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INDIGENOUS KNOWLEDGE AND BIODIVERSITY CONSERVATION: A CASE STUDY OF MEDICINAL PLANTS AND NYAMWEZI PEOPLE IN TABORA REGION, TANZANIA.

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ABSTRACT

This study was geared to obtaining and documenting indigenous knowledge used by Nyamwezi people in Tabora region (Tanzania) to conserve and utilise sustainably the diversity of medicinal plants. Tabora rural district in which this study was conducted is one of the districts occupied by Nyamwezi people. Four administrative wards were chosen randomly: Magiri, Ilolangulu, Igalula, and Ikongolo. The indigenous knowledge of this cultural group was thought to be important due to the fact that Tabora region falls in the 'Miombo' woodland zone where about 60% of the plants are known to have medicinal value. Another factor was that human activities in Tabora are threatening plant survival today. The fact that indigenous knowledge of Nyamwezi was getting eroded with the biodiversity like that of other indigenous cultural groups elsewhere, made this study important.

Three survey methods were employed during this study to collect data from the field. Two participatory rural appraisal (PRA) techniques were used to collect indigenous knowledge related to conservation of medicinal plants and/or their habitats. PRA techniques used were open-ended conversation and intriguing practice and beliefs. Semi-structured interview was used to obtain the commonly used medicinal plants and related aspects. This method was also employed to ascertain the household's therapy. Paired comparison was used to find out the activities considered most threatening to the diversity of medicinal plants and/or their habitats.

It was found that Nyamwezi people host important indigenous knowledge/practice that can be blended with formal techniques to conserve biodiversity effectively. These include Nyamwezi people beliefs and taboos regarding the conservation and use of medicinal plants, handling and care of sacred groves (Mazimbu), home gardens and observing indigenous rules and regulations. Concerning household's treatment, it was observed that a large number of Nyamwezi people use both traditional and formal healing systems for their primary health care. There was highly significant difference (**$p<0.01$, $F=16.67$,$df=2,6$) between the number of people using traditional healing system alone, those who use both treatment systems and those using formal/modern system only across the wards studied.

Regarding medicinal plants and related aspects, it was found that about 122 plant species falling in 49 families were being used to treat a total of thirty-eight diseases/conditions commonly found in Tabora. It was observed that roots were the most frequently used parts accounting for over 65% of all the prescriptions. Sixty-four percent of the respondents noted that more time was needed to obtain medicinal plants now than it used to be ten years ago indicating that some traditional herbal medicines are becoming less available. Tobacco cultivation was found to be the major threat to medicinal plants and/or their habitats having been identified as the first threat by 21% of the respondent households, and as one of the three most dangerous activities by the majority of the respondents. Collection of medicinal plants was considered safer, sustainable harvesting being one of the contributing factors. It was recorded that traditional practitioners were obtaining their material from almost every habitat except for some few plant species having restricted distribution. This study therefore recommends that; the Nyamwezi indigenous knowledge/practice be blended with formal techniques to ensure sustainable use and conservation of their culturally important medicinal plants in particular and the biota in general. This implies that the local people must be part in the planning and implementation of conservation and development programs.

1. INTRODUCTION

1.1 Traditional Medicine

Traditional medicine has been the healing system available to indigenous cultural groups since time immemorial. It involves application of beliefs, knowledge, skills and cultural practices concerned with human health. Before one becomes a traditional practitioner he/she has to undergo training, which makes him/her a specialist. There are those who specialise in using herbs, others are professionals in spiritual healing, while still others are birth attendants and bonesetters (Aregbeyen, 1996).

Herbalists use medicinal plants to treat cases brought to them and use specific plants for specific conditions or diseases. Broadly, medicinal plants are considered to be a set of all higher plants that have effects which relate to health, or which have been proven to be useful as drugs, or which contain constituents that are used as drugs (Farnsworth and Soejarto, 1991). However, this definition encompasses all higher plants known by indigenous communities and recognised by western science as having medicinal properties. Indigenous people know a lot of plants that are important in their health care but not known by western science. For a plant to qualify as medicinal, it does not necessarily require western recognition but its usefulness to the community (Odera, 1997).

1.2 Historical Background

The need for treatment probably arose from the day the first human being got sick. It was necessity that taught humans how to go about with diseases. History discloses that the use of plants to cure human traumas and conditions started since prehistoric times. Pedanios in the 1st century AD described in his work, *De materia medica*, about 600 taxa of medicinal plants (Stace, 1984). Records show that, in India, the use of medicinal plants dates back to over 5000 years wherein more than 8000 herbal remedies have been recorded (Principe, 1991). In China, a country where traditional medicine is believed to have existed for 3000 years, it is documented that one of the Emperors described 365 herb remedies (Principe, 1991). Old records of medicinal plant use exist for Egypt, Rome, Europe, Arabia and America (Principe, 1991).

1.3 Contribution of Medicinal Plants to Human Health

Today, medicinal plants play a great role in human health services. Globally, there are about 121 clinically useful prescriptions of drugs derived from higher plants (Farnsworth *et al.* cited in Farnsworth and Soejarto, 1991). It has also been observed that, of these, 45 with known chemical formula can not be synthesised in the laboratory (Farnsworth and Soejarto, 1991). Lange (1997) reported that 28% of the total inventory of the world's plant species are used in ethnomedicine. It is also reported that 21,000 plant taxa (some being synonyms) are used worldwide for medicinal purposes (Groombridge, 1992). Leading countries in the use of traditional medicine are India, Korea, Hongkong, China, Japan and Malaysia. In these countries, medicinal plants form about 80% of the total prescriptions. In China, about 15% of the 35,000 plant species are used for medicinal purposes (Farnsworth and Soejarto, 1991) and 40% of the primary health care is attended using Chinese medicinal plants (Akerele, 1991). Country wide sales of crude plant drugs in China is about 1.4 bill. Dollars (Li Chaojin in Akerele, 1991).

In the U.S.A., modern prescriptions containing one or more plant product rest at 25% of all prescriptions, and the American public spent more than 8 bill. Dollars in 1980 on plant derived drugs (Husain, 1991).

In Africa, traditional medicine plays a central role in health care needs of the rural people and urban poor. It is said that, this situation would remain so as long as modern medicine continues to be unable to meet the health care of the people of the continent effectively (WHO, 1976; Plotkin, 1991; Anokbanggo 1992; Iwu, 1993). According to Aregbeyen (1996), for many rural communities in Africa traditional healing system is the major and in some cases the only health care system available.

The World Health Organisation (WHO, 1976) report shows that 70-80% of the African population rely on traditional herbal medicine for their health care needs as they have no access to modern health care services. Other authors e.g. Huxlry in Plotkin (1991) estimated that, about 95% of the African population were depending on traditional healing system. As Anokbbango (1992) rightly observed, ignoring traditional medicine today in Africa is like ignoring the health of over 70% of the people of the continent. To show the importance of traditional medicine to people in Africa, Marshal (1998) cites an

example of Mozambique where there was one traditional healer for every 200 people and one formal doctor for every 50,000 people in 1994.

In Tanzania, 80% of the population depends on traditional medicine for treatment of different diseases and conditions especially in rural areas (Mahunnah, 1990). A study done in only four of the twenty regions of mainland Tanzania recorded 405 medicinal plant species belonging to 87 families of higher plants (Mahunnah, 1990).

The other significant importance of medicinal plants is the contribution they make to the development of modern medicine. In modern medicine, plants accomplish the following important functions as analysed by Principe (1991) and Plotkin (1991):

- Provision of constituents which are used directly as therapeutic agents,
- Provision of constituents for the synthesis of useful drugs,
- Provision of natural products which serve as models for pharmacologically active compounds in the field of drug synthesis and,
- In research of chemicals whose side effects are too strong to allow their use as prescription drugs.

Therefore, plants hold a central position in development of modern medicine. Examples of drugs that were derived from plants are many. Principe (1991) presents a list of nine widely used drugs, which were developed from plants between 1930-1980. These are:

- A family of contraceptive steroids derived from diosgenin, a chemical obtained from Mexican yam *Dioscrea* (Diodcoreaceae)
- The antihypertensive and tranquillising alkaloids: respine, deserpidine and rescinnamine obtained from *Rauvolfia* (Apocynaceae)
- The anti-cancer chemicals: leucocristine and vincaleukoblastine obtained from rosy periwinkle *Vinca* (Apocynaceae)
- Laxative sennosides A and B derived from *Cassia* (Caesalpinaceae)
- Cardiac glycosides extracted from *Digitali* (Scrophulariceae)

These findings are encouraging pharmacoligists and ethnobotanists to search from nature possible cure of diseases which are attacking humankind today. Currently, there are reports on the possible cure of AIDS and Malaria just to mention a few. Published examples include; isolation of active principles which have anti-HIV activity such as:

- Quinoline alkaloids from *Euodia roxbughiana* (Rutaceae) (Mc Cormick *et al.,* 1996) and methanolic abstract of fresh fruit of *Annona squamosa* (Annonaceae) which inhibits HIV replication in Lymphocyte cells (Chang Wu *et al.,* 1996).
- Methanolic abstract from the whole plant of *Geum japonicum* which inhibits HIV_1 protease enzyme (Hong- Xi Xu *et al.,* 1996).

In Tanzania, it has been reported that members of plant families of Meliaceae, Rubiaceae and genera *Uvaria* (Annonaceae) and *Artemisia* (Compositae) show anti malarial activity (Nkunya, 1992). The most intensively screened plant species reported by Gessler *et al.,* (1994) are:

- *Cissampelos mucronata*
- *Maytenus senegalensis*
- *Salacia madagascariensis*
- *Zanthoxylum chalybeum*

Not only the reported findings make the plants important sources of medicine but Brodie and Smith, and Tyler both cited in Farnsworth and Soejarto (1991), point out that drugs for cure of economically important diseases/symptoms in the coming century will still be sought from plants. Targeted diseases are:

- Viral diseases e.g. herpes, AIDS and certain cancer
- Diseases of unknown aetiology e.g. arthritis, some cancers
- Self inflicted diseases e.g. alcoholism, liver diseases, obesity, drug dependency
- Genetic diseases e.g. cystic fibrosis, haemophilia, sickle cell anaemia
- Control of symptoms such as pain, high cholesterol levels and hypertension.

Medicine from plants is only a fraction of the general direct or indirect dependency of humankind on plants. Other living organisms also depend on plants for food, shelter and

cover. Records show that about 250,000 plant species exist on which all other different kinds of organisms depend (IUCN, 1986).

Usefulness of medicinal plants goes beyond their medicinal value. They offer ecological and biological services in ecosystems where they occur. Some medicinal plants are multipurpose. For example, *Phyllanthus engleri, Vitex mombassae,* produce fruits that are eaten. Others like *Pterocarpus angolensis* and *Afzelia quanzensis* produce valuable timber, whereas others like *Launea cornuta* are vegetables and others are ornamental. *Dalbergia melanoxylon* provides suitable materials for carvings. Conservation of medicinal plants is therefore important for human survival.

As discussed above, medicinal plants command an important role in human health and it is obvious that mankind's dependency on medicinal plants is likely to increase. On the other hand, loss of habitats due to increased pressure on resources and over exploitation is threatening their existence. Due to uncertainty which surrounds the medicinal plants, since not all medicinal plants, are known today, conservation of diversity might be the best option (Principe, 1991).

1.4 Background and Justification

Today, conservation of biodiversity in Tanzania and in many other countries rests on the hands of governments and non-governmental organisations (local and/or foreign). Many conservation programmes and initiatives have been set to combat the enlarging problem of biodiversity loss especially in developing countries. Funds are made available and another replaces one conservation project and in many occasions what comes out is a good report to please sponsors but little success on the ground. Biodiversity loss at a higher scale continues in developing countries where about two thirds of the world's plant species occur. One major reason for such unsuccessful conservation measure is that, the indigenous people and their appropriate knowledge systems are not involved in these programmes. Indigenous knowledge, however rich it may be, is considered obsolete, old fashioned and a barrier to development. In few cases where indigenous people are involved like in a case of Joint Forest Management (JFM) popularised in Tanzania today, they are not part of the planning process and they are only involved at

the implementation stage. Even here their indigenous knowledge is not part of the implementation strategies.

On the other hand, it has been observed that formal techniques of using protected areas to conserve biodiversity can not work alone and change the trend of biodiversity loss. It is obvious that protected areas, however important they may be, can cover not all the important plant species. Furthermore, protected areas have become more and more vulnerable to encroachment today.

The way out is therefore to involve cultural groups and their knowledge, a special role of which in management and conservation of biodiversity has been recognised in recent years WRI/IUCN/UNEP (1992a); IUCN/UNEP/WWF (1991). Suggestions are that, indigenous knowledge be blended with formal techniques for better results. However, while formal techniques are documented and thus available in written form, indigenous knowledge is tremendously getting lost as it has not been documented (Philips and Gentry, 1993; Luoga, 1994; Quiroz 1994).

Nevertheless, majority of people in Africa depends on traditional healing system for their health care, which mainly uses plants. This is also the case in Tanzania. However in the National Forest Policy (1998), medicinal plants are covered under Other Non-Wood-Based Industry and Products section. Under this section stress is given to investment and marketing, no conservation strategies are put for these important plants.

It is most likely that Nyamwezi people in Tabora uses medicinal plants in their health care and therefore they have accumulated knowledge of conserving medicinal plants. This knowledge is most likely that is also facing the erosion threat as it has never been studied and recorded. This work was, therefore, initiated in order to study and document the indigenous knowledge held by the Nyamwezi people on use and conservation of diversity of medicinal plants and/or their habitats.

1.5 Objectives

The main goal of this study was to access and document indigenous knowledge useful in conservation and use of medicinal plants by the Nyamwezi people of Tabora region in Tanzania and suggest how it can be blended with formal techniques. In order to fulfil this goal, the following specific objectives were set:

1. To assess household's dependency on traditional healing system.
2. To assess activities which are considered to be major threats to medicinal plants and/or their habitats by Nyamwezi people in Tabora.
3. To inventorize medicinal plants commonly used in Tabora region.
4. To collect and document indigenous knowledge/practice used by the 'Nyamwezi people to conserve medicinal plants in Tabora region.

2. LITERATURE REVIEW

2.1 Loss of Diversity of Medicinal Plants

The worry about species of medicinal value is greater as there is evidence that extinction of plant species is obvious today. Disturbances and overexploitation by humans are causing major global reduction of plant diversity (Allen and Barnes; 1985; Bownder 1987; Mather 1987; IUCN/UNEP/WWF, 1991; Whitemore and Sayer 1992; Brown and Brown, 1992; Reid, 1992). According to IUCN (1978) an average of one in ten of species of vascular plants known are rare or are under severe threat. Wilson cited in Plotkin (1991) estimated the current rate of extinction to be 400 times faster than what happened in the recent geological times. According to WHO/IUCN/WWF (1986), 90% of plant materials used as medicine are collected from the wild without parallel regeneration programs and as a result many medicinal plant species are driven to extinction or severe genetic loss. However, as observed by WHO/IUCN/WWF (1986), detailed information on the actual effect of such overexploitation is not available. When a population of a given species is reduced beyond the threshold level, the remaining population may suffer both from heterozygosity and allelic diversity loss and if such threats continue genetic drift can not be avoided. This is a situation that makes that population susceptible to extinction at times of environmental crisis. The worry about species extinction is with a ground, it is clear that once a species is lost it can never be retrieved.

Regarding plant species getting lost today, different scientists give different estimates. For example, Reven cited in Heywood and Stuart (1992), predicted that if the moist forest area is reduced to less than 10% which is likely to happen within the next years, it is estimated that about 65,000 plant species will become extinct in the next several decades. This number corresponding to a quarter of the world's known species. It is known that the moist forests contain about half of the world's total species of higher plants. Another prediction discloses that under the current trend of habitat loss, up to 60,000 plant species may be extinct or may suffer severe genetic erosion by the middle of next century (IUCN-WWF cited in Principe, 1991).

Wolf cited in Ledec and Goodland (1992) estimated that under the current trend of habitat destruction, about 15-20% of species of plants and animals living in 1980 might

be extinct by the year 2000. Myers in Whitemore and Sayer (1992) estimated the percentage of extinction to range between 25-30 for the same period.
In the same line, Reid (1992), using the species area relationship estimated that in Madagascar where about 90% of the forest has been lost and conversion of forest to other uses continues, 50% of plant and animal species are at risk of imminent extinction in the near future.

On the other hand, Heywood and Stuart (1992), though they agree that a sizeable number of species become extinct every year, they argue that the numbers estimated are too big to be realistic. However, in general terms, as Plotkin (1991) observed exists an agreement among biologists that the current extinction rate is alarming. Some authors, e.g. Wilson cited in Plotkin (1991) go as far as considering extinction to be the major tragedy and folly of the 1980's. Actually, Plotkin (1991) concluded that humans have started causing the first major reduction of global plant diversity since the origin of life. On the same line, Ledec and Goodland (1992) considered the rate of reduction of biodiversity in the last quarter of the 20th century to be unprecedented on the history of life on earth.

Many problems are associated to loss of species diversity. Some species lost are ecological key species (species which play a significant role in ecological processes and sustainability) and some are socio-economic key species (playing a great role in people's socio-economic wellbeing). As Ledec and Goodland (1992) warned the world, not all the consequences that come as a result of extinction of these species are known.

