

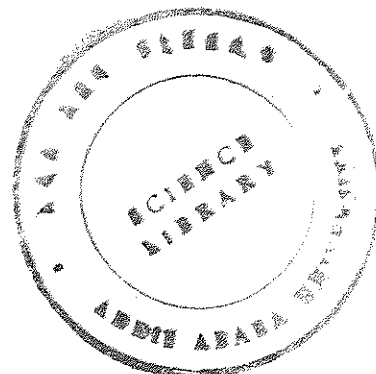
ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

**INTERFACES OF MIOMBO WOODLAND BIODIVERSITY AND LOCAL
COMMUNITY: WOODY PLANT SPECIES USE AND CONSERVATION
PRACTICES AT SINGIDA DISTRICT, TANZANIA**

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**A thesis submitted to the School of Graduate Studies of
Addis Ababa University in the partial fulfillment for the requirements for the
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DEDICATION

To my wife Josephine George Myula and our children Elizabeth and James who suffered a lot during my absence but remain my richest source of my self-esteem.

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ABSTRACT

A total of 117 woody plant species representing 81 genera and 34 families (34.2% and 65.8% shrubs and trees respectively) were collected and identified from the study area while 22 families (70 species) were reported to be highly utilized by the local community. The area was dominated by species of the family Fabaceae (26.5%) followed by Combretaceae and Rutaceae (11% each). *Brachystegia speciformis* (IVI = 69.85) and *Julbernardia globiflora* (IVI = 51.2) were found to be the dominant tree species. About 41% stems of woody species were found in the reserved but not in the unreserved land where by 97.74% and 61.7% of this proportion were recorded as stumps in the latter sites. 57.3% of the total woody plant species were highly utilized by the local community. On the other hand, other useful species such as *Aerva lanata*, *Boscia massaiensis*, *Senna singueana* and *Lannea schweinfurthii* var. *stuhilmannii* were locally extinct due to over exploitation. TWINSPLAN has revealed six plant communities based on relative disturbances at various plots. There was a significant negative correlation between diversity and disturbance ($r = -0.456$ $p = .000$) and between richness and disturbance ($r = -0.318$, $p = .001$). One Way Analysis of Variance (ANOVA) has exhibited that the six communities were statistically different with regard to their diversity ($p = 0.000$). Diversity was significantly high in the reserved area ($p < 0.0001$) but there was no significant difference among sample villages ($p = 0.749$). Similarly, species richness has displayed a statistically significant difference ($p = 0.0001$) between the two sites but no difference existed among the villages ($p = 0.43$). Moreover, Sorensen's coefficient of similarity has revealed high similarity in species composition (76.5%) between reserved and unreserved land. With regard to structure, density was significantly higher in the reserved land ($p = 0.0019$). Although both sites have portrayed a reversed J-shape trend student t test has revealed significant differences among small reproductive trees (dbh class 10.1-20cm) ($p = 0.0186$) and among large reproductive trees (dbh class >20 cm) ($p = 0.0199$) but no significant differences in the poles (dbh class 4.1-10cm) ($p = 0.1147$) and seedlings and saplings (dbh class ≤ 4 cm) ($p = 0.5429$) between the unreserved and reserved land. Stump density was significantly higher in the unreserved ($p = 0.0194$) than the reserved land. On the other hand, tree basal area showed normal J-shape trend but has exhibited a significantly high value in the reserved land ($p = 0.0095$) with statistical differences $p = 0.0011$, $p < 0.0001$ and $p = 0.0279$ among poles, small reproductive trees and large reproductive trees respectively. Although the population structure of the study area has revealed normal recruitment potential there was high degree of anthropogenic impacts. The

miombo woodland is currently being used in an unsustainable manner. The direct use categories in the area are medicinal, firewood, charcoal, timber, building and fodder, beehives, food and cultural. Most of these are also used to generate income at household level. However, local communities were found to lack the appropriate knowledge of resource conservation and sustainable uses. Furthermore, the traditional setup of the Sukuma people who are immigrants to the area has posed negative impacts on the status of the woodland owing to increased human and livestock population and land clearance for settlements and farming. The current study has revealed differences in the harvesting periods of useful woody species. Current conservation strategies and practices have proved inadequate to combat the ongoing rate of destruction in the area. Thus, there is need for deliberate efforts that will ensure sustainable use and conservation of the resource via natural regeneration, enrichment planting and encouraging use of living fences. It is important to explore new approaches that will attract people's attention and interest on the woodland and to involve majority of the local people in the planning and implementation of conservation strategies. Each actor needs to realize that his/her operations have impacts on sustainable development of the area. There is need to improve animal husbandry practices and auction markets in the area and throughout the country. Moreover, deliberate programs should be established to hasten the pace of village boundary demarcation and prepare legalized land use plans based on Participatory Land Use Management (PLUM).

1.0 INTRODUCTION

1.1 Historical Background

The integration of economic development with biodiversity conservation has become one of the most important elements in the search for sustainable development especially in rural areas of developing countries where biodiversity is concentrated and where poverty tends to be persistent (Wells, 1994; World Bank, 1992). Since most of these countries have been facing a variety of development crises but with limited public funding they have lowly invested in biodiversity conservation. Hence, fragile and unique ecosystems in these countries are being massively degraded (Wells, 1994).

However, humans, through historical land use activities have maintained miombo woodlands over the last 550 centuries (Lawton, 1978). Such activities include cutting cultivation and frequent fires. Increase in human and livestock populations that have especially occurred during the 20th Century have intensified these land use activities (Chidumayo, 2002; Dregne, 1986). These activities are usually coupled with poor conservation strategies and have been extending towards unaffected lands and/or protected areas leading to changes in the structure and functioning of the savanna woodland ecosystems, thus gradually threatening the status of woodlands (Mugabe and Clark 1998; Tuxill and Nabhan 2001; Chidumayo, 2002).

In Tanzania, miombo woodlands, which were estimated at about twothird of all forest and woodland coverage (Rodgers, 1996) contribute to most of the Tanzanian public woody plant resources by supporting the livelihood of millions of people in the country (Mugabe and Clark, 1998; MNRT, 1998). Generally, woodlands are characterized by being low stocked open stands of trees at least 8m tall commonly with canopy tree cover 40%, sparse shrub layer and grass field strata (White, 1983). Particularly, miombo woodlands are distinguished from other woodlands by being dominated by trees of the genera such as *Julbernardia*, *Isobelinia* and *Brachystegia* (Lind and Morrison, 1974; White, 1983; Frost, 1996).

Wood harvesting and farming are considered to cause direct impacts on the structure of woodlands in Tanzania (Dregne, 1986; URT, 2002). Increase in demand for charcoal and firewood is presumed to be a major cause of deforestation in the country. As a result woodlands

in the public lands of Tanzania have been the worst affected areas (URT, 1998). This has led to the National Forestry Policy being changed to focus on regulating the impacts of wood harvesting in the country (SAPU, 2001).

In Singida rural district, degradation of the environment through poor farming methods and overgrazing pose danger to the natural resource base. Woodlands of mostly Miombo, *Acacia* species and Itigi thickets with patches of water logged *hyperenia* species dominated the district. Over 25% (3,005 km²) of the district area (12,164 km²) is woodlands and forests (SDC, 2002).

Minyughe woodland in Singida district covers over 75% of the whole forested land in the district (Wily, 2001; SDC, 2002). The woodland has been under intensive human exploitation for decades (Sjöholms, 1998) providing timber, firewood, building materials and other woodland products. In recent years, efforts have been made towards community-based management with the aim of empowering the villagers around the forest under the new national forest management guidelines (SAPU, 2001). Since 1997, Singida District has developed a strategy towards this by assisting local communities in taking action to rescue parts of the forest falling under their respective village lands and until 2000 cut lines was put in some villages to separate unreserved from reserved lands (Wily, 2001). Under these guidelines, communities around the forest are expected to protect and utilize the forest in a sustainable manner.

By 1995, Minyughe had not been gazetted because of lack of resources and enough time to conduct surveys and mapping (Wily, 2001). In 1998 the woodland was considered among the potential national reserves in Tanzania (LAMP, 2001). The plan was to bring the forest under Government tenure and management. According to this plan there would be a total ban of timber harvesting to allow recovery of the highly degraded woodland. Prior to this time, a provisional inventory of the forest had indicated its poor condition; disturbed age classes and lack of mature trees (Mwansasu, 1992; NFI, 1996).

Due to its extended coverage, it proved expensive to control and manage Minyughe woodland by the government (Opole, 1995 cited in Wily, 2001). In 1997, the regional forestry program in Singida through the Land Management Programme (LAMP) put Minyughe woodland under

investigation (Wily, 2001). The programme aimed at providing education on sustainable management of natural resources to local communities in the district.

The LAMP program in coordination with the District forestry division have achieved one major output in the area, which is the installation of some beacons at key points along the village boundaries in the two Divisions (Wily, 2001). In addition, cutlines that serve to demarcate woodland-reserved land and human settlement (unreserved) land exist in many of the villages (Personal observation). Despite these achievements by the LAMP project and the District forestry division, some serious problems still persist in the study area. Villagers are still unaware of the extent of their village lands. Human activities are still going on in the woodland reserved site (Wily, 2001; Personal observation). Currently, Minyughe woodland reserve falls within registered village lands and is therefore legally owned by villages. It no longer represents single continuous woodland but represents a series of large forested areas interspersed with permanent and semi permanent settlements (Personal observation).

The current research was therefore conceived in the premise that people in Tanzania still rely heavily on their surrounding forests and /or woodlands for subsistence needs and income generation (Hines and Eckman, 1993). Moreover, since the local people in Minyughe woodland have been continuously interacting with the woodland, they know certain species for specific uses. This knowledge is based on their experience often with indigenous species leading to selective exploitation of such species. Therefore, the conservation of such species requires matching people's knowledge and preferences with appropriate conservation strategies.

1.2 Justification

Despite its great and important role to the local community, not much is known about Minyughe woodland todate (LAMP, 2001). The status and vulnerability of useful woody species as a result of anthropogenic disturbances are not well explored (Wily, 2001). Prior to this study the knowledge of the local people on use and conservation of useful woody species has not been studied (Wily, 2001). However, due to uncontrolled resource exploitation (Wily, 2001), human activities such as pit sawing and farming are extensively taking place (Sjöholm, 1988). As a result the woodland exhibits poor condition, disturbed age classes and lack of big and mature

trees (Sjöholm, 1988; Mwansasu, 1992; Wily, 2001). This study aimed to obtain basic information on local usage, the status and potential threats and indigenous conservation practices of woody species of the study area. Based on the assumption that human plant resource exploitation has impact on the status of natural vegetation, the distribution of woody species in different diameter classes was related to anthropogenic pressure.

1.3 Objectives of the study

1.3.1 Overall Objective

To assess and document useful woody species composition and knowledge on use and conservation of the highly utilized woody plant species by the local community including the potential threats on the status of such species in Singida rural district of central Tanzania.

1.3.2 Specific Objectives

- ❖ To understand woody species communities.
- ❖ To elicit the useful woody plant species and the way the local community is using them.
- ❖ To assess the threats to the useful woody species of Minyughe miombo woodland (MW)
- ❖ To explore the traditional conservation strategies of useful woody plant species.

1.3.3 Research Questions

- ❖ What are the composition, size classes, basal area and density of useful woody plant species in reserved and unreserved lands of Minyughe miombo woodland?
- ❖ What are the woody plant species useful to the local communities?
- ❖ What is the present status in terms of dominance of the highly utilized woody plant species in the study area?
- ❖ What are the threats to the survival of the useful woody plant species?
- ❖ What are the conservation practices applied by the local community?

2.0 LITERATURE REVIEW

2.1 Plant Resources in Tanzania

Tanzania is endowed with rich plant resources ranking second out of the 48 countries of Afro-tropical realms in the number of plant species by having 12,667 distinct terrestrial plant species in a total of 250 families (URT, 1998) which accounts to more than one third of the total plant species in Africa (Heywood and Davis, 1994; URT, 1998). Of the 12,667 species, 1,122 are endemic (Heywood and Davis, 1994) and 4.4% are threatened (Walter and Gillet, 1997). The more alarming situation is the fact that some of these species are at the verge of extinction even before their uses are identified (UNEP, 1991). Besides, the country contains one of the biodiversity hotspot areas in the world: the Eastern Pare Mountains (Mugabe and Clark, 1998).

This diversity is a reflection of the variety of habitats and Phytogeographical regions (phytochoria) that are present in Tanzania. The country falls under five biogeographical regions (Mugabe and Clark, 1998). These are: the Afromontane Archipelago-like Regional Centre of Endemism; the Somali –Masai Regional Center of Endemism (in which Minyughe is found); the Zambebian Regional Centre of Endemism; the Zanzibar-Inhambane Regional Mosaic and the Lake Victoria Regional Mosaic (White, 1983). Each of the five phytochoria is represented by a number of characteristic plant species and as a result of the large variety of phytochoria; Tanzania's terrestrial flora has been diverse.

More than 33 million hectares (about 40 %) of the Tanzanians' total land area is classified as forests and woodlands (MNRT, 1998; URT, 2002). Of the 33 million hectares, 75% (25 million hectares) is covered with open woodlands (which are commonly known as miombo) that are largely located in the public lands (MNRT, 1998). The standing volume of trees in closed forests is estimated to be 197m³/ha while that of trees in woodlands vary from 15 to 47m³/ha (MTNRE, 1994). Minyughe woodland occupies about 0.4% of the *Brachystegia-Julbernardia* savanna woodland ecological zone (which covers approximately 554,600 km²) within the Zambebian phytochorion (URT, 1998), which is about 2.2% of the whole woodland area in the country.

2.2 The Importance of Woody Plants to Human Life

In many areas of the world, products derived from woody plants provide essential goods and services such as fuel for cooking and heating, construction material for housing, forage for cattle, and non woody products (Hussain and Khaliq, 1996; Hedberg and Hedberg, 1968; UNEP, 1995). Moreover, plants are important as they maintain human populations WCMC (1992) through maintenance of cultural values and symbolic use and by being sources of ministerial raw materials. They also provide aesthetic values and maintain the environment. Hence, they are important for providing support to the earth's life. For this reason human life has great impact on plant species diversity and vice versa (Delcourt *et al.* 1986; UNEP, 1995). In Africa, 80% of all people use plants for the major part of their daily needs (Cunningham, 1993). Though, such roles have been taken for granted. Due to the increasing population pressures and lack of appropriate proper management strategies, the benefits are no longer readily available.

Miombo woodlands in Tanzania, serve a great role to humanity both in the rural and urban areas. They provide food, fuelwood, medicine, water conservation, weather moderation, soil stabilisation and pollution reduction have significant contribution to national income at large (Mugabe and Clark, 1998). Additionally, forestry contributes 10% of the registered exports and provides employment to more than 700,000 people annually (MTNRE, 1994; MNRT, 1998). Recent estimation (FBD, 2000), forest based activities generate employment to about 800,000 people per year; half of them women.

2.3 Uses of Woody Plants in Tanzania

2.3.1 Medicine

Tanzania is reported to have approximately 60,000 traditional healers (Weenen, 1990; cited in Hines and Eckman, 1993). Majority of botanical studies in Tanzania have identified a number of medicinal plants from forests. However, it has remained difficult to assess the species that are of major economic importance in the field of medicine. The status of these plants in the natural environment has been given little priority by the majority of researchers (Hines and Eckman, 1993; Posey, 1996). It is therefore important that the status of the significant medicinal plants are realized so that appropriate conservation measures can be taken to ensure that their medicinal value continue to be available on sustainable basis.

2.3.2 Firewood

Wood supplies about 95% of Tanzania's fuel energy (Iddi and Hakan, 1998). In Tanzania, firewood serves the main source of energy for rural areas, and an important source of cooking fuel in urban places (Hines and Eckman, 1993) and many other domestic tasks such as heating and lighting. It is the predominant source of energy for most of the small scale processing enterprises such as brewing, bricks firing, tea drying, making of pottery, bread making, fish smoking and tobacco curing. Tobacco curing has been identified as one of the main causes of natural woodlands depletion in Tabora, shinyanga, and Iringa regions. In Iringa for example, it was estimated that approximately 15kg of stacked wood is needed to produce only one kilogram of cured tobacco where as burning 50,000 bricks requires about 20 tonnes of firewood (Hines and Eckman, 1993). This high consumption of wood for firewood is ascribed to low percapita income and limited investments in alternative energy sources (SADC Energy sector, 1993).

2.3.3 Charcoal

Despite its steep rise in price charcoal still forms the most reliable and relatively cheap source of domestic energy for most urban dwellers in Africa (SADC Energy sector, 1993). In many rural areas, charcoal making have been considered an alternative source of income. According to Hines and Eckman (1993), charcoal production at a small-scale level is a significant source of income for many farmers. However, it is regarded a significant cause of deforestation especially in the miombo woodlands (URT, 1998; SADC Energy sector, 1993). Farmers normally construct small kilns of 5 to 6 cubic meters of wood to produce more than ten 35 kg bags of charcoal (Hines and Eckman, 1993).

2.3.4 Building Materials

In most rural areas of Tanzania forests are still the main sources of material for constructing bomas, houses and fences. People in the rural areas do not buy building materials for their own use (Hines and Eckman, 1993). Hines and Eckman (1993) noted that, there were some selling of building materials by villagers and traders who make the materials to towns and that preferred species tend to vary according to availability and the specific use within the construction scheme. This demand for building materials exerts considerable pressure on natural forests and woodlands

especially those near villages and towns. Poles are harvested from forest reserves for personal use without a license and free of charge.

2.3.5 Fodder

In Tanzania, livestock production is part of household production systems. For livestock keepers, herds serve for future security and unexpected needs (Hines and Eckman, 1993). Trees from forests and woodlands are primary sources of fodder in these areas. Fodder plants are normally important during dry seasons when grasses are not on ground. However for small-domesticated ruminants such as goats and sheep, fodder plants are a requirement throughout the year.

2.3.6 Timber

Timber is a valuable product of indigenous tree species. However, literature shows that there is tremendous increase in scarcity of the preferred species for timber (Hines and Eckman, 1993). The increase in demand for timber, which is fostered by the rise in population and demand for timber, has fostered a serious depletion of indigenous tree species in the country (Hines and Eckman, 1993).

2.3.7 Beehives

Traditional beekeepers make their living from the forest where hives are put in carefully selected tree species. It can be understood that honey is a uniquely exploited product because it does not compete with other land uses or cause degradation. However, burning has been mentioned as an adverse effect of traditional beekeeping practices (Hines and Eckman, 1993). Also, because hives are more preferable due to their qualities, certain specific species are selected for making quality hives; this being a cause of selective harvesting from forests.

2.3.8 Rituals

Tanzania is endowed with a variety of ethnic groups with a variety of cultural functions. Since forests have been and still are an integral aspect of the social structure, religion, art, history, medicine and politics their features, are viewed as both sources and protectors against evil and as providers of fortune and power (Hine and Eckman, 1993). There are certain trees, which can serve to link the living with their ancestors and symbols for beliefs within lives of purpose. Some

species are considered sacred, possessing special powers (Hines and Eckman, 1993). This aspect of linkage between humans and forests is important to consider in sustainable conservation because it is one way of sustaining our culture.

2.3.9 Living Fences

Living fences form one of the most useful agro techniques used in controlling the movement of wild and domestic animals in African land use systems (Rocheleau *et al.*, 1988). The role of living fences varies depending on purpose. Some fences were built to keep out domestic or wild animals while in some cases they were used to demarcate areas where general access is discouraged such as around a compound, house, cropland, fodder lot garden or orchard (Rocheleau *et al.*, 1988). They may also form livestock driveways and enclosures or separate fields, which are different rotations of crop or pasture management (Paddocking). In the majority of the fences, trees/shrubs are planted close together in one or more rows to make them dense and impenetrable.

2.4 Threats to Woody Plant Species Diversity and their Degradation Trends

Although the diversity of woody plants is fundamental both for the present and future human well-being plant species are being destroyed at an unprecedented rate in many parts of the world (IPGRI, 1993). More than 30 per cent of the world's woodlands and forests have been deforested (Litvinoff, 1990) whereby approximately 44 percent of all vascular plants in the world are threatened to extinction at the extent that an aggregate average of around 88 percent of their primary vegetation has already been lost (WCMC, 1992). This problem is exacerbated by policies, which encourage land conversion, resource overexploitation as well as lack of information about the economic value of biodiversity conservation (Wells, 1994).

Africa has been reported to be the most severely affected continent in which forests and woodlands have been cleared 29 times faster than they were being planted in the early 1980s compared to 10.5 in Tropical America and 4.5 in Tropical Asia (Holmberg, *et al.*, 1991). Plant loss has been a chronic problem especially in the drylands where it has claimed 74% of the total land area (UNEP, 1995). Anthropogenic factors such as deforestation have been identified to be the main causatives of plant species loss in developing countries (UNEP, 1995; Tuxill and

Nabhan, 2001). FAO (1993) estimates for species loss in Africa for the period of 1981 – 1990 were 2 % for tropical rain forests and 3.5 % for dry zones and upland forests. According to Rosero-Bixby and Palloni, (1996) socio-economic and political forces that determine the mode of development in Africa have a great influence on woody vegetation degradation and destruction. Forest or woodland degradation at national and local levels is said to be associated with rural population pressure through subsistence activities (WRI, 1996).

Kakembo (2001) defines vegetation degradation as the deterioration of the healthy conditions of the vegetation, which is expressed through changes in its composition, structure and function. The changes that lead to woody plant degradation unlike deforestation are gradual changes (Horta, 2002) and are represented by the decrease of area and by qualitative losses such as reduction of species diversity, decrease of shrub layer and reduction of woody species (Dregne, 1986).

The rises in human and livestock densities that are coupled with a narrow range of economic activities in most local settings of Africa are primary causes of Habitat destruction (Mugabe and Clark, 1998). They are the main factors for the increase in demand for settlement areas, grazing /or browsing areas and woody plant products such as timber, charcoal, firewood and building materials. This over exploitation of many woody plant species has led to reduced plant population levels and in some cases to extinction (WCMC, 1992).

Although Tanzania, when compared with many other African countries is still well wooded, deforestation has spread rapidly, mainly in semi-arid areas where forest and bush regeneration is slow (MNRT, 1998). The country has been experiencing rapid rates of deforestation. Forests and woodlands on public lands of Tanzania are vulnerable to extinction because of poor management. Plant resources are being lost at rapid rates leading to serious environmental degradation in most parts of the country (URT, 1998). Grazing lands and tobacco growing areas are also especially affected (Manoko, 1999).

However, estimates of the magnitude and rate have varied widely. According to the assessment of tropical forests and woodlands in 76 countries in Africa, carried out by FAO in cooperation

with UNEP within the Global Environmental Monitoring System (GEMS), during 1978 - 1981, deforestation rates were estimated and forecasted for the period 1981 - 1985 (MNRT, 1998; URT, 2002), about 130 000 ha were estimated to be annually cleared for agriculture in Tanzania, of which 92.3% is from woodlands and that a fifth of the cleared area (i.e. 24 ha per annum) will be lost as tree vegetation for a long time because of terrain conditions. Annual deforestation rate during 1990s would increase to about 500 000 ha of which, due to clearing for agriculture from about 140,000 ha to 160 000 ha, due to fuelwood from about 200 000 ha to 330 000 ha. In 1989, the Ministry of Lands, Tourism, Natural Resources and Environment (MLTNRE, 1989) estimated that Tanzania has been losing between 300,000 and 400,000 ha of forest per annum. The FAO and World Bank estimates give an average annual rate of 130,000 ha or 0.3% (WRI 1990; World Bank 1992). It is estimated that Tanzania's forest and woodland area has declined from 44,300,000ha, which is 50% of total land area in 1938 to the current 33.5 million ha of the total land area (URT, 2002). Recent estimates (URT, 2002) indicate that Tanzania deforestation rate is about 92,000 ha per annum. Such disparities of data have made it difficult to assess the magnitude of the problem and to come up with strategies aimed at minimising it and dealing with its impacts.

Reasons for such variations vary, but mainly due to lack of proper mechanisms for collecting and analysis of data. Regardless of the variations in the estimates it is apparent that significant reduction of the woodlands has occurred (Campbell, 1996). Worldwide, factors such as harvesting pressure for commercial trade and predations from introduced exotic species have been reported to be evident in species extinction. The WRI/ IUCN/ UNEP (1990) Global Biodiversity Strategy have identified human direct factors affecting the level of biodiversity as to include exploitation of wild resources, habitat destruction and fragmentation, pollution, and the expansion of agriculture. In Tanzania, reasons for this tremendous decline of woodlands and forests include the uncontrolled wood harvesting for timber, fuel, building for domestic needs as well as for income generation and shifting cultivation, development of settlements, overgrazing and uncontrolled fires (URT, 1998).

Plant loss accounts for major economic, social and environmental problems facing majority of the people over the world (UNEP, 1995). Small and fragmented habitats tend to support fewer

organisms hence reducing population levels and the ultimate changes in climatic conditions have negative impacts on social well being (UNEP, 1995). This has led to the current efforts towards the recognition of the need to ensure sustainable conservation of plants by most of the developing world (IPGRI, 1993), which is actually a vital step in ensuring ecosystem preservation. However, its effectiveness in attaining national and local development objectives need a proper evaluation of our natural ecosystems which should be culturally acceptable and make biological diversity accessible (Pearce and Moran, 1994). Of particular importance is the need to understand the contribution of these factors to the woodland destruction crisis in different areas and to find out the link between the process of degradation and the development process in the country

2.5 Local Communities and Conservation of Woody Plants in Tanzania

Conservation approaches in Tanzania have been top down in nature (Sosovele *et al.*, 1999), and skewed on modern practices, which are certainly unknown to the local people, hence leaving them behind the race (Goldman, 2003; Scoones, 1995). Like for many other African countries, the establishment of government-protected areas (forest reserves and National parks) has been the conventional approach to conservation of woodland resources (Chidumayo, 2002).

The knowledge and practices of local communities have great role in preserving the local environments. However, Goldman (2003) notes that traditional knowledge has not been put in to practice; instead, local communities in Tanzania have been viewed as tools for, or commodities of conservation rather than as active knowing agents as a result community participation has remained passive in nature. Hence, conservation strategies and policies in the country need radical transformation of their culture and institution so as to consider local communities as partners of such policies and practices (Goldman, 2003). Since the culture of using and conserving plant species especially in their natural environments (in situ conservation) is directly linked to knowledge and practices of the local communities (Posey, 1999). It is through their traditional practices local communities conserve the useful plant species which inturn has contributed to the shaping of the landscape (Moreno-Black *et al.*, 1994).

The reliance by both local and national governments on rules and regulations to protect and enhance forest resources has currently proved inadequate. Thus a focus on plant conservation has

little point in itself, without the exploration of their usage. Basically, local communities conserve plant genetic resources for use. Hence, excluding their knowledge in conservation strategies means neglecting the genetic base needed by the local community alike to increase productivity in the future (Posey, 1999).

