deforestation through other uses (18%), and overgrazing (4%). About 68% of the respondents noted that the current environmental changes observed in the area such as persistent drought and siltation of water bodies is a result of forest degradation. Increasing drought creates livelihood insecurity to both pastoralists and cultivators. The pastoralists in turn are forced to invade the river valleys and wetlands, which are also utilized for dry season cultivation. Thus extended drought is most likely to lead into escalation of resource use conflicts (Kisoza *et al.*, 2004) which ultimately result into its degradation.

4.4.3 Management actions for forest/woodland conservation by the local people

As a means of overcoming environmental problems escalating in the study area and to reduce dependence on the reserve for forest products and services, majority of the respondents (81%) retain trees on their farms during preparation of new farms (Table 15). Trees left include those that serve some purpose such as supply of firewood, poles, fruit, timber, shed, medicine, and beekeeping. On the other hand tree planting practices has not been well taken up by the local community as reflected by the low percentage of the respondents (25%) who have planted trees. Mbwapbo (2000) argued that planting of trees around homesteads reduce pressure on common pool resources thereby reducing chances of resource use conflicts. Most of the trees planted were for fruits, poles, timber, shade, firewood, soil fertility improvement, oil and other products. Tree planting in this manner, aims at restocking the forest and enhancing people's capacity to get alternative source of

the forest products that could otherwise be obtained from the forest reserve (Mialla *et al.*, 2004).

Table 15: Management interventions to reduce forest degradation and impacts by communities adjacent to Mpanda Line Forest Reserve, Urambo District, Tanzania

Information/issue	% of respondents in each village				Overall % of respondents (N = 130)
	Maboha (n = 30)	Shella (n = 30)	Lumbe (n = 30)	Ukumbi Siganga A (n = 40)	
Tree retention					
Yes	97	77	90	65	81
No	3	23	10	35	19
Trees planting					
Yes	20	17	20	38	25
No	80	83	80	62	75
Traditional forests or woodlands					
Yes	100	53	83	0	55
No	0	47	17	100	45

Furthermore, there is a big proportion of woodlands (*ngitiri*) (55%) reserved by the villages in the study area. Maro (1995) and Kamwenda (1999) argued that management of woodlands (*ngitiri*) optimise fodder and thatching production, provide forest based products and services, and are capable of mitigating environmental degradation. Maboha and Shella villages had both individual and village owned woodland plots while Lumbe village have already set aside a strip of 1 km as a village woodland within the corridor. Ukumbi Siganga A village, is still at preliminary stage of participatory village land use planning (PLUM), which will eventually assist the villagers to have a land use management plan and thus allocate their land according to various uses as identified by themselves.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Mpanda Line Forest Reserve has been subjected to unplanned and unsustainable levels of human exploitation, which threatens the biodiversity of the Malagarasi-Muyovozi wetlands and the survival of communities whose livelihood depend on them. The growing human population and the increasing demand for resources, threatens the ecological integrity of the wetlands and the well-being of people, plant, and wildlife resources that depend on them.

Forest disturbance (i.e., dead, new cut and old cut stems) in the three vegetation types showed significant difference in both trees and poles. Forest disturbance as well as the use intensities (i.e., new cut and old cut stems) were highest in the open woodlands followed by closed woodlands and wooded grasslands, implying high human impacts in the open woodlands.

The threat reduction assessment index of 16% for the reserve is very low indicating that the reserve is highly threatened. This signifies that little attempts have been taken by the management to reduce threats on the Mpanda Line catchment forest reserve. The survey also showed that, wildfires, illegal timber harvesting, overgrazing, and encroachment for cultivation and settlement (contributed by an excuse of no clear boundaries) are the major threats to the catchment forest reserve.