2.2 Threats to Medicinal Plants and their Habitats in Tabora

Information on threatened plants in Tanzania is scanty. Of the 250 plant species recorded in the IUCN 1978 Plant Red Data Book only two are from Tanzania. These are:

i) *Caralluma distincta*

ii) *Gigasiphon macrosiphon*

Obviously, plants in Tanzania in general and specifically in Tabora are not immune to the global problem. They are also threatened, and it is likely that some are getting lost

today even before they are recorded. FRMP (1997) reviewed the problems that bring about disappearance of woodland /forests in Tabora to be:

- Demand of agricultural and livestock products
- Commercial demand of forest produces.

To meet these demands, different activities (the major ones being those listed below) are being undertaken which are now threatening plant diversity in Tabora:

- Forest fires
- Charcoal making
- Grazing
- Logging
- Tobacco farming
- Collection of medicines
- Beehive making
- Firewood collection

These activities have caused extreme pressure to plant resources in Tabora. Public land which used to accommodate these activities can no longer withstand the pressure and the situation has been extreme such that what is happening now is encroachment into reserve areas. A study done by the Forest Resources Management Project in Tabora (FRMP, 1997) showed that all the forest reserves have been encroached and some are either severely depleted or completely cleared. The effects of such activities to diversity of plants of Tabora are discussed below:

2.2.1 Forest fires

Forest fires are defined as uncontained and free spreading combustion which consume the natural fuels of the forest that is duff, litter, grass, dead branchwood, snags, logs, stumps, weeds, brush foliage and to a limited extent, green trees (Brown and Davis 1973). Fires consume and remove large amount of woody and vegetative materials from forests in a short period of time through combustion.

Fire effects may either be negative or positive depending on the aim of starting it. A person who sets fire knows what to achieve. If that aim is attained, then to him fire has brought about positive results. In general, fires have effect on compositions of the stand and the future floral compositions of the burnt site. However, as it has been reported the effect depends on timing in relation to plant phenology and intensity and duration of burning (Brown and Davis, 1973; Frost, 1996).

Frost (1996) reported the fact that fire intensity in 'Miombo' woodland is related to time of burning and amount of fuel. He further explained that the most intense and therefore more destructive are fires set during the late dry-season (August to October) because at that time most of the trees will have flushed. Fires that are set during the early dry season (May to June) cause little harm, as much of the vegetation is still green and moist. Chidumayo (1989) reported stem mortality of 3-4% as a result of early dry season burning and 18-40% as a result of later burning.

In most cases the extent of fire damage is not the same in all types of vegetation or plant species. There are vegetation types or species more susceptible to burning than others are and therefore requiring protection from fires. Trapnell (1959) categorises plant species into four on the basis of their response to fires as, fire intolerant species, fire tender species, fire semi-tolerant species and fire tolerant species.

Fire intolerant species are those species which survive only when protected from fire. Fire-tender species are species, which grow better under protection and decline when burning is regular. Examples in this group are *Julbernadia paniculata, Isobelinia angolensis, Brachystegia spiciformis* and *B. longifolia.* These species are mostly affected by later burning. The third group of semi-tolerant category is formed by species which are mostly affected by later burning but relatively unaffected by early fires. Fire tolerant species are those species, which are able to survive regular later fires as adult, sapling or regrowth. When the duration of burning is considerably long and the fire is with higher intensity, it is likely that it can kill all plants (Brown and Davis 1973; Frost 1996); the difference in fire resistance between individual species becoming less important.

Fires also affect the composition of species at the burnt sites. Tuite (1992) reported the observation that plant species diversity increase with low fire intensity but decrease at higher fire intensities. She also observed that fire reduces individual plant species abundance in 'Miombo', where intermediates suffer most as compared to canopy and shrub layers in less disturbed places.

2.2.2 Charcoal burning

Charcoal is one of the most important sources of energy in Tanzania, third to firewood and electricity, respectively. Whereas in 1980 charcoal constituted 4% of the total energy used in all the sectors, electricity and firewood constituted 7% and 86% respectively (Openshaw, 1982).

Charcoal, as Kaale (1995) observed is the frequently most used source of energy in urban areas; the preference of charcoal being because it is economical, has high calorific value, can be stored easily and is smokeless compared to firewood. Good charcoal in Tanzania is obtained from 'Miombo' (Rodgers, 1996) and therefore Tabora is one of the target areas for charcoal business. Chidumayo *et al.* (1996) reported that every year Tanzania uses about 3.5 mill.m^3 of wood materials for charcoal. Considering the 'Miombo' productivity of 40 -60 m^3/ha annually (Temu, 1979) between 58,333 and 87,500 hectares of 'Miombo' are cleared annually for charcoal making.

The negative impact of charcoal making depends on the intensity of harvesting. When the harvesting is selective, the impacts are seldom pronounced but when it is clear felling, charcoal making can result in deforestation (Hosier, 1998; Kaale, 1995; Rodgers, 1996).

Deforestation among other things leads to species extinction (Allen and Barnes, 1985; Bowander, 1987; Mather, 1987; Kariuki, 1992). This is likely to occur in Tabora since it is surrounded by regions e.g. Shinyanga that is known to have charcoal and firewood shortage.

2.2.3 Grazing

Tabora is found in a 'Miombo' zone, which has a lower carrying capacity (1 livestock head/ha or 0.05 TLU/ha). Currently, the area supports one of the largest animal biomass

in the country far in excess of its carrying capacity that has brought about overgrazing that lead to total loss of plant biomass, reduction of palatable species and soil erosion (Government of Tanzania, 1997). In terms of total number of livestock, Tabora region ranks 7th with 6.4% of the National herd. A study done by Overseas Development Administration (ODA, 1982) indicates that with the exception of few individuals and institutions who practice zero grazing, livestock husbandry methods are extensively relying on large areas of natural grazing land. However, after harvesting crops, livestock are grazed in crop residues on farms. Traditionally, any land that is not currently under cultivation is available for grazing to any member of the community in Tabora (ODA, 1982). As a result of this, overstocking, short fallow period due to increased population and poor technology in agriculture and livestock sectors, the amount of grazing land has been reduced (FRMP, 1997).

The negative effects of grazing have been reported by Mosoud and Maganga (1996) to be reduction of heights and diameter of various stages of development of plants, livestock trampling and reduction of forest litter and exposure of the soil to erosion agents. Tuite (1992) reported the decrease of plant diversity as a result of overgrazing. In severe cases grazing can lead to deforestation (Kariuki, 1992; Abeli and Nsolomo, 1998) and as observed by Frankel and Soule (1981) browsing/grazing can even be the cause for extinction of taxa as it interferes with successional stages of plant life cycles.

2.2.4 Logging

Logging involves felling of trees and transportation of logs normally aiming at getting timber or chipboards. Logging may be intensive or non- intensive depending on the aim of the loggers (Johns, 1992a). Non-intensive logging is normally aimed at domestic uses whereas intensive timber harvesting involves the use of heavy hauling and transporting machinery, and usually, building of appropriate processing and marketing infrastructure. This can be considered to be commercially oriented and in tropical rainforests it involves either selective harvesting, which is common (Mather 1987; Johns, 1992a) or clear felling of whole stand (Johns, 1992a).

Logging becomes a threat especially when it is combined with rapid population growth that brings about pressure on forested land. The highest annual rate of forest destruction

of more than 3% has been reported (FAO production year book cited in Mather, 1987) and in some case this could be as severe as 40% (Myers cited in Mather; 1987).

Although selective Logging is considered favourable in the tropics when compared to clear felling, it still has some negative effects which include tree damage and soil compaction (Maganga and Chamshama 1984; Mather, 1987; Johns 1992a, Whitman *et al.*, 1997). Maganga and Chamshama (1987); Sist *et al.* (1998) observed that the extent of the damage depends on the intensity of logging. For example, at higher intensities the rate of damage is always higher and in some cases logging kills trees (Sist *et al.*, 1998). A study done in Usambara mountains showed that selective logging was one of the causes of forest degradation (Kikula, 1989). It is also reported that the gaps which were created were being colonised by *Measopsis eminii* an invader which has left no or little chance for desirable species to establish or grow successfully (Hamilton, 1989).

On the other hand, logging makes the forest accessible to subsistence cultivators that use the logger's infrastructure to penetrate and eliminate the residue forests (Allen and Barnes, 1985; Mather, 1987; Johns 1992b). Sommer in Mather (1987) estimated that for every $5m^3$ of wood removed through logging, cultivators eliminate one hectare of residue forest. Logging is reported to be one of the causes of deforestation in Tanzania (Abeli and Nsolomo, 1998), a situation, which as it has been said, leads to species extinction.

Logging is also reported to decrease diversity of plants with time. Johns (1992b) found that, in the area he was studying, diversity of plant genera had dropped from 60 to 4-5 woody species per 0.125 hectare in only 3-4 years as a result of competition. Reduced diversity as a result of logging has also been reported in Nigeria by Okafor and Ladipo (1992).

Regeneration following logging is the way that may return the forest woodland to its original state but this depends on a number of factors including mobile links (pollinators), seed dispersal agents that are mostly animals and soil fertility. As observed by Saulein in Johns (1992a) mobile links and seed dispersal agents can easily be eliminated as a result of clearance of forest/wooded areas. At the same time, as a result of logging some essential elements like phosphorus are reduced from the soil as a result

of reduced mineralisation levels (Yanai, 1998) and altered soil pH (Mc Nabb *et al.*, 1997).

2.2.5 Tobacco cultivation

Tobacco is the major cash crop in Tabora region. The region produces 60% of the flue-cured tobacco in Tanzania (Temu, 1979; Stenson, 1996; Stenson *et al.*, 1996). The regional GDP, which is Tshs. 55,012 bill. rely mostly on tobacco production. The flue-cured tobacco was introduced in Tabora in the 1950s (Nshubemuki *et al.*, 1998), the production by then being promoted by the British American Tobacco Company (BAT).

Tobacco production has been cited as environmentally unfriendly undertaking in Tabora; a threat to habitat (Temu, 1979; Stenson *et al.*, 1996; Stenson, 1996; Nshubemuki *et al.*, 1998). Reasons surrounding this observation lie on the mode of cultivation of the crop. To establish a farm, a tobacco farmer must clear virgin woodland, stalk the wood materials, burns the remaining brush for fertilization and soil sterilization mainly to kill nematodes. A newly cleared and burnt area is planted with tobacco for not more than two consecutive tobacco growing seasons after which the farmer shifts to a new area avoiding the risk of nematodes (Temu, 1979; Stenson *et al.*, 1996). Furthermore, Stenson *et al.* (1996) observed that other reasons which motivate the shift and therefore clearance of new tobacco farms are: the general belief that tobacco planted on newly cleared land is of a superior quality and that; less fertilization is required when tobacco is planted on new established farms.

Firewood is another important requirement for tobacco cultivation that makes it a threat to biodiversity and has contributed to the depletion of natural forests and woodlands in Tabora. Curing of 1 tonne of tobacco (1000kg) requires 17.94m^3 of stalked wood (Stenson, 1996). Taking the yield capacity of 'Miombo' woodland to be 40m^3 - 60m^3/hectare (Temu, 1979), this means large areas of woodland are cleared annually (Table 1) and possibly many plant species including medicinal ones have lost their habitats or are at risk of being extinct.

Table 1: Forest area cleared in Tabora 1985/86-1994/95

Year/Season	Tobacco Production (Metric Tonnes)	Estimated Fuelwood Consumption (m3) Stacked (volume)	Estimated Forest Area Cleared (Hectares)
1985/86	9,672,764	173,529.39	4,338.23
1986/87	6,613,252	118,641.74	2,966.04
1987/88	6,176,310	110,803.00	2,770.10
1988/89	5,640,292	101,186.83	2,259.70
1989/90	4,632,817	83,112.74	2,077.82
1990/91	5,961,349	106,946.60	2,673.67
1991/92	12,122,903	217,484.87	5,537.12
1992/93	14,443,381	259,114.25	6,477.86
1993/94	11,499,472.5	206,300.52	5,157.50
1994/95	17,133,300	307,371.40	7,684.29
Total			41,942.29

Source: Stenson *et al.* (1996).

As can be seen from Table 1, **41,942.29** hectares of wooded area in Tabora were cleared in 10 years (1985/86 - 1994/95) and this means a lot to plant life in Tabora region.

2.2.6 Harvesting of medicinal plants

Traditional healers harvest roots, bark, leaves, flowers/fruits and sometime whole plants to make medicines that they use to cure different diseases and conditions (Kokwaro, 1976; Anokbbango, 1992; Iwu, 1993). Exploitation of these parts of plants, which include both reproductive and vegetative parts as for any other non-timber forest products, is not without ecological impact. The negative effects that occur depend on the floristic composition, nature and intensity of harvesting, the species harvested and the specific plant part extracted or compound extracted (Peters, 1994). For example, Cunningham (1992) noted the fact that, *Faurea macnauglitonii and Podocarpus henkelii* can not survive debarking regardless of how small it may be. Pests immediately attack them, whereas there is a complete bark regrowth in species like *Warburgia salutaris* and *Prunus africana* except where demand exceeds the stock available.

According to Peters (1994), overharvesting may lead to depletion or even local extinction of some plant species especially in areas where plants are rare or endemic to particular

habitats. Although no studies have been conducted in Tabora, this might have been the case because Tabora falls in the 'Miombo' zone that is rich in plant species, that are widespread but rare (Government of Tanzania, 1997). On the other hand, where seeds or fruits are used survival of the species is reduced. This lies on the unpredictability of seed regeneration and growth, as it is known that during seed dispersal 98% of seeds may get lost through predation and pest attack (Peters, 1994). Peters (1994) further observed that the seedlings are not quite safe as they are susceptible to diseases, pests and mechanical injury.

Harvesting of vegetative parts may result in killing of the individual, wound it fatally or in a few cases the plant may regenerate the lost part through meristematic activities. Root removal or injury, negatively affects the growth and physiology of the plant, resulting on its death in the long run.

Overexploitation may lead to scarcity and in case of medicinal plants this means more time will be needed to collect parts of plants required by traditional healers. Cunnigham (1996) observed that with increased scarcity, commercial trade develops and prices rise and this means more exploitation. Actually, this is what brings unsustainable models (Campbell *et al.* cited in Brigham *et al.,* 1996).

Another threat to medicinal plants is a result of demand of botanicals locally or/and internationally which results in overexploitation and lack of regeneration programs. Globally more than 90% of plant species used in the industry are collected free from the wild without parallel regeneration programs to replenish the stock (IUCN/UNEP/WWF, 1991). Lange as cited in Lange (1997) estimated this amount to be between 70-90%. The ever-increasing demand of botanicals is a threat on itself. In 1994 worldwide leading importers of plant material for medicinal purposes namely; Hong Kong, Japan, Germany, USA, South Korea and France imported a total of 244,783 tonnes. Three years later (1997) the amount reached 271, 071 (Lange as cited in Lange, 1997). Chihongo (1992) reported a six times increase of *Cinchona spp.* import from Tanzania which rose from 119.8 tonnes (1981) to 755.92 tonnes (1991). The global annual production of *Cinchona* is estimated to about 8,000-10,000 tonnes (Husain, 1991).

Examples of medicinal plants entering the world market from Tanzania as reported by Farnsworth and Soejarto (1988) are:

- *Agave sisalana*
- *Carica papaya*
- *Cinchona calisaya*
- *Cinchona ledgeriana*
- *Cinchona officinalis*
- *Cinchona pubescens*

Others, which are rare but being ordered in huge amounts for screening purposes according to the Government of Tanzania (1997), are:

- *Maytenus senegaleasis* nearly depleted from Iringa region
- *Tabernaemontana elegans* from Usambara mountains
- *Strophanthus kombe* from all over the country

2.2.7. Hive making

There are two types of hives in Tanzania, modern and traditional hives. Modern hives are box hives made from sown timber of soft or hard wood depending on the availability of the raw materials. Traditional hives commonly used in Tanzania are bark and log hives although baskets and pots are also sometimes used. Kiwhele as cited in Kiwhele (1994) estimated that over 99% of Tanzanian beekeepers use traditional hives made from log and bark. These hives are made by craftsmen in the villages as a business or by beekeepers themselves. A good craftsman in Tabora can make 3 or 4 log and bark hives, respectively, in a day (Manoko, 1997).

Good bark hives are constructed from barks of mature *Brachystegia speciformis, B. bohemii, Julbernadia globiflora or J. paniculata.* To make a hive, a good mature tree is chosen from which a bark of about 1m long in obtained. This is a complete ring debarking, a process which stops the translocation of nutrients synthesised by the plant. In a shorter or long period of time such ring debarked trees die not only because of nutrient translocation problems but because such wounded trees are also vulnerable to infection.

Parry (1966) estimated that about one million mature trees of *Julbernadia globiflora* are killed annually as a result of debarking for hive making in Tabora. Connected to this is the fact that there has been an increase of bee products in Tabora. Among the ways of increasing bee products is to increase the number of colonies, meaning more hives therefore more debarking. It is possible that ring debarked and cut trees may not necessarily be medicinal, but possibilities are that, such plants are umbrella species the survival of which ensures survival of other plants which may have medicinal value.