Scoones, (1995) observed that, conservationists working with the dynamic ecological processes such as that characteristic of arid and semi arid environments may well benefit from the insights and practical experiences of local knowledge. Therefore, in order to understand their traditional methodologies and how they relate to scientific ones, we need to look on the way phenomena are perceived and interpreted within human culture and the scientific classifications and analysis of the role of the indigenous knowledge systems in sustaining the vegetation. In the context of human-environmental interactions, Martin (1995) and Cotton (1996) state that traditional categorizations vary from community to community and they are based on several factors such as plant use, color, life forms and/or a combination of all or some of them.

Knowledge and practices of the local people need to be well documented and effectively utilized. Documentation helps to provide the basis for creating awareness on the need to protect the threatened species (Senanayake, 1999) and serves as the basis for setting priorities for sustainable conservation measures (UNEP, 1996 and Posey, 1999). It is for this reason local communities need to be fully and effectively involved into planning processes. This should be done through letting peoples land use techniques and forms of social and ecological organizations conform to recognize land use categories and approved land use planning practices. Moreover, measures designed to conserve biodiversity should provide economic incentives to increase the net local benefits from conservation and sustainable resource use (McNeely, 1988).

2.6 Species Diversity

Species diversity has been considered as one of the key indices of sustainable land use practices (Shackelton, 2000). Although diversity has been equated with species richness (Peet, 1974); the latter fails to consider the relative abundance, or the evenness of species; i.e. two communities with the same number of species but with different relative abundance would have the same level of species richness (Peet, 1974). Shannon-Wiener Index as a measure of information content

should be used only on random samples drawn from a large community (Krebs, 1972). The index combines two components of diversity, which are number of species and equitability, or evenness of allotment of individuals among the species Ludwig and Reynolds (1998). Its value increases with increase in the number of species or when the distribution of individuals among the species becomes even. H' is zero only and only if there is one species in the sample and maximum only when the same number of individuals represents all species. Shannon Wiener Index has been probably the most widely used in community ecology. It is based on information theory (Shannon and Wiener 1949) and is a measure of the average degree of uncertainty in predicting to what species an individual chosen at random from a group of species and individuals will belong (Ludwig and Reynolds, 1998).

Diversity can also be measured in terms of species similarity between habitats belonging to the same geographic area or β -diversity. High β -diversity results from low similarity between the species composition of different habitats or different locations along a gradient (Huston, 1994).

2.7 Species Richness

The concept of species richness has been the oldest simple and basic measure of species diversity (Whittaker, 1970; Krebs, 1998). This concept refers to the number of species in the community and was first coined by McIntosh (1967). However, according to Krebs (1998), it is often difficult to enumerate all the species in a natural community. But, Oosting (1965) noted that species richness is easy to determine only in easily censured communities with few species. In this study, species richness was adopted because not many species were noted per plot.

2.8 Relationships Between Tree Diversity, Richness and Human Influence

In some cases, Plant species diversity, Richness and Shannon index can be lower in areas close to human influence (Columba, 2003). This implies those tree populations; especially the populations of the highly utilized species have higher probabilities of being threatened if they are located closer to human settlement or infrastructures. According to Shackelton and others, plant species Richness may vary with changes in disturbance (Shackelton *et al.*, 1994)

2.9 Ranking and Scoring

Preference ranking and matrix scoring are tools that are used primarily to explore people's perceptions, elicit criteria, and understand their choices and decision-making (Nemarundwe and Richards, 2002). They enable researchers to obtain information on farmers' preferences, priorities, and criteria for evaluating changes to the farming system (Bernard, 1988)

These techniques can be also used to obtain qualitative information about resource use or income, which would otherwise have been collected using more conventional, data-intensive means. For example, data on labour use for different activities can be collected either by asking the farmer to record or recall the number of hours or days spent on each activity, or by asking him or her to allocate weights (e.g. seeds) to each activity to reflect labour use. Ranking and scoring tools also provide a means of assessing relative wealth and well being (Nemarundwe and Richards, 2002). Preference ranking and matrix scoring have distinct advantages over more conventional data collection techniques when used in a participatory framework. (Bernard, 1988)

Compared with verbal responses to interviewer questions, these physical activities carried out by the farmers themselves, shift attention away from the traditional roles of 'outside' interviewers and 'local' respondents towards the activity itself. Since the activity does not rely on quantitative data, which may be sensitive (especially in the case of income derived from farming activities), this defuses the situation and allows people to express their perceptions. In addition, the discussion associated with ranking and matrix scoring results in deeper understanding of the farming system (Martin, 1995). Four basic types of ranking and scoring tools are Preference ranking, Pairwise ranking, Matrix scoring and weighting and wealth ranking and well-being analysis. This study has utilized two of these techniques for ranking and scoring namely preference ranking and matrix scoring and weighting. The two are as described below:

2.9.1 Preference Ranking

Overview Preference ranking is simply a tool by which farmers can indicate the relative importance they attach to an array of items. It can be used to identify, list and prioritize problems and possible solutions to problems (Martin, 1995). As a tool it helps development workers and understand farmers' criteria and decision-making.

Preference ranking has been used to identify desired characteristics of new and existing technologies and to establish criteria for evaluating results of experiments and programs. When carried out with a range of farmers it can be used to compare the priorities of different groups (men and women, young and old, rich and poor) (Martin, 1995). The process of preference ranking is relatively simple but needs a skilled and experienced development worker to implement properly. While the actual preference ranking itself takes a short time, there is substantial time involved in preparation of the ranking cards and in the subsequent analysis.

The analysis of the preference ranking can be done in various ways. A simple analysis can be done immediately, to get feedback from the participants, or later by the development worker. Project staff can do more complex analysis with access to computers. An immediate analysis only takes a few minutes and enables validation and discussion with the workshop participants.

2.9.2 Matrix Scoring and Weighting

Matrix scoring and weighting techniques have advantages over preference ranking in that it draws explicitly upon multiple dimensions (Martin, 1995). In this technique, not only the rank or order of preferences is obtained but also a measure of the strength of preference, i.e. 'how much more' one item is preferred over another. It can be done by a group of people in whom participants reach consensus on the ranking of each item or vote according to their individual understanding and assessments (Martin, 1995). For this reason, not only can matrix scoring and weighting show the magnitude of differences between a set of preferences, but the technique also enables the identification of criteria and of the trade-offs involved in choosing between alternatives.

2.10 Twinspan Analysis

This is a divisive classification technique, which splits reciprocal averaging (RA) ordinations (Pielou, 1984). It treats all plots as a single entity at the onset, and iteratively divides them into hierarchical groups. It performs a one-dimensional RA ordination and breaks the axis at the centroid so as to crudely divide the data points into two classes; this procedure is repeated with the species quantities weighted in such a way as to emphasize the influence of especially useful diagnostic species (i.e. "indicator" species) identified by the first ordination. TWINSpan

produces a dendrogram showing relationships between plot groupings, such that groups positioned close to each other in the dendrogram are most similar (Hill, 1979). The two-way indicator species is one of the most powerful tools available for vegetation analysis and it has an advantage of making use of all the available information to create critical divisions (Gauch, 1982). However, this technique has a disadvantage of being common in rigid dichotomous divisions Orłóci (1967). Groups may break too early regardless of their homogeneity causing them to have very little information about the natural structure within the communities. In this study, vegetation data based on presence absence were used to perform TWINSpan analysis (McCune and Mefford, 1999).

3.0 STUDY AREA

3.1 Description of the Study Area

3.1.1 Location

The study was conducted from September to December 2005 in Minyughe woodland in Singida District council in the Central Tanzania. The district lies between latitudes 3° and 7° south of the equator and longitudes 34° and 35° east (Fig. 1). It borders five other districts, which are Tabora to the west, Iramba to the north, Hanang to the East, Kondoa to the SouthEast and Manyoni to the South. Minyughe woodland is savannah woodland covers about 240,000 ha (2,400km²). It is located in the southwest of Singida district falling within the *Brachystegia-Julbernardia* savanna woodland ecological zone within the Zambezian phytochorion. The forest falls within Ihanja and Sepuka divisions located between latitudes 4° 68'to 5° 37' South and 34° 55' to 34° 69' East, bordering Iramba district to the North, Tabora to the West, Ikungi division to the South and South East and Singida Urban to the North East.

3.1.2 Geology

The geology of the area is typical for the whole Singida region. The dominant soil of the forest is mainly sandy, clay soils are mainly found along river valleys while hilly areas are dominated by a mixture of clay and loam soils (Ikaku, 2002; Elisha, 2004).

3.1.3 Climate

Minyughe woodland has a semi arid climatic condition. There are two seasons, the dry season, which starts in May up to October, and the rain season in November to April. The average rainfall is between 600mm – 700mm per annum while the average minimum temperature is 15°C-30°C (Fig. 1)

3.1.4 Topography

The land area of Singida district is mainly a highland of the central plateau. However, Minyughe woodland is mainly lowland and plains. Altitude ranges between 1200m and 1600 a.s.l. The area is formed of undulating hills, flat plains, valleys and seasonal rivers. There exist two main rivers, which are mainly seasonal. Wamba River extends from Tabora district to cover most parts of Ihanja division while Makhonda River takes most parts of Sepuka division.

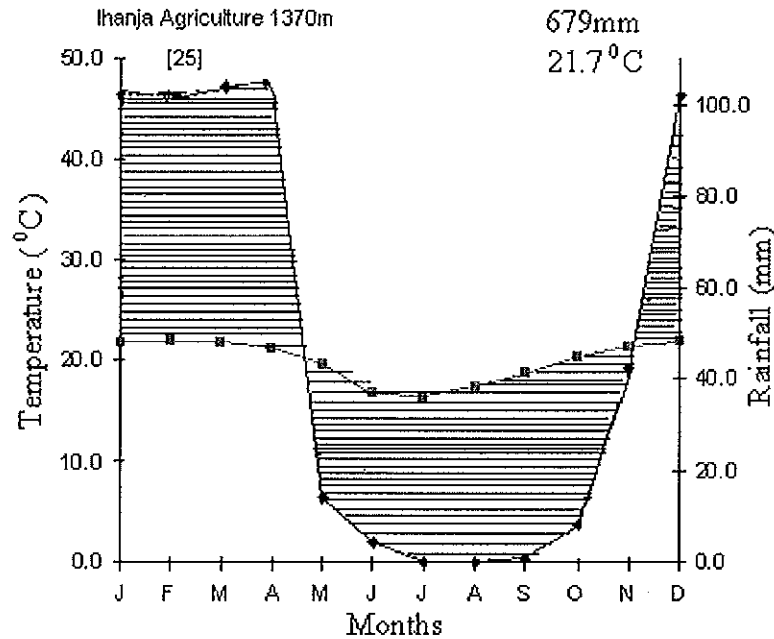


Figure 1. Climatic Diagram Showing Mean Annual Rainfall and Temperature for the Last 25 Years (1975-2004) of Minyughe Woodland.

Source: The National Meteorological Agency of Tanzania

3.1.5 Vegetation

Minyughe woodland is not forest in the traditional forestry definition. It is basically miombo woodland with some patches of thicket especially in the southern part bordering manyoni district. The dominant species in the woodland are *Brachystegia speciformis* and *Julbernardia globiflora* with occasional *Pterocarpus angolensis* while stands of acacia are dominated by *Acacia tortilis*. According to Mwansasu (1992) the forest was estimated to have mean wood volume of 18m³/ha. However, recent estimates by the national forestry inventory (NFI) in 1996 indicated that the woodland had a woodvolume of 58m³ / ha (NFI, 1996).

3.1.6 Population and the People

People of different ethnic groups inhabit the area. At present, the dominant groups are the Sukuma and Nyaturu people. The Nyiramba also exist but are relatively few and are highly dispersed in the area. The Nyaturu people are indigenous in the area and are believed to have settled in the area for more than 200 years (Jerald, 1936). The Sukuma are believed to have settled in this area for about 20 years now. They are mostly agro-pastoralists and have migrated from Mwanza and Shinyanga Regions in search for free land for cultivation and grazing. This

migration process has accelerated in the late 1990s (Wily, 2001). Based on the 1988 national population census (Bureau of statistics, 1989) and the national population census 2002, the population values in the sample villages varies between 47% and 91%, with an overall population increase of 72.8%, which is relatively higher than the District and National values (Table 1). Currently, the Sukuma are the second dominant group in the area. The existence of the different ethnic groups in the area implies different perspectives of utilizing the forest resources. Conservation approaches by the local people may also be different since each of the tribes has a unique culture.

3.1.7 Land Use and Economy

There are four major economic activities in the area. These are farming, small business, livestock keeping and honey harvesting. The forest is relied upon for fuelwood, building material, timber and nonwood forest products, all largely for subsistence purposes. About 80% of the people are farmers whereby farming is mainly characterized by shifting cultivation. This type of cultivation is considered as a remedy for the weed problem and nutrient depletion from the soil, which lead to poor crop production. Main food crops are maize, sorghum, millet, cassava and sweet potatoes while cash crops are peanuts, sesame and sunflower.

Livestock keeping is the second major economic activity in which the Sukuma people are the dominant livestock keepers. Dominant livestock are cattle, goats, sheep and donkeys. Free grazing is the main type of livestock keeping in the area. In recent years, large groups of the Sukuma people from Mwanza and Shinyang Regions with large herds of livestock migrate to the area and inhabit virgin forest land.

Some people get engaged in honey harvesting, a process which is mostly done in the forest. Beekeeping involves use of logs and barks of species such as *Brachystegia speciformis*, *Julbenardia globiflora*, *Sclerocharia birrea subsp. multiflorolata*, *Commiphora ugogensis* and *Terminalia sericea* that are used for making beehives. During honey harvesting, smoke is used to chase and confuse bees, which sometime cause an unprescribed fire. Small business is another economic activity in the area. These include local brews, small restaurant (mama lishe) and shops.

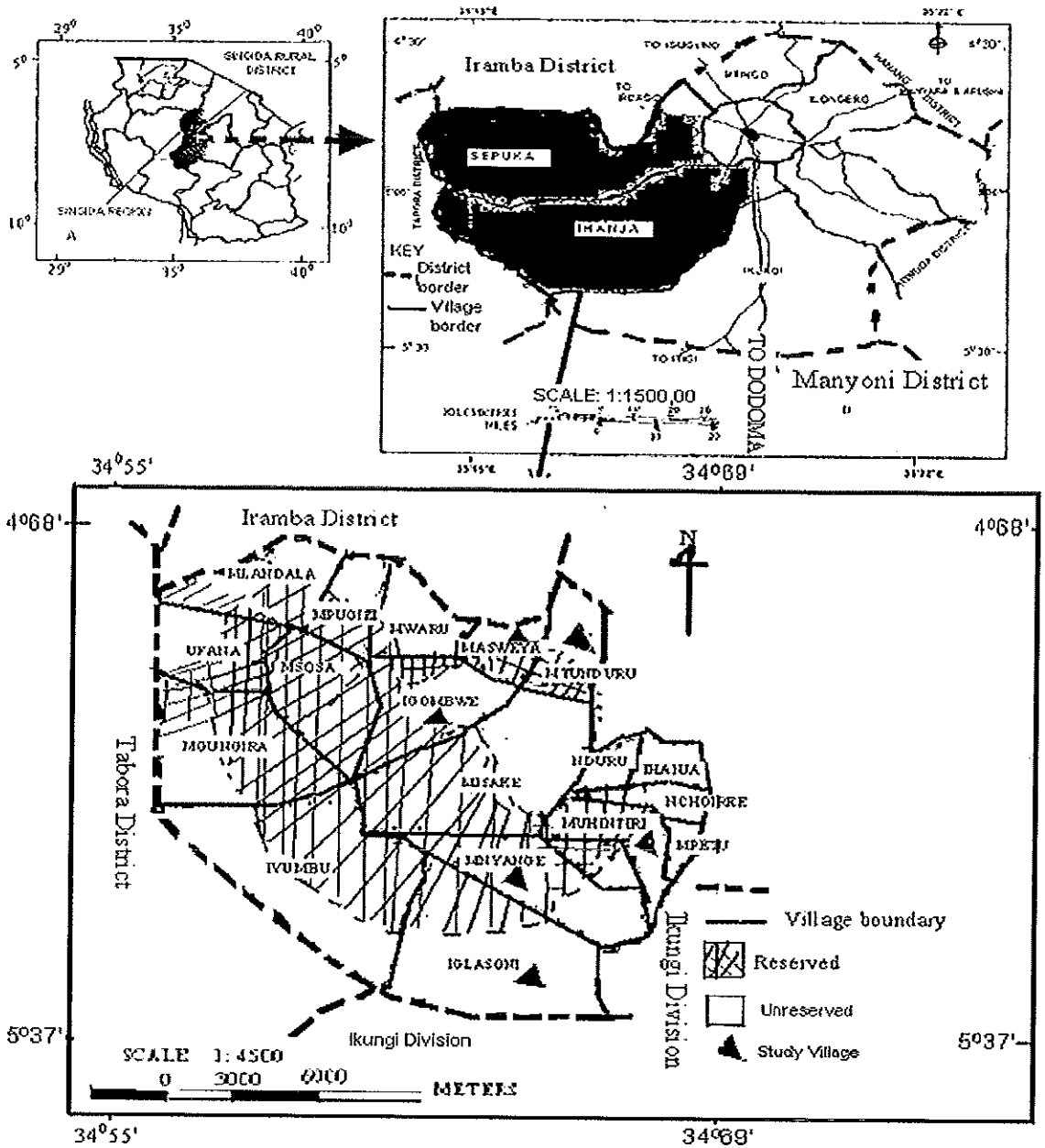


Figure 2: Map of A: Tanzania Showing Singida Region B: Singida Rural District Showing the Location of Ihanja&Sepuka Divisions C: The Study Area (Minyughe Woodland) Showing the Location of Study Villages and Reserved & Unreserved Lands.

Source: A: URT, 2004; B & C: SDC, 2002

Table 1: Population Statistics for 1988 and 2002 of Selected Villages

(Popn=Population, H=Household, inc.=increase, SRD=Singida Rural)

Village	Popn. 1988	Popn. 2002	Popn. increase	% inc. in popn.	No of H	Total Area (ha)	Forested area (ha)
Iglasoni	4,457	8015	3,558	79.83	1145**	58,819**	35,000(60%)**
Munyange	1,885	3,430	1,545	81.96	527**	34,044**	22,000(66%)**
Muhintiri	1,673	3,191	1,518	90.73	490**	29,119**	15,000(50%)**
Igombwe	2,873	4,228	1,355	47.16	680**	17,356**	7,000(40%)**
Masweya	1,895	3,209	1,314	69.34	458**	14,834	1,500(10%)**
Mtunduru	3,800	6,580	2,780	73.15	1112**	9,462	500(10%)**
Total	16,583	28,653	12,070	72.8			
SRD	792,387	1,090,758	298,371	38			
Tanzania	23,126,952	34,569,232	11,442,280	49.5			

Source: Bureau of Statistics (1989); Government of Tanzania, (2002); ** Obtained from respective village government offices. (SRD=Singida Rural District; SR=Singida Region)

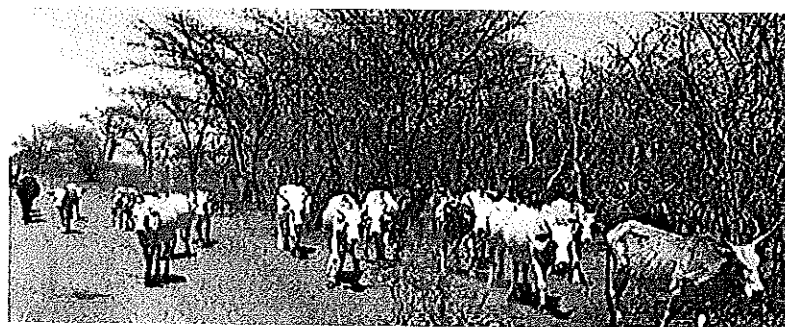


Plate 1: Free Grazing Animals Igombwe Village

4.0 MATERIALS AND METHODS

4.1 Reconnaissance Survey

A four days reconnaissance survey was made before actual fieldwork from 1st to 3rd of September 2005 to obtain information on the community set up and the general vegetation patterns in the area. Since the study was intended to compare unreserved land and reserved lands of the area, villages for sampling were established basing on their closeness to the forest by considering the assumption that human selective exploitation of plant resource impacts plant availability in the natural environment. Based on this, it is believed that, anthropogenic impact on vegetation decrease as one move away from human settlement to the forest. This formed the basis for adopting the transect method as it is believed to provide a picture of how natural woody resources are used and managed and to help identify the problems (threats) and opportunities that exist in the area.

Square quadrats were used because they were easier to construct (Kingsford and Battershill, 1998) than circular ones. Preference ranking and matrix scoring techniques were adopted to collect and analyze data from informants because they are simple to apply and not time consuming and could allow indepth participation of the informants without the influence of external factors. Moreover, informants could express their views in a free manner and enable validation and discussion among participants (Martin, 1995). Matrix-scoring technique was used as a two-way analysis because it indicates both the order and strength of preference (Bernard, 1988). A total of six villages (three from each division) were selected for sampling and for each village, two transects were established in such a pattern that served to minimize edaphic and topographic variations. An informal interview was conducted with some villagers in order to realize the nature of the local community and to enable soliciting information about the people with ethnobotanical knowledgeable (Alexiades, 1996). The questionnaires were tested using five people from each village.

4.2 Woody Vegetation Sampling

Two transects were established in each village making a total of 12 transects. Along each transect, plots were established (depending on the size of the reserved land available in the respective village) (Table 1) at 400 m intervals using nested quadrats of: 5 × 5 m for shrubs and

20 × 20 m for trees. Each transect had at least 8 plots whereby half of them were located in the reserved land and the other half in the unreserved land. In order to achieve a systematic distribution of sample plots, straight-line transects were walked along a compass bearing. Within each sampling plot all individual woody plant species were counted, recorded and their height and diameter at breast height (dbh) were measured. Height was measured using a Clinometer while dbh was taken at 1.3m heights by using a Vernier Caliper.

Tree stumps appearing in every 20 x 20m plot were counted, recorded and when possible identified using their bark and wood characteristics, coppicing leaves and /or shoots and symmetry of the stump (Luoga *et al.*, 2002) and by the assistance of the local people. Disturbance levels were assigned subjectively based on observation (Kumlachev Yeshitla and Tamrat Bekele, 2002) whereby four values were used to describe the level of disturbance in every sampling plot. These values are 0 = undisturbed (when completely no signs of disturbance); 1 = Lowly disturbed (at least two stumps are present or little anthropogenic disturbance with good signs of regeneration); 2 = Moderately disturbed (at most five stumps, moderately grazed or browsed but signs of regeneration are observed) and 3 = Highly disturbed (highly grazed or browsed, at least six stumps and little or no signs of regeneration). Plants were identified in the field where possible and later verified by using preserved specimen at the herbarium of the udsm.

4.3 Ethnobotanical Data Collection

4.3.1 Sampling Design

Systematic sampling was used to select a total of 244 knowledgeable people as informants from all villages by the assistance of village elders, community members and local administrators. The distribution of the informants in the villages was as follows: Iglasoni 60, Munyange 30, Muhintiri 30, Igombwe 44, Masweya 30 and Mtunduru 50. The criteria used in selecting the informants included their ethnobotanical knowledge and specializations, gender, tribe (type of ethnic group), number and age. At least 10 people (from each village) including those with specified ethnobotanical knowledge were used as key informants.

Gender representation was considered because like many other African tribes, social roles of the Nyaturu and Sukuma people are gender determined. However, both men and women were

considered equally, for the reason that both genders get involved in various social and economic activities in the area. Tribal representation was necessary because two different tribes dominated the area, which could imply different perspectives of utilization and conservation measures of the plant species. This was especially important in villages with relatively large number of the Sukuma tribe. Adults are assumed to be more knowledgeable than children because they have long period of interaction with the local environment. For this reason a proportion of 70% adults and 30% young people (10-17years) were interviewed, many of them were found in schools. All key informants were informed on the objectives and expected outcomes of the study.

4.3.2 Social Data Collection Methods

PRA anthropological techniques described by Coe *et al.* (1999) and Grenier (1998) were employed to obtain ethnobotanical data. The techniques are discussed below:

4.3.2.1 Semi-Structured Interviews

Semi structured interviews (Martin, 1995; Cotton, 1996 and Alexiades, 1996) were mainly used to obtain both qualitative and quantitative data form the community. The technique involved asking at least ten people (from each village) to respond to the same set of Semi-structured questions. The qualitative and quantitative information about the abundance, scarcity, collection, usage including preparation (for medicinal plants), threats, local conservation practices of plants, villagers involvement in conservation, level of household dependence and income were obtained using this technique (Appendix H).

In order to obtain the extent of household dependence on the woodland, dependence level was categorised to three based on information from the informants. The categories were assigned the following values: -

- ❖ Category 1 denotes full direct dependence (75% or above). This category involved households reported to be surviving through direct exploitation of the forest resource by either burning charcoal, firewood cutting, timber selling, cattle rearing and/ or any other activity of the alike.

- ❖ Category 2 denotes moderate dependence (50 – 74%) that refers to those who supplemented direct forest exploitative activities with small business or employment as sources of income for the household.
- ❖ Category 3 denotes little direct dependence (<50%), which included those households whose source of income was greatly not obtained from the forest but not directly by exploiting the woody forest resources. Since most of the villagers were not conversant with English language, interviews and discussions were conducted in Swahili language, which is the national language of the country, and occasionally in Local languages (Nyaturu & Sukuma language).

4.3.2.2 Participant Observation

The researcher lived with the local community in the study area for three months and shared some facets of their life from subsistence activities to ritual occasions such as religious cerebrations, burial and drama ceremonies. Direct observation enabled the collection of information about subsistence activities, plant usage, scarcity, harvesting, indigenous plant conservation practices, threats, community involvement in conservation activities and other socioeconomic aspects.

4.3.2.3 Group Discussions

Group discussions were conducted for the purpose of reaching an agreement among respondents and the researcher on local names and physical variations associated with the collected plants. Each village had 10 respondents selected for group discussions. These respondents were selected on the basis of good ethnobotanical knowledge, tribe, gender and age.

4.3.2.4 Guided Field Walks (Participatory Inventorizing)

At least five key informants accompanied the researcher to the field during vegetation data collection to document useful woody plant species in the community along a transect line as described by Maundu (1995) in each village. This technique was employed to obtain information on usage, harvest, rarity or scarcity and preparation (for medicinal species) and was used to supplement data obtained through semi-structured interviews (Maundu, 1995).

4.3.2.5 Preference Ranking

This technique was used to determine the highly preferred woody species based on informant's understanding or interest of such species for a particular use. Information on scarce species, extent of villagers' involvement in conservation activities and period for harvesting the preferred species of each use category, distribution of social responsibilities were obtained using this technique. The highly destructive use categories as perceived by the local people were also determined through preference ranking technique. Under this technique informants were given a fixed number of plants (five or ten) that were mentioned by the informants themselves as being useful for a particular function and asked to rank them by giving them integer values.

Preference ranking involves asking people to think of some items and arrange them according to a given criterion (Martin, 1995). In the current study each rank was given an integer value of 1, 2, 3, 4 and 5 or in some cases up to 10 in which the most preferred or scarce woody species or preferred period for harvesting was given the highest value. The least preferred or the less scarce plant species was given the least value. The overall group rank for a given plant species was obtained by the sum of the figures provided by all respondents in the group. An aggregate rank was obtained for every use category by combining all rank results from each village in order to obtain an overall result for the study area. Ten respondents with good ethnobotanical knowledge were selected for this activity in each village. The selected species or factors for this purpose were based on consensus information obtained from all members of the group.