The final mean score of the management effectiveness assessment was 28%. This indicates that the forest reserve is poorly managed and therefore it stands a chance of losing its status as biodiversity conservation and wetland catchment area if the situation is not attended adequately. Successful management effectiveness should include ingredients such as clear reserve boundaries, management plan, sustainable funding, adequate law enforcement, appropriate and well-trained staff, and local community involvement. Also education and community outreach programmes, resource inventory, equipments, and a good system of monitoring and evaluation are important. A number of conservation initiatives in the area, may contribute greatly to reducing the threats that face the catchment and increasing the management effectiveness in the long run. Such initiatives include those undertaken by SIMMORS, UCCP, Robin Hurt and Safaris Company and FUM as well as the local institutions. In order to be successful, these initiatives should be persistent probably by building capacity among the local people through PFM programmes.

Out of the eight socio-economic factors considered to influence forest disturbance in the reserve only three; age, ethnicity, and demand of forest products and services were found to fit well at 5% significant level in the logistical regression model developed and respond rationally to increases in forest disturbance in the catchment forest reserve. Thus, solutions to ensure protection of this degrading environment and productivity for people need an integrated approach focusing on conservation while maintaining livelihood benefits to the local people. In order to manage the increasing pressure and achieve sustainable management of the forest reserve active collaboration between the local communities and the government across the wetland ecosystem is thus required.

5.2 Recommendations

Based on the findings and discussions from this study, the following recommendations are proposed as strategies to mitigate the problems facing the wetland catchment.

- There is a need of increasing awareness and understanding of all stakeholders on the multiple values and functions of the wetlands. This can be achieved through enhancing forest extension and environmental education programmes to communities living adjacent to the wetland ecosystem.
- There is a need of developing appropriate land use plans which will address and acknowledge local needs and priorities, geared towards improving land productivity and sustainable farming. Forming community-based small entrepreneur groups such as those engaged in modern beekeeping practices, processing wild fruits into juice, jams, wine and jellies or craft production from rafters are also very important. This is a strategy of diversifying income generating activities which is guided by best management practices that enhance livelihoods and support forest conservation by reducing human impacts.
- To prevent further degradation and support local communities in gaining control over their natural resources in and around the catchment forest reserve, there is a need of initiating participatory resources management programme. Collaboration with the local communities through JFM, CBFM and WMAs programmes are instrumental in reinforcing their commitment to conserving and sustainable use of the natural resources and in safeguarding their livelihoods.

- The government should consider developing an effective management plan for the catchment forest reserve. Priority activities and resource allocation should base on overcoming identified critical management threats and ensuring sustainable utilization of the forest resources in order to maintain and improve catchment functioning and reduce negative impacts on water resources. This can be achieved through zoning the reserve into different management objectives and by promoting lesser known and research proven high quality and abundant timber species such as *Brachystegia spp.*
- There is a need to conduct repeated assessments on forest conditions, utilization threats, management effectiveness, and priorities on resource allocation in the catchment forest reserve in order to monitor the status, ecological integrity and to evaluate the extent and nature of changes that are taking place.
- There are potential amenity sites in the catchment forest reserve that need to be developed and advertised so as to attract more ecotourism. Together with the existing wildlife potential these could provide more earnings to the government and the local communities.

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APPENDICES

Appendix I: A checklist of identified trees species and their uses in Mpanda Line Forest Reserve, Urambo District, Tanzania