2.2.8 Firewood collection

It is estimated that fuelwood constitutes more than 90% of the total energy used in Tanzania of which firewood forms more than 85% (Openshaw, 1982; Kaale, 1984b). Projection given by Openshaw (1982) showed that up to the year 2000 fuelwood will still constitute 83% of energy consumed in Tanzania. It is further reported that per capita consumption of firewood in Tanzania ranges between 0.5-3m^3 (average 1.8m^3) annually (Kaale, 1984a; Temu and Mbwana, 1984). The highest annual consumption of about 2-3m^3 being in areas where firewood is not a problem (Kaale, 1984 b). The annual mean consumption per head in Tabora is estimated at 2m^3 (Okiting'ati, 1984). Findings of the consumption of Mwanza, Dar es Salaam and Arusha regions were expected to double or triple by the year 2008 (UNDP/World Bank, 1988). Tabora region although recorded an excess of energy supply of 0.17 million m^3 (MLNRT 1983; Kaale 1984a) serves as a source of fuelwood for Mwanza region, which has fuelwood poverty.

The threats brought by firewood collection to habitats are obvious and increasing. The accessible woodlands where firewood is collected are being depleted and degraded often seriously by current rates of exploitation (Openshaw, 1982). It has been reported by ODA (1982) that domestic fuel consumed more wood (1,270,000m^3), than even tobacco curing (301,500m^3).

This simply means that deforestation caused by firewood requirement with its consequences such as biodiversity loss which has been reported to be one of the consequences of deforestation (Mather, 1987; Bownder, 1987; Whitmore and Sayer, 1992; Brown and Brown, 1992) will remain high in Tabora.

2.3 Disturbance and Diversity of Plants

Although as seen above in some cases disturbance has been reported to increase diversity, the resulting diversity may not necessarily comprise of economically viable species (Cunningham, 1992). It is more likely to be made up of ruderals especially when stress intensity is low and the intensity of disturbance is higher (that is, rate of habitat production is low as compared to that of destruction of vegetation). Ruderals are normally annual or short-lived plants with shorter lifecycle and they are normally herbs (Grime, 1979). This means that in highly disturbed areas a woody layer can be lost and it is unlikely that this layer can be restored easily as life cycle patterns are long or very long (Grime, 1979).

Furthermore, it is expensive and complicated to restore the lost vegetation after disturbance, as many successional stages must pass before reaching climax condition. Causes of disturbance in Kondoa are reported by Mbegu and Mlenge (1983) to be deforestation as a result of fuelwood collection, overstocking, forest fires and inappropriate farming systems. In the attempt to reverse the situation, the government started the Hifadhi Ardhi Dodoma (HADO) project in 1973. This project which existed for ten years (1973-1983) and spent millions of shillings, achieved not much to restore the original vegetation. Another example is from Shinyanga where desertification is now an ominous threat. In the 1930s, forests of Shinyanga were cleared as part of tse tse fly control programme. This was followed by extensive clearance of forests in the 1940s for development of cotton plantations. Today, the area is almost bare. Although Hifadhi Ardhi Shinyanga (HASHI) project has been in Shinyanga for not less than two decades plus international and local non-governmental organisations all trying to rehabilitate the denuded land, however, it is only now that some success has started to show.

2.4 Indigenous Knowledge and Biodiversity Conservation

Indigenous knowledge (IK) is defined as a set of concepts, propositions and theories unique to each particular group of culture in the world (Meenah cited in Kajembe, 1994). Almost in the same way, Grenier (1998) defines indigenous knowledge as unique traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographical area. Due to the fact that IK is unique to a specific culture, it follows that IK is diverse, as there are diversity of groups

of culture in the world and in a country. In fact, according to Quiros (1994) "cultural diversity and biological diversity are two sides of the same coin".

Indigenous knowledge is knowledge that has been available to indigenous people since time immemorial, which proved to be vital and has significantly contributed to conservation of biodiversity. This fact follows the reasoning that each indigenous population through time has developed its own way of conserving nature because the lifestyle of each community has evolved with the biota separately. For example, Plotkin (1991) observed that all strategies geared towards development and conservation of the Amazon required the indigenous knowledge of the Amazonian Indians to be successful.

Indigenous knowledge is broad, ranging from that which is specific to conservation and management of specific species *per se* (Cunningham in Cunningham, 1992;Kajembe, 1994), to a particular group of useful plants, e.g. food plants, wild relatives of cultivated crops, medicinal plants (Cunningham, 1992). Reported also is knowledge that covers the entire diversity of communities and their ecological interactions at large (Messerschmidt in Luoga 1994; Kilahama 1994; Clerke, *et al,* 1996; Odera, 1997).

Indigenous people develop their knowledge through long-term experiment and informal research (Chambers 1983;Warren, 1992; Hanyani-Mlambo and Hebnick, 1996). "Indigenous knowledge is made possible by creating orders from disorders and it does not just come as response to practical human needs such as sustenance" (Hawes and Chambers cited in Kajembe and Wiersum, 1997). Agroforestry system practised by Chagga and Haya people in Tanzania is cited by Fernandes in Kajembe and Wiersum (1997) as an example. The two tribes are banana and coffee growers and have been practising agroforestry for centuries to the extent that through time it is now an extremely refined system. This observation takes us to a fact that, IK is dynamic accommodating new findings/innovations from within or from external sources. (Grenier, 1998). Recognition of indigenous knowledge by formal scientists is minimal and one reason can be that indigenous people rarely publish their findings (Chambers, 1983)

In the case of biodiversity conservation, indigenous knowledge is viewed as pivotal for successful sustainable use of the biota and balanced development (Warren in Agrawal;

1995; Odera, 1997). Therefore, for successful conservation a breakaway from disregarding indigenous knowledge is inevitable (Chambers, 1983; Agrawal, 1995; Odera, 1997) as Chambers (1983) suggested we need to listen to the farmers.

Importance of indigenous knowledge in conservation of biodiversity is evident in cases where involvement of people's knowledge has brought success which otherwise could have been impossible. Reported cases include, the conservation of Bwindi impenetrable forest in Uganda (Cunningham, 1996) and the emerging success of HASHI (Soil conservation project in Shinyanga (Tanzania) in vegetation restoration and management. In this project customary rules set by 'dagashida' (community assembly which formulates customary laws and holds violators responsible) were extremely important (Johansson and Mlenge, 1998). Kilahama (1994) reported that recognition of 'Ngitiri' (indigenous *in-situ* way of conserving wood lots for grazing during dry seasons) has added success to the HASHI project.

Other reported successes as far as indigenous knowledge and conservation of boidiversity is concerned includes the conservation of Duru-Haitemba forest in Babati district (Tanzania) where 25 forest patches are protected by traditional rules and modern management practises (Wily and Haule, 1994). Odera (1997) reported that conservation of Got Ramogi forest on the northern shore of Lake Victoria and Kaya forests in Kwale and Kilifi districts in Kenya lie on the fact that they are considered sacred places by cultural groups living near those forests.

Okafor and Ladipo (1992) reported the existence of fetish grove conservation system in Nigeria where diversity of plants has been recorded to be up to 5 times greater than in non conserved areas. This indigenous practice has managed to protect threatened plant species in southern Nigeria.

Taboos and beliefs are reported to be used to conserve plants of values (e.g. food, medicinal) to indigenous communities (Cunningham, 1992; Luoga, 1994; Odera, 1997; Kajembe and Wiersum, 1997). Other indigenous conservation practises include restriction of gathering plants (Odera 1997, Cunningham 1992), for example, restriction of young people from cutting or felling trees of medicinal values. It was also believed

that in order to prevent disease relapse soil must be returned to cover the tree after digging the roots. It is further recommended that only lateral roots should be collected and that ripping of the plant out of its roots must be avoided (Odera, 1997).

Planting and maintaining sacred trees at homestead (Odera, 1997) and protection of vegetation at graveyards has been observed in South Africa (Webb and Wright in Cunningham, 1992).

Indigenous ways of maintaining the resources sustainably as seen above is enormous. It is likely that it exists among the Nyamwezi people in Tabora who depend on ''Miombo'' for their daily livelihood. ''Miombo'' provided firewood, charcoal, timber, food (mushrooms, leaves and roots, fruits, insects, honey), beeswax, leaf litter, tannins, dyes, oils, resins, medicine and spiritual and cultural values (Clerk, *et al*, 1996). Gadner in Luoga (1994) reported that about 60% of ''Miombo'' species have medicinal properties.

To ensure availability of these services, indigenous cultural groups have been utilising ''Miombo'' species sustainably and possibly indigenous practice has been the only knowledge available to conserve the 'Miombo' woodland, as formal knowledge of managing it is scarce. Frost (1996) observed that it is the Ndola experiment of 1933 only which describes the response of ''Miombo'' species to disturbances such as fires. Formal scientists therefore cannot claim to have adequate knowledge of conserving ''Miombo'' ecosystem and is aggravated by the loss of traditional knowledge and a blind eye given to it even in cases where it exists (WRI/IUCN/UNEP, 1992).

The act of ignoring indigenous knowledge is condemned by Brokensha *et al.* cited in Agrawal (1995) as a way that ensures failure in development. On the other hand, Luoga (1994) and Cunningham (1992) are of the opinion that even indigenous knowledge has its own weaknesses and therefore for the best results it must be blended with formal system.

2.5 Methods in Ethnobotany

These are techniques that are used to investigate the relationship between plants and humans (Cotton, 1996). Ethnobotany being a multidisciplinary subject gets its methods

from a range of fields. It has been reported that ethnobotanical methods come from Botany, Economics, Linguistics, Ecology, Anthropology and Chemistry (Martin 1995; Cotton, 19960.

Anthropological field methods and expertise in language enable the researcher to interact with the community. The value of such methods becomes significant when the study focuses on the most frequently used plants as in food and medicinal plants. Taxonomy helps to identify plants whereas ecological methods are essential in assessing the impact of humans on environment and the sustainability of the relationship between humans and plants (Cotton, 1996). According to Martin (1995) results obtained through ethnobotanical studies show how people interact with the plant world and the activities to be undertaken fall in the following four categories:

- Basic documentation of traditional botanical knowledge
- Quantitative evaluation of the use and management of botanical resources
- Experimental assessment of the benefits derived from plants
- Applied projects that seek to maximise the values local people attain from their ecological knowledge and resources.

In general, these activities allow one to carryout a systematic survey of the traditional botanical knowledge in a single community or region and the quantification of some aspects. Martin (1995) and (Cotton 1996) have categorised ethnobotanical research methods into qualitative or quantitative approaches. Quantitative methods include free listing, pile sort and preference ranking which encompasses paired comparison, and triadic ranking. Others are rank order, structured interview and use value analysis. Qualitative field techniques are participatory rural appraisal, semi-structured interview, open-ended conversation and participant observation. Grenier (1998) classified all the above qualitative methods under participatory rural appraisal (PRA) techniques. Martin (1995) recommended the use of both quantitative and qualitative methods in ethnobotanical works for one to be able to collect complete and reliable information. The three methods used in the present study:

Semi-structured interview, paired comparison and participatory rural appraisal are reviewed as follows.

2.5.1 Semi-structured interviewing

Interviewing refers to asking people about a particular topic. During semi-structured interviewing respondents are asked to respond to predetermined questions or topics and some questions arise as the process continues (Martin, 1995; Cotton 1996; Grenier, 1998). In order to gather in-depth information in some cases, it is better to hold interview with people who are knowledgeable about the topic at hand. Such respondents are those referred to as key informants (Martin, 1995; Granier, 1998). Martin (1995) suggested that in semi-structured interview one respondent be interviewed at a time.

The advantage of this approach is that a respondent is able to express his/her viewpoint, discuss disagreement in the community and speak freely without being interrupted or contradicted by others as is normally the case in group interactions.

2.5.2 Paired comparison (Direct pairwise ranking and scoring)

This technique is used to discover local altitudes on various topics. The procedure of this technique requires respondents to compare, score and rank individual items using their own criteria (Martin, 1995;Granier, 1998). During the actual data collection a researcher randomizes pairs of the items/objects and creates a list of all possible pairs from the relation **(N-1) N/2,** where N is the number of items (Martin, 1995). For every pair of items the respondent is asked which item he /she thinks is more or less than the other basing on a specific concept.

Scores of each respondent can be recorded in a pairwise matrix basing on which rank for each item is given. To obtain the general trend of the study area, scores for each item from all the informants are added together (Martin, 1995). On the other hand, in order to evaluate the differences and similarities in the way the informants respond, Martin (1995)
recommended the use of cluster analysis.

The advantage of this method is that it avoids ready made answers and the result obtained shows perfect transitivity, that is, a logical contradiction to find out the most or least item as per the criterion according to the respondent (Martin, 1995). Weller and Romney (1988) considered paired comparison the most reliable technique when dealing

with illiterates and with relatively small number of items. Weller and Romney (1988) have also reported the successful application of paired comparison technique in the study of disease concepts in Mexico where ten diseases were ranked basing on four concepts.

2.5.3 Participatory rural appraisal (PRA)

PRA is an anthropological field technique. It was developed during the 1980s as the shortcoming of conventional methods of gathering and analyzing useful information on rural life and rural reality continued to become apparent. Workers like Robert Chambers are credited for spearheading the development of this approach. PRA was first developed to guide and evaluate development initiatives. This technique allows the researcher to extract and document indigenous knowledge as it can reveal the complexity of indigenous knowledge systems (Grenier, 1998).

Grenier (1998) recognised thirty-one PRA techniques exist. The choice of one of these techniques as he observed depends on the information one wants to generate.

For the purpose of the present study the following two PRA techniques are reviewed.

2.5.3.1 Open-ended conversation

Open-ended conversation involves discussion with informants. The discussion is directed by the researcher who from a wider perspective narrows the discussion to his/her subject (Martin, 1995). To be able to generate the real knowledge of the cultural group, (Martin 1995) recommended that, the researcher should lower himself/herself so that he/she can fit in the community. During data collection the technique requires the researcher to be able to listen and learn from the respondents (Martin, 1995; Grenier, 1998). He/she should pose open questions, allow respondents to give answers without interfering them so that they are able to give exactly what they know or believe. It is recommended also that the researcher has to be patient and observant to ensure that the respondents are not bored with the conversations (Martin, 1995). Discussions for every topic/question end when the consensus has been reached. This is said to be the point when no more new information is being generated from the discussants.

2.5.3.2 Intriguing practice and beliefs

This technique is used to gather indigenous beliefs /practice related to interaction of the community and the environment. Intriguing practice and beliefs is a form of interaction where a researcher conducts open-ended discussions about beliefs attached to plants with a group of key informants (Grenier, 1998). The researcher's responsibility during this exercise is to ensure that the discussion is exhaustive by asking or revealing points that she/he overlooked. Grenier (1998) recommended that during this exercise knowledge of people should be recorded even if it may be based on myth or superstition.

2.5.4 Advantages and disadvantages of PRA techniques.

PRA is preferred because it is participatory; that is, it allows full participation of the respondent in data collection and analysis. Respondents are not used just as subjects but as full participants in the study. The method is known also to be flexible, less time consuming, less expensive in terms of funds and equipment and directs how the results can be used (Martin, 1995).

Successful uses of PRA have been reported in a number of ethnobotanical studies. Granier (1998) reported the use of PRA techniques by Wickham 1993 among Hindu people in Indonesia. Using a number of PRA techniques, e.g. direct observation, intriguing practices and beliefs Wickham, was able to record villages' knowledge, techniques, beliefs and practices related to sustainable use of plant resources in a study that took four months. Martin (1995) has also reported the use of PRA techniques in Bengal where forest regeneration and harvesting of non-wood forest products were recorded. Another reported work is by Dery *et al.* (1998) who used PRA tools to study indigenous knowledge and prioritisation of medicinal trees in Shinyanga region, Tanzania. From this study about 300 medicinal trees were recorded and ranked in order to get a list of ten priority medicinal plants.

PRA tools are recommended (Martin, 1995) as methods to be used in documenting interactions of people and the environment. However, on the other hand, Grenier (1998) and Martin (1995) have reported weaknesses of PRA as summarised below:

- Because PRA involves group discussion, it is likely that the group can project the ideas of the most influential people to create the consensus with the views of these

people identified as the common interest. Views of ordinary people (poor, children, women, and minority) may not come out as public opinions.

- Constrained with time, it may not allow deep working relations with the community and sometimes careful documentation of cultural and biological aspects of local knowledge is not possible.

3. CHARACTERISTICS FEATURES OF THE STUDY AREA

3.1 Location

Tabora region is located in mid western zone of Tanzania. The region is situated between longitude 30° to 34° E and latitude 4° to 7.5° S. It borders Kigoma and Rukwa regions on the West, Mbeya and Singida on the South, and on the East respectively and to the North is Shinyanga region. The region is the 2nd largest in Tanzania with an area of 76,151 km^2 representing about 9% of the land area of mainland Tanzania.

3.2 Climate

Tabora region has a warm climate with highest temperatures recorded in the months of September and October when it is over 30°C. This is just before the onset of the rainy season. The temperature is lower from May to July (about 28°C) which is marked by the starting of dry winds which goes up to October. The daily mean temperature of the region is around 23°C.

The region experiences mainly one season of rainfall from January to April but there are short showers between November to December. The mean annual rainfall ranges from 700mm in the East of the region to 1000mm in the West.