4.3.2.6 Matrix Scoring and Weighting

This was used to determine the threats and the highly preferred species of multiple uses. In this study, species reported (through interviews and questionnaires) as being useful for several use categories were ranked against each category and overall rank obtained as described by Martin (1995).

4.3.3 Data Recording Framework

Data from each plot or transect were recorded separately on field data books. Field notes were taken on plant ecology including evidences for disturbance (e.g. overgrazing, bush clearing, timber and charcoal making etc.). Environmental data to show location, altitude, and latitude

were recorded using a Global Positioning System (GPS) while climatic data recorded by the Ihanja Agriculture meteorological station (the nearest station) were obtained from the Tanzania meteorological agency. Whenever specimens or study sites of particular interest are encountered; plategraphs were taken. Data obtained from group discussions, structured interviews were recorded on questionnaires while data resulted from unstructured interviews, observation, preference ranking and matrix scoring and weighting techniques were recorded in notebooks.

4.4 Data Analysis

4.4.1 Woody Plant Community Analysis

TWINSPAN (McCune and Mefford, 1999) of species abundance data as recorded by the presence absence of species from the sample plots was used to classify groupings of the sample plots and species and to develop a two-way indicator species dendrogram (Fig 4).

4.4.2 Woody Species Diversity

Shannon Wiener index (H) and species richness were used to measure the diversity of woody species and to depict the extent of human woody plant species exploitation (destruction) in the study area. Shannon index is a measure of the average degree of uncertainty in predicting to what species an individual chosen at random from a group of species and individuals will belong (Ludwing and Reynolds, 1998). The index was used because it highlights the relative abundance of rare species Vs the dominant ones, which is important to consider in an ecosystem where species are disappearing. Higher value of the index represents higher diversity. Richness gives the number of species (Krebs, 1998). The data collected in the field was processed into MS-Excell database and from which species richness, composition, density and basal areas were extracted. Species diversity measured by the Shannon-Wiener index was estimated for all plots in the unreserved land and reserved land. Shannon-Wiener Index (H) was also calculated separately for each village using the formular: $H' = -\sum p_i \ln p_i$ where p_i is the proportion of individuals or the abundance of the i th species expressed as a total. $\ln = \log_{base\ n}$ (Zar, 1999). Both One Way Analysis of variance (ANOVA) and student t-test were used to compare Shannon Wiener and richness values between villages and sites respectively.

4.4.3 Woody Species Similarity Between Reserved and Unreserved Lands

Sørensen's community similarity index (β – diversity) was used to find out if there were differences in species composition between reserved and unreserved land. The common number of species of two sites is compared with the expected number of species to be present, which should be the total number of species in both sites. This test was performed to test differences between unreserved and reserved areas basing on the aspect that the main factors causing destruction in the two sides are the establishment of settlements, agriculture, tree harvesting for charcoal, firewood, timber, making beehives and building materials. Since the Sørensen's similarity index does not consider relative abundance of the various species it is considered the most useful analytical technique when the major interest is the presence/ absence of the species in the two sites (Sørensen, 1948). Sørensen's community similarity index was calculated using the formula Coefficient of community (CC). $CC = 2c / (s^1 + s^2)$. Where: c = number of species common to both communities; s^1 and s^2 = number of species in communities 1 and 2 respectively CC = coefficient of community

4.4.4 Woody Species Population Structure

The population structure of woody plant species can reveal information about stand dynamics (Metz, 1997) and regeneration status (Saxena and Singh, 1982). Since information of age data was beyond the scope of this study, the population structure of woody species was estimated based on analysis of tree size (diameter at breast height) classes. The vegetation data were analyzed for species abundance (Curtis and MacIntosh, 1950) and heterogeneity. Assessment of the status of woody species and the impacts of use to the general condition of woody species in the study area were confined to species population structure and diversity. Structure was based on species density and basal area. Student t-test was used to discover if there were significant differences in population structure between the noreserved and reserved lands.

In order to capture the population structure, diameter at breast height (dbh) classes were designated as 4.1 – 10 cm (Poles), 10.1 – 20 cm (Small reproductive trees) and >20 cm (Large reproductive trees) (Luoga, 2003). Individuals of ≤ 4 cm were designated as seedling/resprouts and saplings. For the purpose of this study, the density of seedling/resprouts and saplings was used to estimate the extent of natural regeneration on both sites (Luoga, 2003). Seedlings are

those newly established plants formed from germinating seeds. Resprouts originate on buds of stumps or damaged roots while a sapling refers to all individuals with diameters of $1 \geq 4$. These classes were adopted from Luoga *et al.* (2002) and for particular use categories as explained by Luoga *et al.* (2000). In these categories poles were mostly harvested for building purposes, small reproductive trees were harvested for fuel wood while large reproductive trees for charcoal, timber and other uses that require trees of large diameters. Such classes could help identify which use category was more destructive basing on vegetation data obtained from the field.

4.4.5 Woody Species Importance Value Index (IVI)

This was used to determine distribution and dominance of species. IVI was calculated for all species within the Unreserved and reserved area as the sum of Relative density, relative basal area and relative frequency of occurrence (Kent and Coker, 1992). This value allows estimations of importance for a particular species within a community not based solely up on dominance. **Relative density** = (Number of stems per ha of the i^{th} species / Total number of stems per ha of all species) x100. **Relative frequency** = (Frequency of i^{th} species / Total frequency of all species) x100. **Relative dominance** = (Sum of basal area of i^{th} species / total basal area of all species) x100. **IVI** = Relative frequency + Relative density + Relative dominance

4.4.6 Relationships Between Diversity, Richness and Human Influence

The relationship between antropogenic disturbance and plant diversity and between disturbance and richness was calculated using Pearson correlation. This was used to determine whether human disturbance influenced the diversity and richness of woody plant species in the study area.

4.5 Social Data Analysis

Descriptive statistics (applied by the help of SPSS program and Microsoft Exell) was used to analyze and summarize (into tables and graphs) the ethno botanical data obtained through interviews, observation, ranking and scoring and guided field walks. Preference ranking technique was used to compare and obtain the preferred species for each use category, to determine the scarce species and to compare the destructive use categories in the study area. Matrix scoring and weighting technique was used to determine most preferred multipurpose woody species in the community.

5. RESULTS

5.1 Floristic Composition of Woody Plant Species

A total of 117 woody plant species representing 81 genera and 34 families (Table 2) were identified from the study area whereby 39 (34.2%) were shrubs and 77 (65.8%) were trees (Appendix A). Of these, 57.3% (Excluding *Aerva lanata*, *Boscia massaiensis*, *Senna singueana* and *Lannea schweinfurthii* var. *stuhilmannii*) were highly utilized by the community (Appendix B). *Aerva lanata*, *Boscia massaiensis*, *Senna singueana* and *Lannea schweinfurthii* var. *stuhilmannii* were mentioned as useful species but were not found on the ground. A combination of them adds to 70 species and 22 families useful by the community (Table 2). The family Fabaceae was found to be the most dominant in the area with 31 (26.5%) species and most useful providing 22 (31.4%) useful species. The families Combretaceae and Rubiaceae were the next dominant, each with 11 (9.4%) different species (Table 2). *Diospyros fischeri* (endemic to east Africa and *Sclerocaria birrea* var. *multifolia* (endemic to eastern and central Africa) were among the indigenous woody plant species to this area. The area was dominated by *Brachystegia speciformis*, *Julbernardia globiflora*, *Acacia tortilis*, *Commiphora ugogensis* and *Combretum collinum* (Appendices D & F). Of all species, 40.5% (47) stems of woody species were found in the reserved land but not in the unreserved land. However, 97.74% (45) and 61.7% (29) of this proportion were also recorded as cutstumps in the unreserved and reserved land respectively (Appendix G).

TWINSpan has revealed six community types which were named after character species and labeled as community type I, II, III, IV, V and VI (Fig.4). The six community types were formed on the basis of relative disturbances and/or abundance in the various plots.

Community I: *Brachystegia microphylla* – *Acacia tortilis* type

This community is found at altitude of about 1645 m a.s.l. The dominant woody species were *Acacia tortilis*, *Brachystegia microphylla* and *Cassipourea mollis*. Other dominant species in this community are *Canthium burtii*, *Brachystegia speciformis* and *Julbernardia globiflora*. All plots of this community were located in the reserved area

Table 2: Proportion of Species by Family

(* = Not existing)

	Family Name	Recorded from the area		Useful plants reported	
		No of species	%	No of species	%
1	Amaranthaceae	*	*	1	1
2	Anacardiaceae	4	3.4	4	6
3	Apocynaceae	1	0.9	2	3
4	Asparagaceae	1	0.9	*	*
5	Balanitaceae	2	1.7	1	1
6	Bignoniaceae	2	1.7	3	4
7	Bombacaceae	1	0.9	*	*
8	Boraginaceae	1	0.9		*
9	Burseraceae	5	4.3	3	4
10	Caparidaceae	9	7.7	3	4
11	Chrysobalanaceae	1	0.9	*	*
12	Combretaceae	11	9.4	6	9
13	Compositae	1	0.9	*	*
14	Connaraceae	1	0.9	*	*
15	Dilaniaceae	1	0.9	*	*
16	Ebenaceae	2	1.7	1	1
17	Euphorbiaceae	7	6.0	*	*
18	Fabaceae	31	26.5	22	31.4
20	Flacourtiaceae	1	0.9	*	*
21	Labiatae	2	1.7	1	1
22	Malvaceae	1	0.9	1	1
23	Olacaceae	2	1.7	2	3
24	Oleaceae	1	0.9	1	1
25	Palmae	1	0.9	1	1
26	Polygalaceae	1	0.9	*	*
27	Rhizophoraceae	1	0.9	1	1
28	Rubiaceae	11	9.4	5	7
29	Rutaceae	2	1.7	2	3
30	Sapindaceae	2	1.7	2	3
31	Simaroubaceae	1	0.9	*	
32	Solanaceae	1	0.9	1	1
33	Sterculiaceae	1	0.9	*	*
34	Tiliaceae	6	5.1	4	6
35	Verbenaceae	2	1.7	3	4
	Grand Total	117	100.0	70	100

Community II: *Brachystegia microphylla* – *Commiphora africana* type

This community is found at altitude of about 1640 m a.s.l. The dominant woody species were *Canthium burtii*, *Tapiiphyllum burnetii*, *Brachystegia microphylla* and *Commiphora africana*, *Lansea schimperii*, *Dalbergia boehmii*, *Catunaregum spinosa*, *Commiphora ugogensis* and *Strychnos innocua*. All plots forming this community type were located in the reserved.

Community III: *Julbernardia globiflora* – *Combretum collinum* type

It is a community that is located at altitude of about 1265m a.s.l. The dominant woody species of the community are: *Brachystegia speciformis*, *Combretum collinum*, *Julbernardia globiflora*, *Tamarindus indica*, *Canthium burtii*, *Cassia abbreviata* and *Sterculia quenquhiloba*. Field observation has revealed that this community was moderately disturbed when compared to community types II & I. Most of the plots forming this community type were from the intermediate sites closer to the boaderline between reserved and unreserved land land.

Community type IV: *Terminalia spinosa* – *Grewia bicolor* type

This community was found at altitude about 1218m a.s.l. with 60% of the 12 plots were from the reserved land. *Terminalia spinosa*, *Grewia bicolor*, *Pavetta stuhlmanii* and *Commiphora mossambicensis* were the dominat species in this community type.

Community type V: *Terminalia sericea* – *Combretum obovatum* type

It is a community, which was found at an average altitude of about 1250 m a.s.l. The community comprised of 18 plots of which only 5 were located within the reserved area. The dominant species in this community were *Terminalia sericea*, *Combretum obovatum*, *Acacia tortilis*, *Strychnos pototorum*, *Markhamia obustifolia* and *Commiphora africana*. Field observation showed that plots in this community were highly disturbed.

Community type VI: *Lannea humilis* – *Cassipourea mollis* type

The community type was found at an altitude of about 1204 a.s.l formed by 16 plots, 12 of which were from the unreserved land especially in Iglasoni, Mtunduru and Masweya villages. Dominat species were *Lannea himilis* and *Cassipourea mollis*. According to the experience observed on ground, species such as *Solanum incanum*, which are known to be indicators for disturbance, were present in this community type. Other species found in this community type were *Balanites aegyptica* and *Commiphora ugogensis*. Plots of this community type were highly disturbed with few scattered standing trees high numbers of tree stumps.



5.2 Diversity of Woody Plant Species

The mean woody plant species diversities for the six community types are shown in table 5 whereby the trend decreased from community type 1 to 6 (Fig.4). One way Analysis of variance revealed statistical differences in the diversities of woody species among the six community types ($F= 20.460$, $p = 0.000$). However, Student-Newman-Keuls analysis revealed no significant differences between the three pairs of community types 6&5 ($p = 0.794$), 4&3 ($p = 0.371$) and 3&2 ($p = 0.112$) but community type I differed significantly from each of the five community types ($p = 2.347$) (Table 3). On the basis of Pearson correlation, the results have revealed significant negative correlation between diversity, disturbance and between richness and disturbance (Table 4)

Table 3: Student-Newman-Keuls Values for the six Communities

Community	6	5	4	3	2	1	Sig.
Number of plots	16	18	14	28	30	10	
Subset for alpha = 1	0.7512 ^a	0.7956 ^a					0.794
.05	2		1.2579 ^b	1.4105 ^b			0.371
	3			1.4105 ^{bc}	1.6825 ^c		0.112
	4					2.3470 ^d	1

Values with the same letter in the same row are not significantly different

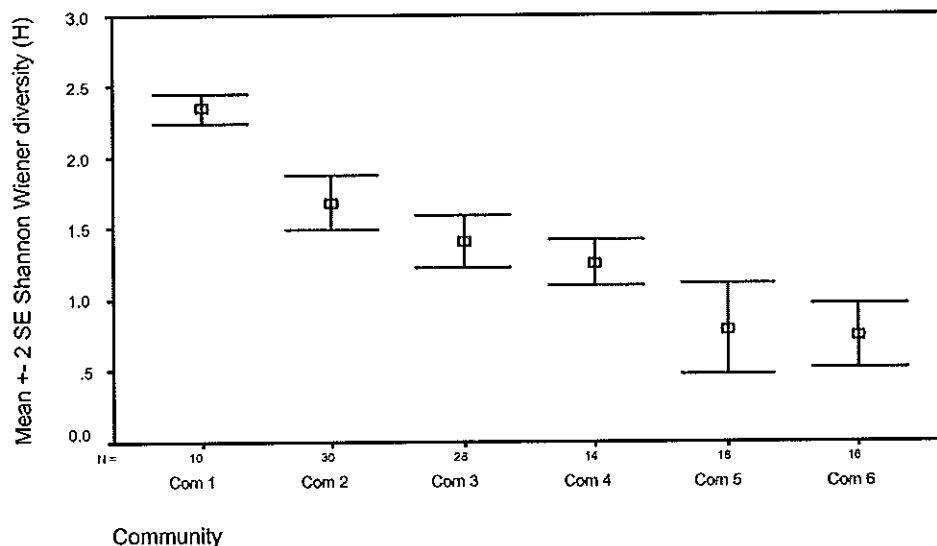


Figure 3: Woody Species Mean Diversities for the six Communities

Table 4: Pearson Correlation of Diversity, Richness and Disturbance Levels in the Study Area

		Diversity	Richness	Disturbance
Diversity	Pearson	1.00		
Richness	Pearson		1.00	
Disturbance	Pearson	-0.456**	-0.318**	1.00
	Sig.(2.tailed)	.000	.001	
	N	116	116	116

** Correlation is significant at 0.01 (2-tailed)

The mean Shannon-Wiener diversity value was statistically higher (2.047 ± 0.0571) in the reserved than in the unreserved (1.344 ± 0.06681) land ($t = 7.955$, $p < 0.0001$). The Sorensen's coefficient of similarity value for the two sites was 0.765 (76.5%) whereby 68 and 114 species were found in the unreserved land (S^1) and reserved land (S^2) respectively while 62 species (C) were common to both sites. Table 5 shows the mean plot diversity and richness for the six villages whereby Munyange village had highest mean diversity and richness values 1.799 ± 0.1247 and 7.50 ± 0.89 respectively while Masweya had the least values (1.54 ± 0.1361 and 5.44 ± 0.62). One-way ANOVA showed no statistical differences in diversity ($F = 0.535$, $p = 0.749$) among these villages. However, significant differences existed among plots of the unreserved land for each village ($F = 3.29$, $p = 0.0088$) and for plots of the reserved land for such villages ($F = 1.317$, $p = 0.02636$). Interm of richness, Student t- test revealed statistical differences in species richness ($t = 11.962$, $p = 0.0001$) for unreserved and reserved lands with respective values of 4.425 ± 0.1834 and 8.837 ± 0.3288 . Like for Shannon Wiener diversity One-way ANOVA showed no significant differences in richness among the six villages ($F = 0.985$, $p = 0.43$) (Table 5). The most dominant woody species in the area were *Brachystegia speciformis* and *Julbernardia globiflora* with IVI values of 29.7 (in unreserved land) and 40.15 (in reserved land) making a total of 69.85 for *Brachystegia speciformis* and 18.6 (in non reserved land) and 32.59 (in reserved land) making a total of 51.19 for *Julbernardia globiflora* (Appendices D&F).

Table 5: Mean Shannon-Weaner Diversities and Richness Values in the six sample Villages

Village	Number of Plots	Diversity (H)	Richness
Igombwe	20	1.740±0.1104	7.20±0.89
Iglasoni	22	1.588±0.1157	5.77±0.58
Muhintiri	20	1.635±0.1466	6.50±0.86
Munyangwe	22	1.799±0.1247	7.50±0.89
Mtunduru	16	1.616±0.1750	6.50±0.62
Masweya	16	1.544±0.1361	5.44±0.62
Total	116	1.66±0.399	6.53±0.33

5.3 Population Structure of Woody Plants

5.3.1 Density of Stems and Stumps

The mean density of woody species for the unreserved and reserved lands was 2225±507.85 and 2920.8±573.08 respectively (Fig. 5a) showing significant differences ($t = 5.939$, $p = 0.0019$) between the two sites. The density decreased from young plants (<4 cm) towards mature plants (dbh >20cm) with a reversed J-shape trend in which the density decreased with increase in diameter classes (Fig. 5b). The density values (respective values for unreserved land site in brackets) were 1208.3±223.02 (1300±313.85), 841.67±203.48 (591.67±108.33), 583.33±120.19 (308.33±91.44) and 287.5±73.46 (25±5) for <4cm, 4.1-10cm, 10.1-20cm and >20cm dbh classes respectively (Figure 5b). Student t-test showed no statistical differences in the density of seedlings and saplings ($t = 0.6525$, $p = 0.5429$) and for poles ($t = 1.908$, $p = 0.1147$) between unreserved and reserved lands but significant differences existed between small reproductive trees ($t = 3.433$, $p = 0.0186$) and between large reproductive trees ($t = 3.857$, $p = 0.0199$) of the two sites.

The mean density of tree stumps in the unreserved land was 298.89 ±51.043 while it was 139.66 ±24.075 in the reserved area (Figure 6). Student t –test revealed significant differences in tree stumps between the two sites ($t = 2.391$, $p = 0.0194$). Appendix G shows the different species identified as cutstumps from the study area.

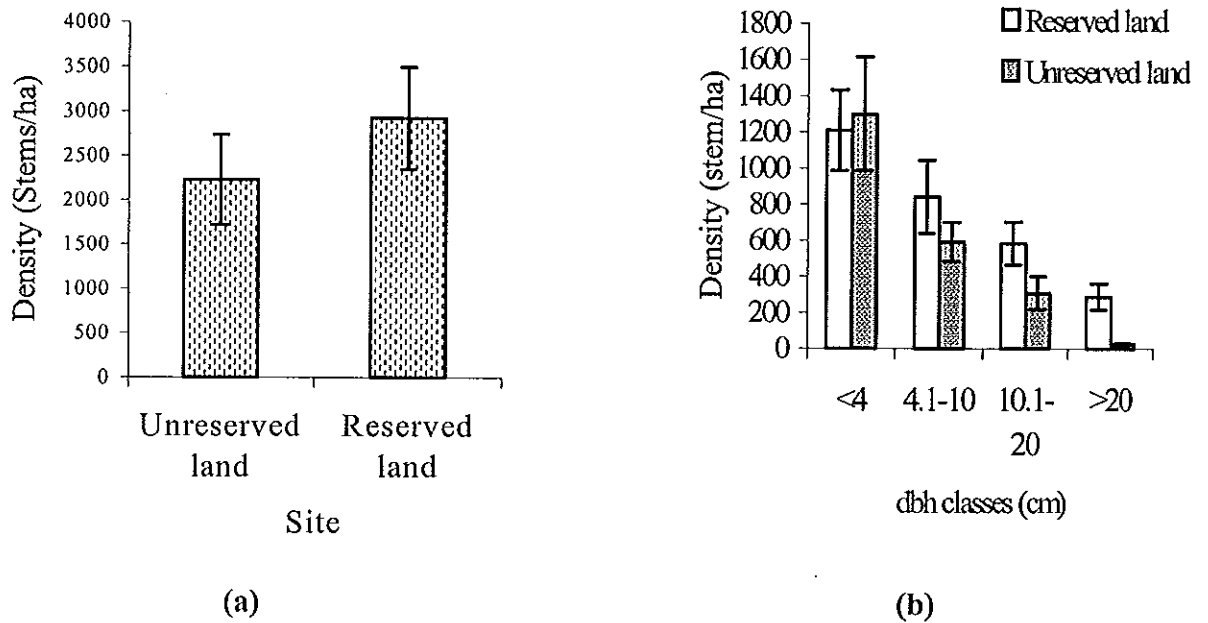


Figure 5: Density of Woody Species (a) and Density of the Different dbh classes (b) in Reserved and Unreserved Lands

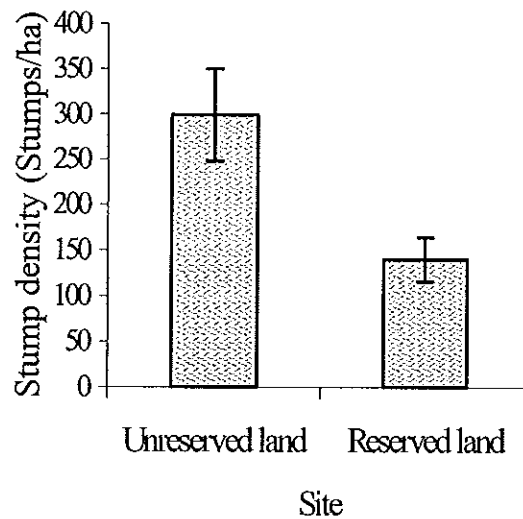


Figure 6: Mean Stump Density of Trees recorded for Unreserved and Reserved Lands

5.3.2 Basal Area

The unreserved land and reserved land had mean basal area per ha of 3.785 ± 0.8237 and 6.895 ± 0.8322 respectively. Student t-test showed significant differences ($t = 2.636$, $p = 0.0095$)

with high basal area in the reserved land (Fig. 7a). The mean basal areas for each structural class were (values for unreserved land in brackets) 0.819 ± 0.141 (0.3027 ± 0.055), 2.7 ± 0.375 (0.624 ± 0.129) and 3.34 ± 0.497 (2.87 ± 0.816) for poles, small reproductive trees and reserved land forming a normal J shape trend (Fig 7b).

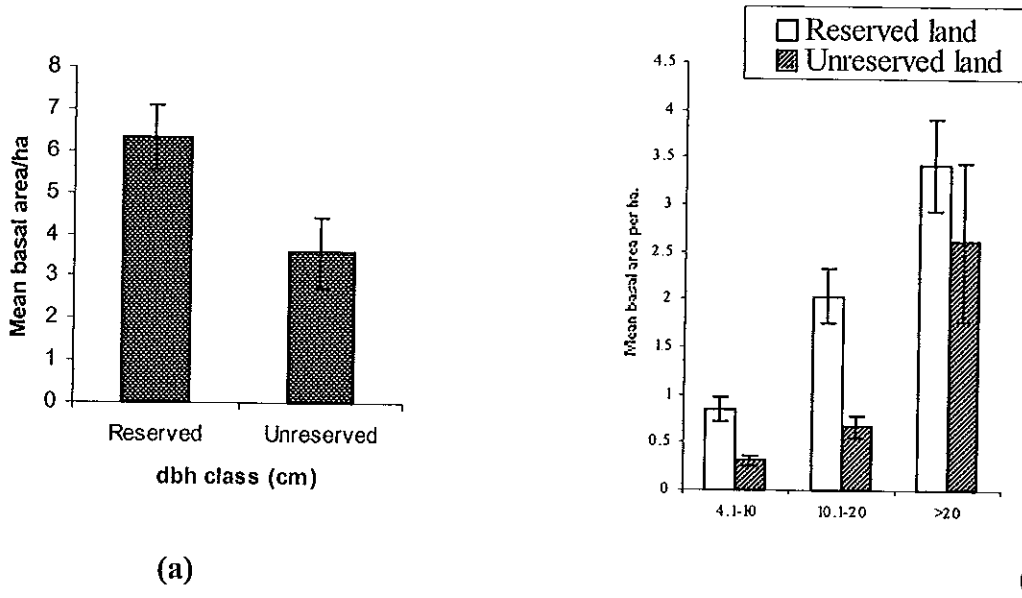


Figure. 7: Basal Areas for Reserved & Unreserved land (a) and Trend Portrayed by Basal Area Among dbh Size Classes

When basal areas for the respective class sizes in the two sites were compared, student t test revealed significant statistical differences between basal areas of dbh class 4.1- 10cm (poles) ($t = 3.431$, $p = 0.0011$), small reproductive trees (10.1-20cm) ($t = 5.073$, $p < 0.0001$) and between large reproductive trees ($t = 0.8015$, $p = 0.0279$).

5.4 Useful Woody Plant Species

5.4.1 Participation of the Local Community in Woody Plant Exploitation Use Categories

Table 6 shows the percentage of respondents' reported to engage themselves in different use categories. Majority (between 68% to 95%) of them use the woody species as sources of Medicine, charcoal, firewood, timber, and building materials while 44% are engaged in timber production.