Code No.	Local/Vernacular name	Scientific name	Family Name	Location in the Strata			Uses ⁷
				Wooded grassland	Open woodland	Closed woodland	
1	Mgunga/Katatula	<i>Acacia senegal</i>	Mimosaceae	Present	Not present	Present	Fd,F,C,M. H,R,Nf,P
2	Mgunga	<i>Acacia tortilis</i>	Mimosaceae	Present	Not present	Present	Fd,F,C,T. P,Hi,Nf
3	Mkola	<i>Azelia quanzensis</i>	Caesalpiniaceae	Not present	Present	Present	T,F,M,Ri
4	Mgando kaguha	<i>Albizia antunesiana</i>	Caesalpiniaceae	Not present	Present	Present	T,F,M,
5	Msindwi	<i>Anisophyllea boehmii</i>	Rhizophoraceae	Not present	Present	Present	Fr,T
6	Mfifa/ Mtopetope pori	<i>Annona senegalensis</i> (<i>A. chrysophylla</i>)	Annonaceae	Present	Present	Present	H,Fr,M
7	Msekela	<i>Antidesma venosum</i>	Euphorbiaceae	Not present	Present	Not present	M,Fr
8	Mkuni	<i>Berchemia discolor</i>	Rhamnaceae	Not present	Present	Present	T,P,Fr,Bf, M
9	Mhama	<i>Borassus aethiopum</i>	Bombacaceae	Present	Present	Not present	Fr,
10	Mgando mkalati	<i>Burkea africana</i>	Caesalpiniaceae	Not present	Present	Present	T,M (poison)
11	Myombo/ Muyenze	<i>Brachystegia boehmii</i>	Caesalpiniaceae	Present	Present	Present	R,Hi,F,C
12	Msilanga	<i>Brachystegia globarrima</i>	Caesalpiniaceae	Not present	Present	Present	C,R,P,F, Bf
13	Mugela	<i>Brachystegia microphylla</i>	Caesalpiniaceae	Not present	Not present	Present	C,T,P,F
14	Mtundu	<i>Brachystegia spiciformis</i>	Caesalpiniaceae	Not present	Present	Present	F,T,R,Hi
15	Munzoka	<i>Cassia abbreviata</i> subsp. <i>abbreviata</i>	Caesalpiniaceae	Not present	Present	Present	F,M,T
16	Mlugala	<i>Cassipourea mollis</i>	Rhizophoraceae	Not present	Present	Present	F,M
17	Mpongole/ Mhotiangoko	<i>Catunaregan spinosa</i>	Rubiaceae	Not present	Present	Not present	M
18	Mseveye	<i>Chrysophyllum bangweolense</i>	Sapotaceae	Not present	Present	Not present	F,M,C,P
19	Mtonga mwaka	<i>Cissus cornifolia</i>	Ampelidaceae	Not present	Not present	Present	F,P
20	Muluzyaminzi	<i>Combretum adenogonium</i> (<i>C. fragrans</i>)	Combretaceae	Present	Present	Not present	F,C,M,Bf, P
21	Mulandala	<i>Combretum collum</i>	Combretaceae	Not present	Present	Present	F,C,T,M, P
22	Mlama	<i>Combretum molle</i>	Combretaceae	Present	Present	Present	F,M,P,T, C,H,Bf
23	Msana	<i>Combretum zeyheri</i>	Combretaceae	Present	Present	Present	F,C,M,P
24	Msanzambeke	<i>Crossopteryx febrifuga</i>	Rubiaceae	Present	Present	Present	F,M,H