3.3 Geology and Soils

Tabora region forms part of an extreme old land surface mainly underlain by granites and gneisses rocks, bounded to east and west by rift valleys. Three major zones are recognised, namely; granite zone, gneisses zone and metamorphic and sedimentary zone. The granite zone underlay mostly the central part of region including Tabora town and the eastern part of the region. Overlying the granite in the eastern part of the region are the old, indurated, sedimentary deposits that occur as remnants of plateau bounded with low scarps.

The gneiss zone is located in the west and southwestern part of the region. The underlying rocks are gneisses of intermediate composition and differ from the granite zone in that the formal contains more quartz and fewer ferro-magnesium minerals.

Metamorphic and sedimentary zone lie in the northeast of the region. It is a zone of metamorphic and sedimentary rocks including banded ironstone, schist, sandstone and tuff. It is the area that has been affected most by faulting and earth movements (Fig.1).

The soils in the region vary greatly depending on whether the area is poorly or well drained. It ranges from sandy loam in the west and southern part of the region which are fairly drained to heavy black and/or dark brown soils in poorly drained areas, mostly in the northern part of the region which includes the two dry districts of Igunga and Nzega.

3.4 Relief and Drainage

Tabora region forms part of the central plateau of Tanzania. Low altitude lying mainly between 1100 and 1300m asl. characterise the region. The land above 1200m coincides exactly with the main watershed that divides rivers into two. One portion is for the rivers that flow westward into the Malagarasi basin and another portion comprises of rivers, which flow northeastwards pouring their waters into the Manonga-Wembere basin. From the watershed the land slopes gently towards the Malagarasi swamps to the west and Wembere swamps in the northeast, the altitude of these swamps is about 1050m. asl. The highest elevation is 1800m. asl. and is located at hills southeast of the region.

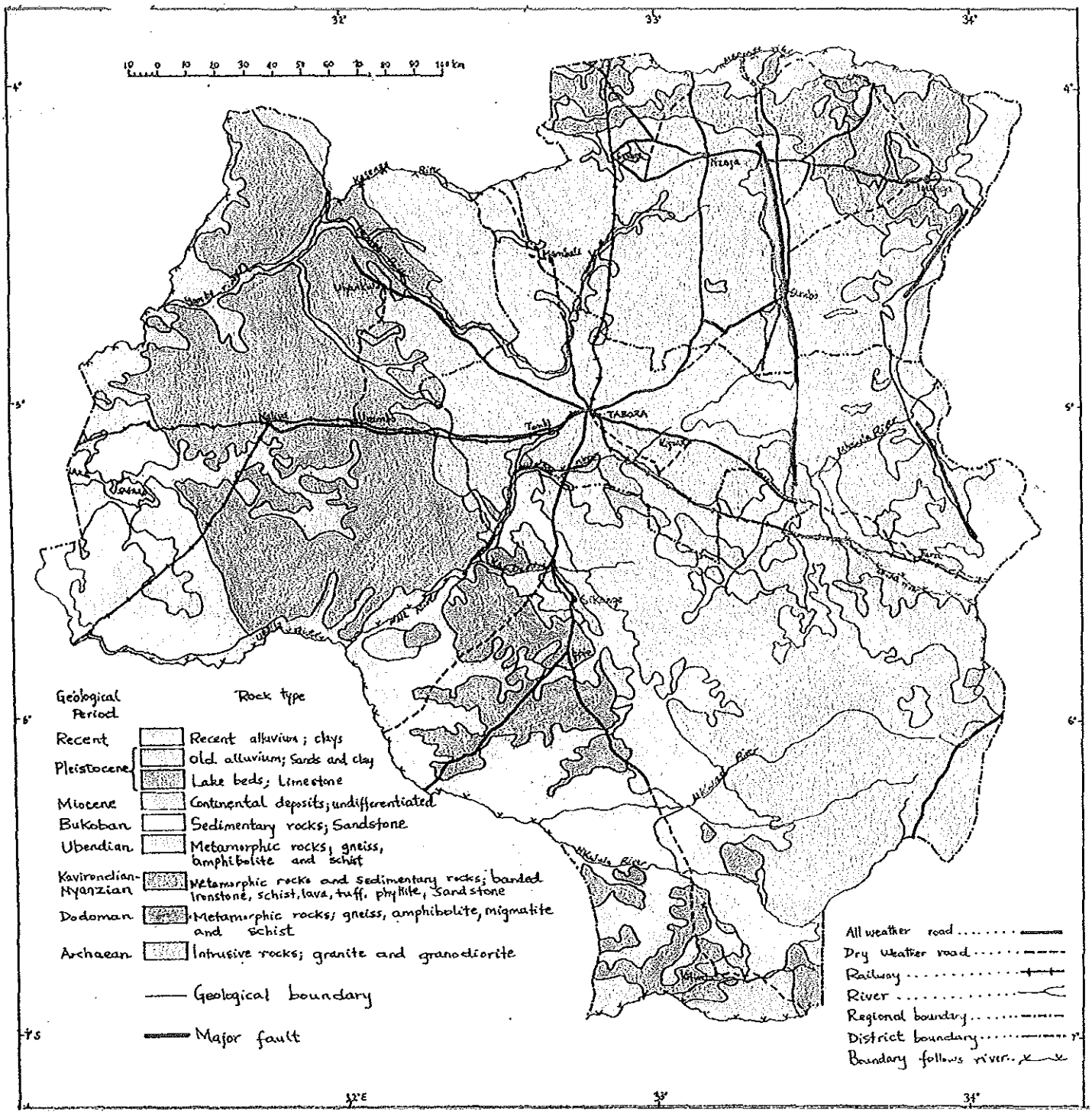


Figure 1: The geology map of Tabora region

The region is mainly drained by two major river systems. To the southern and western part is river Malagarasi that drains into Lake Tanganyika and on the other part is the Manonga-Wembere River, which drains into Lake Eyasi. Apart from these major drainage, insignificant part of the region drain in Lake Victoria, Rufiji and Lake Rukwa catchment (Fig.2).

3.5 Vegetation

A study done by ODA (1982) divides the Tabora vegetation into two main categories namely the upland and lowland or *Mbugas*.

3.5.1 Upland vegetation

Upland vegetation falls into two main groups; the 'Miombo' vegetation which covers most of the region and a number of vegetation communities in the drier north-east including *Acacia/Combretum* woodland, bushland and bushed grassland.

3.5.1.1 'Miombo' woodland

''Miombo'' is a colloquial term used to denote those central, Southern and East African woodlands dominated by the genera *Julbernardia, Brachystegia* and/or *Isoberlinia* closely related genera from the legume Family Caesalpinaceae. The shrub layers associated with 'Miombo' vary in density and composition whereas the ground cover varies from dense coarse grass growth of sparse cover of herb and tall grasses.

In Tanzania, 'Miombo' occurs in two distinct blocks; the southeast block and western block in which Tabora falls and generally it covers 50% of Tanzania, thus the largest ecosystem in the country (Rodgers, 1996).

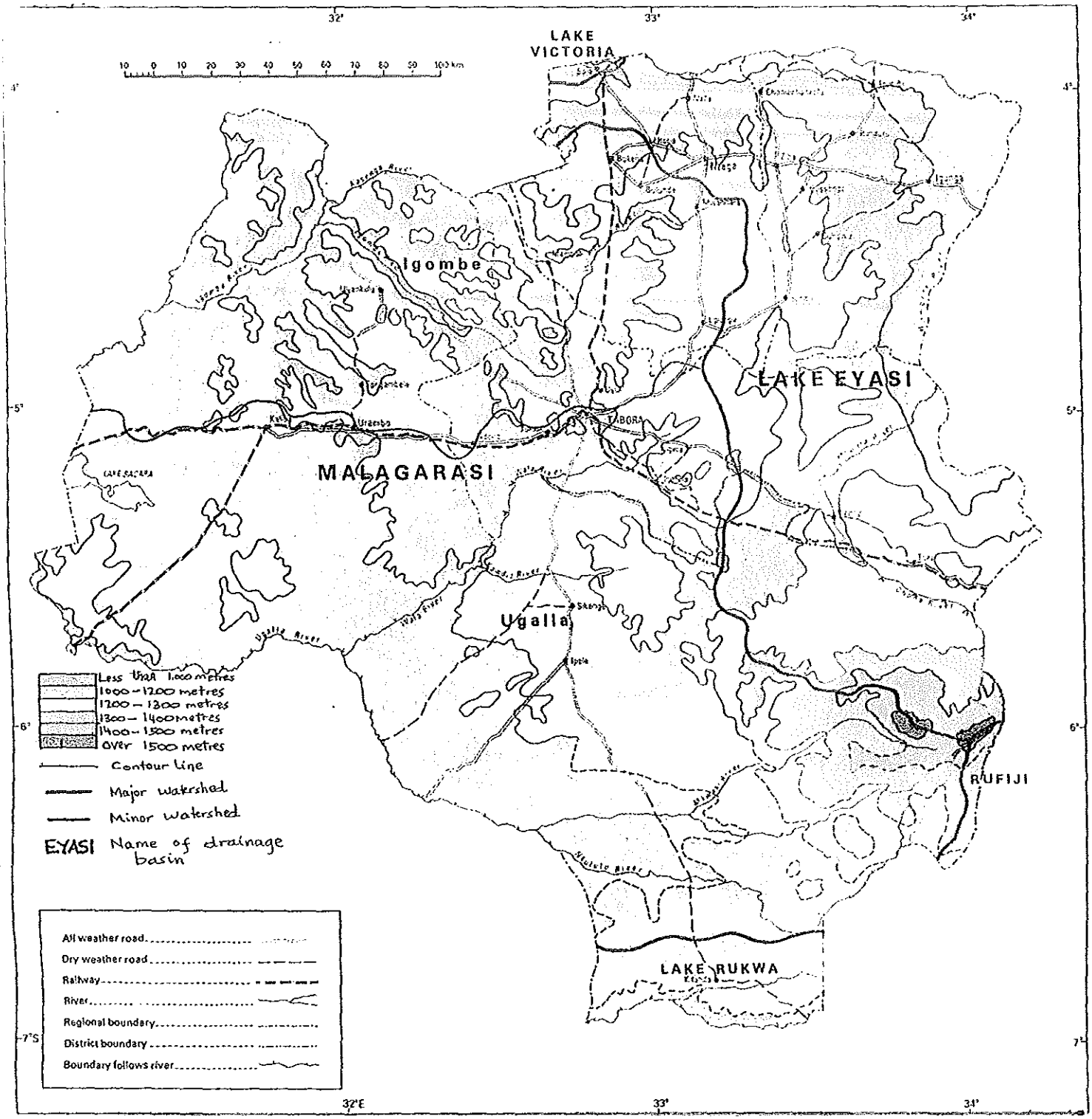


Figure 2: Relief and drainage map of Tabora region

In Tabora 'Miombo' covers 60% of the region, 22,810km^2 in Tabora district, 12,970km^2 in Urambo, Nzenga (1,980km^2), Igunga (400km^2) (ODA, 1982). 'Miombo' woodland contains the majority of the commercially exploitable timber such as *Pterocarpus angolensis, Julbernardia globiflora, Brachystegia boehmii* and *Brachystegia specifomis.*

Towards the northeastern limits of 'Miombo' there is a transitional zone where 'Miombo' species decrease and *Acacia* and *Comiphora* species builds up reflecting the dryness of the climate.

3.5.1.2 The drier vegetation communities

Three vegetation types fall under this category. The first is *Acacia/Combretum* in which *Acacia* or *Comiphora* species may be dominant associated with *Combretum* species. This vegetation type occurs mainly in Nzenga district and on the plateau bordering Wembere south of Igunga. The second vegetation type is the bushland and bushed grassland that is mostly spread on the northeast. Bushland results from degradation of several vegetation types that have been cleared browsed or selectively grazed. Dominant species is *Acacia drepanolobium*, which together with grassland is a result of burning and clearance for grazing. The third vegetation is the Itigi thickets a dense impenetrable deciduous thicket of multistemmed shrubs. This occurs on the eastern part of the region.

3.5.2 Lowland vegetation

These vegetation types occur in waterlogged areas. Three main types occur; 'Mbunga' wooded grassland, which consists of tall coarse grasses with scattered trees especially around termite mounds. It is extensive within ''Miombo'' especially on valley floors and floodplains. Mbunga grassland is the second vegetation type in this category. It occurs in areas that are invariably flooded for long periods during wet seasons. Nyahua mbuga and Lyela mbuga follow under this category. Swamps form the category of vegetation type, which includes the Malagarasi and the Wembere (Fig. 3).

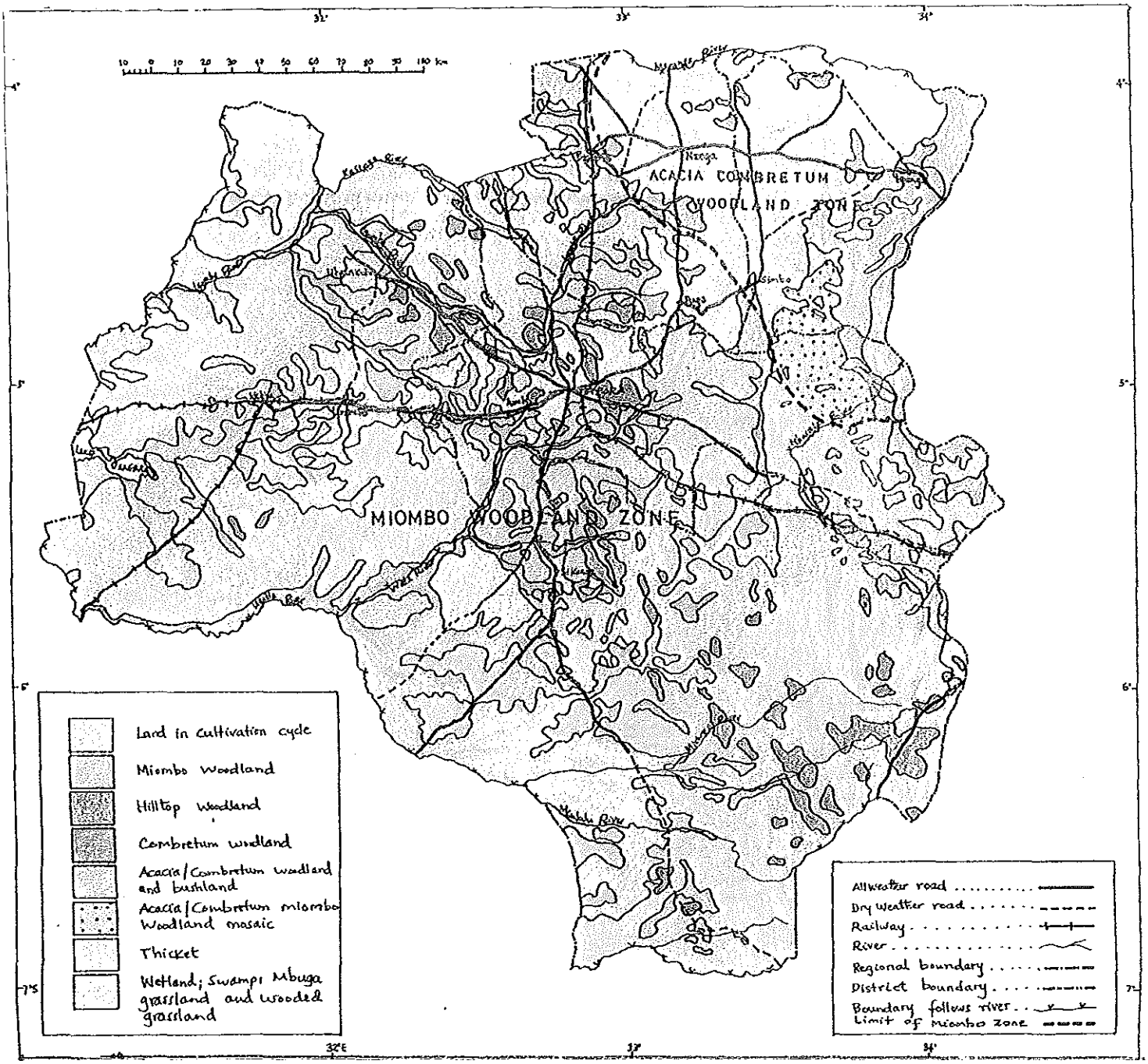


Figure 3: Vegetation map of Tabora region

3.6 Protected Areas and Their Threats

3.6.1 Protected areas

Tabora has two types of protected areas; these are forest reserves and a game reserve. Thirty-three forest reserves occupying a total area of 3,456,400 hectares are known in Tabora (Table 2).

Table 2: Forest reserves in Tabora region.

District	No. of Forest Reserves	Area (ha)
Tabora rural	7	267,900
Sikonge	8	1,947,700
Urambo	4	994,400
Igunga	3	115,200
Nzenga	11	121,200

Source: Forest Resource Management Project - Tabora

The only game reserve in Tabora is Ugalla River Game Reserve, which covers an area of 4,800km^2. There are also 7 controlled and 3 open game areas. The general distribution of protected areas is shown on Fig. 4.