Table 6: Engagement of the Local Community in Various Use Categories as Reported by Informants in the Study Area

Use category	Iglasoni	Munyange	Muhintiri	Igombwe	Mtunduru	Masweya	Average (%)
Building	89	88	85	89	75	78	84
Timber	48	33	45	30	50	55	44
Firewood	95	92	97	96	93	98	95
Charcoal	88	65	75	76	89	85	80
Medicine	78	72	70	65	60	65	68
Fruits	45	35	23	43	44	45	39
Beehives	65	45	30	24	48	58	45
Rituals	45	55	45	56	45	56	50

5.4.2 Woody Plant Species of Medicinal Importance

A total of 41 indigenous woody plant species reported were found to have medicinal value of which 40 were identified in the field while one species was not found to exist on the ground. Of all these 76% were trees while 24% were shrubs. It was revealed through interview that traditional medicines are used to treat common diseases like malaria, venereal diseases, diarrhoea, stomachs, coughs, flues and infertility problems. They added that medicines are made from different plant parts, which are roots, barks, leaves and fruits (Appendix F). Further analysis showed that 48% of all medicinal species have their roots being utilized for medicinal purposes followed by barks (31%) while only 2% are used as whole plants (Fig. 8)

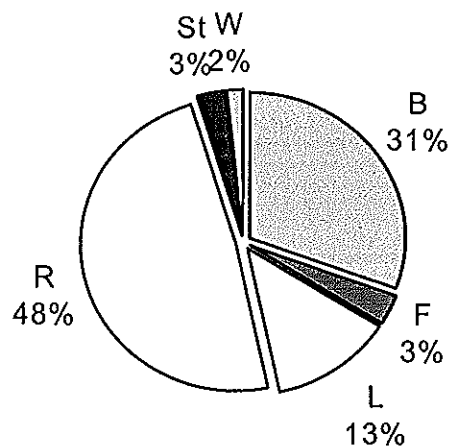


Figure 8: Plant Parts Utilized for Making Traditional Medicine

(L=leaves, F=fruit, B=bark, St=stem, W=whole plant, R=root)

Furthermore, it was found that the area had a few centers for medical services in the area. Only one reputable medical center was found in each of the two divisions. Such centers were found to be located far from some of the villages. The medical center in Ihanja division was at about 40km from Munyange, approximately 70km from Iglasoni and about 100km from Mugungira village, which borders Tabora district. A similar case was also found in Sepuka division.



Plate 2: A traditional Healer from Munyange Collecting Roots of *Securidaca longipendunculata*

5.4.3 Woody Plant Species for Fuel Wood

The results showed that 21.4 % (25) of all woody species were highly preferred for firewood. Majority (80%) of households depend on firewood as their main source of energy (Fig. 9). The aggregate preference ranking in all villages for 10 highly preferred species for firewood in the study area indicate that *Grewia bicolor* and *Cantium burtii* are the most preferred woody species (Table 7). It should be understood that ranking differed from one village to another. In this study the interest was the overall rank, therefore, preference ranks from each village were combined in order to obtain a single rank.

Table 7: Aggregate Preference Ranking Scores for 10 Highly Preferred Woody Species for Firewood in Minyughe Woodland

Species name	Iglasoni	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya	Total	Average	Rank
<i>G. bicolor</i>	30	38	45	44	42	41	240	40	1
<i>C. burtii</i>	43	30	36	42	38	43	232	39	2
<i>D. cinerea</i>	33	40	38	36	38	40	225	38	3
<i>D. melanoxylon</i>	36	32	35	38	40	25	206	34	4
<i>A. tortilis</i>	35	20	30	39	40	39	203	34	4
<i>A. quanzensis</i>	21	41	39	40	33	31	205	34	4
<i>T. sericea</i>	36	36	39	34	28	18	191	32	7
<i>B. microphylla</i>	22	34	25	29	37	35	182	30	8
<i>C. zeyheri</i>	18	28	29	36	32	33	176	29	9
<i>B. speciformis</i>	15	18	37	28	30	32	160	27	10



Plate 3: Dry Season Firewood Collection: A: Munyange Village, B: Iglasoni Village

Species, which are highly preferred for charcoal, are *Brachystegia speciformis*, *Julbernardia globiflora* *Azzeria quanzensis*, *Brachystegia microphylla*, *Kiggeria africana* and *Acacia tortilis* (Table 8). Among these highly preferred species, *Brachystegia speciformis* was ranked number 1 being followed by *Azzeria quanzensis*. *Acacia tortilis* and *Combretum zeyhri* scored the same. This study has revealed that 18.3% of the households depend on charcoal as a second source of energy while only 1.7% for other sources (paraffin) of energy (Fig. 9). Although this shows that a few households use charcoal as a source of energy, there is an increasing demand for this commodity in the neighboring centers such as Singida town such that charcoal making has become an economic earning activity in the villages (Personal observation). Table 6 shows an average of 80% informants who get engaged in charcoal burning in the six sample villages.

Table 8: Aggregate Preference-Ranking Scores for 7 Highly Preferred Woody Species for Charcoal in Minyughe Woodland

Species name	Iglasoni	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya	Total	Average	Rank
<i>B. speciformis</i>	49	38	44	41	39	46	257	43	1
<i>A. quanzensis</i>	37	31	38	32	38	40	216	36	2
<i>B. microphylla</i>	13	24	40	41	33	45	196	33	3
<i>C. zeyheri</i>	25	29	36	30	35	38	193	32	4
<i>Acacia tortilis</i>	45	36	37	17	36	18	189	32	4
<i>J. globiflora</i>	30	30	34	40	25	16	175	29	6
<i>Kiggeria africana</i>	20	27	27	21	31	36	162	27	7

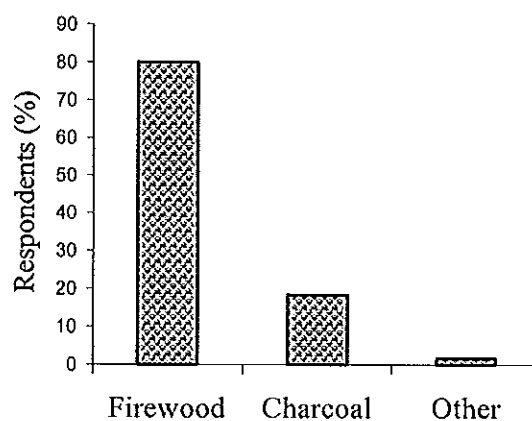


Figure 9: Dependence on Fuel Wood in the Study Area



Plate 4: Charcoal kiln in Masweya Village

5.4.4 Woody Plant Species for Timber

A total of 14 tree species (12% of all) were important for timber production in the study area (Appendix C). Table 9 shows preference ranking for six highly preferred species for timber with *Pterocarpus angolensis* the most preferred species followed by *Julbernardia globiflora* and *Dalbergia melanoxylon* and *Terminalia sericea* the least. Although there has been an increasing scarcity for species preferred for timber, it has been a valuable product from indigenous tree species in the area. Reasons given to support informants preferences are for timber production are those which are pest resistant with high strength, straight growth, and suitable color. Species lacking one or more of such qualities were less preferred. However, as a result of scarcity species such as *J. globiflora*, which have relatively low quality, have been utilized in the absence of *P. angolensis*.

Table 9: Aggregate Preference Ranking Scores for 6 Highly Preferred Woody Species for Timber in Minyughe Woodland

Species name	Iglasoni	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya	Total	Average	Rank
<i>P. angolensis</i>	46	37	42	47	50	47	269	45	1
<i>J. globiflora</i>	41	44	35	42	40	38	240	40	2
<i>B. speciformis</i>	34	30	32	30	30	34	190	32	3
<i>A. quanzensis</i>	31	20	31	32	35	37	186	31	4
<i>T. sericea</i>	33	35	25	14	15	30	152	25	5
<i>D. melanoxylon</i>	28	33	16	21	17	33	148	25	5

5.4.5 Woody Plant Species Used for Building Purposes

Appendix C shows 31 (26.5% of all) woody species suitable for building purposes (i.e making poles, timber, beams and posts). Table 12 shows the aggregate preference ranking for nine highly preferred species for the use category in the study area. Most of the traditional houses and grain storage facilities were made of wood materials (Plate 6). Such species are also used to make a variety of building materials and other household utensils, tools and equipment which include paste, axe, spade and hoe handles, spears, mortar, arrows, bows and stirring sticks. *Brachystegia speciformis* and *Afzeria quanzensis* were the most preferred species for building (Table 10). Reasons given to support informants preferences straight growth with little branching and strong wood; easy curving; easy peeling; low permeability for items such as spoons and cups and high pests resistance.

Table 10: Aggregate Preference-Ranking Scores for 9 Highly Preferred Woody Species for Building Purposes in Minyughe Woodland

Species name	Iglasoni	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya	Total	Average	Rank
<i>B.peciformis</i>	96	87	81	82	89	77	512	85	1
<i>A. quanzensis</i>	76	81	84	87	86	97	511	85	1
<i>P. angolensis</i>	76	80	75	88	69	82	470	78	3
<i>D. cinerea</i>	77	62	86	73	78	76	452	75	4
<i>C. zeyheri</i>	58	72	69	62	74	74	409	68	5
<i>T.sericea</i>	72	58	50	50	86	78	394	66	6
<i>C. burtii</i>	74	73	60	45	29	65	346	58	7
<i>G. bicolor</i>	47	63	71	33	35	44	293	49	8
<i>C. molle</i>	71	41	39	44	12	20	227	38	9

5.4.6 Woody Plant Species of Fodder Importance

Appendix C shows a total of 18 (15.4% of all) woody species reported to be suitable for fodder in the area which include *Dichrostachys cinerea*, *Brachystegia speciformis*, *Grewia fobersii*,

Kiggeria africana, *Strychnos pototorum*, *Vangueria mombassae*, *Brachystegia microphylla*, *Grewia bicolor*, *Vitex payos* and *Acacia tottilis*. *Dichrostachys cinerea* was the most preferred followed by *Acacia tortilis* and *Grewia bicolor* (Table 11). Field observation showed remarkable evidence of browsing pressure (especially in the unreserved land) in most of the villages as a result large livestock herds (Plate 1) has contributed to increased grazing and browsing distances, viz., during the dry seasons. There were also evidences of browsing due to wild animals such as Elephants in some parts of the reserved land.

Table 11: Aggregate Preference-Ranking Scores for 6 Highly Preferred Woody Species for Fodder

Species name	Iglasoni	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya	Total	Average	Rank
<i>D. cinerea</i>	94	87	83	84	90	75	513	86	1
<i>A. tortilis</i>	76	79	84	87	86	98	510	85	2
<i>G. bicolor</i>	77	80	75	88	69	82	471	79	3
<i>K. africana</i>	78	62	86	73	78	76	453	76	4
<i>J. globiflora</i>	68	73	68	61	74	75	419	70	5
<i>B. microphylla</i>	71	58	50	52	84	73	388	65	6



Plate 5: A: Lumbering Pit Found Within Reserved Land in Muhintiri Village, B: Cleared Area as Result of Extensive Cutting and Grazing in Iglasoni Village

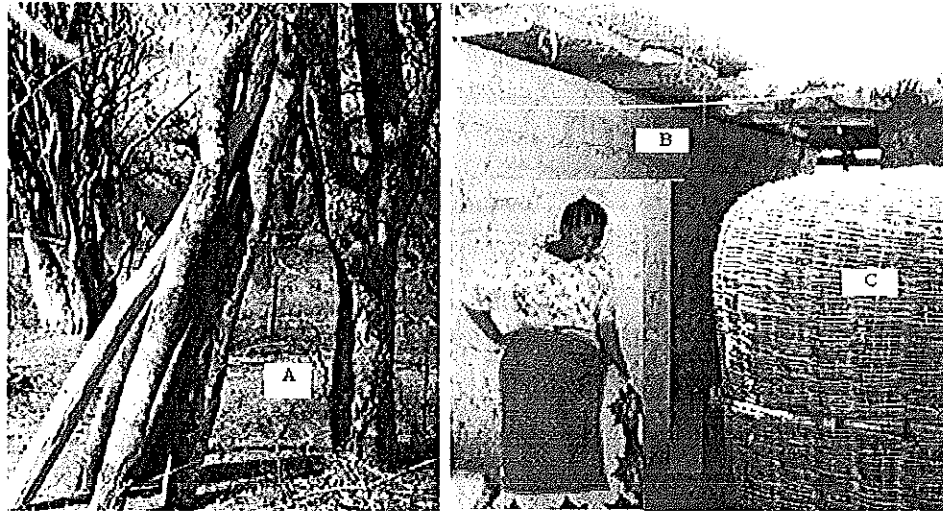


Plate 6: A: Poles Found in the Reserved Area in Mihintiri Village; B: House Built of Poles in Iglasoni; C: Traditional Grain storage Container in Iglasoni

5.4.7 Woody Plant Species Used for Making Beehives

A total of 12 woody species were reported as useful for making beehives (Appendix C). Of all the species reported for this use category, four species were highly preferred which are (given in descending order of preference) *Julbernadia globiflora*, *Brachystegia speciformis*, *Brachystegia microphylla* and *Acacia tortilis*. The reasons for informant preferences were durability and easy peeling of the barks.



Plate 7: Julbernadia Globiflora Found Debarked for Making Beehives

5.4.8 Edible Woody Plant Species

Fourteen (12% of all) different edible woody species were identified (Appendix C) whereby most of them are fruit bearing plants. Of all these *Adansonia digitata* scored highest (76). Almost every one in the community uses its fruits. *Vitex mombassae* was next (75) while *Cadaba farinosa* (55) out of the six highly preferred species (Table 12). Usage was seen to vary from 52 to 88 percent among the different villages however, some villagers reported not to use the fruits (Fig. 10). Such species provided edible fruits, which also serve as income sources with prices varying between Tsh. 50 (\$0.05) and Tsh. 150 (\$0.15) per kilogram leading to an actual income per season ranging between Tsh. 30,000 (\$30) and Tsh. 50,000 (\$50).

Table 12: Aggregate Preference-Ranking Scores for 6 Highly Preferred Edible Woody Species

Species name	Iglasoni	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya	Total	Average	Rank
<i>A. digitata</i> .	84	77	73	74	80	65	453	76	1
<i>V. mombassae</i>	66	69	74	77	76	88	450	75	2
<i>V. payos</i>	67	70	65	78	59	72	411	69	3
<i>X. americana</i>	68	52	76	63	68	66	393	66	4
<i>Z. africana</i>	58	63	58	51	64	65	359	60	5
<i>C. farinosa</i>	61	48	40	42	74	63	328	55	6

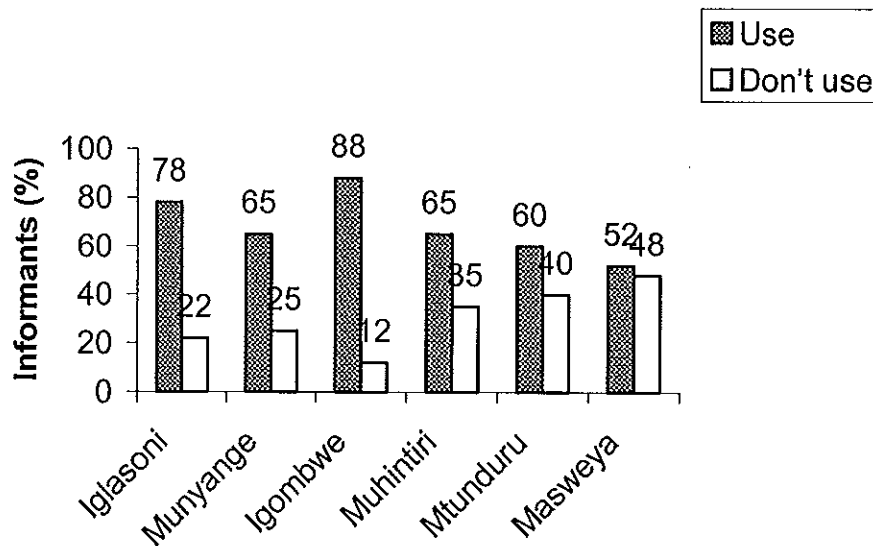


Figure 10: Variability in Usage of the Edible Species in the six Villages

5.4.9 Woody Plant Species of Traditional and Cultural Values

Thirteen (11% of all) woody plant species have been identified in connection to traditional and cultural importance (Appendix C). Such species served for different functions, which are described below:

- ❖ Sexual attraction. Species such as *Strychnos innocua* and *Canthium burtii* are used for strengthening sexual intimacy between two individuals of opposite sex.
- ❖ Customer attraction. Species such as *Balanites aegyptica*, *Canthium burtii* and *Strychnos pungensis* are used to increase the number of customers to a business.
- ❖ Protection against diseases, witchcraft, misfortune and rain shortage. Species such as *Adansonia digitata*, *Azzeria quanzesis*, *Cassipourea mollis*, *Combretum molle*, *Dalbergia melanoxylon*, *Sclerocaria birrea* var. *multifolia*, *Tamarindus indica*, *Terminalia sericea* and *Xeroderris stuhlmanii* are used.
- ❖ Peace making and reconciliation. Species such as *Combretum molle* and *Grewia bicolor* are used.
- ❖ Causing misunderstandings, misfortunes and theft. Species such as *Schrebberea trichoclada* are used.

The preparation and application for each function varies by function and species. This knowledge applied both to the Sukuma and Nyaturu people since this information was obtained in the field with a group of people representing all tribes.

Only three places that are traditionally respected by the Nyaturu people were visited in Iglasoni (**Kumbi**), Igombwe (**Mukunda**) and Munyange (**Kwamabala**) villages. These areas have been used for traditional practices such as circumcision under the leadership of traditional healers and clan leaders. The existence of all these places is associated with certain historical events, for example, the Kwamabala in Munyange is a place where people believe the existence of their ancestors because the famous taturu traditional healer died while in Igombwe village the Mukunda was named after a famous traditional doctor who lived and died there. These places were still important in the community because some people especially the elders visit them for purposes of offering sacrifices, cure of diseases, getting rid of misfortunes and asking for food and rain.

5.4.10 Multipurpose Woody Plants

A total of 40 (34% of all) (Appendix C) woody species were recorded to serve as multipurpose species. They provide several uses in the community leading to their high exploitation. The aggregate matrix scores for the 10 most preferred multipurpose species against their use categories are shown in table 13 whereby *Brachystegia speciformis* has scored the highest (14.1%). The next was *Julbernadia globiflora* (13.1%), both being useful in all use categories except one (edible use) while *Combretum zeyheri* had the least score (7.4%) out of the 10 highly preferred.

Table 13: Aggregate Matrix Score and Weighting for the Highly Utilized Multipurpose Woody Species

Use category	Building	Timber	Firewood	Charcoal	Medicine	Fruits	Fodder	Beehives	Total	Average	Rank
<i>B.speciformis</i>	44	50	55	59	34	-	12	48	302	37.75	1
<i>J.globiflora</i>	40	55	40	40	36	-	12	58	281	35.13	2
<i>D.melanoxydon</i>	48	45	41	43	30	-	24	30	261	32.63	3
<i>G.bicolor</i>	41	-	58	6	38	34	30	-	207	25.85	4
<i>C.burtii</i>	54	33	57	33	-	-	-	24	201	25.13	5
<i>P. angolensis</i>	59	58	30	-	36	-	-	12	195	24.38	6
<i>A.quanzensis</i>	44	30	42	31	15	-	-	24	186	23.25	7
<i>D.cinerea</i>	32	-	54	6	34	-	56	-	182	22.75	8
<i>C.molle</i>	35	20	24	30	27	-	-	35	171	21.38	9
<i>C.zeyheri</i>	35	30	35	34	-	-	-	24	158	19.75	10

5.5 Preferred Period for Harvesting (or using) Woody Species Among the Use Categories.

Seasonal variations with regard to preferences for harvesting or using the woody species among respondents in the study area were presented (Table 14). Generally, 57.1% people do their plant use activities during the dry season while only 18.5% get involved in such activities during wet seasons. Specifically, majority of informants (ranging from 51.7% to 91.7%) have reported that species for timber, building, firewood, charcoal and beehives are preferably exploited during dry

seasons while wild edible species are preferably exploited in both seasons depending on availability and/or type of species. 66.7% informants reported that species for medicine are harvested during dry seasons while 50% and only 31.7% have reported that ritual activities are conducted during rainy and dry seasons, respectively.

Table 14: Preferred Period for Harvesting (or using) Woody Species Among the Use Categories

Use category	RESPONDENTS			TOTAL
	Dry season	Wet season	Both	
Medicine	13.3% (8)	20.0% (12)	66.7% (40)	100.0% (60)
Timber	71.7% (43)	18.3% (11)	10.0% (6)	100.0% (60)
B & C	91.7% (55)	5.0% (3)	3.3% (2)	100.0% (60)
Firewood	81.7% (49)	13.3% (8)	5.0% (3)	100.0% (60)
Charcoal	93.3% (56)	5.0% (3)	1.7% (1)	100.0% (60)
Edible use	21.7% (13)	16.7% (10)	61.7% (37)	100.0% (60)
Beehives	51.7% (31)	20.0% (12)	28.3% (17)	100.0% (60)
Rituals	31.7% (19)	50.0% (30)	18.3% (11)	100.0% (60)
TOTAL	57.1% (274)	18.5% (89)	24.4% (117)	100.0% (480)

5.6 Distribution of Responsibilities by Gender Among the Use Categories

Variations of responsibilities by gender for all use categories in Minyughe are given (Fig. 11). It was noted that 76.7% of the respondents have reported that women collect firewood while 60% of them has attributed traditional activities to women. Furthermore, 80% and 85% of the respondents have reported that men are mostly engaged in timber and building activities, respectively. On the other hand, 55% of the respondents have reported that men were engaged in charcoal burning; the figure was 43.3% for women. 71.7% respondents have reported that both men and women are engaged in harvesting of plants for medicine.

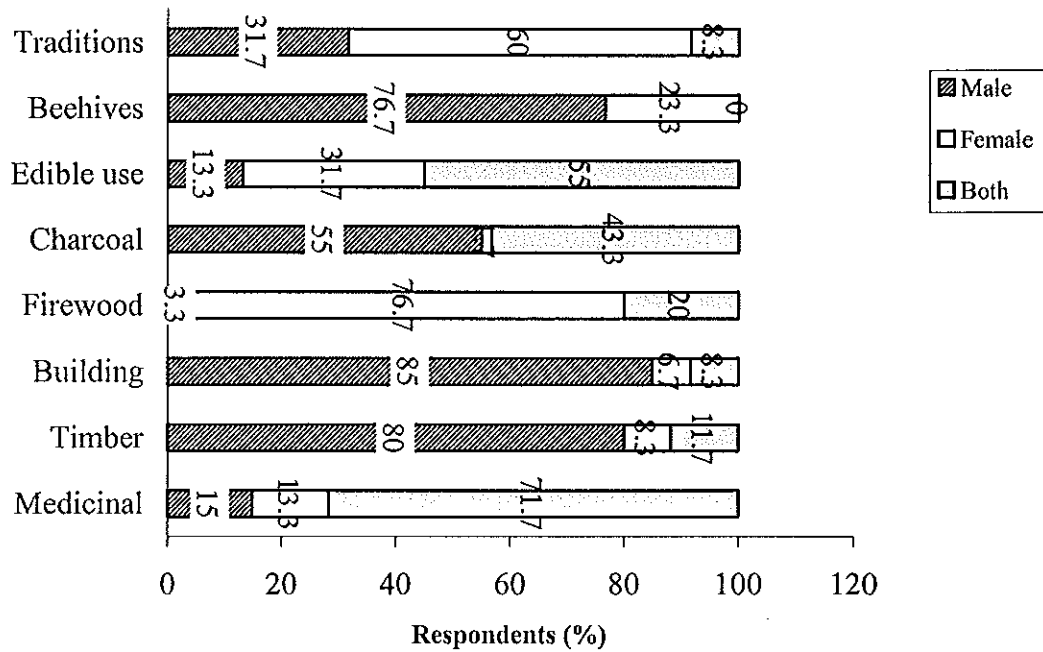


Figure 11: Distribution of Responsibilities by Gender for 11 Use Categories

5.7 Scarcity of Useful Woody Wpecies

Appendix B shows species reported to be scarce in the study area (with **). Fourteen (12% of all) woody plant species were reported to have decreased abundance from the study area. When the first 4 species were selected and ranked by informants from each village, aggregate preference ranking for the six villages indicated that *Pterocarpus angolensis* was the most scarce while *Canthium burtii* was the least scarce of such species (Table 15).

Table 15: Aggregate Preference-Ranking Scores for 4 Woody Species Highly Increasing in Scarcity

Species name	IGLASONI	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya	Total	Average	Rank
<i>P. angolensis</i>	44	43	43	43	45	40	258	43	1
<i>A. quanzensis</i>	40	40	30	40	38	39	227	38	2
<i>D. melanoxylon</i>	30	21	35	34	27	37	184	31	3
<i>C. burtii</i>	32	20	37	30	30	27	176	29	4

5.8 Time Taken and Distance Covered to Obtain the Useful Species

It has been found that the time and distance to get useful species are generally increasing in comparison to previous years (5-10 years back) according to 78.3% of the informants (Fig. 12). On the other hand, 20% of the informants have reported the existence of no differences while 2% have maintained that the required time and distance traveled to obtain the resources have decreased.

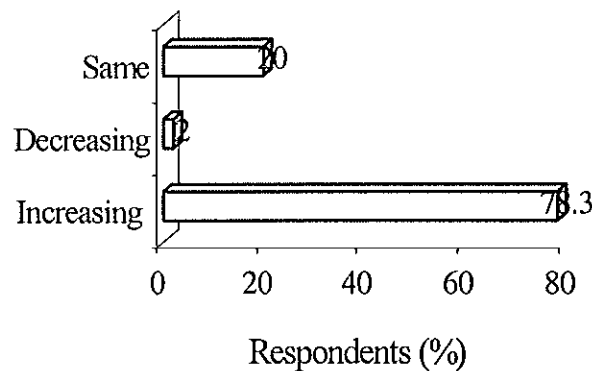


Figure 12: Average Distance and Time to Harvesting Places

5.9 Household Dependence on Woody Plant Resources

Figure 13 shows the evaluation of informants on the extent of household dependence on woody resources from the woodland. It was reported that, 56.7% households were totally dependant on the woodland while 31.7% had moderate dependence. Only 11.7% had little dependence. It was revealed through interviews that at least every individual's life was linked to the woodland resources.

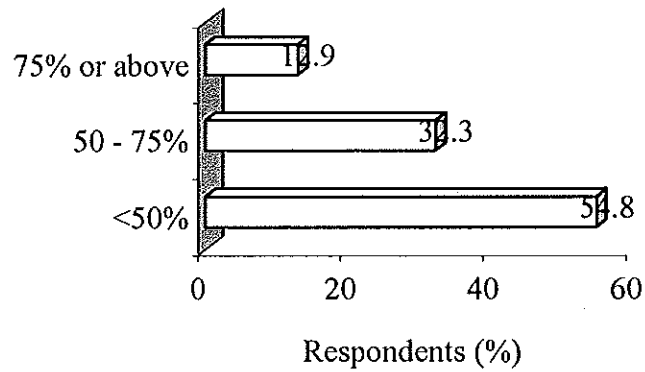


Figure 13: Household Dependence on Woody Plants

5.10 Household Daily Income Obtained From Woody Plant

Figure 14 shows average daily household earning obtained from woody plant resources, which ranged between Tsh. 500 (0.5 \$) to Tsh. 2000 (2 \$). It was revealed that 70% lived below or on the poverty line (\$1 per day) (Word Bank, 2000) while 19% were above this line. Of the majority 43% had an average income of Tsh 500 (\$ 0.5) per day while only 6% had an average daily income of \$2.).