Code No.	Local/Vernacular name	Scientific name	Family Name	Location in the Strata			Uses ⁷
				Wooded grassland	Open woodland	Closed woodland	
25	Kapondolambasa /Kafinulambasa	<i>Dalbergia nitidula</i>	Papilionaceae	Not present	Present	Present	F,C,P,H, M,Ca,Fd, D
26	Katindili/ Kasunzulu/ Mutunduu	<i>Dichrostachys cinerea</i>	Mimosaceae	Not present	Present	Present	F,C,P,H, M,Fd,Bf, Nf
27	Mnumbulu	<i>Diospyros kirkii</i>	Ebenaceae	Present	Present	Present	F,P,M
28	Msinde/ Mkinde	<i>Diospyros mespiliformis</i>	Ebenaceae	Not present	Not present	Present	F,C,T,Ca, Fr,M,Bf,
29	Msonga	<i>Diplorhynchus mossambicensis</i>	Apocynaceae	Present	Present	Present	F,M
30	Mtuzya	<i>Ekebergia discolor</i>	Meliaceae	Present	Present	Not present	M
31	Mfutambula	<i>Entada abyssinica</i>	Mimosaceae	Not present	Not present	Present	F,M,Nf
32	Mlungulungu	<i>Fagara merkeri</i>	Rutaceae	Not present	Not present	Present	F,C,T,Fr
33	Mkuyu	<i>Ficus sycomorus (F. gnaphalocarpa)</i>	Moraceae	Not present	Not present	Present	F,Fr,M,Hi .Ca
34	Mpuguswa	<i>Flacourtia indica</i>	Flacourtiaceae	Not present	Present	Not present	F,T,Fd,Fr, M
35	Msalansi	<i>Friesodielsia obovata</i>	Annonaceae	Not present	Present	Present	Fr,M,P,F
36	Mkuwa	<i>Hexalobus monopetalus</i>	Euphorbiaceae	Not present	Present	Present	M,Fr,H
37	Msongaluguka	<i>Holarrhena febrifuga</i>	Apocynaceae	Not present	Present	Present	H
38	Mpala/ Kapala	<i>Hymenocardia mollis</i>	Euphorbiaceae	Present	Present	Present	F,P,M
39	Mulembela/ Mnembela	<i>Isobertinia angolensis</i>	Caesalpiniaceae	Present	Present	Present	F,M,T
40	Muba/Muva	<i>Julbernardia globiflora</i>	Caesalpiniaceae	Present	Present	Present	F,Bf,T,R
41	Mvungwa/ Mdungwa	<i>Kigelia africana (K.aethiopum)</i>	Bignoniaceae	Not present	Present	Present	F,M
42	Mgumbu	<i>Lannea schimperi</i>	Anacardiaceae	Present	Present	Present	R
43	Muale/ Mbale	<i>Lonchocarpus capassa</i>	Papilionaceae	Present	Present	Present	F,T,H,M, Fo,Bf,Fd
44	Msang'wa	<i>Maerua triphylla</i>	Capparidaceae	Present	Present	Present	Bf,Fd,M
45	Kasenga	<i>Marigarraria discoidea</i>	Euphorbiaceae	Not present	Present	Present	M,Fr
46	Mpapa/ Mbapa	<i>Markhamia obtusifolia</i>	Bignoniaceae	Not present	Present	Present	F,T,P,H, Fd,M,R
47	Mkukuti	<i>Monotes adenophyllus</i>	Dipterocarpaceae	Present	Present	Not present	F,M,H
48	Mwezya/ Mkombilonda	<i>Mytenus senegalensis</i>	Celastraceae	Present	Present	Present	M
49	Katungulubaganga	<i>Ochna schroenifurthiana</i>	Ochnaceae	Not present	Present	Present	M
50	Mliwamfwengi	<i>Oldfieldia dactylophylla</i>	Euphorbiaceae	Not present	Present	Present	M,P
51	Mkalakala/ Mzambarau pori	<i>Ozoroa insignis (Heeria reticulata)</i>	Anacardiaceae	Not present	Present	Present	T,M,G