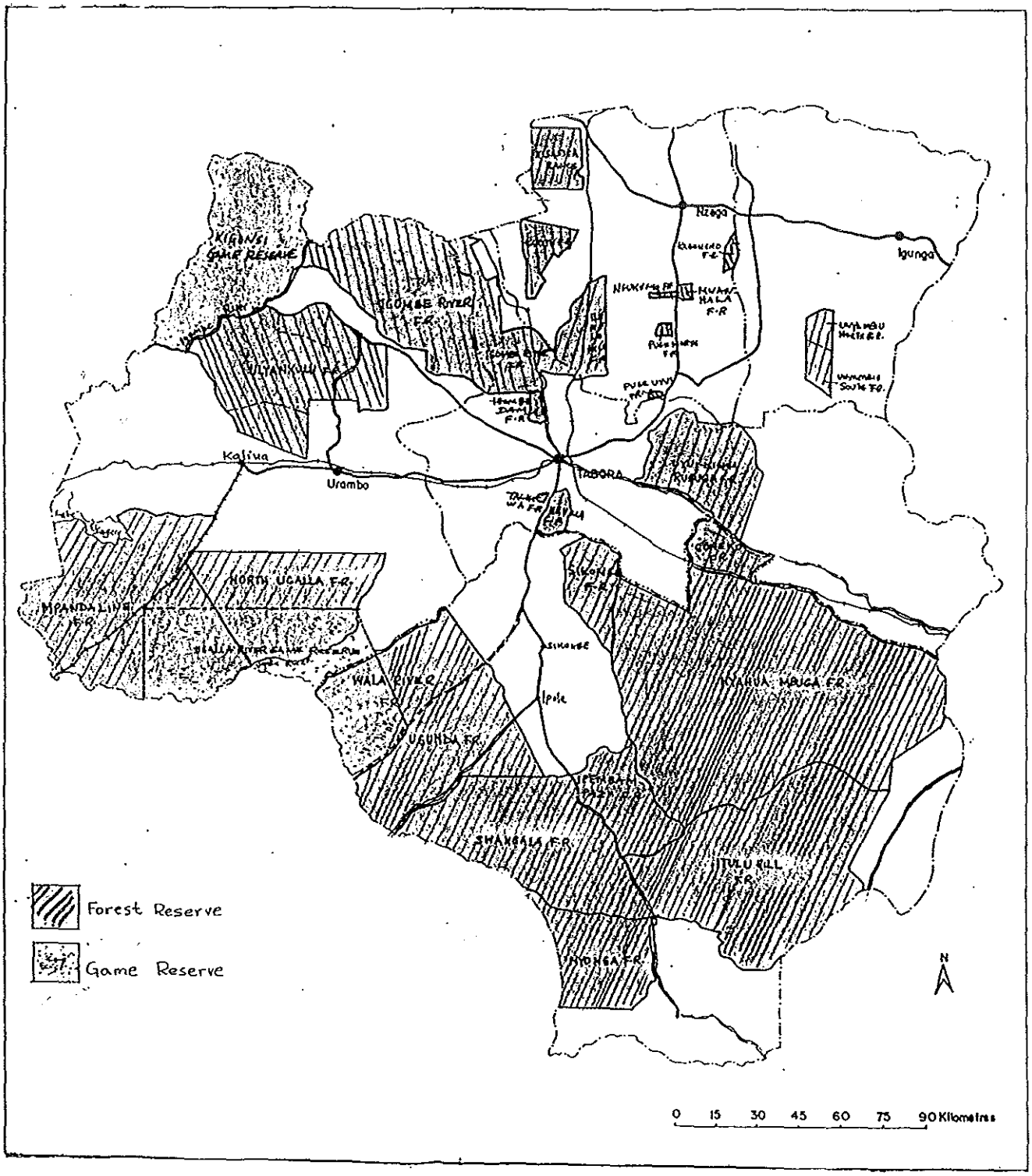


Figure 4: Map of Protected areas in Tabora

3.6.2 Threats to protected areas

The main threat to forest reserve in Tabora is encroachment as a result of which there has been a tremendous depletion of forest reserves. It is estimated that 200,000 hectares of forest reserve has disappeared and a number of forest reserves either are depleted or severely depleted. For example, Puge South and Puge North, Kagong'ho and Mwakululu forest reserves have completely been swept away (Forest Resource Management Project, 1997). Encroachment is in the form of agriculture, fuelwood collection, logging, grazing and beekeeping (Table3). Although the referred report do not define the criteria used to categorise forest reserves in Tabora region as indicated in Table 3, it suffices here to show that encroachment has changed the status of forests in Tabora.

Threats to Ugalla Game Reserve are mainly poaching in the form of illegal hunting, logging and illegal fishing.

Table 3: Extent of encroachment in Tabora Forest Reserves

DISTRICT	FOREST RESERVE	ACTIVITIES	CURRENT STATUS
TABORA	Igombe dam	Agriculture/Fuelwood Logging/Grazing/Beekeeping	Depleted
	Igombe river	Agriculture/Fuelwood Logging/Grazing/Beekeping	Depleted
	Ntalikwa	Fuelwood/Beekeeping/Grazing	Severely damaged
	Simbo	Fuelwood/Beekeeping/Grazing	Depleted
	Urumwa	Grazing	Depleted
	Uyui-Kigwa-Rubuga	Agriculture/Beekeeping/ Fuelwood/Grazing	Depleted
	Goweko	Agriculture/Fuelwood/Grazing/	Severely damaged
SIKONGE	Itulu hill	Agriculture/Fuelwood/Grazing/ Beekeeping	Partially depleted
	Inyonga	Agriculture/Grazing/ Logging/Beekeeping	Partially depleted
	Swangala	Agriculture/Logging/ Grazing/Beekeeping	Partially depleted
	Nyahua mbunga	Agriculture/Logging/ Grazing/Beekeeping	Partially depleted
	Sikonge	Agriculture/Logging/ Grazing/Beekeeping	Depleted
	Ugunda	Logging/Beekeeping	Slightly depleted
	Mpembazi	Logging/Beekeeping	Slightly depleted
	Wala	Logging/Beekeeping	Slightly depleted
URAMBO	Igombe river	Agriculture/Grazing/ Fuelwood/Beekeping	Depleted
	Mpanda line	Agriculture/Grazing/ Logging/Beekeeping	Partially Depleted
	North Ugalla	Grazing/Logging/ Beekeping	Depleted
	Ulyankulu	Agriculture/Grazing/ Logging/Fuelwood/	Depleted
IGUNGA	Unyambiu North and South	Grazing/Beekeping	Depleted
	Ziba	Grazing/Beekeeping	Depleted
	Igombe river	Agriculture/Fuelwood/ Beekeeping	Depleted
	Mwanhala	Gazing/Beekeeping	Depleted
	Ngukumo	Grazing/Beekeeping	Depleted
	Ilomero	Agriculture/Grazing/ Fuelwood/Beekeeping	Severely depleted
	Itobo dam	Grazing	Depleted
	Kangong'ho	No longer existing as forest reserve but as settlement, grazing or farmland.	
	Karitu	Agriculture/Grazing	Depleted
	Mwakulu	No longer exists as forest reserve but settlement &grazing	
	Mwakalundi	Agriculture/Fuelwood/Grazing/ Beekeping	Depleted
	Puge North	No longer exists as forest reserves but farmland and grazing areas.	
	Puge South		

Source: Forest Resources Management Project (FRMP,1997).

3.7 People and Human Activities

3.7.1 People

The indigenous people of Tabora region are Nyamwezi. It is speculated that the ancestors of Nyamwezi tribe were hunters who arrived in Tabora (Nyamweziland) in 17th or 18th century. The exact historical details are not clear. They established themselves through conquest, persuasion or other means. These groups stated founding minor states that were focusing on chiefdom *butemi* to be a centre of all activities.

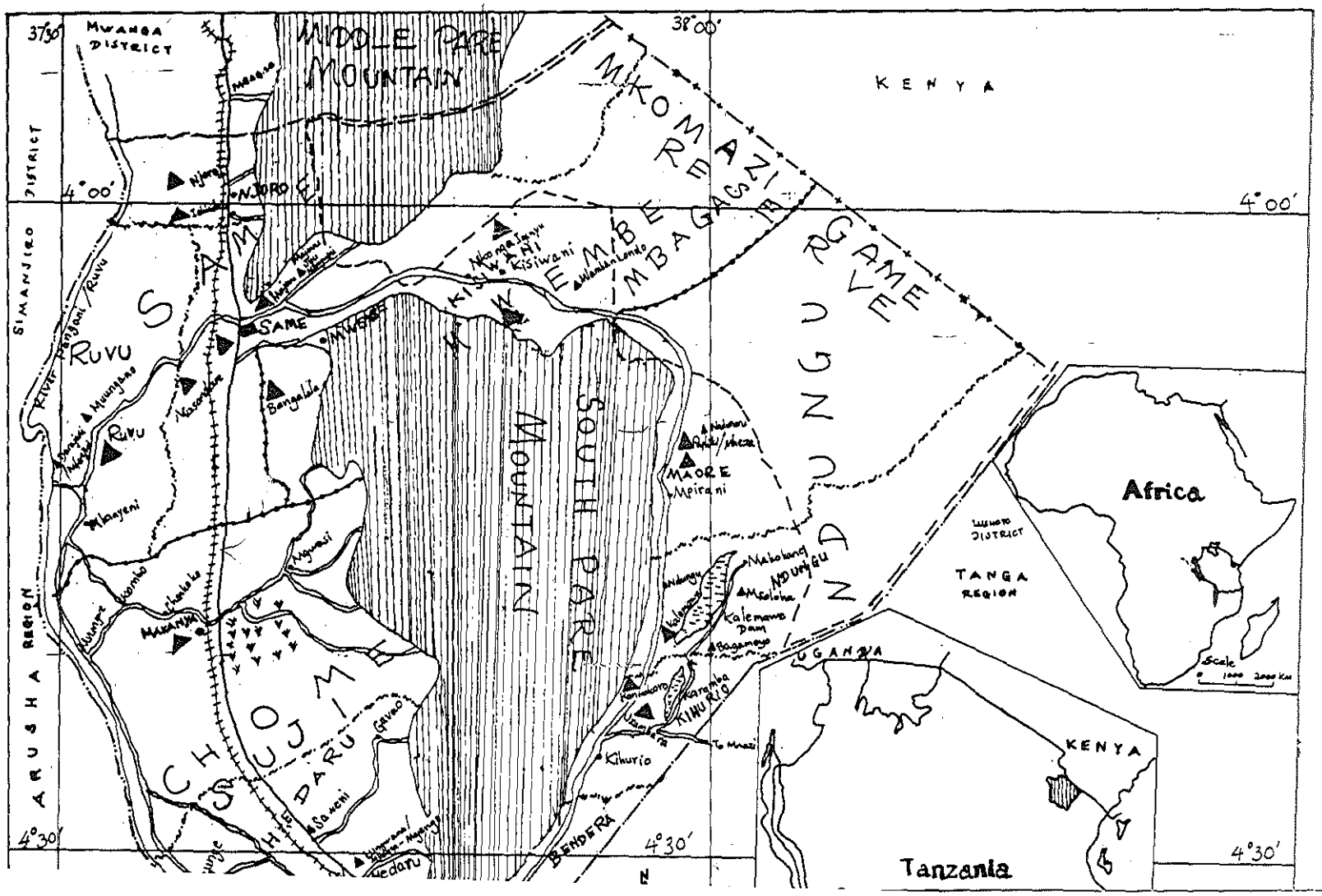
The names *Tabora* and Nyamwezi developed after the occupation of this area. Tabora originated from the word *Matoborwa* meaning sweet potato, which was a staple food for *Nyamwezi* people. Visitors couldn't pronounce the word properly, they ended up pronouncing Tobora which later on changed to Tabora. The name Nyamwezi came into existence in the 1830s after the formation of Kahama town in Shinyanga region. People travelling between Tabora and Kahama towns when asked by Arabs where they were coming from they used to say they were coming from *Unyamwezini* meaning a place where moon rises; hence *Nyamwezi* people.

Before their exposure to the outside world in 19th century the Nyamwezi people considered the top leader **'Ntemi'** as a ritual figure. The traditional Nyamwezi State operated through a union of rituals and administrative functions shared by the chief (Ntemi) and his important headsmen. The actual functions of the chiefdom 'butemi' were left to the Ntemi's subordinates - who at the grassroots were known as **'wezengakaya'**. The famous chief of Nyamwezi was Ntemi Mirambo who ruled the Nyamwezi for about 44 years from 1840 to 1884.'Nyamwezi' is a collection of a number of ethnic groups, which share the same language and cultural characteristics.

In the 1988 census there were 1,036,294 people in Tabora with a population density of 14.0 people per km^2 and an annual growth rate of 2.4%.

3.7.2 Human activities

Productive sectors which employ large human population in Tabora region are agriculture and livestock, natural resources, mining and industry and trade in that order of importance.


MIDDLE PARE MOUNTAIN
SOUTH PARE MOUNTAIN
MKOMAZI GAME RESERVE
MBAGASE
KENYA
MWANGA DISTRICT
SIMANJIRO DISTRICT
ARUSHA REGION
LUSHOTO DISTRICT
TANGA REGION
UGANDA
Tanzania
Africa
SAMEE
CHOME
SUJI
HEDARU
RUVU
NDUNGU
SAME
NJORO
MWANGA
MAORE
KIHURIO
BENDERA
Kisiwani
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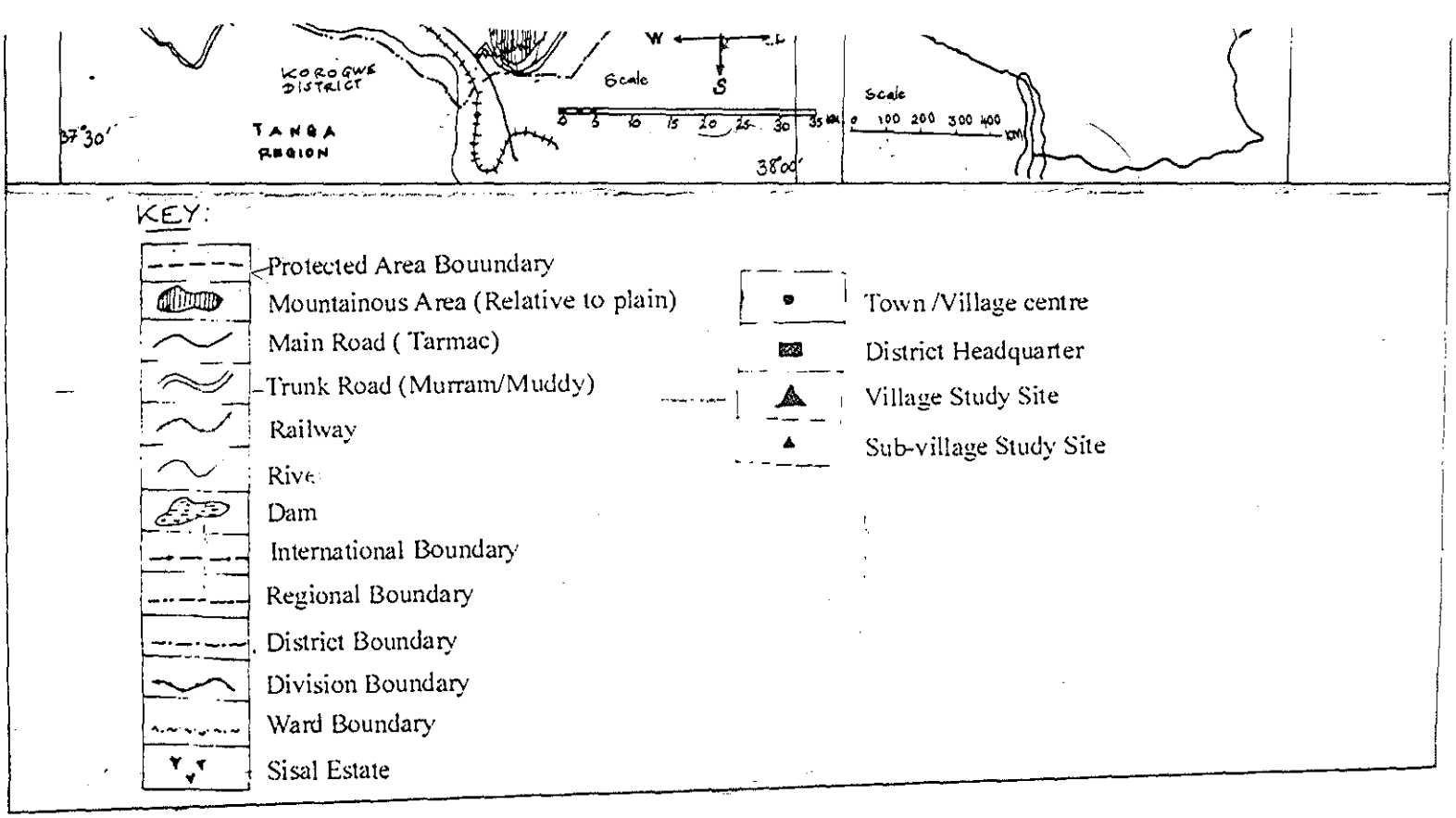


Figure 1. Map of Same District showing study sites
(Source: URT, 2000)

3.7.2.1 Agriculture and livestock

Agriculture is the leading economic activity in the region. Food crops produced in Tabora in their decreasing order of importance are maize, rice, sorghum, cassava and legumes, the most important in the last category being beans always intercropped with maize. Cash crops grown in Tabora are tobacco, cotton, groundnuts and sunflower.