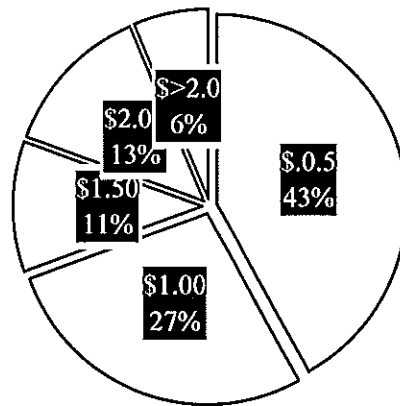


Figure 14: Household Earning Per Day at the Study Area

These values were obtained by taking the total average earnings per month for per year dividing by the total number of days. This value was then distributed among the total number of individuals in a family in order to obtain the average earning per person in a household. Village

wise, Muhintiri Mtunduru were found to have the highest number of people with the lowest income while it was almost uniform distribution in Munyange (Fig 15).

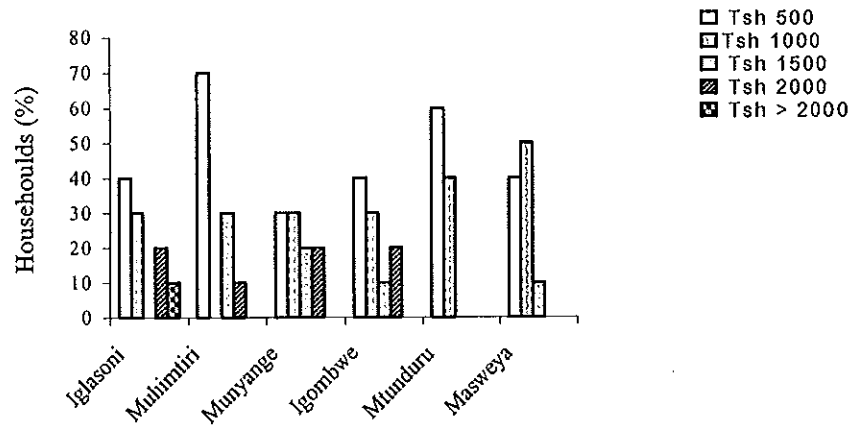


Figure 15: Household Daily Income Obtained From Woody Plants in Each Village

5.11 Threats to the Diversity and Abundance of Useful Woody Plants

Five major threats, which are responsible for change in the diversity of woody plants in the study area, were identified. These are population growth, uncontrolled harvesting, climatic change, livestock keeping and lack of conservation education among the villagers. These threats have varied values from village to village (Table 16). In general terms, population growth and uncontrolled harvesting have scored highest (27% each) while climatic change has received the lowest value (Fig.16). Based on interview results, many reasons have been found to cause poor dissemination of conservation education in the area owing to limited funding, lack or poor transport facilities, lack of sufficient skillful people in the forestry sector, and the inaccessibility of some places. Furthermore, poor leadership has contributed to local illiteracy in conservation of biodiversity; certain leaders feared to take action against people who went against regulations because they would not vote for them in the next election.

Table 16: Factors Threatening the Diversity of the Useful Woody Species in Each Village

Factor	Iglasoni N=40	Muhintiri N =40	Munyange N =36	Igombwe N =32	Mtunduru N =35	Masweya N =37
Population growth (%)	40	30	20	40	20	10
Uncontrolled harvesting (%)	10	30	40	0	30	50
Poor climate (%)	10	00	10	20	00	10
Livestock (%)	30	20	00	30	20	00
Lack of conservation education (%)	10	20	30	10	30	30

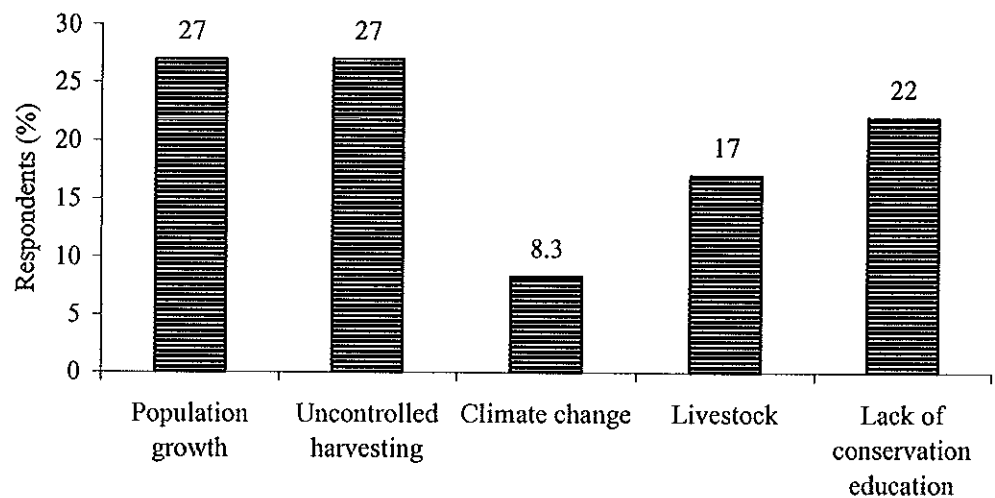


Figure 16: Factors Threatening the Diversity and Abundance of Woody Plants

When the extent of destruction imposed by each use category was compared, most respondents have reported that charcoal burning, farming, building, timber making and firewood collection are the major destructive activities. The mean scores for each category are shown in Fig. 17. One

way ANOVA has revealed significant differences among the categories ($F = 170.926, p = 0.000$) while Student-Newman-Keuls, grouped them into four groups, with no differences. The groups included charcoal burning and farming ($p = 0.551$); timber, firewood and building ($p = 0.373$); medicine and fodder ($p = 0.602$) and beehives which was placed alone but showing significant differences from all the groups (Table 17).

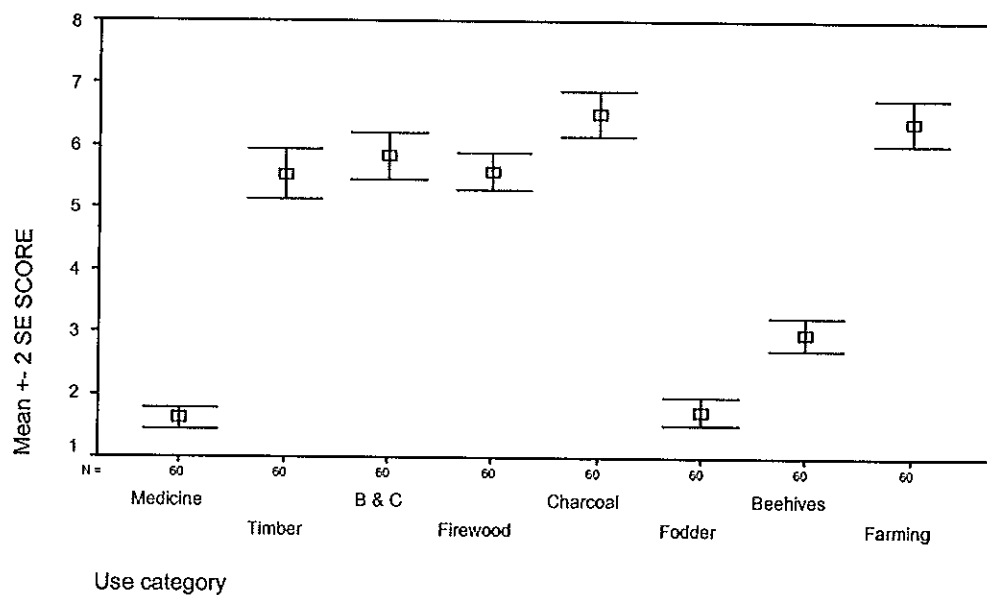


Figure 17: Destructive Use Category as Graded by Informants in the Study Area

Table 17: Student-Newman-Keuls Comparison of the Use Categories Based on Extent of Destruction (Values with the same letter in the same row are not significantly different)

	Use category	Medicine	Fodder	Beehives	Timber	Firewood	B & C	Farming	Charcoal	Sig.
N		60	60	60	60	60	60	60	60	
	1	1.62a	1.73a							0.602
	2			2.97b						1
Subset for alpha = .05	3				5.53c	5.58c	5.83c			0.373
	4							6.38d	6.52d	0.551



Plate 8: Extensive Bush Clearing for Agricultural Activities

5.12 Traditional Conservation Practices

Traditional conservation practices in connection to woody species in the study area are given (Fig. 18). Four main practices have been identified, i.e., live fencing, forest protection through Sungusungu military, culturally respected places or certain specific species and by leaving some species in farmlands. The traditional practices meant to leave some species on farmlands and traditional military were common. They account for over 50% of the conservation practices in the area while live fencing had a contribution of 13%. A similar trend was portrayed in the individual villages whereby the practice of having certain specific woody species in farmlands was common in all villages (Table 18). The species found on farms include *Combretum molle*, *Pterocarpus angolensis*, *Azzeria quanzeisis*, *Acacia tortilis*, *Adansonia digitata*, *Canthium burtii*, *Zanha africana* and *Dalbergia melanoxylon*.

Table 18: Conservation Practices Applied by the Local People in Minyughe (%)

Practice	Iglasoni	Muhintiri	Munyange	Igombwe	Mtunduru	Masweya
Leaving some woody species in farmlands	50	50	20	50	30	50
Live fencing	10	10	20	10	20	0
Protection through sungusungu culturally respected places and/ or species	20	20	50	10	40	50
	20	20	10	30	10	0

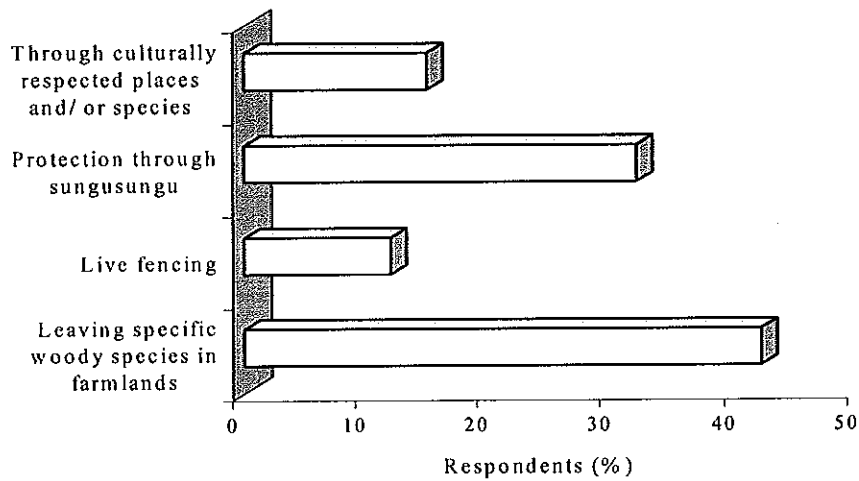


Figure 18: Traditional Conservation Practices Applied by the Local People

5.14 Involvement of the Local Community in Conservation Activities

50% and 32% of informants have reported low and moderate community involvement respectively while only 18% have reported full community involvement in conservation activities by the respective governments (Fig 19a). Village wise, a large proportion (50%) of informants has reported moderate involvement in Munyange while Mtunduru and Masweya had high number of informants who reported low community involvement (Fig. 19b).

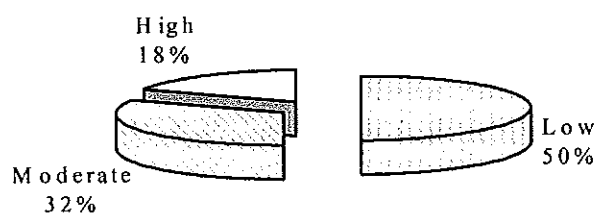


Figure 19a: Informant Evaluation of the Extent of Involvement of the Local Community in Conservation Activities at Minyughe Woodland

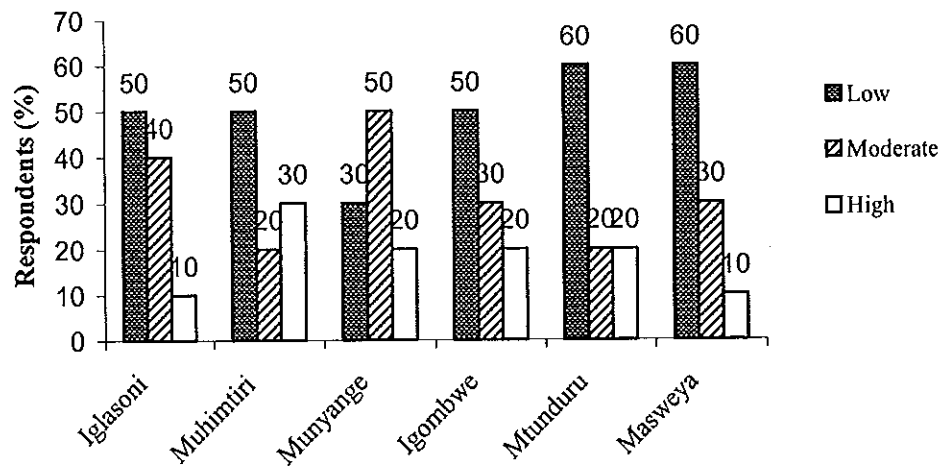


Figure 19b: Variations in Villagers' Involvement in Conservation Activities Among Villages

6.0 DISCUSSION

6.1 Floristic Composition and Diversity of Woody Plants

The variations in diversity, and richness which emanates from different levels of disturbance among community types and between reserved and unreserved sites and the remarkable paucity of standing trees dominated by small trees or shrubs may be attributed to the variations in the intensity of human pressure imposed on the woody plant resources in the study area. Such variations suggest that the diversity and abundance of the woody plants were influenced by land use activities, which were found to be more severe in the unreserved land than in the reserved land. This result concurs with previous investigation at Kolli hills of the Eastern Ghats in India (Chittibabus and Parthasarathy, 2000), Kitulangaro (Zahabu, 2001) and Tabora (Mbegu, 2004) miombo woodland in Tanzania and in the Northern Province woodlands and semi arid savanna of South Africa (Columba, 2003; Chidumayo 1997 & 2002; Higgings *et al.*, 1999). This has also been clearly supported by the results of Pearson correlation where diversity and richness had significant negative correlation. High disturbance has resulted into low species diversity and richness.

The woodland has been under human exploitation for decades (Sjöholms, 1988; Wily, 2001) prior to the demarcation of the area into reserved and unreserved lands. The demarcation process has considered relatively unaffected land as reserved land. This suggests that the delimitation was based on differences in disturbance levels. It is to be noted that selective exploitation of woody plants has been advancing from settlement areas towards unaffected parts of the woodland due to increased need for new settlements, farming land, charcoal and other products (Table 1). The use of two man crosscut saws or pit saws and ground fire to fell the trees, which might have resulted in a lack of large trees and sprouts, was evident in the area including the reserved land. This observation concur previous findings (Sjöholm, 1988 and Wily, 2001) in the Minyughe and Grundy (1995) in Zimbabwe.

Relatively high diversity in community types I and II could have been due low disturbance in the many of the plots forming these community types most of which were also located in the unreserved land whereas low diversity in community types V and VI was due to dominance of highly disturbed plots from the unreserved land. Plots in the transition zone close to the cutline

separating the reserved and unreserved site dominated community types III and IV. Such plots were found to be moderately disturbed. Community types II and I were dominated by highly preferred species such as *Acacia tortilis*, *Brachystegia speciformis*, *Canthium burtii* and *Julbernardia globiflora* as a result of low exploitation. *Brachystegia speciformis* and *Julbernardia globiflora* were among the highly utilized woody plant species, though they remained dominant in the area. This may be attributed to their high coppicing capacity because they are well adapted to cutting or periodic fire (Luoga *et al.*, 2003).

The high coefficient of similarity between reserved and unreserved lands suggests a uniform ecosystem. However, anthropogenic pressures seem to predict wide differences between the two sites in the near future since more species were recorded in the reserved than in the unreserved land. In addition, a relatively high density of stumps of such species was recorded in the unreserved land.

6.2 Population Structure of Woody Plants

The reversed J-shaped structure for densities and normal J-shape for basal areas obtained from both sites suggest a normal recruitment potential of the woody species in the study area. This concurs earlier findings reported in Kitulangalo forest (Luoga *et al.*, 2003) Morogoro-Tanzania. However, the fewer individuals in the 4.1-10 cm (poles), 10.1-20 cm (small reproductive trees) and >20 cm (large reproductive trees) size classes in the reserved than in the unreserved land could suggest restricted recruitment potential from the small reproductive trees to large reproductive ones when compared to unreserved land, implying that trees in such size classes are under high human activities which may be the factor for the annual deterioration of the woodland condition. Such activities include illegal and licensed harvesting, free grazing, unregulated new settlement and ring debarking. Mbegu (2004) reported that severe human pressure caused considerable negative impacts on the structure of trees in the Miombo woodlands in Tabora-Tanzania. High density of stumps in the unreserved land portrays a similar observed scenario for the density and basal areas. Scarce species such as *Pterocarpus angolensis*, *Canthium burtii* and *Azzeria quanzeis* had high number of cut stumps in the reserve land suggesting they were highly exploited. In general, high density of cut stumps for the highly utilized woody species (especially multipurpose species) and low density for the less useful ones was observed from both sites.

6.3 Woody Species Use and Conservation Issues

High dependence (ranging between 65% and 78%) of the local community on traditional medicines may be attributed to the remarkable insufficiency of medical centers in the study area. In Tanzania, poor medical service is a country level problem, which affects majority of the rural communities (URT, 2004). This problem is normally linked with high levels of poverty and poor communication and transport infrastructures in these areas (URT, 2003). Similar observations were reported in Ruvuma north forest reserve of Tanzania (Mathew, 1999). On the other hand, the results have suggested that the local people are highly knowledgeable and widely engage themselves in the use of traditional medicine as a means of disease treatment. More than half of the useful woody species found in the study area are sources of medicine. Local people prefer roots and barks to any other parts of the plants. These parts have been found to have more chemical concentration (Mills, 2000 and Atuwodi, 2005). This in turn suggests high destruction of such species. This was mapped during the fieldwork where some villagers were found collecting medicine inside the woodland (Plate 2). This concurs with previous report by Elisha (2004), which has shown that the majority (48%) of the local inhabitants were reported to prefer roots to other parts. These harvesting strategy and preference may have lead to the observed local extinction of *Securidaca longipendiculata*, *Aerva lanata*, *Boscia massaiensis*, *Senna singueana* and *Lannea schweinfurthii* var. *stuhilmanii* in the study area.

The apparently high proportion of people and households largely relying on firewood for energy and income shows high consumption of plant wood resources from the woodland. The high proportion (95%) of informants who reported to be engaged in firewood collection obtained in the current study was higher than that reported by Elisha (2004) (67.7%) in Muhintiri, Nkhoiree and Misake villages in Minyughe but concur previous findings (FBD, 2000) that more than 90% of the population in Tanzania, use biomass energy for cooking and heating accounting for approximately 90% of the total energy consumption in the country. In 1993, fuelwood consumption was estimated at 43.8 million cubic metres of firewood in the rural areas of Tanzania but it was estimated to surpass 60million cubic metres with an average of 45,000 trees of 0.2 cubic metres size being cut daily in the 1980s (URT, 2002). Basing on the estimate that an average household (5 to 8 persons) would require around 7 cubic meters of firewood per year (Mitchell, 1984 and Kihyo, 1991), the total annual wood requirement for Mtunduru village (cf.

Table 1) is 7,784 m³. This value implies that more than 16 hectares of the woodland would be destroyed annually just to meet the village firewood requirement. High preference of *Grewia bicolor*, *Canthium burtii* and *Dichrostachys cinerea* for firewood may be due to their high calorific value. This has resulted to the observed high number of cut stumps of these species in the unreserved land. It is to be noted that *D. cinerea* was seen only in form of sprouting stumps.

Charcoal was the second energy source in the study area because it was easily available and cost effective. A large proportion of informants have reported their engagement in charcoal burning owing to its income generating capacity in the area. Charcoal is produced in large quantities for sale at the nearby towns including Singida municipality. Charcoal making was evident in all villages whereby charcoal kilns were seen scattered inside the reserved land (Plate 4). Earlier report Hines and Eckman, 1991) has suggested that charcoal was a significant source of income in the miombo woodland of Tanzania. Like for firewood, species preference for charcoal was based on qualities preferred by the local community.

Like for charcoal, timber and building materials were found to be valuable products of indigenous tree species despite their increased scarcity in the area owing to increased household demands and income generation. Elisha (2004) has reported that villagers collect wood materials for household usage as well as for income generation when they were sold at considerable prices. Woody plant species with the preferred quality for timber or building purpose are highly exploited. *Pterocarpus angolensis*, which is categorized as a protected species and requires a special permit for harvest, is being enormously disappearing from the area because many wood harvesters in this area do not observe this requirement. This species has a good wood quality for timber or poles. This observed rarity and subsequent local extinction of *P. angolensis* could be attributed to uncontrolled harvesting such as selective pit sawing and lumbering in the area. Sjöholms (1988) and Kindeketa *et al.* (2004) had similar observations in the same area. The remarkable number of stumps (Plate 5b) and lumbering pits (Plate 5a) and the cutting of plants for poles and other building materials (Plate 6) may pose serious ecological consequences in the area (cf. Mathew, 1999).

Increased livestock numbers due to immigration of the Sukuma people led to grazing shortages especially during dry seasons. Large herds of livestock were observed in Muhintiri, Iglasoni, Masweya and Igombwe villages (plate 1) following settlement of the Sukuma people. Kindeketa *et al.* (2004) and Elisha (2004) had similar observations in Mlandala, Msosa, Misake and Mpugizi villages of Minyughe woodland area.

High preference of *Julbernardia globiflora* and *Brachystegia speciformis* by the local community for making beehives could have been attributed to their good qualities (see section 5.3.7) and that they were easily obtained because they are abundant. As a result, many of the *J. globiflora* and *B. speciformis* were found debarked in the area (Plate 7). Although *A. digitata* was reported to be one of the species for this use category, it was not used in making beehives; it is used for hanging beehives because its succulent stem prevents honey bees from attacking the hives. Furthermore, knowledge of edible species obtained in this study reveals the importance of woody species in human nutrition as well as income generation.

The miombo woodland plays an important role in preserving the cultural values of the people in Minyughe. However, some species such as *Dalbergia melanoxylon*, *Combretum molle*, *Canthium burtii*, *Azzeria quanzensis*, *Balanites aegyptica*, *Terminalia sericea* and *Xeroderris stuhlmanii* that are mainly associated to traditional and cultural values were still harvested for firewood, timber and poles. These species were found to have low densities and basal areas but high density of stumps (Appendices D, E & G). This may be attributed to the accelerated loss of respect to traditional taboos and traditional beliefs in the area, which has resulted from extreme poverty and the growth of religious faith with labels such as satanic by the people. According to Serwaa-Asamoah (1990), the proliferation of religious faith among villagers in Ghana could result in a change in attitude and perception towards traditionally instituted laws.

People selected woody species for multiple uses on the basis of their quality products. Among the preferred multipurpose species, *B. speciformis* had the highest score while *Combretum zeyheri* scored the least value. This may imply that *B. speciformis* has the highest use value in the study area because of its multiple usage. On the other hand, such highly preferred species are facing a high degree of vulnerability.

6.4 Community Dependence and Rarity of Woody Plant Species

Plant rarity has led to increased time and long distance to get locally preferred woody species in the study area. Species which are currently rare used to be easily obtainable some 5-10 years ago. This rarity could be attributed to selective logging. The existence of some of these species in the unreserved land could be due to the tendency of some farmers to leave them in their farmlands owing to these species high potentiality.

Species that are used for timber, building, firewood and charcoal were preferably harvested during the dry season to avoid the effect of rainfall and make use of easy transportation. Edible plant parts such as fruits were available during both seasons owing to varied phenology of the species. Fruits of *Adansonia digitata* and *Tamarindus indica* are consumed while dry and normally are ready in the dry seasons. However, individuals' interest and access to certain species may have contributed to the observed differences among the informants.

The social responsibilities in relation to the utilization of woody plant species in the two major ethnic groups of the study area were based on gender. As a result, activities such as timber making and building (heavy duty), are not allocated to women because they are regarded as weak and less energetic. However, many women were engaged in income generating activities such as charcoal making. Treatments for diseases were a responsibility of both genders implying equitable distribution of knowledge in the community. Their remarkable dependence on the woodland has emerged from high poverty levels, lack of entrepreneurship and incompetence in village leadership. Furthermore, their lack of a reasonable knowledge of sustainable resource use and management has immensely contributed to the observed deterioration of the miombo woodland. Despite the fact that the woodland acted as the main income source for the majority in the area had, their average earning per day falls below the poverty line (World Bank, 2000).

The disparities in income from one village to another could be due to differences in occupational activities among the villagers, i.e., the activities vary from businessmen to a mere peasant. This may have led to various degrees of dependence of the local community on forest and forest products. Similar results were reported elsewhere (Arnold and Bird, 1999; Barraclough, 1990). It is obvious that poor communities often fail to provide adequate forest resource management

because they are most likely to support themselves with subsistence slash and burn agriculture, use forest products as fuel, fodder and building materials.

6.5 Traditional Conservation Practices

Farmland conservation of selected woody species was exercised by majority of informants, and hence, it is the most common traditional conservation practice. Its commonness could be attributed to the existing District policy, which demands the preservation of at least five trees in one acre of farmland. However, it is to be noted that this practice is losing respect among farmers because it is apprehensive in connection to the impact of many the trees in the farmlands on crop production due to competition. This perception may have emanated from the poor cropping system where farmers mainly practice subsistence cropping on infertile, i.e., farmlands where fertilizer, pesticide and/or irrigation were rarely applicable. Thus, farmers usually select only the most preferred species to preserve in their farmland, and hence, a few standing trees.

Although the least attention was given to live fencing, it is a valuable practice in conservation and sustainable resource use. This is because areas that exercised this traditional conservation practice appeared to be in a relatively good condition. Moreover, construction of living fences was done at much lower costs that is affordable by the local community of the study area. Therefore, a proper management of live fencing could play important roles in resource management. Furthermore, living fences can improve microclimate within small enclosures by reducing wind and soil surface temperatures. In fact, the purpose of living fences varied depending on prospect. Some were built to keep out domestic or wild animals; others to demarcate areas where general access is discouraged such as around a compound, house, cropland, garden or orchard. In the latter, species of the genera *Euphorbia* and *Commiphora* were used in making live fences. Similar result was reported in Mandara Mountains of northern Cameroon (Rocheleu *et al.*, 1988). Owing to the observed selective encroachment into reserved areas under Sungusungu military conservation practice, the latter is not an effective practice for resource conservation and sustainable use. This may not call for its complete ban but rather improvements. The major problems of this practice are lack of military training among the villagers and poor transport and communication.

Traditionally, Nyaturu people do respect certain plant species or places of significant value. In contrary, no specific place but only plant species were reported to be of traditional value to the Sukuma people because they are immigrant and usually very young to a given area. The fact that more elders than young people expressed more respect for the existing traditional setup may shows its uncertain future. This trend in turn has an immense impact on traditional resource management and sustainable uses.

6.6 Constraints (threats) to Sustainable Use and Conservation of Woody Plant Resources

Uncontrolled harvesting, population growth and high livestock number were reported to be the most threatening factors to the diversity of woody species in the study area. It should be noted that these threats have inflicted significant (large scale) direct destruction of the resources. Similar findings were reported elsewhere, e.g., Tanzania (Mugabe and Clark, 1998), Costa Rica (Rosero-Bixby and Palloni, 1996) in particular and Africa (United Nations, 1992; ISRIC, 1991) and the world (WCWC, 1992) at large. Furthermore, lack of knowledge of resource conservation and sustainable uses and competent leadership has intensified anthropogenic impacts on woodland resources unchecked, leading to the observed ecological crisis at the study area.