Code No.	Local/Vernacular name	Scientific name	Family Name	Location in the Strata			Uses ⁷
				Wooded grassland	Open woodland	Closed woodland	
52	Mbula/Muvula	<i>Parinari curatellifolia</i>	Rosaceae	Not present	Present	Present	F,C,T,Fr, M,Fd,Hi, Ta
53	Mbanga	<i>Pericopsis angolensis</i> (<i>Afromosia angolensis</i>)	Papilionaceae	Present	Present	Present	F,C,T,P, Fd,M,Nf
54	Mngongondi	<i>Phyllanthus engleri</i>	Euphorbiaceae	Not present	Present	Not present	Fr,M,C,P
55	Mtindambogo/Mshindambogo	<i>Piliostigma thonningii</i> (<i>Bauhinia thonningii</i>)	Caesalpiniaceae	Present	Present	Present	F,C,P,T, Fr,M,Fd, Bf,D,Ta,R
56	Mtungulu	<i>Pseudolachnostylis maprouneifolia</i>	Euphorbiaceae	Present	Present	Present	F,C,T,M, P,Fd,D,Ri
57	Msaluhunda	<i>Psorospermum febrifugum</i>	Clusiaceae	Present	Present	Present	M,Fr
58	Mninga	<i>Pterocarpus angolensis</i>	Papilionaceae	Present	Present	Present	F,C,T,H, Ca,P,M, Fd,Bf,Nf
59	Mkulungu	<i>Pterocarpus tinctorius</i>	Papilionaceae	Present	Present	Present	F,C,T,P, M
60	Mkondokondo/Sitalama	<i>Rothmania engleriana</i>	Rubiaceae	Not present	Present	Present	M,Fr
61	Mputika	<i>Schrebera trichoclada</i>	Oleaceae	Not present	Present	Present	F,M
62	Mng'ong'o	<i>Sclerocarya birrea</i> subsp. <i>caffra</i> (<i>S. caffra</i>)	Anacardiaceae	Not present	Not present	Present	F,T,Hi,M, Fr,Bf,Fd, Ca
63	Mogavagoli/Mogavami	<i>Stereospermum kunthianum</i>	Bignoniaceae	Not present	Present	Present	F,P,H,Bf, M
64	Mtonga/Mumilwa	<i>Strychnos cocculoides</i>	Loganiaceae	Present	Present	Present	F,P,H,M Fr
65	Mpundu	<i>Strychnos imocua</i>	Loganiaceae	Not present	Not present	Present	F,H,P,Fr
66	Mgwegwe	<i>Strychnos potatorum</i>	Loganiaceae	Not present	Present	Present	M,C,P
67	Mkome	<i>Strychnos pungens</i>	Loganiaceae	Not present	Present	Present	M,C,Fr (poison)
68	Mwage	<i>Strychnos spinosa</i>	Loganiaceae	Not present	Present	Present	F,C,T,Fr (poison), M,Fd
69	Kasanda	<i>Swartzia madagascariensis</i>	Caesalpiniaceae	Not present	Present	Present	F,C,P,Ca, Bf,M
70	Mwasya/Kasyamongo	<i>Syzygium guineense</i>	Myrtaceae	Present	Not present	Present	F,C,T,P, H,Ca,Fr,F d,M,Bf,Ta
71	Mkwaju/Msisi	<i>Tamarindus indica</i>	Caesalpiniaceae	Not present	Present	Not present	F,C,T,P,F r,Fd,M
72	Mkelenge	<i>Terminalia mollis</i>	Combretaceae	Present	Present	Present	F,C,P,M
73	Mzima/Mpululu	<i>Terminalia sericea</i>	Combretaceae	Present	Present	Present	F,C,T,P,H ,M,Bf,R, D
74	Mgelelya	<i>Vangueriopsis lanciflora</i>	Rubiaceae	Not present	Present	Not present	F,C,H,Fr, Bf,M
75	Mfulu/Mfululegen	<i>Vitex doniana</i> (<i>V. cuneata</i> , <i>V. cienkowski</i>)	Verbanaceae	Not present	Present	Present	F,C,T,P,F r,Fd,Bf ,M,Ta,D

Code No.	Local/ Vernacular name	Scientific name	Family Name	Location in the Strata			Uses ⁷
				Wooded grassland	Open woodland	Closed woodland	
76	Mtalali	<i>Vitex mombassae</i>	Verbanaceae	Present	Present	Present	F,Fr,Bf
77	Mnembwa/ Mtundwa	<i>Ximenia americana</i>	Oleaceae	Not present	Present	Present	F,H,Fr,M, Fd
78	Mshenene/ Msyenene	<i>Xylopiia antunesii</i>	Annonaceae	Not present	Present	Not present	M,P
79	Kagowole/ Kagoele	<i>Ziziphus mucronata</i>	Rhamnaceae	Not present	Present	Present	F,C,P,M, Fd

⁷Uses:

M = Medicine

F = Firewood

C = Charcoal

T = Timber

Fr = Fruits

P = Poles

Fd = Fodder

Ca = Carving

G = Gum

H = Handles/utensils

R = Ropes

Fo = Food (seeds and leaves)

Hi = Hives

Bf = Bee forage

Ri = Ritual tree

Nf = Nitrogen fixation

D = Dye

Ta = Tannin

Appendix II: Location of forest disturbance plots and their status in Mpanda Line Forest Reserve, Urambo District, Tanzania