Livestock keeping is the second predominant economic activity in Tabora. In this region livestock are kept as sign/or evidence of personal wealth, prestige or insurance. Three types of livestock are kept, and according to the National census of Agriculture 1994/95 there were 1,009,571cattle, 464,327 goats and 151,034 sheep. Presence or absence of tse tse flies and area available for grazing determine the distribution of livestock in the region. Livestock concentration is more in the north east of the region in Igunga and Nzega districts, which are almost entirely tse tse fly free.

3.7.2.2 Natural resources

Natural resources industry employs a big number of people in Tabora. Leading sectors are forestry, wildlife, beekeeping and fisheries. Forests in Tabora serve three main purposes, that is timber and fuelwood and production of non-timber forest products such as mushroom, traditional medicine and famine food. The overall fuel consumption in the region amounts to about 2,330,000 m^3 per year and this includes fuelwood for domestic use requirements, for tobacco curing (1.3 mill m^3/year) and requirement for brewing, fish smoking and beer making. The natural regeneration is estimated to be 2.2 mill. m^3/year. Data obtained from the Regional Natural Resources Office show that the regional production of round wood for the year 1995 and 1996 were 1,555 m^3 and 1,540 m^3 respectively and the leading producer was Tabora (rural) district which capitalised almost 90% for the two years. In the same period, no production was recorded in Nzenga district.

Beekeeping is another sector, which employs a lot of people especially in rural areas. According to Regional Natural Resource Officer, it is estimated that there were about 13,000 and 14,000 beekeepers in the year 1995 and 1996 respectively. Records also reveal that production of bee products (honey/beeswax) have been increasing from 1985

to 1996. In 1985, 5,906 and 328 tonnes of honey and beeswax, respectively, were recorded and in 1996 over 9,900 tonnes of honey and 553 tonnes of beeswax were recorded with Tabora rural taking the lead.

Fisheries and wildlife are other important sectors in Tabora. Although Tabora has no important rivers or lakes the few that are available are used as sources of fish. Fishing activities are confined to Lake Sagara, Ugalla River and artificial dams of Igombe, Kilimi, Mihama, Bulenya and Mwamapuli. The contribution of wildlife to the region economy is through tourism that is concentrated on Ugalla River Game Reserve.

3.7.2.3 Mining, trade and industry

Tabora is not an important region for mining, trade and industry. These activities employ only a small fraction of the population although the contribution of these sectors to the regional economy is appreciated.

3.8 Health and Health Infrastructure

Two health systems exist in Tabora; formal and traditional health systems both in urban and rural areas. Data from the Regional Medical Officer indicates that malaria is the major cause of morbidity and mortality causing about 54.4% of all cases in the region. Ear diseases cause the least problem (Table 4)

Table 4: The ten common sources of morbidity in Tabora region.

Disease	Percentage of all cases
1. Malaria	54.4
2. Upper respiratory tract infection (URTI)	17.2
3. Diarrhoea	9.4
4. Eye disease	4.5
5. Pneumonia	2.3
6. Intestinal worm	4.3
7. Skin disease	4.1
8. Anaemia	1.5
9. Gonorrhoea	1.3
10. Ear disease	0.6

Source: Regional Medical Officer, Tabora

The formal health infrastructure in Tabora is far to be adequate. Quite insufficient hospitals, health centres and dispensaries exist in the region. There are 7 hospitals, 15 rural health centres and 182 dispensaries. While other districts have at least one hospital Tabora rural district have none (Table 5).

Table 5: Distribution of health infrastructure in Tabora region.

District	No.of Health centres	No. of Hospitals	No. of dispensaries
Tabora urban	0	1	48
Nzega	5	2	33
Tabora rural	1	0	30
Igunga	4	2	26
Urambo	3	1	29
Sikonge	1	1	16

Source: Regional Medical Office, Tabora

4. METHODS OF STUDY

4.1 Selection of Study Area and Study Sites

The study was carried out in Tabora rural district from October 1st 1998 to January31st, 1999. Tabora rural district was selected randomly from the three less degraded and mostly occupied by 'Nyamwezi districts.' The two other districts in the same category are Urambo and Sikonge. The degraded districts are Nzenga and Igunga and they are both occupied mostly by Sukuma and Nyamwezi.

A less degraded criterion was used based on the assumption that it was likely that such districts had ways of conserving their immediate surroundings and that they had few emigrants. The list of less degraded areas was obtained from the Regional Natural Resources Officer in Tabora and was ascertained using the study carried out by ODA (1982) which consider Nzenga and Igunga districts most degraded.

From the fifteen wards that make the Tabora rural districts, data were collected from four randomly selected wards. These were Magiri, Ikongolo, Igalula and Iolangulu. In each ward three villages were randomly selected and therefore data were collected from twelve villages. (Fig. 5).

4.2 Sampling of Respondents

In each village four different types of respondent were selected. Fifteen percent of the households randomly selected formed a sample for the study of most threatening activities to medicinal plants and/or their habitats. Fifteen to twenty-five elders 38 years old and above were selected randomly from a list of indigenous people for indigenous knowledge study. The age of 38 years and above were selected basing on the fact that for the purpose of this study they were considered key informants as suggested by Martin (1995). Almost all traditional healers in each village were visited for issues related to traditional medicine and about 30% of households randomly selected were consulted for household's therapy/treatment study.

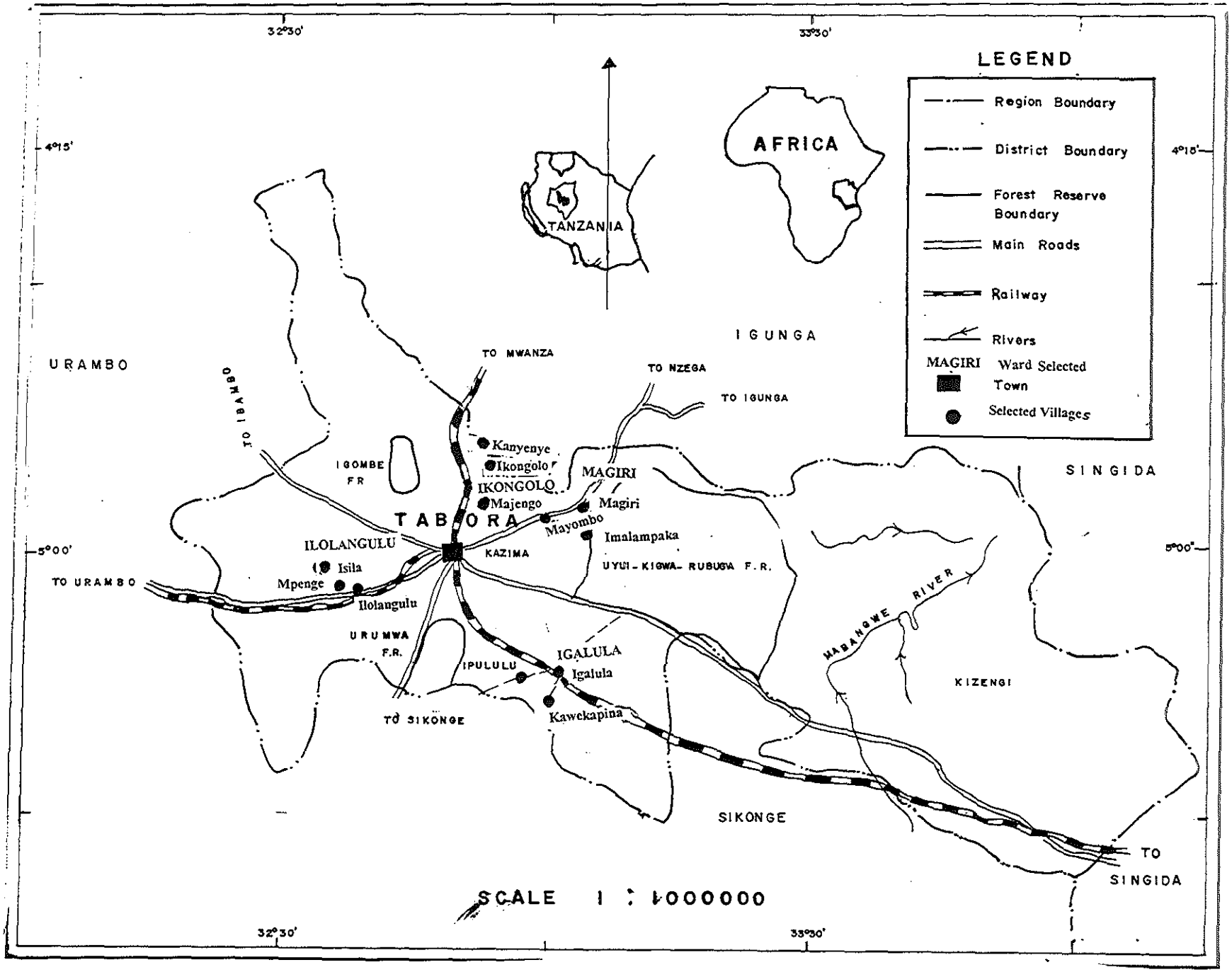


Figure 5: Study area and sites in Tabora rural District

4.3 Survey Methods for Ethnobotanical Data Collection

Three methods were employed in this study:

- PRA techniques
- Semi-structured interviewing and
- Paired comparison

4.3.1 Participatory rural appraisal (PRA)

Two PRA techniques were used to gather indigenous knowledge related to conservation of medicinal plants and/or their habitats. These were open-ended conversation and intriguing practices and beliefs.

4.3.1.1 Open-ended conversation

Open-ended conversation as described by Martin (1995) and Cotton (1996) were used to gather indigenous knowledge of Nyamwezi people related to conservation of medicinal plants and/or their habitats. Conditions described by Martin (1995) and Grenier (1998) were carefully followed to ensure successful data collection (Section 3.2.3.1). Consensus reached on each topic/questions discussed was taken to be the Nyamwezi's indigenous knowledge related to conservation of medicinal plants and/or their habitats.

4.3.1.2 Intriguing practice and beliefs

Intriguing practice and beliefs as described by Grenier (1998) was used to gather information on how the community (Nyamwezi people) as a whole uses beliefs/taboos to conserve diversity of medicinal plants.

The two PRA techniques are presented separately here for convenience but during data collection they were applied at the same time

4.3.2 Semi-structured interview

Semi- structured interview as described by Martin (1995), Cotton (1996) and Grenier (1998) was used to obtain information from Fifty traditional healers/practitioners and also to gather data for establishment of household remedy system. Ready prepared questions (interview schedule) were used to guide data collection from traditional practitioners (Appendix 1). Traditional healers were asked about the plant and plant parts

used to treat the top ten diseases in their region (Section 3.1.8) and five more diseases they thought they were experts for treating. Healers were also asked, if generally, they needed more time to find plant species they were using to treat people than it used to be 10 years ago. Reason(s) for the trend and steps taken to ensure a constant supply were also established To establish household's therapy (whether households depended on traditional healing system, formal system or both for treatments of diseases and conditions), 224 households were consulted. In each household only one mature individual was selected randomly for this purpose.

4.3.3 Paired comparison

Paired comparison as described by Martin (1995) was used to establish the activity/activities perceived by the Nyamwezi people to be the major threat to medicinal plants and/or their habitats in Tabora. Eight activities established from the literature and general observation were used to form the pairs for comparison. The activities were, forest fires, charcoal making, grazing, logging, tobacco cultivation, collection of medicinal plant, beehive making and firewood collection.

The number of pairs were established from the relation **(N-1) N/2,** where **N** is the number of activities (Martin, 1995). In this case, 28 pairs were obtained serially that is 1,2; 1,3; 1,4..... . The pairs were wrote on 28 pieces of paper, which were mixed together in a container. From the container, pieces of paper were picked one after another without replacement. The first pair to be picked was assigned serial number 1, the second 2, up to the last that was given serial number 28 (Appendix 2).

The established randomised pairs were used to get individual's responses as described by Martin (1995.) (Section 2.5.3.2). Each respondent was requested to select an activity that he considered being a major threat to medicinal plants and /or their habitats from each of the 28 established pairs. At least three respondents were considered from each household (1 adult male, 1 adult female and 1 child above 7 years old). Scores for each household were added together and a mean score was found. This was recorded in a pairwise matrix and basing on the mean score of households, a rank was assigned to each of the eight activities (Appendix 3). In cases

where three individuals could not being obtained from a single household, more than one house was consulted and their responses treated as responses of one household. At the end of the exercise each respondent was asked why he/she scored a certain activity first and another one last. A total of 276 individuals from 92 households were involved in this exercise.

4.4 Data Analysis

Consensus reached on each topic/question discussed during participatory rural appraisal (PRA) exercise was recorded and considered to be the Nyamwezi's indigenous knowledge related to conservation of medicinal plant diversity and/or their habitats in Tabora.

On the case of medicinal plants, plants used to treat 38 diseases (9 of them falling on the 10 most important diseases) were recorded. Local name, botanical name, family and parts used were all recorded for every plant mentioned by traditional practitioners. Plants named were collected, pressed dried and taken as voucher specimens. To ensure that the right specimen was collected key traditional healers guided the exercise s.

To establish if relatively more time was required to collect medicines than it used to be ten years ago, the total number of individuals who said they needed more time now than before were obtained by adding such respondents from all the four wards. In the same way those who could not see any difference. Ratios were used to establish the difference between the two groups.

Data obtained through semi-structured interview on household treatment were analysed by a Two way Analysis of Variance (ANOVA). This was performed in order to see if there was a significant difference between the number of households that depend only on modern treatment system, traditional healing system or both and if the difference was existing across the four wards.

Household responses recorded in a pairwise matrix during paired comparison exercise were used to obtain the general trend of the district. To be able to arrive at this, scores for similar cells for all households were added together and totals used to establish which

activity was considered more threatening to medicinal plants and/or their habitats than others by the 'Nyamwezi' people. This was followed by cluster analysis that was performed to establish the similarities and differences among the household's observations on activities considered more threatening. A computer program known as Syntax was used in the exercise. Household's ranks were used as subjects.

5. RESULTS

5.1 Organisation of Results

The results obtained during this work have been organised into four sections. The first section deals with the household's therapy, this is followed by a section that presents the findings related to threats to medicinal plants and /or their habitats as ranked by indigenous people. In section three, medicinal plants commonly used by Nyamwezi people are presented. In section four indigenous knowledge related to conservation of medicinal plants and their habitats is presented.

5.2 Household's Therapy

It was found that most households of Nyamwezi people in Tabora depend on both traditional and modern healing systems. Least depends on traditional healing system only. This was true almost throughout the wards except in Ilolangulu where the number of households depending on modern system only were equal to that of individuals depending on modern system exclusively. (Table 6).

Table 6: Number of households in each ward depending on one of the three treatment systems.

	Treatment systems			
WARD	Modern only	Traditional only.	Both	TOTAL
Magiri	16	7	24	47
Ikongolo	20	6	32	58
Igalula	18	2	33	53
Ilolangulu	12	12	42	66
TOTAL	66	27	131	224

Basing on the results on table 6 a two-way analysis of variance (ANOVA) was performed in order to ascertain if the observed difference was significant. The result of the analysis showed that, there was a highly significant difference in number of people going for different treatments across the four wards (**$p<0.01$, $F=16.67$, $df=2,6$).

5.3 Nyamwezi People Perception of Threats to Medicinal Plants and/or their Habitats

It was found that Nyamwezi people consider tobacco cultivation as the most destructive activity than the others in Tabora. The mean score was 565 (21.93% of the total mean scores). Medicine collection is considered the least destructive activity with a mean score of 91, (3.3% of the total mean scores). Forest fires were ranked second while charcoal making and grazing were third and fourth, respectively (Table 7).

Table 7: Total mean score and ranking of the eight activities

Activity	Tobacco	Fires	Charcoal	Grazing	Logging	Firewood	Hives	Medicine
Total mean score	565	478	428	404	304	174	136	91
Percentage	21.93	18.60	16.61	15.70	11.80	6.60	5.30	3.46
Rank	1	2	3	4	5	6	7	8

The explanation given by the respondents regarding the squence in Table 9 are presented below.

5.3.1 Tobacco farming

Nyamwezi people in Tabora consider tobacco farming to be the major threat to medicinal plants and/or their habitats due to the following facts:

- Shifting cultivation, where a farmer clears a new farm almost every cultivation season was mentioned as a feature that makes tobacco cultivation to rank highest. As to why shifting cultivation was a necessary feature of tobacco farming, respondents said that a new farm requires less fertilisation and it is a way of avoiding pests (nematodes) and harvesting good quantity and quality tobacco leaves which fetch good market price. It was said that a small-scale farmer might clear up to 2 hectares in every season whereas the larger scale farmer can clear up to 50 hectares. Most of the farmers clear between 5-20 hectares every season.