Although the impact of fire was reported to be occasional and insignificant by most of the informants, its impact on the miombo woodland cannot be neglected. Fire has always been made in the course of farmland preparations, honey harvesting or clearance for settlements (Plate 8). In fact, fire is very essential when kept at low frequency in the savanna ecosystem (Cotinho, 1990; cited in Horta 2002; Mistry, 2000; cited in Horta 2002; Lawton, 1978). Moreover, it has been reported as a stimulant to germination and resprouting in old burnt areas (Chidumayo, 2002). However, the observed situation in the Minyughe woodland suggests contrary to the aforementioned reports. Fire was observed to be frequent and could cause significant destruction in many areas especially when it was used for land clearance (Plate 8). The observation concur previous findings by Issango (2004) who reported fire to be destructive even to tolelant species in Mgori forest reserve in Singida District of Tanzania.

7.0 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Minyughe woodland provides a wide range of useful woody species in a variety of use categories including medicinal, firewood, charcoal, timber, building and other domestic materials, fodder, beehives, food, cultural, aesthetic and environmental services. The woodland is, therefore serves as major source of both household use and income generation materials.

Although, the reversed J-shape (for species density) and normal J-shape (for tree basal area) trends for the various structural classes obtained in this study suggest a promising regeneration potential in the study area, the local community was found to have little knowledge of sustainable use and conservation of the resources. As a result of this, the woodland is being threatened owing to uncontrolled and haphazard harvesting.

Population growth, poverty, human subsistence activities, poor monitoring and lack of legal measures taken against the offenders of the various issues stipulated in the district, ward or village environmental protection by laws are deleterious to the sustainability of the woodland.

Despite the cultural disrespect that is gaining speed in the area, conservation and sustainable use through cultural and traditional practice such as live fencing and rituals seems possible and easy to effect in the area especially where poverty and poor scientific knowledge are problems.

7.2 Recommendations

Following are recommendations for obligated people and institutions such as the district forestry department, the Land Management Programme (LAMP) management, ward and village leaders for making developments, and ameliorate the balance between resource use and sustainable conservation in the study area.

The estimate of variables such as density, basal area and presence absence of the useful species have to be considered more for further manipulation of the woodland as they show promising recruitment potential. However, more studies are needed in order to characterize the regeneration,

growth requirements and genetic diversity of the already known and potentially valuable species in the study area for future silvicultural treatments and breeding.

There is need for the overexploited species and affected areas to be given more priority so that they are left to regenerate or rehabilitated. If possible, to invigorate enrichment planting of such species and by encouraging use of properly established and managed live fences to protect areas deliberately planned for conservation.

The culture and traditions of the local people need to be encouraged and given due respect and to create awareness among the people so that they attach to such areas and species similar respect attached to the traditionally respected areas and species.

A need for the understanding of the status of Minyughe woodland by the local people both as a reserve site for conservation of fauna and floral species, a potential world heritage site and one of the biosphere reserves of the country is necessary at present in order to ensure the conservation of woody plants with potential to serve as sources of genetic resources.

There is need for several efforts including community education about the sustainability and in situ conservation techniques of both timber and non-timber forest products to be adequately undertaken and backed by appropriate incentives in order to ensure the contributions of the local people in conservation and sustainable development. There is need to involve the majority local people and all stakeholders at the regional and district levels in the planning and implementation of conservation strategies through proper PRA techniques.

There is need to introduce use of improved stoves which will serve for reducing the severity of exploitation of the woody species for firewood in the area.

There is need to improve animal husbandry practices and auction markets in the area and the country at large in order to limit livestock herds according to carrying capacity. This can be achieved through improved extension services, integration of livestock keeping and crop production through exchange of products such as crop residues and livestock dung, microhabitat

management and water and soil conservation. Furthermore, premeditated programs should be established to speed up the place of village boundary demarcation and issuing of title deeds to villagers/farmers and prepare legalized land use plans based on PLUM.

8.0 REFERENCES

- Alexidades, M. (1996). Collecting Ethnobotanica data. An introduction to basic concepts and techniques. Alexidades, M. and Sheldon, J.W. (ed) Selected guideline for ethno botanical research. A field manual. The New York Botanical Garden. New York.
- Arnold, J.E.M. and Bird, P. (1999): Forests and the Poverty-Environment. Nexus New York: United Nations Development Programme and European Commission, 4-5.
- Atuwodi, E. S. (2005). Conservation in Vitro typanocidal activities of Petroleum Ether, Chloroform, Methanol and A queous extracts of some Nigerian Savannah plants. *African Journal of Biotechnology*. Vol. 4(2): 177- 182.
- Barraclough, S. (1990) "The Social Dynamics of Deforestation in Developing Countries: Principal Issues and Research Priorities," Discussion Paper No. 16 (New York: United Nations Research Institute for Social Development, p 15.
- Bernard, H.R., (1988). Research Methods in Cultural Anthropology. Sage Publications, Newbury Park, California.
- Bureau of Statistics, (1989). Population census in Tanzania 1988, Central Bureau of statistics. Dar es Salaam.
- Campbell, B.M., (1996). The Mionmbo Woodland in Transition; Woodland and Welfare in Africa. CIFOR, Bogor, Indonesia, 266pp.
- Chidumayo, E. N. (1997). Miombo Ecology and Management: An Introduction. Intermediate Technology publications, London, p166.
- Chidumayo, E. N. (2002). Changes in Miombo woodland Structure Under Different Land Tenure and use Systems in Central Zambia. *Journal of Biogeography*. Vol. 29 Issue 12. p 1619
- Chittibabus, C. V. and Parthasarathy, N. (2000). Attenuated tree species diversity in human impacted tropical evergreen forest sites at Kolli hills, Eastern Ghats, India. *Journal of Biodiversity conservation*. 9: 1493 – 1519.
- Coe, M. J., McWilliam, N. C., Stone, G. N. and Packer, M. J. (1999). Mkomazi: *The ecology Biodiversity and conservation of a Tanzania savanna*. Royal Geographical society. London, Collins Sons and Co. Ltd London. pp 5, 7.
- Columba, J.C.L. (2003). Effects of Woodland fragmentation on tree density in the Nothern province, South Africa.

- Cotton, C. M. (1996). *Ethnobotany: Principles and Applications*. John Willey and Sons. Chichester, England. 402p.
- Cunningham, A. B. (1993). *African Medicinal Plants: Setting Priorities at the Interface Between Conservation and Primary Healthcares*. UNESCO, Paris.
- Curtis, J.T and MacIntosh, R.P. (1950).The interrelations of certain analytic and synthetic physiological characters. *Journal of Ecology* **31**: 476-496.
- Delcourt, P. A., Cridlebaugh, H.R and Chapman, J. (1986). Holocene ethnobotanical and paleoecological record of human impact on vegetation in the Little Tennessee river Valley, Tennessee, USA. *Quaternary research (NewYork)* **25 (3)**: 330
- Dregne, H. E. (1986). Desertification of Arid Lands. In: *Physics of Desertification*, ed. F. EL-Baz and M.H.A. Hassan. Dordrecht, The Netherland:Martinus, Nijhoff.
- Elisha, E. (2004). Contribution of non-Timber forest products to the Livelihood of the local communities living around Minyughe woodland in Singida- Unpublished.
- FAO (1993). Nonwood forest products. A Regional Expart Consultation for English Spaking African Countries. Arusha, Tanzania. 17–22 October 1993. Proceedings pp 9-12
- FBD (2000). Tanzania Forestry Action plan 1990/91-2007/08. Main Report Forestry and Beekeeping Division (FBD) Ministry of lands, Natural Resources and Tourism. Dar es Salaam.
- Frost, P. G. H. (1996). The Ecology of Miombo Woodlands. In: Campbell, B. (Ed.) 1996: *The Miombo in transition: Woodlands and welfare in Africa*. Center for international forestry research, Bogor. 266pp.
- Gauch, H.G. (1982). *Multivariate analysis in Community Ecology*. Cambridge studies in Ecology. Cambridge University press. New York.
- Gauch, H.G. and Whittaker, R.H. (1981). Heirarchical classification of Community data. *Journal of Ecology*. Vol. **69**: 135 – 152.
- Godman, M. (2003). Partitioned Nature, Privileged knowledge: Community Based Conservation in Tanzania; In: *Development and Change* Vol. **34 No 5**; Blackwell, The Hague.
- Government of Tanzania (2002). "Population and Housing Census 2002" accessed at <http://www.tanzania.go.tz/census/tables.htm> on 8th June 2002.

- Grenier, L. (1998). Working with Indigenous Knowledge: A guide for Researchers. International Development Research Center (IDRC), Ottawa, Canada. Pp. 115.
- Grundy, I. M. (1995). Regeneration and Management of *Brachystegia speciformis* Benth. and *Julbernardia globiflora* (Benth) Troupin in Miombo woodlands, Zimbabwe. D. Phill. Thesis. University of Oxford (Unpublished).
- Hedberg and Hedberg, O. (1968). Conservation of Vegetation in Africa South of the Sahara. Proceedings of a Symposium Held at the 6th Plenary Meeting of the (A.E.T.F.A.T) Upsala September 1996 Pp2-7 – Almqvist and Wicksells Boktryckkari AB- Upsala.
- Heywood, V.H. and Davis, S.D. (1994). Importance of Plant Diversity. In: Centers of Plant Diversity Vol.1, Europe, Africa, Southwest Asia AND the Middle East. Scandinavian University Press, Oslo.
- Higgins, S. I., Shackleton, C. M. and Robinson, E. R. (1999). Changes in Woody Community Structure and Composition under Constructing Land Use Systems in a semi arid savanna South Africa. *Journal of Biogeography*, **26**, 619-627.
- Hill, M.O. (1979). TWINSpan – A FORTRAN Program for Arranging Multivariate Data in an ordered two-way table by classification of the individuals and attributes. Ithaca, New York, Cornell University.
- Hines, D. A. and Eckman, K. (1993). Indigenous Multipurpose Trees of Tanzania: Uses and Economic Benefits For People. Ottawa, Ontario, Canada
- Holmberg, J., S. Bass, and L. Timberlake. (1991). *Defending the Future*. London: Earthscan
- Horta, M.B. (2002). Assessment of Human and Physical factors influencing spatial distribution of vegetation degradation – Environmental Protection Area Cachoeira das Anlorinhas, Brazil pp 5-20
- Hussain, F. and Khaliq A. (1996). Ethnobotanical studies on some plants of dabargai Hills Swat. Proceedings of first training work shop on “*Ethnobotany and its application to conservation*” NARC, Islamabad. pp: 207-215
- Huston, M.A., (1994). *Biological diversity: Coexistence of species on changing landscape* Cambridge university press, Cambridge.
- Iddi, S and Hakan, S. (1998). Managing natural forests at the village level Reaching ultimate development goal. A paper presented in 2nd Forestry workshop, Sokoine University of Agriculture, Olomontonyi Training forests Arusha, Tanzania.

- Ikaku, T.C. (2002). Mgori Forest reserve, Orgut Project annual report, Singida, Tanzania (unpublished)
- IPGRI (1993). Diversity for Development. The Strategy of the International Plant Genetic Resources Institute, Rome.
- Isango, O. J. (2004). Impact of Fire on the Woody Vegetation in Mgori Forest Reserve, Singida, Tanzania. Msc. Thesis. Addis Ababa University, Ethiopia. (Unpublished)
- ISRIC (1991): World map of the status of human-induced soil degradation (by L.R. Oldeman, R.T.A. Hakkeling and W.G. Sombroek). Global Assessment of Soil Degradation (GLASOD). Nairobi, UNEP.
- Jerald, R. C. (1936). The tribes of Tanganyika. Their districts, Usual Dietry and Pursuits G. P. D 538pp
- Kakembo, V. (2001). Trends in Vegetation Degradation in Relation to Land Tenure, Rainfall and Population Changes in Peddie District, Eastern Cape, South Africa. *Environmental Management*, 28(3) 335 - 349
- Kent, M. and Coker, P. (1992). *Vegetation Description and Analysis, A Practical Approach*. Belhaven Press, 25 Floral Street, London, 363 pp.
- Kihiyo, V. B. M. S., (1991). 'The woodfuel situation under the ujamaa village programme of Tanzania' Beitr. *Trop. Land Wirtch.* Vet. Med. Vol. 29: 25-31.
- Kindeketa, W. J., Kibure, O., Elia, J. and Urrio, H. L. (2004). Report on Conservation, Ethnobotanical and Ecological studies of Minughe Forest in Singida Rural District, Singida Region. Contract: LAMP 2004 Activity no: 1126. (Unpublished).
- Kingsford, M, and Battershill, C. (eds) (1998) Studying temperate marine environments. Canterbury University Press.
- Krebs, C. J. (1989). *Ecological Methodology*. Addison Wisley Longman, 2nd Ed Harper and Row, NY, U.S.A. 652pp
- Krebs, C. J. (1998). *Ecological Methodology*. Addison Wisley Longman, Second Ed. Menlo park California. 620 pp.
- Krebs, C.J. (1972). *Ecology. The experimental analysis of distribution and disturbance*. Harper and Row. London.

- Kumlachev Yeshitla and Tamrat Bekele, (2002). Plant Community Analysis and Ecology of Afromontane and Transitional Rainforest Vegetation of Southernwestern Ethiopia. *SINET Ethiop. Journal of Science*. **59:247-265**.
- LAMP (2001). Community Based Management Initiatives for Minyughe woodlandry. Project No: 260: Management of Minyughe woodlandry Singida District. (Unpublished).
- Lawton, R. M. (1978). A study of the dynamic ecology of Zambian vegetation. *Journal of Ecology*, **66, 175-198**.
- Lind, E. M. and Morrison, M. E. S. (1974). East African vegetation. 1st edn. Longman, London.
- Litvinoff, M. (1990). The Earthscan Action Handbook for People and Planet. London: Earthscan.
- Ludwing, J.A. and Reynolds, J. F. (1998). Statistical Ecology. A Primer on Methods and Computing. John Wiley & Sons. Inc. Canada.
- Luoga, E.J (2000). The effects of Human disturbances on diversity and dynamics of eastern Tanzania Miombo woodlands. Ph.D Thesis. University of the Witwatersrand. Johannesburg.
- Luoga, E.J., Witkowski, E.T.F. and Balkwill, K. (2000). Differential utilization and ethnobotany of trees in Ktulangalo forest reserve and surrounding communal lands, Eastern Tanzania. *Journal of Economic Botany*. **54: 328 – 343**.
- Luoga, E.J., Witkowski, E.T.F. and Balkwill, K., (2002). Harvested and Standing woodstocks in protected and Communal Miombo Woodlands of eastern Tanzania. *Journal For Ecological Management*, **164: 15 - 30**
- Luoga, E.J., Witkowski, E.T.F. and Balkwill, K. (2003). Regeneration by coppicing (resprouting) of miombo (African savanna) trees in relation to land use. WiTS 2050, Johannesburg, Gauteng, South Africa.
- Manoko, M.L. (1999). Indigenous Knowledge and Biodiversity Conservation: A case study of Medicinal Plants and Nyanwezi people in Tabora Region, Tanzania. MSc Thesis Addis Ababa University (Unpublished)
- Martin, G. J. (1995). Ethnobotany: A conservation manual. Chapman & Hall, London.
- Mathew, A. M. (1999). Human impact on Woody Vegetation in Ruvuma North Forest Reserve, Tanzania. Msc. Thesis SUA Morogoro, Tanzania pp 20- 26.
- Maundu, P. M. (1995). Methodology for collecting and sharing indigenous knowledge: A case study: indigenous knowledge and development. *Monitor* **3(2): 3-5**.

- Mbegu, M.A. (2004). A comparative Ecological study of the Miombo woodland in Tabora – Tanzania. Msc Thesis. Addis Ababa University, Ethiopia. (Unpublished).
- McCune, B. and Mefford, M. J. (1999). *Multivariate Analysis of Ecological Data*. Version 4.20. MjM Software, Gleneden Beach, Oregon, U.S.A.
- McIntosh, R.P. (1967). An Idea of Diversity and the relation of certain concepts to diversity. *Ecology*. **48**: 392 – 404.
- McNeely, J. A. (1988). *Economics and Biological Diversity: Developing and using Incentives to Conserve Biological Resources*, IUCN, Gland, Switzerland.
- Metz, J.J. (1997). Vegetation dynamics of several little disturbed temperate forests in eastern Nepal Mountain research and development. **17**, 4
- Mills, S. and Bone, K. (2000). *The Principles and Practice of Phytotherapy: Modern Herbal Medicine*. Churchill Livingstone, London.
- Ministry of Lands, Tourism, Natural Resources and Environment (MLTNRE) (1989). *Tanzania Forestry Action Plan 1990/91 -2007/08*. Dar es Salaam
- Ministry of Natural Resources and Tourism (MNRT), (1998). *National Forest Policy*. Dar es Salaam, Tanzania.
- Ministry of Tourism, Natural Resources and Environment (MTNRE) (1994). *Tanzania Forestry Action Plan 1994/95 - 2007/08*. Update. Draft.
- Mitchell, A. J. B. ed. (1984). *Land evaluation and Land use planning in Tabora Region, Tanzania*. Land Resources Development Centre; Tolworth/Tower, England.
- MNRT (1998): *The National Forest Policy*. Ministry of Natural Resources and Tourism, Tanzania. 59pp.
- Moreno-Black, G.; Pomnasong, P. and Thanithawan, S. (1994). *Women in Northern Thailand: Preservers of Botanical Diversity, Vol. 2*.
- Mugabe J. and Clark N. (1998). *Managing Biodiversity: National Systems of Conservation and Innovation in Africa*. African centre for technology studies (ACTS), Nairobi Kenya. 279pp.
- Mwansasu, S., (1992). *Proposed forest reserve inventory report*. p 7 (unpublished).
- National Forestry Institute (NFI), (1996). *Results for Arusha, Dodoma and Singida Regions 1992 – 1996*. Survey and Inventory section, Forestry and Beekeeping division, Ministry of Natural Resources and Tourism, Draft, 35pp

- Nemarundwe, N. and Richards, M. (2002). Participatory Methods for Exploring Livelihood Values derived from forests: Potential and Limitations. In: B.M. Campbell and M. K. Lckert (eds.), *Uncovering the Hidden Forest: Valuation Methods for Woodland and Forest Resources*. Earthscan Publications Ltd., London. pp 168-197.
- Oösting, H.J. (1965). The study of plant communities. An introduction to plant Ecology. 2nd Ed. 440pp.
- Orloci, L. (1967). An Agglomerative Method of classification of plant communities. *Journal of Ecology* **55**: 193 - 205
- Pearce, D. W. and Moran, D. (1994). The Economic Value of Biodiversity. Earthscap, London.
- Peet, R.K. (1974). The measurement of species diversity. Annual Review of ecological systematics **5**: 285- 307
- Pielou, E.C. (1984). The Interpretation of Ecological Data. John Wiley & Sons, New York.
- Posey, D. A. (1996). "Protecting Indigenous Peoples' Rights to Biodiversity." Environment (October): 6+.
- Posey, D.A. (1999). Cultural and spiritual value of Biodiversity: A complementary contribution to the Global Biodiversity Assessment. UNEP, Nairobi, Kenya.
- Rocheleau, D., Weber, F and Field-Juma, A (1988). Agroforestry in Dryland Africa. ICRAF, Nairobi, Kenya.
- Rodgers, W. A. (1996). The Miombo woodlands. In: (Madanaha and Young Eds.) East African habitat; Oxford University Press, D.C.pp3-8.
- Rosero-Bixby, L. and Palloni, A. (1996). "Population and Deforestation in Costa Rica," Working Paper No. 96-19 (University of Wisconsin-Madison: Center for Demography and Ecology, 1996): 24.
- South and Central African Development Coroeration (SADC) Energy sectors (1999). Energy statistics YearBook for 1990/91 – 2007/08. TAU, Luanda.
- Saxena,A.K. and Singh, J.S. (1982). A pytosociological analysis of woody species in forest communities of a part of Kumaun Himalaya. Vegetatio. Vol. **50**:3-32
- Scoones, I. (ed) (1995). Living with Uncertainty: New directions in Pastoral Development in Africa. London: International Institute for Environment and Development (IIED).

- Senanayake, R. (1999). Voices of the Earth. In: Cultural and Spiritual Values of biodiversity. A Contribution to the Global Biodiversity Assessment, pp119 – 166, (Possey, D. A. ed). UNEP. Intermediate Technology Publications (it). Nairobi, Kenya.
- Serwaa-Asamoah, A. (1990). Villagers perception towards Monkeys and Sanctuary. Unpublished Bsc., KUST, Kumasi.
- Shackelton, C.M. (2000). Comparison of plant diversity in protected and communal lands in the Bushbuckridge Lowveld savanna, South Africa. *Biological conservation*: 273 –285
- Shackelton, C.M., Griffen, N.J., Banks, D.I., Mavradonis, J.M. and Shackelton, S.E. (1994). Community structure and species composition along a distance gradient in a communally managed South African savanna vegetation. 157-167
- Shannon, C.I. and Wiener, W. (1949). *The mathematical theory of communication*. University of Illinois press, Urbana, Illinois.
- Singida Rural District Council (SDC) (2002). Mission Report to Singida Rural District Council
- Sjöholm H. (1988). Identification of an approach to the management of natural forest reserves in the Singida region Tanzania. Swedforest consulting AB, 28P.
- Sørensen, T. (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. *Bind V. Nr. 4*, Copenhagen.
- Sosovelle, H., Shechambo, F. and Jambiya, G. (1999). Round Table Discussion on Wildlife Policy (1998) and Community Based Conservation. IRA and EPIQ – Tanzania, Bagamoyo.
- Strategic Analysis and Planning Unit (SAPU) (2001). Community based Forest Management guidelines. Ministry of Natural Resources and Tourism, SAPU, Forestry and Beekeeping Div; Min. Natural Resources and Tourism, Dar es Salaam, 86p
- Tuxill, J. and Nabhan, G.P. (2001). *People, Plants and Protected areas: A Guide to In Situ Management*. Earthscan Publications LTD, UK and USA. pp 110-115
- United Nations Environmental Programme (UNEP) (1991). *The State of the World Environment*, UNEP, Nairobi, Kenya.
- UNEP (1995). *Global Biodiversity Assessment*. Cambridge University Press
- UNEP (1996). *Desertification Control Bulletin. A Bulletin of World Events in the control of Desertification, Restoration of Degraded Lands and Reforestation*. UNEP. Nairobi, Kenya.
- United Nations (1992): *Nations of the Earth report. UNCED national reports summaries*. NY

- United Republic of Tanzania (URT) (2003). Poverty and Human Development Report 2003. 162pp Dar es salaam
- URT (1998). Country Study on Biological Diversity. UNEP/GEC/NORAD
- URT (2004). Poverty Reduction Strategy: The third progress report 2002/03. 77pp Dar es Salaam.
- URT (2002). Johannesburg Summit 2002. "Country Profile" accessed at <http://www.un.org/esa/agenda21/natlinfo/wssd/tanzania> on 7th June 2005.
- Walter, R.T. and Gillet, J. H. (1997). The IUCN Species Survival Commission. 1997 IUCN Red list of Threatened Plants.
- Wells, M. P. (1994). Biodiversity conservation and Local peoples' Development aspiration: New priorities for the 1990's. Network paper 18a Tunnelevien 3, 3400 Lier, Norway.
- White, F. (1983). Vegetation of Africa. National Resources Research No 20 UNESCO, Paris 356pp.
- Whittaker, H.G. (1970). Communities and Ecosystems. Collier-Macmillian Ltd. London
- Wily, A.L. (2001). Facilitation towards community based forest management of Minyughe woodland, Singida
- World Bank, (1992). World Development Report 1992. Development and the Environment. Oxford University Press.
- World Bank, (2000). Poverty reduction and the World Bank: Progress in Fiscal 1999, World Bank, Washington.
- World Conservation and Monitoring Centre (WCMC), (1992). Global Biodiversity: The Status of the Earth's Living Resources. WCMC, Chapman and Hall, London.
- World Resources Institute (WRI), (1996): World resources 1996-97. New York, Oxford University Press.
- WRI (1990). World Resources 1990-91. New York: Oxford University Press.
- WRI, IUCN, UNEP (1990). Global Biodiversity Strategy: Guidelines for Action to Serve, Study and Use Earth's Biotic Wealth Sustainably and Equitably. Washington DC.
- Zahabu, E. (2001). Impact of Charcoal Extraction on Miombo woodlands at Kitulungalo area Morogoro. Sokoine University of Agriculture. Morogoro Tanzania.
- Zar, J.H. (1999). Biostatistical Analysis. 4th edn. Prentice Hall, Upper Saddle River, New Jersey.

APPENDICES

Appendix A: List of Woody Species Collected and Identified From Minyughe Woodland

(+ denotes present; - denotes absent; NRL = non reserved land; RL = reserved land; T= tree; S= shrub, Ha=Habit).