Vegetation type	Transect	Compass Readings	GPS begin of plot	Trees				Poles				GPS end of plot	Transect length (m)	No. of plots	Effective distance (m)
				Live	Dead	New cut	Old cut	Live	Dead	New cut	Old cut				
Wooded grassland	1	045°NE	Alt. 1079 m	24	5	0	2	168	12	0	1	Alt. 1059 m	1200	10	200
			327747E									328950E			
			9372824N									9375714N			
	2	045°NE	Alt. 1106 m	29	5	0	0	57	2	0	0	Alt. 1109 m	720	6	120
			307388E									308108E			
			9381352N									9382143N			
	3	360°N	Alt. 1108 m	6	1	0	0	42	2	0	0	Alt. 1068 m	600	5	100
			316752E									316743E			
			9398448N									9399049N			
Sub-total	3			59	11	0	2	267	16	0	1	356	2520	21	420
Open woodland	1	270°W	Alt. 1091 m	52	7	3	4	139	16	1	4	Alt. 1084 m	1680	14	280
			327085E									325405E			
			9366302N									9366310N			
	2	360°N	Alt. 1115 m	117	8	4	5	132	9	0	1	Alt. 1128 m	2520	21	420
			301849E									309918E			
			9378166N									9380684N			
	3	140°SE	Alt. 1110 m	63	4	5	4	54	10	1	1	Alt. 1010 m	1440	12	240
			299883E									300813E			
			9377828N									9376746N			
	4	045°NE	Alt. 1155 m	26	3	1	2	52	4	0	5	Alt. 1160 m	720	6	120
			290691E									291441E			
			9381398N									9382163N			
	5	320°NW	Alt. 1186 m	9	4	2	2	65	5	0	0	Alt. 1189 m	840	7	140
			287732E									286894E			
			9385142N									9387143N			
	6	270°W	Alt. 1090 m	38	5	5	7	62	12	0	1	Alt. 1086 m	1680	14	280
			318711E									317033E			
			9395726N									9395724N			

Vegetation type	Transect	Compass Readings	GPS begin of plot	Trees				Poles				GPS end of plot	Transect length (m)	No. of Plots	Effective distance (m)
				Live	Dead	New cut	Old cut	Live	Dead	New cut	Old cut				
	7	180°S	Alt.1080 m 318441E	46	4	4	8	75	6	2	1	Alt.111 m 318574E	1320	11	220
			9396010N									9394784N			
	8	180°S	Alt.1103 m 312609E	34	3	6	13	105	7	6	0	Alt.1102 m 312670E	1200	10	200
			9406346N									9405310N			
	9	180°S	Alt.1070 m 327712E	52	7	8	13	92	4	1	0	Alt.1096 m 329034E	1320	11	220
			9418192N									9418208N			
	10	150°SE	Alt.1089 m 336082E	54	5	13	8	135	11	34	3	Alt.1081 m 337119E	1800	15	300
			9419120N									9417374N			
Sub-total	10			491	50	51	66	911	84	45	16	1714	14520	121	2420
Closed woodland	1	090°E	Alt.1020 m 327078E	29	2	1	3	49	9	0	0	Alt.1010 m 327679E	600	5	100
			9361244N									9361242N			
	2	070°NE	Alt.1069 m 283640E	42	6	2	1	30	5	0	0	Alt.1089 m 284238E	600	5	100
			9386022N									9386423N			
	3	135°SE	Alt.1123 m 297025E	44	4	2	2	52	6	0	0	Alt.1132 m 298223E	1200	10	200
			9408200N									9407469N			
	4	090°E	Alt.1098 m 295264E	30	3	1	1	39	3	1	0	Alt.1118 m 296375E	1200	10	200
			9408150N									9408058N			
	5	090°E	Alt.1061 m 294088E	33	7	2	2	155	11	1	0	Alt.1087 m 295289E	1200	10	200
			9409220N									9409122N			
	6	045°NE	Alt.1119 m 329306E	19	0	3	0	83	2	1	0	Alt.1088 m 329904E	600	5	100
			9402788N									9403018N			
Sub-total	6			197	22	11	9	408	36	3	0	686	5400	45	900
Total	19			747	83	62	77	1586	136	48	17	2756	22440	187	3740