- Another feature of tobacco farming that was considered by the respondents as making it the major threat was the firewood requirement. Respondents pointed out that curing of tobacco required a lot of firewood that was all obtained from natural woodlands in public lands and even protected areas. Encroachment in Uyui-Kigwa forest reserve by farmers in Imalampaka village for tobacco farm establishment and as source of firewood was cited as a living example of the situation taking place in most areas in Tabora. When asked the amount of firewood required for curing tobacco leaves harvested from one hectare, respondents said that depending on the quality of fuelwood 2-3 lorries each of capacity 7 tones (14 to 21 tonnes of stalked wood) were required. Firewood also was said to be required for bed sterilisation.

- Respondents also pointed out that tobacco cultivation involves large number of people. Almost everybody able to work in the rural areas was involved in the activity and as a result many areas were rendered bare every year.

- It was also pointed out that except in places where shortage of trees has necessitated the use of mud bricks to construct barns, normally barns were constructed using tree poles.

Respondents in Magiri, Igalula and Ikongolo wards pointed out that tobacco farming was a reason for clearance of public woodlots in their villages. In Magiri and Ikongolo wards a large proportion of traditional healers said that they needed more time for medicine collection now than it used to be ten years ago.

5.3.2 Fires

In cases where fires were scored higher reasons given by respondent were that: fires burn large areas at a time killing herbs, seedling and sapling and sometimes mature trees. It was also mentioned that since fires were mostly unpredictable in some incidences, it has-been burning up houses, farmlands and even killing people and many animals.

5.3.3 Charcoal making and grazing

Other activities with high scores were charcoal making and grazing. In cases where charcoal was scored higher, the reason given was that it was no longer selective that is, it

was almost taking a shape of clear cutting in most cases leaving only timber trees. Respondents also pointed out that charcoal was destructive, as many people were involved. They consider it to be a business that requires little or no capital and that unlike farming charcoal was not a seasonal practice. The fact that charcoal was required in urban and currently even in rural areas due to shortage of firewood was making the activity even more threatening.

Reason given by respondents who scored grazing higher was that, cattle grazing leads to cutting of trees for tse tse fly expulsion. Other reasons given were that, it causes erosion, makes the soil compact thus hard to till, graze litter or residues in farmlands which could have served as compost and that cattle brought in Tabora from Shinyanga during dry seasons were being grazed even in croplands.

5.3.4 Least scored activities

It was found that medicine collection, hive making and firewood collection were considered least threats to medicinal plants and/or their habitats. Reasons as to why medicine collection was scored a safer activity among the eight factors was that medicine collection rarely kills plants immediately and that as compared to other activities only few people are involved in the activities

For the case of firewood, most respondents considered it to be less destructive because women who collect firewood go for dead logs, branches and leftovers thus inflicting almost no harm on living plants. They also pointed out that firewood collectors, collect mostly trees and shrubs and rarely herbs. Only two households ranked firewood collection high and their general reasoning was that every household in the rural areas and families with lower living standards in urban Tabora use firewood. They also mentioned that in areas where firewood availability was a problem, living trees were cut and kept to dry at home.

Hive making was considered less destructive by respondents as it was selective to specific tree species that could produce log or bark for hives thus leaving medicinal plants safe. In addition, it was said that beekeeping was not equally important in all the

villages. Respondents also pointed out that hive making was a seasonal undertaking and that beekeepers were necessarily not constructing new hives every year.

5.4 Cluster Analysis

From the cluster analysis nine clusters were obtained (Fig. 6) the characteristics of clusters and subclusters are summarized in Table 8.

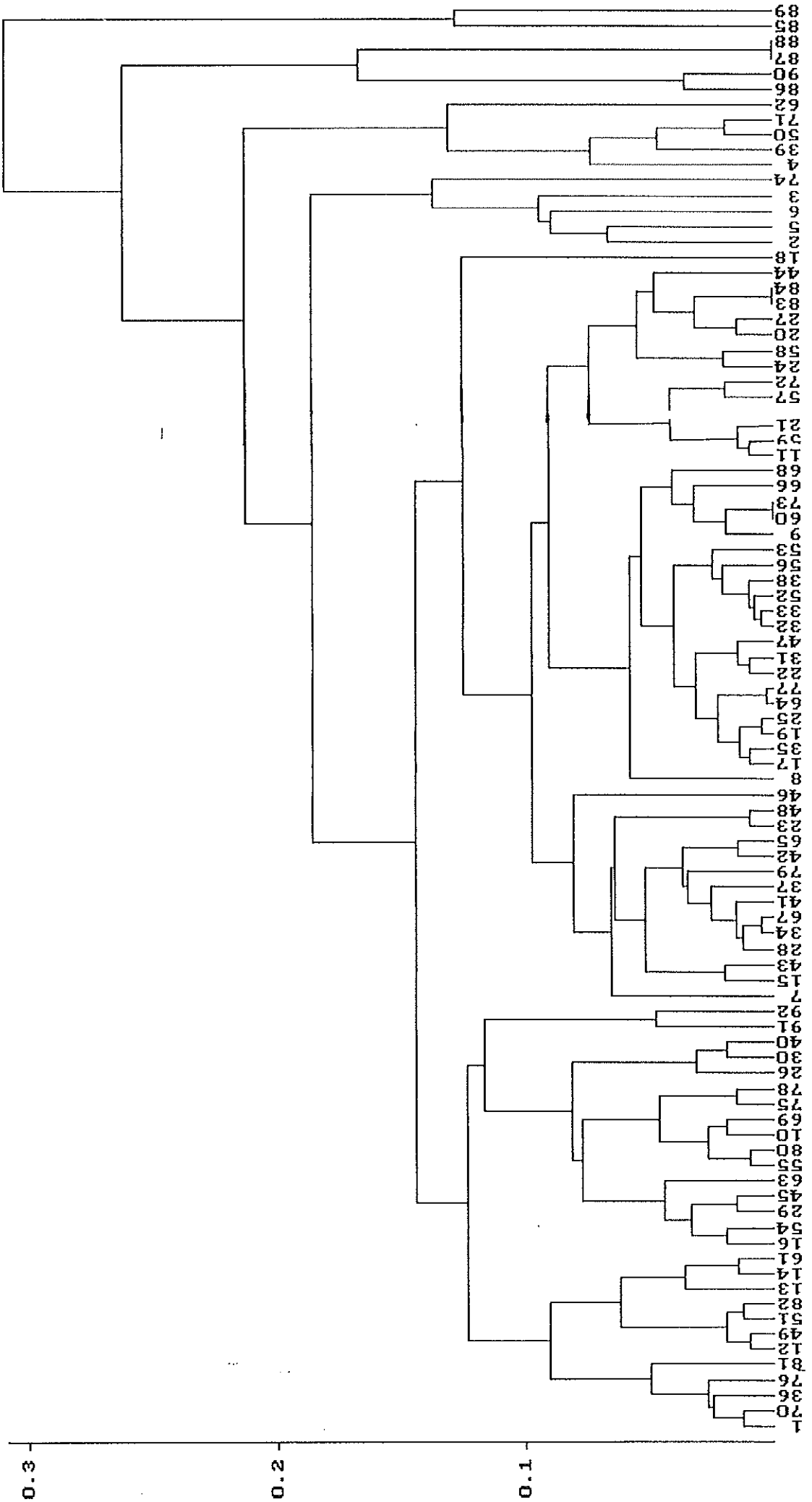


Figure 6: Dendrogram of house clusters

Table 8: Common features of the clusters

Cluster No.	Cluster's household	Ward of origin	Household total	Common properties
1	(I) 1,70,36,76,81.	Magiri,Ikongolo Ilolangulu,Igalula	5	Rank charcoal making first. Tobacco third.
	(II)12,49,51,82,13,14,61	Ilolangulu,Igalula	7	Rank tobacco cultivation first Rank charcoal making third.
		Ikongolo	12	Whole cluster considers medicine collection safer
2	(I) 16,54,29,45,63.	Ilolangulu,Magiri Ikongolo	5	Rank tobacco cultivation first. Rank firewood collection last.
	(II) 55,80,10,69,75,78	Ikongolo,Igalula,	6	Rank charcoal making first Tobacco cultivation second.
		Ilolangulu.		Consider medicine collection safer.
	(III) 26,30,40.	Magiri	3	Rank tobacco cultivation first. Rank firewood collection last.
	(IV) 91,92.	Igalula	2	Rank tobacco cultivation first
				The whole cluster consider hive Making, firewood collection
			16	And medicine harvesting safer.
3	7,15,43,28,34,67,41,37,	Igalula,Magiri		Rank grazing first. Tobacco cultivation second.
	79,42,65,23,48,46.	Ilolangulu, Ikongolo		Rank firewood collection last.
			14	
4	8,17,35,19,25,64,77,22, 31,47,32,33,52,38,56,53 ,9,60,73,66,68.	Igalula,Magiri		Consider tobacco cultivation to be the major threat.
		Ilolangulu, Ikongolo		Medicine collection is considered safer by this cluster.
			21	
5	11,59,21,57,72,24,58, 20,27,83,84,44,81.	Igalula,Magiri		Consider fires to be the major threat. Charcoal making second.
		Ilolangulu, Ikongolo		Hive making is ranked last.
			13	
6	2,5,6,3,74.	Ilolangulu, Ikongolo		Rank tobacco cultivation first.
				Hive making is considered safer.
			5	
7	4,39,50,71,62.	Ilolangulu, Ikongolo	5	Rank tobacco cultivation first.
		Magiri		Medicine collection is considered safer.
8	86,90,87,88.	Igalula	4	Rank tobacco first, charcoal making last
9	85,89.,	Igalula		Rank firewood first.
			2	Rank charcoal making last.

As can be seen from tables 8 a combination of factors appear to be held responsible for their effect on medicinal plants and /or their habitats. In most clusters importance is given to tobacco farming cluster 1 subcluster (ii) and clusters 2,4,6,7and 8. Fire is considered to the major threat by cluster 5 whereas cluster 3 and cluster 9 observes that grazing and firewood collection respectively cause the major threat to medicinal plants and/or their habitats in Tabora.

5.5 Medicinal Plants

A total of 122 plant species falling into forty-nine families was recorded through the study of the Nyamwezi traditional healers for treating thirty-eight disease/conditions in Tabora. Diseases/conditions treated include nine of the ten diseases/known to cause a high rate of morbidity and mortality in the region. The top four featuring families were Caesalpinaceae, Papilionaceae, Rubiaceae and Euphorbiaceae whereas the mostly used species were *Entada abyssinica, Cassia abbreviata* and *Ozoroa insignis*. It was also found that roots were the most used plant part comprising about 65% of the total prescriptions (Appendix 4).

Responses concerning source of medicinal plants (habitats) showed that medicinal plants were scattered in *Mbugas,* 'Miombo' woodlands, grassland, wooded grassland, *Terminalia-Combretum* dominated woodlands, rocky areas, anthills, old farmlands wetlands and homesteads. In most cases species were cutting across a number of habitats except for some few species which seemed to be restricted to specific habitats. Examples of these species are:

- *Solanum incanum* said to be restricted on anthills.
- *Piliostigma thonningii, Orthossiphon rubicundus, Lannea humilis* and *Cassia abbreviata* found on 'Mbugas' mostly.
- *Pistia stratiotes* and *Cyperus articulatum* restricted only to wetlands and
- *Thevetia peruviana* restricted to rocky areas.

On whether relatively more time was generally needed to obtain medicinal materials than it used to be ten years ago, 32 respondents (64%) out of 50 contacted healers (Appendix

6) said that more time was needed now than it was ten years ago. The highest percentage was in Ikongolo ward where nine healers out twelve (75%), observed that they were using more time now than in the past ten years. Only eight healers among the fourteen (57%) and seven out of twelve (58%) healers in Igalula and Ilolangulu, respectively, said they needed more time now (Table 9).

Reasons given for these trends were:

i) Increased woodlands clearing for tobacco farm establishment

ii) Clearance of woodlands by commercial charcoal burners

iii) Unsustainable harvesting of medicinal plants by commercial dealers from outside the district.

Table 9: Response of traditional healers on whether they needed more time now than it used to be 10 years ago.

Ward	Yes	No	Total
Magiri	8	4	12
Ikongolo	9	3	12
Igalula	8	6	14
Ilolangulu	7	5	12
Total	32	18	50

Healers mentioned twenty-five plant species of medicinal value, which were collected/harvested by medicine sellers/traders thought to come mainly from Shinyanga region. The named species were:

Albizia tanganyikensis

Albizia versicolor

Allophylus africanus

Boscia angustifolia
Burkea africana
Cassia abbreviata
Cassipourea mollis
Crossopteryx febrifuga
Dalbergia melanoxylon
Ekebergia banguelensis
Entada abyssinica
Erythrina abyssinica
Flacourtia indica
Piliostigma thonningii
Securidaca longipedunculata
Swartizia madagascariensis
Terminalia kaiserana
Terminalia mollis
Xeroderris stuhlmanii
Xylopia antunensii
Zanthoxylum chalybeum

In the case of the following plants only their local names were obtained (no specimen were found): *Msagunida, Mtandala, Msebeye and Mgakamo*

On steps taken (e.g. planting) to ensure availability, most healers interviewed although observed that plant materials were being obtained relatively far with time, they had not taken any steps. They believed still that, they could obtain materials from the wild. Most practitioners pointed out that although planting was their option for important but rare plants, it was not easy to establish most of wild plants at homesteads because most of them could not be propagated through vegetative propagation e.g. cuttings. In cases where plants were planted succulents and plants that can be propagated by the use of cuttings were preferred. Few had planted some plants which were no longer easily available or they were maintaining some plants e.g.*Amaranthus graecizans, Euphorbia sp.,Solanum sp.*in their crop farms from which harvesting was always done sustainably.

5.6 Indigenous Knowledge Related to Conservation of Diversity of Medicinal Plants and/or Their Habitats

During participatory rural appraisal sessions about four indigenous ways featured out to be used in conservation of medicinal plants. These ways are presented below:

5.6.1 Beliefs and taboos

Discussants pointed out that a number of medicinal plants are protected from local threats by beliefs and taboos attached to these plants. People believe that breaking such taboos brings bad omen to the breaker, to his/her family or to whole the community. It was also pointed out that in some cases breaking of such taboos could lead to death of the breaker.

Stressing this possibility, discussants at Magiri village gave an example of a young man who died because of killing the African Python (*Python sebae*) which is considered sacred by Nyamwezi. Some medicinal plants conserved under the umbrella of beliefs and taboos are listed on Table 10. Nyamwezi names for these plants describe the consequences one should expect if the beliefs/taboos attached to these plants are violated. Examples for such names are summarised on Table 11.

Table 10: Some medicinal plants conserved under beliefs and taboos by Nyamwezi people

Botanoical Name	Nyamwezi Name	Taboos/beliefs	Possible consequences In case of failure
	Ndyati*	Use as firewood	Madness
	Kazengula*	Use as firewood	Closure of good fortune
Annona senegalensis	Mfila	Use as firewood	Black snakes will come at home
Brachystergia boemii	Myombo	Use as firewood	Household chaos
Cassipourea mollis	Mlugara	Bring home, Use as firewood	Closure of family's good fortune
Catunaregan obovata	Mwiwasungwa	Use as firewood	Epidemics will occur
Diospyros usambarensis	Mfubata	Use as firewood	Black snakes will come at home
Entada abyssinica	Mfutwambula	Use as firewood	
Gardenia ternifolia	Kilindilamgunda	Cut it deliberately	Getting bad omen
Lannea schimperi	Mgumbu	Use as firewood	Death of twins
Ochna holtzii	Isambula	Burn it in any way or use as building poles	Family disintegration
Ochna polyneura	Mmwaga	Use as firewood, Bring home	Family disintegration
Parinari curratellifolia	Mbula	Use as firewood	Mother or farther death
Pericopsis angolensis	Mbanga	Use as firewood	Cook will get headache
Schrebera trichoclada	Mputika	Bring home, use as firewood or building material	Death of people and livestock
Securidaca longipedunculata	Mteyu	Cut it deliberately	Serious sickness, scorpions will come at home
Strychnos spinosa	Mmage	Use as firewood	Endless quarrelling
Swartizia madagascariensis	Kasanda	Bring home, Use as firewood or Building material	Endless chaos Family disintegration
Terminalia kaiserana	Mzima	Use as firewood	Household chaos
Tricalysia ruandensis	Mkome	Use as firewood	Getting bad omen

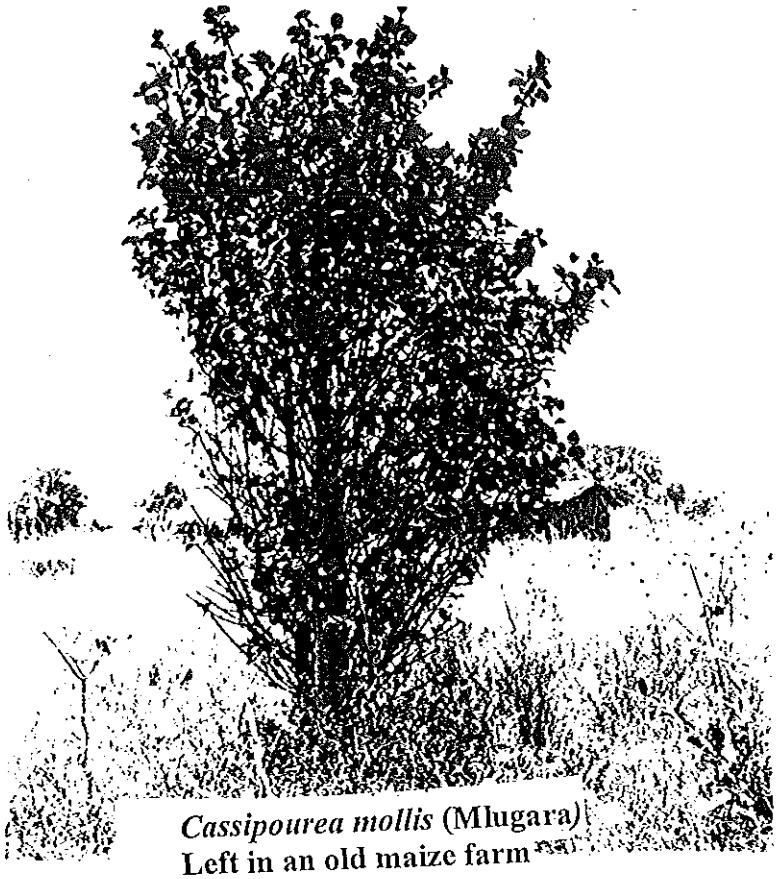
* Specimens for these species were not obtained thus they are presented here by their Nyamwezi names only.