S/N	V/N	Scientific Name & Author	NRL	RL	Communities						Ha	Family Name
					1	2	3	4	5	6		
1	JB4	<i>Abrus schimperi</i> Bak. ssp. <i>Africana</i> verdc.	+	+	-	+	+	+	+	+	S	Fabaceae
2	JB34	<i>Acacia polyacantha</i> Willd	+	+	+	+	-	+	+	+	T	Fabaceae
3	JB61	<i>Acacia senegal</i> (L.) Willd	-	+	-	+	+	+	+	-	T	Fabaceae
4	JB44	<i>Acacia sieberana</i> D.C	+	+	-	+	-	-	+	+	T	Fabaceae
5	JB45	<i>Acacia tortilis</i> (Forssk) Hayne	+	+	-	+	-	+	+	+	T	Fabaceae
6	JB46	<i>Adansonia digitata</i> L.	+	-	+	+	+	+	+	-	T	Bombacaceae
7	JB66	<i>Aeschynomene abyssinica</i> (A. Rich.) Vatke	+	+	-	-	+	-	+	+	T	Balanitaceae
8	JB35	<i>Azzeria quanzensis</i> Welw.	+	+	+	+	+	+	+	-	T	Fabaceae
9	JB117	<i>Albizia anthelmintica</i> Brongn	-	+	-	+	+	-	-	-	T	Fabaceae
10	JB41	<i>Albizia gemifera</i>	+	+	-	+	+	+	-	-	T	Fabaceae
11	JB43	<i>Albizia harveyi</i> Fourn	-	+	-	+	-	-	-	-	T	Fabaceae
12	JB65	<i>Allophylus africanus</i> P.Beauv	-	+	+	+	+	-	-	-	S	Sapindaceae
13	JB118	<i>Antidesma venosum</i> Tul.	-	+	-	+	+	+	+	-	S	Euphorbiaceae
14	JB119	<i>Asparagus falcatus</i> L.	-	+	-	+	+	+	+	-	S	Asparagaceae
15	JB36	<i>Azanza garckeana</i> (F. Hoffm.) Excell & Hillcoat	-	+	-	-	-	-	-	-	T	Malvaceae
16	JB120	<i>Balanites aegyptica</i> (L) Del.	-	+	-	+	+	-	-	+	T	Balanitaceae
17	JB121	<i>Borassus aethiopum</i> Mart.	-	+	-	-	-	-	+	-	T	Palmae
18	JB37	<i>Boscia angustifolia</i> A. Rich.	-	+	-	+	-	-	-	+	T	Capparidaceae
19	JB47	<i>Boscia mossambicensis</i> Klotzsch.	-	+	-	-	-	-	+	-	T	Capparidaceae
20	JB38	<i>Boscia salicifolia</i> Oliv.	+	+	-	+	-	-	+	-	T	Capparidaceae
21	JB122	<i>Brachystegia microphylla</i> Harms	+	+	+	+	+	+	+	-	T	Fabaceae
22	JB39	<i>Brachystegia speciformis</i> Benth	-	+	+	+	+	+	+	+	T	Fabaceae
23	JB40	<i>Bredelia cathartica</i> Bertol. F.	-	+	-	+	+	-	-	-	T	Euphorbiaceae
24	JB123	<i>Burkea africana</i> D.C.	-	+	-	+	+	-	-	-	T	Fabaceae
25	JB62	<i>Cadaba farinosa</i> Forssk	+	+	-	-	-	-	+	-	S	Caparidaceae
26	JB42	<i>Canthium burtii</i> Ballock	-	+	+	+	+	+	+	+	T	Rubiaceae
27	JB20	<i>Capparis tomentosa</i> Lam.	-	+	-	-	+	-	+	-	T	Caparidaceae
28	JB19	<i>Cassia abbreviata</i> Oliv.subsp. Abreviata	-	+	+	+	+	-	-	-	T	Fabaceae
29	JB111	<i>Cassia singueana</i> (Del) Lock	+	+	-	+	+	-	+	-	T	Fabaceae
30	JB18	<i>Cassipourea mollis</i> (R.E.Fr) Alston	+	+	+	+	+	+	-	+	S	Rhiphoraceae
31	JB112	<i>Catunaregum spinosa</i> (Thumb)Tirveng	+	+	+	+	+	+	+	+	T	Rubiaceae
32	JB17	<i>Combretum collinum</i> Fresen	+	+	-	+	+	-	+	-	T	Combretaceae
33	JB59	<i>Combretum constrictum</i> (Benth) Laws	+	+	+	-	+	+	+	+	T	Combretaceae
34	JB113	<i>Combretum fragrans</i> F. Hoffm	-	+	-	+	+	+	+	+	T	Combretaceae

Appendix A continued

35	JB16	<i>Combretum hereroense</i> Schinz	-	+	-	+	-	-	+	-	T	Combretaceae
36	JB114	<i>Combretum molle</i> G.Don.	+	+	-	-	+	+	-	+	T	Combretaceae
37	JB15	<i>Combretum mossambicense</i> (Klotzsch) Engl.	+	+	-	+	+	+	+	+	T	Combretaceae
38	JB115	<i>Combretum obovatum</i> F.Hoffin	+	+	-	-	-	-	+	+	S	Combretaceae
39	JB116	<i>Combretum paniculatum</i> Vent.	+	+	+	+	-	-	+	-	T	Combretaceae
40	JB14	<i>Combretum zeyheri</i> Send.	+	+	-	-	+	-	+	+	T	Combretaceae
41	JB106	<i>Commiphora africana</i> (A.Rich.)Engl.	+	+	+	+	+	+	+	+	T	Burseraceae
42	JB13	<i>Commiphora mombassensis</i> Engl.	+	+	+	+	+	+	+	+	T	Burseraceae
43	JB108	<i>Commiphora mossambicensis</i> Engl.	+	+	+	+	+	-	+	+	T	Burseraceae
44	JB109	<i>Commiphora schimperi</i> (O. Berg)Engl.	+	+	-	-	+	+	+	-	S	Burseraceae
45	JB110	<i>Commiphora ugogensis</i> Engl.	+	+	-	-	+	+	-	-	T	Burseraceae
46	JB12	<i>Dalbergia boehmii</i> Taub.	+	+	+	+	+	+	+	+	T	Fabaceae
47	JB105	<i>Dalbergia melanoxylo</i> Guill and Perr.	+	+	+	+	-	-	-	-	T	Fabaceae
48	JB80	<i>Dalbergia nitidula</i> Welw.ex Baker	+	+	+	+	-	+	+	-	T	Fabaceae
49	JB11	<i>Dichrostachys cinerea</i> (L.) Wight & Arn.	-	+	-	-	+	+	+	-	S	Fabaceae
50	JB81	<i>Diosperos zombensis</i> (B. L. Burt) F. White	-	+	+	+	+	-	+	+	S	Ebenaceae
51	JB103	<i>Diospyros fischeri</i> Gurke	+	+	-	-	-	-	-	-	S	Ebenaceae
52	JB104	<i>Ehretia amoena</i> Klotzsh	-	+	-	+	+	+	-	-	T	Boraginaceae
53	JB10	<i>Euphorbia metabelensis</i> Pax.	-	+	-	-	+	-	-	-	S	Euphorbiaceae
54	JB82	<i>Euphorbia candelabrum</i> Kotschy	-	+	-	-	-	-	-	+	S	Euphorbiaceae
55	JB83	<i>Euphorbia grantii</i> L.	-	+	-	-	+	-	-	+	T	Euphorbiaceae
56	JB9	<i>Flacourtia indica</i> (Burm. F.) Merrill.	+	+	-	-	-	-	-	-	T	Flacourtiaceae
57	JB79	<i>Flueggea virosa</i> (Willd) Voigt.	-	+	-	+	+	-	-	-	T	Euphorbiaceae
58	JB84	<i>Grewia bicolor</i> Juss.	+	+	-	+	+	-	+	-	S	Tiliaceae
59	JB102	<i>Grewia burtii</i> L.	-	+	+	+	+	+	+	+	S	Tiliaceae
60	JB21	<i>Grewia fallax</i> K. Schum.	+	+	-	-	-	+	+	-	S	Tiliaceae
61	JB99	<i>Grewia fobersii</i> Mast	-	+	+	-	+	-	+	-	S	Tiliaceae
62	JB54	<i>Grewia mollis</i> Juss.	-	+	-	-	-	-	+	-	S	Tiliaceae
63	JB85	<i>Grewia platyclada</i> Juss.	+	+	-	+	-	-	+	-	S	Tiliaceae
64	JB23	<i>Harrissonia abyssinica</i> Oliv.	+	+	-	-	+	-	-	-	T	Simaroubaceae
65	JB55	<i>Hoslundia opposita</i> Vahl	+	+	-	-	+	+	+	+	S	Labiatae
66	JB24	<i>H.parvifolium</i> Oliv susp. <i>Scabrum</i> (Stapf) Verdc.	+	+	-	-	+	-	-	+	S	Rubiaceae
67	JB78	<i>I. rynchocarpa</i> Welw.ex Baker var. <i>rhyncocarpa</i>	+	+	+	+	+	-	+	+	S	Fabaceae
68	JB86	<i>Julbernardia globiflora</i> (Benth) Troupin	+	+	-	+	+	-	-	-	T	Fabaceae
69	JB25	<i>Kiggeria africana</i> (K. aethiopica) (Lam) Benth.	+	+	+	+	+	+	+	+	T	Bignoniaceae
70	JB1	<i>Lannea humilis</i> (Oliv) Engl.	+	+	-	-	-	-	+	-	T	Anacardiaceae

Appendix A continued

71	JB87	<i>Lannea schimperi</i> (Hochst. Ex.A. Rich.)	+	+	+	+	-	-	+	+	T	Anacardiaceae
72	JB56	<i>Lonchocarpus capassa</i> Harms	+	+	-	+	-	-	+	+	T	Fabaceae
73	JB88	<i>Maerua angolensis</i> D. C.	-	+	-	-	+	-	+	+	S	Caparidaceae
74	JB2	<i>Maerua edulis</i> Gilg.	-	+	-	-	+	-	-	-	S	Caparidaceae
75	JB89	<i>Maerua kirkii</i> (Oliv) F. White	-	+	-	-	-	+	-	+	S	Caparidaceae
76	JB3	<i>Maltidentia crassa</i> (Hiern) Bridson & Verdc.	+	+	-	-	-	-	+	-	S	Rubiaceae
77	JB90	<i>Markhamia obtusifolia</i> (Baker) Sprague	+	+	+	+	+	+	+	+	T	Bignoniaceae
78	JB57	<i>Monotis africanus</i> A. DC.	-	+	-	+	+	-	+	-	S	Dilaniaceae
79	JB75	<i>Ormocarpum kirkii</i> S. Moore	-	+	-	+	+	-	+	-	T	Fabaceae
80	JB101	<i>O. insignis</i> Delile subsp. <i>Reticulata</i> (Baker f.) J.B Gillet	+	+	-	+	-	-	+	-	S	Anacardiaceae
81	JB5	<i>Parinari curatellifolia</i> Benth.	-	+	-	-	+	-	+	-	T	Chrysobalanaceae
82	JB74	<i>Pavetta gardenafolia</i> A. Rich. var. <i>gardeniifolia</i>	+	+	-	-	-	-	-	+	S	Rubiaceae
83	JB100	<i>Pavetta stuhlmanii</i> Verd.	+	+	-	+	+	+	+	+	T	Rubiaceae
84	JB6	<i>Pericopsis angolensis</i> D.C.	-	+	+	+	+	+	-	-	T	Rubiaceae
85	JB58	<i>Phyllanthus englerii</i> Hutch	-	+	-	+	+	-	-	-	T	Euphorbiaceae
86	JB7	<i>Plectranthus barbatus</i> Andr.	-	+	+	+	-	-	+	-	S	Labiatae
87	JB73	<i>Pluchia dioscoridis</i> D.C.	+	+	-	-	-	-	+	-	T	Compositae
88	JB98	<i>Pseudolachmostylis maprouneifolia</i> Pax	+	+	-	+	+	-	+	-	T	Fabaceae
89	JB8	<i>Pseudoprosopis fischeri</i> D. C.	+	+	-	-	+	+	-	+	T	Fabaceae
90	JB97	<i>Pterocarpus angolensis</i> DC	+	+	+	+	+	-	-	+	T	Fabaceae
91	JB63	<i>Rourea orientalis</i> Baill	+	-	-	-	-	-	-	-	S	Connaraceae
92	JB26	<i>Schreberia trichoclada</i> Welw Syn	+	+	+	+	-	+	-	-	S	Oleaceae
93	JB72	<i>Sterocaria birrea</i> var. <i>multifolia</i> (A. Rich) Hochst.	-	+	+	+	-	+	-	-	T	Anacardiaceae
94	JB96	<i>Securidaca longipendunculata</i> Fres.	+	+	-	+	-	+	-	-	S	Polygalaceae
95	JB60	<i>Solanum incanum</i> L.	+	+	-	-	-	-	+	+	S	Solanaceae
96	JB27	<i>Sterculia quinqueloba</i> (Garcke) K. Schum	+	+	-	-	+	-	-	+	T	Sterculiaceae
97	JB95	<i>Strophanthus eminii</i> Ach. & Pax.	+	+	+	+	+	-	-	-	T	Apocinaceae
98	JB71	<i>Strychnos innocua</i> Del.	+	+	+	+	-	+	+	-	T	Loganiaceae
99	JB28	<i>Strychnos pototorum</i> L.F	-	-	-	+	+	-	+	-	T	Loganiaceae
100	JB50	<i>Strychnos pungensis</i> Solered	-	+	+	-	+	+	-	-	T	Loganiaceae
101	JB94	<i>Swartzia madagascariensis</i> (Desv.)	+	+	-	-	+	-	+	+	T	Fabaceae
102	JB29	<i>Tapiphyllum burnettii</i> Tennant	-	+	-	+	+	-	+	-	T	Rubiaceae
103	JB93	<i>Tarrena graveolens</i> (S. Moore) Bremek	-	+	-	+	-	-	+	-	T	Rubiaceae
104	JB30	<i>Teclea nobilis</i> Del.	+	+	+	+	+	-	+	-	T	Rutaceae
105	JB92	<i>Tamarindus indica</i> L.	+	+	+	+	+	+	+	-	T	Fabaceae
106	JB51	<i>Terminalia sericea</i> Burch.ex DC.	+	+	+	+	+	+	+	+	T	Combretaceae
107	JB91	<i>Terminalia spinosa</i> Engl.	+	+	+	+	+	+	+	+	T	Combretaceae
108	JB31	<i>Thylachium africanus</i> Lour.	+	+	+	-	+	-	+	-	T	Capparidaceae

Appendix A continued

109	JB69	<i>Vangueria infausta</i> (<i>V. tomentosa</i>) Burch	-	+	+	+	+	-	-	-	S	Rubiaceae
110	JB67	<i>Vangueria madagascalensis</i>	-	+	-	+	-	-	+	-	T	Rubiaceae
111	JB32	<i>Vitex mombassae</i> Vatke	+	+	+	+	-	+	-	-	T	Verbenaceae
112	JB52	<i>Vitex payos</i> (Lour.) Merr.									S	Verbenaceae
113	JB68	<i>Xeroderris stuhlmanii</i> (Taub) Mendonca & E.P.Sousa	-	+	-	+	+	+	+	+	T	Fabaceae
114	JB53	<i>Ximania americana</i> L.	+	+	-	+	-	-	-	+	S	Olacaceae
115	JB70	<i>Ximenia caffra</i> Sond.									S	Olacaceae
116	JB48	<i>Zanha africana</i> (Radlk) Exell	-	+	-	-	-	-	-	-	T	Sapindaceae
117	JB33	<i>Zanthoxylon chalybeum</i> Engl. Varchalybeum	-	+	+	+	-	-	+	-	S	Rutaceae

Appendix B: List of Useful Woody Species Identified From Minyughe Woodland
(* = Scarce species; * = not found in the field)

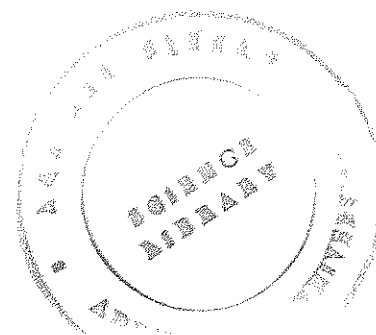
S/N	Nyaturu Name	Sukuma Name	V/ No	Scientific Name	Habit	Family
1	Muhinti	Itinje	JB1	<i>L. humilis</i>	T	Anacardiaceae
	Mulade Wa	Nsana	JB3	<i>M. crassa</i> **	S	Rubiaceae
2	Puma					
3	Mukankhosi	Nsungululu	JB6	<i>S. emanii</i>	T	Apocynaceae
4	Ngage	Hogo	JB7	<i>P. barbatum</i>	T	Labiatae
5	Mutunduu	Ntunduru	JB11	<i>D. cinerea</i>	S	Fabaceae
6	Muhanyatre	Nsana	JB14	<i>C. zeyheri</i>	T	Combretaceae
7	Mobula	Ilandala	JB17	<i>C. collinum</i>	T	Combretaceae
8	Mjuampiti	Nugala	JB18	<i>C. mollis</i>	S	Rhizoporaceae
9	Mndaa	Nundalunda	JB19	<i>C. abbreviata</i> **	T	Fabaceae
10	Mupogho	Mpelemese	JB22	<i>G. farbersii</i>	S	Tiliaceae
11	Mungungu	Ng' Wicha	JB25	<i>K. africana</i>	T	Bignoniaceae
12	Muruma	Mbudika	JB26	<i>S. trichoclada</i>	S	Oleaceae
13	Mupandepande	Mpande	JB28	<i>S. pototorum</i> **	T	Loganiaceae
14	Mubaghai		JB29	<i>T. burnatii</i>	T	Rubiaceae
15	Mpaghatia		Jb30	<i>T. nobilis</i>	T	Rutaceae
16	Musasati	Nsungwi	JB32	<i>V. mombassae</i>	T	Verbenaceae
17	Mulungu	Nungu	JB33	<i>Z. chalybeum</i> **	S	Rutaceae
18	Mukese	Ngu	JB34	<i>A. polyacantha</i>	T	Fabaceae
19	Mnkhoa	Nkola	JB35	<i>A. quanzensis</i> **	T	Fabaceae
20	Mutroghe		JB36	<i>A. garckeana</i>	T	Malvaceae
21	Mutrumba		Jb37	<i>B. angustifolia</i>	T	Capparidaceae
22	Mfumbu	Ntundu	JB39	<i>B. speciformis</i> **	T	Fabaceae
23	Msule	Nkamu	JB42	<i>C. burtii</i> **	T	Rubiaceae
24	Mughunga	Ngunga	JB45	<i>A. tortilis</i> **	T	Fabaceae
25	Muandu	Ng'wandu	JB46	<i>A. digitata</i>	T	Bignoniaceae
26	Muhingiri	Ihingili	JB47	<i>B. mossambicensis</i>	S	Capparidaceae
27	Mujiuyo	Ng' Watya	JB48	<i>Z. africana</i> **	T	Sapindaceae
28	Mofuru	Njima	JB51	<i>T. sericea</i>	T	Combretaceae
29	Mufuu		JB52	<i>V. payos</i>	S	Verbenaceae
30	Mutrundwe	Ntundwa	JB53	<i>X. americana</i>	S	Olacaceae

Appendix B continued

31	Musuna	Nkoma	JB54	<i>G. mollis</i>	S	Tiliaceae
32		Mmale	JB56	<i>L. capassa</i>	T	Fabaceae
33	Mutula	Itula	JB60	<i>S. incanum</i>	S	Solanaceae
34	Mukhubo	Igwata	JB61	<i>A. senegal</i>	S	Fabaceae
35		Ntundusubuya	JB62	<i>C. farinosa</i>	S	Capparidaceae
36		Ningwiwe	JB65	<i>A. africanus</i>	S	Sapindaceae
	Mwamui	Ikulwang'	JB69	<i>V. infausta</i>	T	Rubiaceae
37		Hwale				
	Mupundu	Ikulwang'	JB71	<i>S. innocua</i>	T	Loganiaceae
38		Hwale				
39	Muhuvi	Ng' Ongwa	JB72	<i>S. birrea var. multiforia</i> **	T	Anacardiaceae
40		Igangula	JB78	<i>I. rynchocarpa</i>	T	Fabaceae
41	Mubibi	Nswiswi	JB80	<i>D. nitundila</i>	T	Fabaceae
	Musuna -Nu-	Nkoma	JB84	<i>G. bicolor</i>	S	Tiliaceae
42	Nkuu					
43	Musankua	Ndagwasa	JB85	<i>G. platyclada</i>	T	Tiliaceae
44	Mukinki	Ntundu	JB86	<i>J. globiflora</i>	T	Fabaceae
45	Mlelei	Mbapa	JB90	<i>M. obtusifolia</i>	T	Bignoniaceae
46		KASANDA	JB94	<i>S. madagascalensis</i>	T	Fabaceae
47	MohanURTre	Nsungululu	JB95	<i>S. eminii</i>	T	Apocynaceae
48	Msato	Nengonengo	JB96	<i>S. longipendunculata</i> **	S	Verbenaceae
49	Munyinga	Ng' Wininga	JB97	<i>P. angolensis</i> **	T	Fabaceae
50	Munyunguampembee		Jb101	<i>O. insignis</i>	T	Anacardiaceae
51	Msekeanja	Nsubata	JB103	<i>D. fischeri</i>	S	Ebenaceae
52	Mfako	Gembe	JB105	<i>D. melanoxylon</i> **	T	Fabaceae
53	Mlahaa	Mponda	JB106	<i>C. africana</i>	T	Burseraceae
54	Mujuhu	Mponda	JB109	<i>C. schimperi</i>	T	Burseraceae
55	Musake	Nsusu	JB110	<i>C. ugogensis</i>	T	Burseraceae
	Mupongwe	Ng'	JB112	<i>C. spinosa</i>	T	Rubiaceae
56		Ochangoko				
57	Mulama	Nnama	JB114	<i>C. molle</i>	T	Combretaceae
	Igombogombo	Igobeko	JB115	<i>C. obovatum</i>	S	Combretaceae
58		Igosha				
59	Mlahai	Lizuzu	JB116	<i>C. paniculata</i>	S	Combretaceae
60	Muduguyu	Nyuguyu	JB120	<i>B. aegyptica</i>	T	Balanitaceae
61	Mfama	Ihama	JB121	<i>B. aehtiopum</i>	T	Palmae
62	Mughaghea		Jb122	<i>B. microphylla</i> **	T	Fabaceae
63	Mutundwe	Mpingi	JB70	<i>X. Caffra</i>	S	Olacaceae
64	Mkwaju	Nshishi	JB92	<i>T. indica</i>	T	Fabaceae
	Musagha	Nsayu		<i>L. schweinfurthii var. stuhlmanii</i> *	S	Anacardiaceae
65						
66	Mufetru			<i>B. massaiensis</i> *	S	Fabaceae
67	Mutungulu	Isambula		<i>S. singueana</i> *	S	Fabaceae
68	Mhalage	Lweja		<i>A. lanata</i> *	S	Amaranthaceae
69	Mjembua	Nnene	JB68	<i>X.stuhlmanii</i>	T	Fabaceae
71			JB117	<i>A. anthelmintica</i>		Fabaceae

Appendix C: List of Highly Utilized Multipurpose Woody Plant Species Identified From Minyughe Woodland

S/N	Species name	Habit	Medicinal	Poles	Timber	Building	Charcoal	Firewood	Fodder	Rituals	Edible	Beehives
1	<i>A. digitata</i>	T	-	-	-	-	-	-	+	+	+	+
2	<i>A. garckeana</i>	T	-	-	-	-	+	+	-	-	+	-
3	<i>A. polyacantha</i>	T	-	-	-	+	-	-	+	-	+	-
4	<i>A. quanzensis</i>	T	-	+	+	+	+	+	+	+	-	+
5	<i>A. senegal</i>	S	+	-	-	+	-	-	-	-	-	-
6	<i>A. tortilis</i>	T	-	+	+	+	+	+	+	-	-	-
7	<i>B. aegyptica</i>	T	+	-	-	-	-	-	+	+	+	-
8	<i>B. aehtiopum</i>	T	-	+	-	+	-	-	-	-	+	-
9	<i>B. microphylla</i>	T	+	+	+	+	+	+	+	-	-	+
10	<i>B. speciformis</i>	T	-	+	+	+	+	+	+	-	-	+
11	<i>C. abbreviata</i>	T	+	-	+	-	-	-	-	-	+	-
12	<i>C. burtii</i>	T	-	+	-	+	-	+	-	+	-	-
13	<i>C. collinum</i>	T	-	+	-	+	-	+	-	-	-	+
14	<i>C. farinosa</i>	S	-	+	-	+	-	+	-	-	+	-
15	<i>C. molle</i>	T	-	+	-	+	-	+	-	+	-	-
16	<i>C. mollis</i>	S	+	+	-	+	-	+	-	+	-	+
17	<i>C. ugogensis</i>	T	-	+	-	+	-	-	-	-	-	+
18	<i>C. zeyheri</i>	T	+	+	-	+	+	+	-	-	-	-
19	<i>D. cinerea</i>	S	+	+	-	+	+	+	+	-	-	-
20	<i>D. melanoxydon</i>	T	+	+	+	+	+	+	+	+	-	-
21	<i>G. bicolor</i>	S	+	+	-	+	+	+	+	+	+	-
22	<i>G. farbersii</i>	S	-	-	+	-	+	+	+	-	-	+
23	<i>G. mollis</i>	S	-	-	-	+	-	+	+	-	+	-
24	<i>J. globiflora</i>	T	-	+	+	+	-	-	+	+	-	+
25	<i>K. africana</i>	T	-	+	+	+	+	-	+	-	-	+
26	<i>L. capassa</i>	S	+	-	-	+	-	-	-	-	-	-
27	<i>L. humilis</i>	T	+	-	-	+	-	+	-	-	-	+
28	<i>M. crassa</i>	S	+	-	-	+	-	+	-	-	+	-
29	<i>M. obtusifolia</i>	T	+	+	-	+	-	-	+	-	+	-
30	<i>P. angolensis</i>	T	+	+	+	+	-	+	-	-	-	-
31	<i>S. birrea var. multiflora</i>	T	+	+	+	+	+	-	+	+	-	+
32	<i>S. innocua</i>	T	-	+	-	-	+	+	-	+	-	-
33	<i>S. pototorum</i>	T	+	+	-	+	-	+	+	-	-	-
34	<i>S. trichoclada</i>	T	+	-	-	+	-	+	-	+	-	-
35	<i>T. sericea</i>	T	+	+	+	+	+	+	+	+	-	-
36	<i>V. infausta</i>	S	+	+	-	-	-	+	-	-	-	-
37	<i>V. mombassae</i>	T	+	-	-	+	+	+	+	-	+	-
38	<i>V. payos</i>	T	+	-	+	-	-	+	+	-	+	-
39	<i>Z. africana</i>	T	+	-	-	-	-	-	-	-	+	-
40	<i>Z. chalybeum</i>	S	+	+	+	+	-	-	-	-	-	-
	TOTAL		23	25	14	31	15	26	18	13	14	12



Appendix D: Summary of Calculated Parameters for Tree Species Recorded From the Unreserved land