**Appendix III: Forest threats reduction assessment index in Mpanda Line Forest
Reserve, Urambo District, Tanzania**

Forest Location	Direct Threats	Area Ranking	Intensity Ranking	Urgency Ranking	Total Ranking	% Threat Met	Raw Score	TRA Index (%)
F11 ⁴	Fire (accidental /intentional)	5	5	2	12	10	1.2	
F12	Timber harvesting	4	4	4	12	15	1.8	
F13	Hunting	2	1	1	4	30	1.2	
F14	Encroachment	1	2	3	6	20	1.2	
F15	Grazing	3	3	5	11	15	1.7	
Sub-Total					45		7.1	15.7
FE1 ⁵	Fire (accidental)	5	5	2	12	15	1.8	
FE2	Grazing	4	3	4	11	15	1.7	
FE3	Fishing	1	1	1	3	50	1.5	
FE4	Firewood collection (tobacco curing)	3	4	5	12	10	1.2	
FE5	Tree/pole cutting	2	2	3	7	15	1.1	
Sub-Total					45		7.2	16
Total					90		14.3	15.8

Where;

Raw Score = Total Ranking x % Threat Met,

TRA = (Raw Score/ Total Ranking) x 100%,

⁴F1 = Forest interior threats (i.e., those which occur inside closed forest more than 100 m from the forest edge),

⁵FE = Forest edge threats (i.e., those which occur within 100 m from the forest edge, and in the forest perimeter zone),

F11 = At least two to three fires occur in the forest per year, a system of early fire detection and fire fighting mobilisation in place, firebreaks cleared and maintained each year and early burning instituted. Forest patrols conducted on a regular basis,

F12 = Timber exploitation completely banned with harvesting plan in place and control mechanisms established e.g., JFM program initiated,

F13 = Poaching completely stopped and control mechanisms established e.g., Frequent patrols and WMA program initiated,

F14 = Encroachment for cultivation and settlement completely stopped and boundary of the forest reserve and the corridor well demarcated, cleared and maintained each year and encroachers evicted,

F15 = Grazing adhered to forest rules and regulations. Forest patrols occurring on a regular basis,

FE1 = See F11,

- FE2 = Land use plans in place and grazing procedures/regulations in the forest reserve are strictly adhered to,**
- FE3 = Illegal fishing completely stopped, use of small nets and poison completely banned and formation of small entrepreneur groups. Patrols conducted on a regular basis,**
- FE4 = Sustainable procedures for firewood extraction in place and implemented and alternative sources of energy/improved mechanisms for curing tobacco sought,**
- FE5 = Trees and poles cutting completely stopped, alternative sources initiated to meet community needs c.g., woodlot reserves, and tree planting.**

**Appendix IV (a): Data sheet for reporting progress in management effectiveness
assessment in Mpanda Line Forest Reserve, Urambo District, Tanzania**

Date assessment carried out: 22/12/2005

Name/s of assessor: SHABAN S. MAKAKA (AFO I – DFO URAMBO)

Name of protected area:	MPANDA LINE FOREST RESERVE	
Location of protected area (district, region and if possible map reference):	URAMBO, TABORA	
Date of establishment (distinguish between agreed and gazetted⁸):	Agreed	Gazetted 07/01/1955
Ownership details (i.e. owner, tenure rights etc):	CENTRAL GOVERNMENT	
Management Authority:	GOVERNMENT (MINISTRY OF NATURAL RESOURCES AND TOURISM)	
Size of protected area (ha):	374,800	
Number of staff:	Permanent 7 (1)	Temporary 72 (9 VEC * 8 VILLAGES)
Budget:	TSHS. 15,000,000/=	
Designations (IUCN category, World Heritage, Ramsar etc):	RAMSAR	
Reasons for designation:	PROTECTION OF WETLAND BIODIVERSITY	
Brief details of World Bank funded project or projects in PA:	-	
Brief details of WWF funded project or projects in PA:	-	
Brief details of other relevant projects in PA:	UGALLA COMMUNITY CONSERVATION PROJECT – UCCP (AFRICARE)	
List the two primary protected area objectives:		
Objective 1:	COMMUNITY INVOLVEMENT IN CONSERVATION OF BIODIVERSITY	
Objective 2:	RESOURCES SHARING BETWEEN THE GOVERNMENT AND COMMUNITY	
List the top two most important threats to the PA (and indicate reasons why these were chosen):		
Threat 1:	WILD FIRES (PROMINENT PROBLEM)	
Threat 2:	ENCROACHMENT (GRAZING) – COURSE SILTATION	
List top two critical management activities:		
Activity 1:	BOUNDARY RESURVEY	
Activity 2:	CREATION OF AWARENESS TO THE COMMUNITY THROUGH PLUM	

⁸ Or formally established in the case of private protected areas.

**Appendix IV (b): Management effectiveness assessment form for Mpanda Line
Forest Reserve, Urambo District, Tanzania**

Issue	Maximum Score	Actual Score⁶ given
I: Context	3	3
1. Legal status - Does the protected area have legal status?		
2. Protected area regulations - Are inappropriate land uses and activities (e.g. poaching, illegal timber harvesting, fishing, encroachment, livestock grazing) controlled?	3	1
3. Law enforcement - Can staff enforce protected area rules well enough?	3	1
4. Protected area boundary demarcation - Is the boundary known and demarcated?	3	2
5. Resource inventory - Do you have enough information to manage the area?	3	1
II: Planning	3	1
6. Protected area objectives - Have objectives been agreed?		
7. Protected area design - Does the protected area need enlarging, corridors etc to meet its objectives?	3	0
8. Management plan - Is there a management plan and is it being implemented?	3	0
• Additional points	3	0
9. Regular work plan (Planning/Outputs) - Is there an annual work plan?	3	1
III: Inputs	3	1
10. Research - Is there a programme of management-orientated survey and research work?		
11. Staff numbers - Are there enough people employed to manage the protected area?	3	1
12. Staff training (Inputs/Process) - Is there enough training for staff?	3	1
13. Current budget - Is the current budget sufficient?	3	0
14. Security of budget - Is the budget secure?	3	0
IV: Process	3	0
15. Resource management - Is the protected area adequately managed (e.g. for fire, invasive species, poaching, encroachment, illegal timber harvesting, fishing, livestock grazing)?		
16. Personnel management - Are the staff managed well enough?	3	0
17. Management of budget - Is the budget managed to meet critical management needs?	3	1
18. Equipment - Is the current equipment adequate?	3	1
19. Maintenance of equipment - Is equipment adequately maintained?	3	0

Issue	Maximum Score	Actual Score ⁶ given
20. Education and awareness programme - Is there a planned education programme?	3	2
21. State and commercial neighbours - Is there co-operation with adjacent land users?	3	1
22. Indigenous people - Do indigenous and traditional peoples resident or regularly using the PA have input to management decisions?	3	0
23. Local communities - Do local communities resident or near the protected area have input to management decisions?	3	0
24. Commercial tourism and hunting - Do commercial tour operators and hunting companies contribute to protected area management?	3	0
V: Outputs • Additional points	2	1
25. Visitor facilities - Are visitor facilities (for tourists, hunters, pilgrims etc) good enough?	3	1
26. Fees - If fees (tourism, hunting, fines) are applied, do they help protected area management?	3	2
VI: Outcomes 27. Condition assessment - Is the protected area being managed consistent to its objectives? • Additional points (Outputs)	3 1	0 0
28. Access assessment - Are the available management mechanisms working to control access or use?	3	1
29. Economic benefit assessment - Is the protected area providing economic benefits to local communities?	3	3
30. Monitoring and evaluation (Planning/Process)	3	1
TOTAL SCORES	96	27
Overall Management Effectiveness = (27/96)*100% = 28.1%		

⁶Scores: 0 = poor, 1 = fair, 2 = good, and 3 = excellent