Species name	Dbh(cm) 4.1-10	Dbh cm) 10.1- 20	Dbh(c m) >20	Basal area	Rel dom	Rel. freq.	Rel. density	I V I
<i>Acacia polyacantha</i>	0.3	0	14.2	14.5	6.84	1.3	1.31	9.46
<i>Acacia sieberiana</i>	0.13	0	1.27	1.4	0.66	0.43	0.44	1.53
<i>Acacia tortilis</i>	1.12	3.44	0	4.56	2.15	3.91	3.93	9.99
<i>Adansonia digitata</i>	0.15	0	40.8	40.95	19.3	1.3	1.31	21.9
<i>Aeschynomene abyssinica</i>	0	0.65	0	0.65	0.31	0.43	0.44	1.18
<i>Azeria quanzensis</i>	0.14	0.38	0	0.52	0.25	0.43	0.44	1.12
<i>Albizia gemifera</i>	0.68	1.32	0.68	2.68	1.26	3.04	3.06	7.36
<i>Albizia gemifera</i>	0	0.65	0	0.65	0.31	0.43	0.44	1.18
<i>Brachystegia microphylla</i>	0.34	1	4	5.34	2.52	3.91	3.93	10.4
<i>Brachystegia speciformis</i>	1.11	0.33	8	9.44	4.45	12.6	12.7	29.7
<i>Burkea africana</i>	0	0.65	0	0.65	0.31	0.43	0.44	1.18
<i>Canthium burtii</i>	0.19	0.25	0	0.44	0.21	0.87	0.87	1.95
<i>C. abbreviata Oliv.subsp. abbreviata</i>	0.13	0	0	0.13	0.06	0.43	0.44	0.93
<i>Cassia singueana</i>	0	0.58	0	0.58	0.27	0.43	0.44	1.15
<i>Catunaregum spinosa</i>	0.16	0	0	0.16	0.08	0.43	0.44	0.95
<i>Combretum collinum</i>	0.68	1.32	0.68	2.68	1.26	3.04	3.06	7.36
<i>Combretum constrictum</i>	0.14	0	1.58	1.72	0.81	0.87	0.87	2.55
<i>Combretum molle</i>	0.2	0.72	4.1	5.02	2.37	3.04	3.06	8.47
<i>Combretum mossambicense</i>	0.68	1.32	0.68	2.68	1.26	3.04	3.06	7.36
<i>Combretum paniculatum</i>	0.18	0.44	0	0.62	0.29	1.8	1.31	3.4
<i>Combretum zeyheri</i>	0.27	0	0	0.27	0.13	1.3	1.31	2.74
<i>Commiphora africana</i>	0.34	1.6	1.61	3.55	1.67	2.17	2.18	6.03
<i>Commiphora mombassensis</i>	0.19	0	0	0.19	0.09	0.87	0.87	1.83
<i>Commiphora mossambicensis</i>	0	0	3.11	3.11	1.47	0.43	0.44	2.34
<i>Commiphora ugogensis</i>	1.02	2.92	5.17	9.11	4.3	5.65	5.68	15.6
<i>Dalbergia boehmii</i>	0.12	1.01	5.16	6.29	2.97	3.04	3.06	9.07
<i>Dalbergia melanoxylon</i>	0.18	0.44	0	0.62	0.29	1.8	1.31	3.4
<i>Dalbergia nitundila</i>	0.14	0	0	0.14	0.07	0.43	0.44	0.94
<i>Flacourtia indica</i>	0.19	0	0	0.19	0.09	0.43	0.44	0.96
<i>Harrissonia abyssinica</i>	0.18	0	0	0.18	0.08	0.43	0.44	0.96
<i>Julbernadia globiflora</i>	0	3.02	8.8	11.82	5.58	6.52	6.55	18.6
<i>Kiggeria africana</i>	0	0	5.1	5.1	2.41	0.43	0.44	3.28
<i>Lannea humilis</i>	0.23		3.18	3.41	1.61	1.74	1.75	5.09
<i>Lannea schimperi</i>	0.66	1.64	1.27	3.57	1.68	3.48	3.49	8.66
<i>Lonchocarpus capassa</i>	0.29	0	0.98	1.27	0.6	0.87	0.87	2.34
<i>Markhamia obtusifolia</i>	0.44	1.68	0	2.12	1	2.61	2.62	6.23
<i>Parinari curatellifolia</i>	0.19	0	0	0.19	0.09	0.43	0.44	0.96
<i>Pavetta stuhlmanii</i>	0.18	0	0	0.18	0.08	0.43	0.44	0.96
<i>Pluchia dioscoridis</i>	0.19	0	0	0.19	0.09	0.43	0.44	0.96
<i>Pseudolachmostylis maprouneifolia</i>	0	0.34	4.5	4.84	2.28	1.3	1.31	4.9
<i>Pseudoprosopsis fischeri</i>	0.34	0	0	0.34	0.16	0.43	0.44	1.03
<i>Pterocarpus angolensis</i>	0.12	0.45	0	0.57	0.27	1.74	1.75	3.75
<i>Sterculia quinqueloba</i>	0	0	5.09	5.09	2.4	0.43	0.44	3.27
<i>Strophanthus eminii</i>	0	0	1.44	1.44	0.68	0.43	0.44	1.55
<i>Strychnos innocua</i>	0.79	1.14	4.02	5.95	2.81	4.35	4.37	11.5
<i>Swartzia madagascariensis</i>	0	0	1.61	1.61	0.76	0.43	0.44	1.63

Appendix D continued

<i>Tapiphyllum burnettii</i>	0	0.4	0	0.4	0.19	0.43	0.44	1.06
<i>Teclea nobilis Del.</i>	0.47	1.35	3.37	5.19	2.45	3.48	3.49	9.42
<i>Tamarindus indica</i>	0	0	1.61	1.61	0.76	0.43	0.44	1.63
<i>Terminalia sericea</i>	2.55	3.13	0	5.68	2.68	3.48	3.49	9.65
<i>Terminalia spinosa</i>	0.47	1.35	3.37	5.19	2.45	3.48	3.49	9.42
<i>Thylachium africanus</i>	0	0.48	0	0.48	0.23	0.43	0.44	1.1
<i>Vitex mombassae Vatke</i>	0.38	0.63	3.05	4.06	1.92	1.3	1.31	4.53
Total	16.26	34.63	138.43	189.32	89.31	97.79	97.49	284.51

Appendix E: Summary of Calculated Parameters for Tree Species Recorded From the Reserved Land

Species name	Dbh 4.1-10	Dbh10.1-20	dbh>20	Basal area	Rel dom	Rel freq	Rel density	I V I
<i>Acacia polyacantha</i>	0.3	0	14.2	14.5	6.84	1.3	1.31	9.46
<i>Acacia senegal</i>	2	2.4	3	7.4	1.626	2.16	2.2	5.95
<i>A. sieberiana</i>	0.6	2.16	0	2.76	0.606	0.18	0.2	0.97
<i>A. tortilis</i>	4.22	0	5	9.22	2.026	3.06	3.1	8.15
<i>A. digitata</i>	0	0	15	15	3.296	1.08	1.1	5.46
<i>Aeschynomene abyssinica</i>	0.2	0.8	0	1	0.22	0.18	0.2	0.58
<i>A. quanzensis</i>	2	2.4	3	7.4	1.626	2.16	2.2	5.95
<i>A. anthelmintica</i>	0	2.32	3.23	5.55	1.22	0.36	0.4	1.94
<i>Albizia gemifera</i>	0	1.2	0	1.2	0.264	0.18	0.2	0.62
<i>Albizia harveyi</i>	0	0	0	0.58	0.58	0.27	0.44	1.15
<i>A. garekeana</i>	0.8	1	2.55	4.35	0.956	0.36	0.4	1.68
<i>B. aegyptica</i>	2.4	0	8.9	11.3	2.483	0.54	0.5	3.56
<i>Borassus aehtiopum</i>	0	0.65	0	0.65	0.31	0.43	0.44	1.18
<i>Boscia angustifolia</i>	0.19	0.25	0	0.44	0.21	0.87	0.87	1.95
<i>B. mossambicensis</i>	0.2	0.8	0	1	0.22	0.18	0.2	0.58
<i>Boscia salicifolia</i>	0.6	2.16	0	2.76	0.606	0.18	0.2	0.97
<i>B. microphylla</i>	0.4	4.4	6.9	11.7	2.571	2.88	2.9	8.33
<i>B. speciformis</i>	6.9	10	20	36.9	8.108	16	16	40.2
<i>Bredelia cathartica</i>	0.6	0	0	0.6	0.132	2.7	2.7	5.53
<i>Burkea africana</i>	0.6	1.8	1.12	3.52	0.773	0.36	0.4	1.49
<i>Canthium burtii</i>	0.4	2.24	4	6.64	1.459	0.9	0.9	3.26
<i>Capparis tomentosa</i>	1.2	6.4	6.7	14.3	3.142	3.96	4	11.1
<i>C. abbreviata</i>	1.4	4.26	4.2	9.86	2.167	1.44	1.4	5.05
<i>Cassia singueana</i>	0.44	0	0.84	1.28	0.281	0.18	0.2	0.64
<i>Catunaregum spinosa</i>	0.6	0	3.59	4.19	0.921	0.18	0.2	1.28
<i>Combretum collinum</i>	1.2	6.4	6.7	14.3	3.142	3.96	4	11.1
<i>Combretum constrictum</i>	0.22	0.48	0	0.7	0.154	0.36	0.4	0.87
<i>Combretum fragrans</i>	0.2	1	2.3	3.5	0.769	0.36	0.4	1.49
<i>Combretum hereroense</i>	0.46	4.88	7	12.34	2.711	3.6	3.6	9.91
<i>Combretum molle</i>	2	2.68	5	9.68	2.127	3.24	3.2	8.61
<i>Combretum mossambicense</i>	0.6	0	0	0.6	0.132	2.7	2.7	5.53
<i>Combretum paniculatum</i>	2.2	7	8.7	17.9	3.933	0.18	0.2	4.29
<i>Combretum zeyheri</i>	1	0	4.82	5.82	1.279	2.52	2.5	6.32
<i>Commiphora africana</i>	0.46	4.88	7	12.34	2.711	3.6	3.6	9.91
<i>Commiphora mombassensis</i>	0	1.76	0	1.76	0.387	0.72	0.7	1.83
<i>Commiphora mossambicensis</i>	0	0	8.5	8.5	1.868	0.72	0.7	3.31

Appendix E continued

<i>Commiphora ugogensis</i>	0.2	3	3.5	6.7	1.472	4.32	4.3	10.1
<i>Dalbergia boehmii</i>	0	2.78	3.4	6.18	1.358	0.9	0.9	3.16
<i>Dalbergia melanoxyton</i>	0	5	5.4	10.4	2.285	2.52	2.5	7.33
<i>Dalbergia nitundila</i>	1.76	0	2.93	4.69	1.031	0.18	0.2	1.39
<i>Ehretia amoena</i>	0	0.65	0	0.65	0.31	0.43	0.44	1.18
<i>Euphorbia grantii</i>	0.19	0.25	0	0.44	0.21	0.87	0.87	1.95
<i>Flacourtia indica</i>	0.13	0	0	0.13	0.06	0.43	0.44	0.93
<i>Flueggea virosa</i>	0.14	0	1.58	1.72	0.81	0.87	0.87	2.55
<i>Harrissonia abyssinica</i>	2	6.06	6	14.06	3.089	1.62	1.6	6.33
<i>Julbernardia globiflora</i>	2.4	11.6	18	32	7.031	12.8	13	32.6
<i>Kiggeria africana</i>	2.2	0	1.84	4.04	0.888	0.18	0.2	1.25
<i>Lannea humilis</i>	0.46	4.9	0	5.36	1.178	1.62	1.6	4.42
<i>Lannea schimperi</i>	2	6.06	6	14.06	3.089	1.62	1.6	6.33
<i>Lonchocarpus capassa</i>	0.46	0	4	4.46	0.98	0.72	0.7	2.42
<i>Markhamia obtusifolia</i>	0.2	0.8	0	1	0.22	0.18	0.2	0.58
<i>Ormocarpum kirkii</i>	0.8	1	2.55	4.35	0.956	0.36	0.4	1.68
<i>Parinari curatellifolia</i>	2.4	0	8.9	11.3	2.483	0.54	0.5	3.56
<i>Pavetta stuhlmanii</i>	1.2	6.4	6.7	14.3	3.142	3.96	4	11.1
<i>Pericopsis angolensis</i>	0.22	0.48	0	0.7	0.154	0.36	0.4	0.87
<i>Phyllanthus englerii</i>	0.6	0	0	0.6	0.132	2.7	2.7	5.53
<i>Pluchia dioscoridis</i>	2.2	7	8.7	17.9	3.933	0.18	0.2	4.29
<i>Pseudolachmostylis maprouneifolia</i>	0.2	3	3.5	6.7	1.472	4.32	4.3	10.1
<i>Pseudoprosopsis fischeri</i>	0	2.78	3.4	6.18	1.358	0.9	0.9	3.16
<i>Pterocarpus angolensis</i>	0	0.65	0	0.65	0.31	0.43	0.44	1.18
<i>Slerocaria birrea</i> var. <i>multiflora</i> .	0.14	0	1.58	1.72	0.81	0.87	0.87	2.55
<i>Sterculia quinqueloba</i>	0.66	1.64	1.27	3.57	1.68	3.48	3.49	8.66
<i>Strophanthus eminii</i>	0.29	0	0.98	1.27	0.6	0.87	0.87	2.34
<i>Strychnos innocua</i>	0.44	1.68	0	2.12	1	2.61	2.62	6.23
<i>Swartzia madagascariensis</i>	0.19	0	0	0.19	0.09	0.43	0.44	0.96
<i>Tapiphyllum burnettii</i>	0.18	0	0	0.18	0.08	0.43	0.44	0.96
<i>Tarrena graveolens</i>	0.18	0.24	0	0.42	0.2	0.87	0.87	1.94
<i>Teclea nobilis</i>	0	0.34	4.5	4.84	2.28	1.3	1.31	4.9
<i>Tamarindus indica</i>	0.79	1.14	4.02	5.95	2.81	4.35	4.37	11.5
<i>Terminalia sericea</i>	0.87	3.36	2.72	6.95	3.28	6.09	6.11	15.5
<i>Terminalia spinosa</i>	0	0.4	0	0.4	0.19	0.43	0.44	1.06
<i>Thylachium africanus</i>	0	0	1.61	1.61	0.76	0.43	0.44	1.63
<i>Vangueria madagascalensis</i>	2.55	3.13	0	5.68	2.68	3.48	3.49	9.65
<i>Vitex mombassae</i>	0.47	1.35	3.37	5.19	2.45	3.48	3.49	9.42
<i>Xeroderris stuhlmanii</i>	2.2	0	1.84	4.04	0.888	0.18	0.2	1.25
<i>Zanha africana</i>	0.46	4.9	0	5.36	1.178	1.62	1.6	4.42
Total	63.57	154.91	260.54	479.6	120.783	137.98	138.97	397.16

Appendix F: List of Medicinal Woody Species in the Study Area

(L=leaves, R= root, B= bark, W= whole plant, F= fruit, St= stem, T= tree, S= shrub)

S/N	Species name	Nyaturu name	Sukuma name	Habit	Part used	Medicinal use	Preparation method
1	<i>Lannea humilis</i>	Muhinti	Itinje	S	B	Treatment of coughs (nyat., suk.)	Barks are chewed
2	<i>Multidentia crassa</i>	Mulade wa puma	Nsana	T	R	Treatment of hookworms	Roots boiled, decoction taken orally
3	<i>Plectranthus barbatus</i>	Nghage	Hogo	T	R	Treatment of infertility in women (suk., nyat.)	Roots are boiled, decoction taken orally
4	<i>Diclostachys cinerea</i>	Mtunduu	Ntunduru	T	R	Treatment of external wounds (nyat., suk)	Roots are dried, powdered then applied on wounds
5	<i>Combretum zeyheri</i>	Muhanyatre	Nsana	T	R, L	Treatment of stomach pains and malaria (suk., nyat.)	Rots are boiled, decoction taken orally. Leave are chewed
6	<i>Balanites aegyptica</i>	Modogoyu	Nyuguyu	T	B	Treatment of seizer in children	Souk in water, decoction taken orally
7	<i>Cassia abbreviata</i>	Mndaa	Nundalunda	T	R	Treatment of infertility in female (suk, nyat.)	Roots are boiled, decoction taken orally
8	<i>Screbbera trichoclada</i>	Muruma	Mbudika	T	R, F, B	Treatment of cough, headache, stomach ulcers, tonsilitis, toothache and throat sores (nyat.)	Roots or barks are dried and ground, mixed with water then taken orally. Fruit ashes are mixed with honey then aken orally
9	<i>Strychnos innocua</i>	Mukulugundu		S	R, B	Treatment of STDs and snakebites (R)	Roots boiled , decoction taken orally to treat STDs. Pounded roots applied on snakebites. An infusion from bark and twigs is taken orally by pregnant women to ease childbirth.
10	<i>Teclea nobilis</i>	Mupagatia	Mju	T	St	Treatment of abduin pain and prevents abortion in women (nyat.)	Pieces of small branches are tied in waist, small stems are chewed.

Appendix F continued

11	<i>Vitex mombassae</i>	Musasati	Nsungwi	T	R	Treatment of malaria and stomach pains (nyat., suk.)	Roots are boiled, decoction taken orally
12	<i>Zanthoxylon chalybeum</i>	Mulungu	Nungu	S	R, B	Treatment of syphilis (suk), Goitre, tonsillitis, boils and pneumonia (nyat.)	Roots or bark are boiled, decoction taken orally
13	<i>Boscia angustifolia</i>	Mutrumba		T	R, L	Treatment of coughs (nyat.)	Roots are soaked in water then solution is taken orally. Leaves are chewed
14	<i>Zanha africana</i>	Mujiyo	Ng'watya	T	R, B, St	Used as snuffs for the treatment of flue, tooth diseases, dysentery, importance & headache (nyat., suk.)	Roots and Stems are chewed or boiled in water and decoction taken orally. Barks are dried and pounded taken with water or used as snuff.
15	<i>Ximenia caffra</i>	Mutundwe	Mpingi	T	L, R	Treatment of coughs, toothache, malaria and hookworms (L). infertility, bilharzias, menstrual problems, STDs & anaemia (R)	Leaves or Roots are boiled, decoction taken orally
16	<i>Terminalia sericea</i>	Mofuru	Njima	T	B	Treatment of yellow fever & coughs (nyat. suk.)	Barks are soaked in water, decoction taken orally
17	<i>Solanum incanum</i>	Mutula	Itula	S	F	Treatment of backache, stomach and anal ulcers (suk., nyat.)	Fruits boiled, decoction taken orally. Dried and burnt, ashes are inserted in anus
18	<i>Acacia senegal</i>	Mukhubo	Igwata	T	B	Treatment of diarrhoea and STDs	Boil in water, liquid taken orally
19	<i>Ximenia americana</i>	Mpingi	Ntundwa	S	R	Remedy for anaemia, intestinal worms, STDs, retained placenta and hernia	Roots are boiled in water and decoction taken orally
20	<i>Vangueria infausta</i>	Mulade mujenguma	Ikulwang'hwale	T	R	Treatment of infertility, intestinal worms, snakebites and STDs	Boil in water, decoction taken orally. Roots are chewed and applied on the site of snakebite
21	<i>Sclerocaria birrea</i> var. <i>multiflora</i>	Muhuvi	Ng'ongwa	T	B	Treatment of coughs (nyat)	Barks are chewed
22	<i>Albizia anthelmintica</i>	Mufeta	Ngada	T	B, R	Treatment of worms	Barks or Roots are biled decoction taken orally
23	<i>Indigofera rynchocarpa</i>		Igangula	T	R	Treatment of stomach pains, bilharzia and chronic malaria in children (suk)	Roots boiled, decoction taken orally.
24	<i>Dalbergia nitundila</i>	Mubibi	Nswiwi	T	R	Snake antipoinson	Roots are chewed

Appendix F continued

25	<i>Grewia bicolor</i>	Musuna	Nkoma	S	B	Treatment of diarrhea	Barks are boiled, decoction taken orally
26	<i>Grewia platyclada</i>	Musankua	Mpelemese	S	R	Treatment of menstrual problems & other gynecological problems	Roots are boiled in water and decoction taken orally
27	<i>Markhamia obusifolia</i>	Mulelei	Mbapa	T	R	Treatment of wounds, including snakebite wounds	Pounded roots boiled in water, then wash on wounds
28	<i>Kigelia africana</i>	Mungungu	Ng'wicha	T	L,B,R	Treatment of malaria, infertility and STDs (L, B). Roots & barks increase lactation in women	Boil in water, decoction taken orally
29	<i>Strophanthus emanii</i>	Muhanyatre	Nsungululu	T	R	Treatment of hookworms and chronic malaria for children	Ground roots mixed with porridge then taken orally or bathing water.
30	<i>Securidaga longipendunculata</i>	Msato	Nengonengo	T	R	Treatment stomach pains, seizer, headache and have viagra effect in men (nyat., suk.)	Roots or root powder boiled to decoction taken orally.
31	<i>Pterocarpus angolensis</i>	Munyinga	Ng'wininga	T	R, B	Treatment of bilhazia (R), Increase blood haemoglobin (B)	Roots are chewed, Barks are boiled and decoction taken orally.
32	<i>Diospyros fischeri</i>	Msekeanja	Nsubata	T	W	Leg problems (suk)	Plant burned to form ashes mixed with juice then taken orally
33	<i>Dalbegia melanoxydon</i>	Mupako, Mfako	Ge-mbe	T	R	Treatment of hernia	Roots are boiled, decoction taken orally
34	<i>Catunaregum spinosa</i>	Mupongwe	Ng'ochangoko	T	B, R	Barks treat ringworm (suk). Roots treat chronic malaria for children (nyat)	Barks are boiled, decoction taken orally. Roots are ground mixed with water then taken orally.
35	<i>Vitex payos</i>	Mufuu		T	R,L,B	Treatment of intestinal worms, skin problems & loss of appetite	R/L are boiled , decoction taken orally. Barks are pounded & taken with water.
36	<i>Combretum collinum</i>	Mlahai	Nandala	T	R	Treatment of urinary tract problems	Boil, decoction taken orally
37	<i>Brachystegia microphylla</i>	Mughaghea	Ntundu	T	B	Treatment of typhoid	Barks are boiled, decoction taken orally
38	<i>Tamarindus indica</i>	Mkwaju	Nshishi	T	R,L	Remedy for Asthma, hookworm, diarrhoea, dysentery & ulcers	Roots are boiled, decoction taken orally. Leaves are chewed or pounded
39	<i>Aerva lanata</i>	Mhalage	Lweja	S	R, L	Treatment of tonsillitis and respiratory tract infection (R), Treatment of chest pains (L)	Both roots and leaves are burned, ashes taken orally
40	<i>Lannea schweinfurthii var. stuhlmanii</i>	Musagha	Nsayu	S	B	Treatment of naemia	Boil , decoction taken orally
41	<i>Senna singueana</i>	Mutungulu	Isambula	S	L.B	Remedy for malaria, coughs, intestinal worms (L) diarrhoea & STDs (L &B)	Leaves are pounded, soaked in water and the ifusion taken orally. Roots are boiled in water & the decoction taken orally.

Appendix G: Woody Species Identified as Stumps

S/N	Species name	Non reserved land		Reserved land	
		No. of stumps	Density (stump/ha)	No. of stumps	Density (stump/ha)
1	<i>Acacia polyacantha</i>	8	200	2	50
2	<i>Acacia tortilis</i>	35	875	11	275
3	<i>Azzeria quanzensis</i>	40	770	14	350
4	<i>Albizia anthelmintica</i>	6	150	2	50
5	<i>Balanites aegyptica</i>	5	125	6	150
6	<i>Brachystegia microphylla</i>	35	875	6	150
7	<i>Brachystegia speciformis</i>	42	1050	11	275
8	<i>Burkea africana</i>	1	25	0	0
9	<i>Canthium burtii</i>	35	875	7	175
10	<i>Catunaregum spinosa</i>	6	150	2	50
11	<i>Combretum collinum</i>	9	225	4	100
12	<i>Combretum constrictum</i>	4	100	1	25
13	<i>Combretum molle</i>	7	175	4	100
14	<i>Combretum paniculata</i>	4	100	3	75
15	<i>Combretum zeyheri</i>	34	850	3	75
16	<i>Commiphora africana</i>	8	200	2	50
17	<i>Commiphora ugogensis</i>	9	225	3	75
18	<i>Dalbergia melanoxyton</i>	34	850	15	375
19	<i>Dalbergia bohemii</i>	5	125	0	0
20	<i>Dalbergia nitundila</i>	2	50	1	25
21	<i>Dichrostachys cinerea</i>	23	575	2	50
22	<i>Diosperos zombeansis</i>	2	50	0	0
23	<i>Diospyros fischeri</i>	4	100	0	0
24	<i>Grewia bicolor</i>	28	700	3	75
25	<i>Julbenadia globiflora</i>	27	675	7	175
26	<i>Kiggeria africana</i>	1	25	0	0
27	<i>Lannea humilis</i>	3	75	4	100
28	<i>Lannea schimperi</i>	4	100	1	25
29	<i>Lonchocarpus cappasa</i>	2	50	0	0
30	<i>Markhamia obustifolia</i>	30	750	4	100
31	<i>Plectranthus barbatum</i>	1	25	0	0
32	<i>Pseudolachmostylis moproucefolia</i>	2	50	0	0
33	<i>Pseudoprosopsis fischeri</i>	2	50	0	0
34	<i>Pterocarpus angolensis</i>	23	575	19	475
35	<i>Schreberia trichoclada</i>	8	200	2	50
36	<i>S. birrea subsp multifoliolata</i>	3	75	0	0
37	<i>Strychnos innocua</i>	1	25	0	0
38	<i>Strychnos pototorum</i>	1	25	0	0
38	<i>Strychnos pungensis</i>	6	150	3	75
40	<i>Teclea nobilis</i>	1	25	0	0
41	<i>Tamarindus indica</i>	1	25	0	0
42	<i>Terminalia serecea</i>	34	850	18	450
43	<i>Thylachium africana</i>	1	25	0	0

Appendix G continued

44	<i>Vangueria infausta</i>	7	175	0	0
45	<i>Ximenia caffra</i>	1	25	2	50
	Total	545	13625	162	4050

Appendix H: Questionnaires

Please answer the following questions: Your good response to these questions could contribute positively in the efforts to sustainable development.

A: Useful woody species

What are the woody plant species you frequently use in your daily life? Fill in the table below

	Local name of plant	Habit (T or S)	Use	Part used	Collectors	Period of collection	Reason for collecting during this period
1							
2							
3							

Of the following, tick the use(s) which you obtain from woody plants

- a). Fruits... b). Medicinal.... c) Fodder.... d). Building... e). Timber.... f). Rituals....
g) Firewood... h) Charcoal... i) Fencing...

3. Of the uses you mentioned in (2) above, which one is the most important in your daily life and Why? Arrange in ascending order 1.... 2.... 3...4....

4. Of the woody plants you mentioned in (1), give the three most useful in your daily life
i.....ii.....iii.....

B: Harvesting and Conservation

Harvesting

How far does it take you to obtain the useful plant at present? Nearby. ...(>

4km)...Moderate distance (4-8 km)...Very far... (<8 km)

How long does it take you to obtain the plants in need in one day? 30min.... 1hr...< 2hrs...

(a) How long did it take you 10 yrs ago?.....5yrs ago?.....(b) If different durations, explain why.....

Compared to previous years, how is the availability of the useful woody plants? More.... Same.... Decreasing....Give possible reasons for this

Based on the uses mentioned in question 2a, fill in the table below: -

	Use	Collector	Period/Season	Reason	Place harvested
1	Fruits				
2	Medicine				
3	Building				
4	Timber				
5	Firewood				
6	Charcoal				
7	Fencing				
8	Rituals				

8. For medicinal species fill in the table below:

S/n	Name of medicinal plant	Part used	Disease	Preparation method
1				
2				
3				
4				
5				

Plant Conservation

1. Mention the conservation practice you commonly apply in your area

a).....b).....c).....

2. Of all the practices you have mentioned in 1 which one do you prefer most?

..... Why?.....

3 Is there any difficulty (ies) you face in applying such practices? Yes...No....

If yes, Mention the such difficulty (ies)

i.....ii.....iii.....

4. What do you think should be done to avoid or reduce the difficulty (ies)?

i.....ii..... iii.....

5. What should be done in order to ensure sustainable use and conservation in your area?

6. Do you easily get the useful species from the local environment? Yes.....No.....If no , mention the scarce species you know in this area

What are their respective use(s)

How do you prepare the materials or products (for medicinal plants)?

Do you easily obtain these plants?

What are the common constraints in the availability you face during collection?

How do you compare these constraints with those you faced 10yrs ago?

What are the causes for these constraints?

What do you think are possible remedies?

C: Identification

1. Village.....2 Ward.....3 Female... Male.... 4 Age...5 Occupation...

Herbarium information:

Botanical family: Scientific name..... Preparation: Herbarium specimen.....

Spirit collection... ..Others.....Total number of duplicates...