Table 11: Meaning of Some Names of Medicinal Plants Conserved under Beliefs and Taboos in Tabora.

Botanical Name	Nyamwezi Name	Meaning of Name
Brachystegia boehmii	Myombo	A tree which breaks peace
Cassipourea mollis	Mlugara	A tree that closes household's good fortune
Entada abyssinica	Mfutwambula	A tree which brings rainfall
Gardenia ternifolia	Kilindilamgunda	Farm protector/guardian
Ochna holtzii	Isambula	A tree that unuthatches houses
Ochna polyneura	Mwaga	A plant which pours/separates
Schrebera trichoclada	Mputika	A plant that breaks easily/immediately
Terminalia kaiserana	Mzima	A tree which puts fire off

Note: Nyamwezi people consider most plants to be trees, habit categorisation (herb, shrub and tree) is not clearly spelt out.

Most of these plants are said not only to be used as sources of medicine, but some are used to protect homestead against witchcraft, shifting bad doers from villages and seeing witches. Details for such plants are not made available to outsiders and are kept by notable healers as secrets. Some medicinal plants conserved under beliefs and taboos are presented on Figure 7



Cassipourea mollis (Mlugara)
Left in an old maize farm



Ochna stolzii (Isambula)



Gardenia ternifolia (Kilindilamgunda)
Left in a new established farm

Figure 7: Some medicinal plants conserved under taboos and beliefs

5.6.2 Sacred groves (*Mazimbu*)

It was found that the Nyamwezi have sacred places (*Mazimbu*) where sacrifices for thanks giving are offered and request prayers made. These places are sacred and therefore protected from being tampered with. Cutting of trees or gathering of any plant material living or dead is prohibited. This rule is serious to the extent that even during sacrifice offering firewood for the purpose is to be carried from far and not obtained from within. No wild animal or bird should be killed or trapped from those places without prior request to the gods through the *mazimbu* guardian. In cases where a sacred place is a dam, fishing for household consumption is allowed upon request to the gods. If this condition is not fulfilled, no fish will be caught and the person can be punished. The punishment ranges from being beaten by unseen persons (gods), loss of traps or hooks to being surrounded by flood. It was also pointed out that some specific plants are necessary in these places. The community normally plants these plants some of these are:

Lweja (*Ochna schweinfurthiana*)- *Lweja* means a tree that cleanses.
Mfutwambula (*Entada abyssinica*) - *Mfutwambula* means a tree which pulls/brings rainfall.
Mhozya (*Sterculia quinqueloba*)- *Mhozya* means a tree, which cools matters.
Mlumba (*Ficus thonningii)* which was recommended to be planted at homesteads for the same purpose.

It was found that the Nyamwezi people maintained their *mazimbu* through their chiefdoms. Responsibility of maintaining these places was and still is in the hands of the clan of the chief (Ntemi) that are also considered to be a virtual figure. The great Nyamwezi chiefdom had its headquarters at Unyanyembe but had other five small chiefdoms each maintaining its *mazimbu* that are maintained todate (Table 12).

Table 12: Sacred groves *(Mazimbu)* Maintained by Nyamwezi Chiefdoms in Tabora.

Chiefdom	Sacred groves
Nguru	Sikonge
Uyui	Magengati (Uwande hills)
Ibili	Ibili hills
Usagali	Usagali hills
Unyanyembe	Nshepa hills (Itetemya)
Ukimbu	Hundi hills (Makuru woman stone)

Other sacred places mentioned during the discussions were Isenefu in Igalula, Kigwa dam, Igombe dam, Ilolangulu hills, and Isikizya at chief's graveyard.

5.6.3 Home gardens:

Another indigenous ways of conserving important medicinal plants was planting them at homestead or maintain them with crops. Discussants pointed out that normally plants obtained from far sources, plants for ritual purposes, and plants for deterrence of witches, multipurpose plants and important but rare species were always planted in home gardens (Fig. 8).



Euphorbia sp. (Ilalyanzovu)



Stegnotaenia arariacea (Mnyongwamembe)



Aloe sp. (Lugaka)

Figure 8: Medicinal plants planted in home gardens.

5.6.4 Indigenous rules and regulations

It was learnt that Nyamwezi had indigenous rules to regulate some activities threatening diversity of medicinal plants and/or their habitats today. However, it was found that most of these rules were no longer applicable as indigenous institutions on which they used to rest no longer exist and therefore they can not be reinforced. It was also pointed out that land ownership was another barrier restricting the application of these indigenous regulations.

- **Fire setting:**

No body was allowed to set fire. If one was convicted to have started fire deliberately, a serious punishment of being fined or jailed followed and if that fire has caused damage, the responsible person was held to compensate the loss. Any fire set by anybody was immediately extinguished by all males in the community after which a thorough investigation spearheaded by 'Wazengakaya' grassroots leaders and 'Wanangwa' village leaders and the community followed later in order to get the law breaker.

In cases where burning was necessary, a person was required to inform his neighbours about his plan. Grassroots meetings 'baraza' were normally held by grassroots leaders to review regulations. In the same 'baraza' children were taught good manners and to refrain from bad deeds, for example setting fires. Children blamed to have started fires were whipped heavily and their parents/ guardians made to settle the losses.

- **Grazing:**

Grazing was not without a control. Cattle herders were allowed to graze in one's land (farmland) after requesting permission from the owner. In some cases a cattle herder was made to enter into an agreement with a farmland owner. Such contracts required him to provide milk or cowdung or both to the *shamba's* owner. Cowdung was used as manure in farmlands.

- .**Tree cutting**

In many places the regulation prevented people from cutting trees from other people's land without prior request or informing the farmland owner. Discussants pointed out that

it was only in newly established settlements where the cutting of bushes/forests that harbour wild animals that this regulation was not applicable.

5.6.5 Condition attached to harvesting of medicinal plants

Indigenous condition attached to harvested of plants used as medicine was also indicated as a way used to safeguard diversity of plants of medicinal value:

- **Harvesting of barks:**

When harvesting bark for medicinal purposes one was urged to observe that bark is obtained from all directions (north, west, south and east) and that only one piece of bark from each direction was allowed for the success of the medicine. This condition is for specific plant species e.g. *Albizia tanganyikensis.*

- **Harvesting of roots:**

Only few roots were allowed from each plant and it was a condition that soil was to be returned to its level as leaving the roots open was like making a grave of the patient the healer was attending to.

5.7 Botanical Collection

During the present study 125 plant species of medicinal value from the study area were collected, identified and deposited at the University of Dar Es Salaam Herbarium. Some of these plants were not mentioned by traditional healers during data collection but identified as being medicinal during specimen collection (Appendix 5). Each species was collected in duplicate.

6. DISCUSSION

The present study has shown that Nyamwezi people in Tabora combine both traditional and modern system for their health care services. There is high significant difference between individuals who depend entirely on traditional or modern system and those who use both systems. This is in agreement with results reported by Dlamin (1997) who found that in Swaziland people were no longer sticking to one form of healing system but were rather using both traditional and modern systems.

It is most likely that people use traditional or modern systems as first or second alternatives and not simultaneously or use them as complementary systems. It is likely therefore that, the social desire of going back to nature is taking people to traditional healing systems especially for diseases/ conditions such as women infertility, snakebite, impotence, epilepsy and obviously evil spirits and witchcraft which healers claim that their medicines do better relative to modern medicines. On the other hand, diseases like malaria that appear to afflict many people in Tabora causing about 54.4% of mortality and morbidity (Section 3.1.8) and not well covered by traditional practitioners (Appendix 4) will take patients to modern system. In addition to this is the growing campaign of maternal care, immunisation services for infants and birth control and their packages, may be some of the factors taking women to the modern system. It is therefore possible that, the deficiency of modern health infrastructure in Tabora (Section 3.1.8) has little to do with the choice of the treatment system one has to make. This comes from the fact that, even in Ilolangulu ward where there is a reasonable number of modern health infrastructure in comparative to the other wards sampled, the number of people using both systems were almost twice those using modern and traditional systems separately combined (Section 5.2).

During this study, it was also found that of the plant parts used in traditional medicine roots were the most featuring constituting 65% of the prescriptions (Section 5.5). Githae (1995) and Matu (1998) also have reported such findings. Possible explanation for this observation is that indigenous healers through their long experiments have been able to ascertain that the root was the most effective part. This observation has a formal scientific backing: Quetin-Leclerq *et al.* (1990) reported that alkaloid composition was two folds higher in roots and barks relative to the amount found in leaves. This was

established from a phytochemistry study of South American plant; *Strychnos species*. It can, therefore, be concluded that roots play an important role in traditional medicine.

The issue which follows this observation is whether the extraction of roots for medicinal purposes is still a sustainable practice in Tabora Cunningham (1992) and Campbell *et al.* (1996) have shown that it can be possible only when the extraction is not commercially oriented. However, observation made during this study was that commercial harvesting of medicinal plants was going on in Tabora. (Section 5.6)

Considering indigenous knowledge, it was found that Nyamwezi people host a rich knowledge related to conservation and use of medicinal plant diversity. Indigenous knowledge related to conservation of biodiversity has also been reported elsewhere in Tanzania. For example, sacred forest reserves in Njombe, Songea and Makete districts (Luoga, 1994) and Duru-Haitemba village forest reserves in Babati district (Wily and Haule, 1994). Home gardens have been reported in Ethiopia (Zemede Asfaw, 1998). The Nyamwezi indigenous knowledge for conservation of medicinal plants reflects the importance of medicinal plants in their daily life.

Medicinal plants are protected from activities, which indigenous people considered threatening. All medicinal plants conserved through taboos and beliefs, for example, are protected from being used as firewood and/or building materials for houses or animal shelters (Section 5.6.1). This reflects the fact that firewood and building were and still are important uses of trees in the rural setting. However, the results obtained during this study do not reflect this reality. Firewood collection is grouped among the three least dangerous activities to medicinal plants together with hive making and collection of medicinal plants. Actually, of the total households (92) only two households (2.17%) ranked it first. The explanation to this observation may be that, in rural areas all households use firewood as the sole source of energy. This reasoning agree with the fact expressed by ODA (1982) (Section 2.2.8) that in Tabora household firewood consumption were far greater than tobacco curing requirement annually. For the second group that considered firewood collection to be among the least destructive activities probably the basis of their response was the fact that indigenous knowledge has protected some important medicinal plants from being used as firewood. In addition, it can also be

argued that, firewood collectors rarely collect living plants but mostly go for dead plant or plant parts.

Tobacco farming was ranked the most threatening activity to medicinal plant diversity and/or their habitats. Forty-six households, 50% of the entire respondent households ranked it first among the eight activities considered to threaten medicinal plants or/and their habitats. (Table 7 and Table 8). Reasons given reflect the analysis presented under section 2.2.5. This finding agrees with the observation made by Temu (1979); Stenson (1998) and Nshubemuki *et al.* (1998) that tobacco farming was the environmentally unfriendly activity in Tabora (Section 2.2.5). Other activities grouped with tobacco farming with respect to their effect or destructiveness are forest fires (burning) and charcoal making. This is probably because they share a common characteristic that they lack indigenous machinery to control their destructiveness. This observation gets its root from the fact that, although Nyamwezi people used to grow tobacco before the introduction of flue-cured variety in the 1950s, the varieties grown in those days were air or sun dried thus requiring no fuelwood. It is also true that at that time tobacco cultivation was done in small scale around homesteads. Furthermore, sun and air-dried varieties had restricted market and prices were low and as a result attracted few people as an economic activity.

The flue-cured tobacco, which is blamed today by Nyamwezi, was introduced in Tabora in the 1950s and it came with a different mode of production; requiring fuelwood for curing and its production is market oriented. Together with these, this variety had and still has ready market, market prices are attractive and the package of incentives attached to it has made tobacco a popular crop in Tabora (Section 2.2.5). Tobacco farming has attracted a large population, and today Tabora produces over 60% of flue-cured tobacco in Tanzania.

Flue-cured tobacco is not indigenous to Tabora. It was introduced, it is likely therefore that there exists no indigenous knowledge to protect diversity of plants of importance to social life from its destructive nature. The indigenous setting had a little chance of withstanding the market oriented production pressure, accompanied with biased modern science geared to ignoring and replacing "indigenous ignorance" with the so called

modern technology. Although there are no studies which showed the species which have been swept away or are at risk of extinction as a result of tobacco farming, it is likely that the huge clearance as indicated in Table 1 (Section 2.2.5) may have eliminated plant species endemic to such habitat including medicinal ones. This follows the reasoning that disturbance and interference are some of the factors, which can lead to local extinction. On the other hand, such tremendous clearance might remove species which are important for survival of other species, for example keystone plant species which are usually sources of nectar, fruit or pollen. Frankel and Soule (1981) argued that keystone plant species persistence is a condition for the maintenance of maximum species diversity. Another important group is that of mobile links (pollinators).

This is the case also with charcoal making where commercial charcoal dealers that invade the rural areas, fell trees indiscriminately and leave the local population with nothing to do. Loyalties collected by governments do not find their way back to the locals who are left with a clearfelt area that is hard to rehabilitate.

Another factor that makes the indigenous people consider tobacco farming highly threatening and ranking charcoal making third, is that, the negative effects left are obvious in Tabora. People talk of bare areas which used to be covered by forest/woodlands, talk of changed microclimate associated with shortage of rainfall, increased wind velocity because there are no trees to check the wind speed as cost of clearance caused by the two activities. Elders considers external pressures to be the cause of forest degradation in these areas and blame the government for not controlling what is happening after abolishing their indigenous institutions. According to the Regional Natural Resources Officer, in Tabora, charcoal selling is a lucrative business and people, especially small-scale dealers consider it a business which requires little or no capital investment. The price of charcoal per sac for 1998 ranged between Tshs. 1000/-(1.6 USD) during dry season to 2500/- (4.1 USD) during wet seasons; and an average of 5000 sacs per month were recorded in the same year (pers. comm. with District Natural Resources Officer-Tabora).

Although no study has been done to assess the effect of charcoal making in Tabora, study done elsewhere supports the observation that charcoal making can lead to deforestation.

Abeli and Nsolomo (1998) reported the deforestation of 120,000 hectares annually in Morogoro as a result of charcoal making. A deforestation of up to 30 km on either side along the Dar Es Salaam-Morogoro highway is reported by Monela *et al.* (1993). Regarding plant diversity in charcoal gaps, observations made by Ndangarasi (1997) showed that only seedling diversity recorded high but other age classes (sapling and poles) recorded lower meaning that not all seedlings germinated were favoured by conditions in the charcoal gaps to grow further.

The present study also found that indigenous people in Tabora considered medicine collection safer to medicinal plants and/or their habitats. Among the 92 households interviewed, 48% ranked it last. Medicine collection was not ranked or scored first by all the respondents but all ranked it among the last three safe activities. This observation is backed by the fact that Nyamwezi people have indigenous ways of conserving diversity of medicinal plants and /or their habitats. But still, elders consider external pressures to be the cause of forest degradation in these areas and blame the government for not controlling what is happening after abolishing their indigenous institutions.

This explanation has got its foundation from the observation that although indigenous conditions for harvesting of medicinal plants is in place, commercial harvesting done by people from outside Tabora was mentioned as a cause of scarcity of medicinal plants (Section 5.5). During specimen collection, the author came across uprooted medicinal plants e.g. *Entada abyssinica* and uncovered roots, which means that market pressure was overriding indigenous knowledge. Collection of medicinal plants although is considered least threatening is therefore no more under the control of indigenous knowledge and thus slowly becoming unsustainable. The author has observed in this study that traditional healers from Shinyanga obtain most of their medicinal plant materials from Tabora. This indicates the fact reported by Dery *et al.*(1998) that priority medicinal plants are extremely scarce in Shinyanga as a result of vast land clearance.

Forest fires were another threat pointed out by respondents actually second to tobacco cultivation. Although the reasons given do not really reflect the effect of fire to diversity of medicinal plants but ranking it second indicates the awareness of indigenous people that wild fire was a growing problem. This is because the indigenous institutions and

ways of controlling fire no longer exist. They have been replaced by a centralised system, which has never been effective thus rendering the situation worse. Fires today are no longer concern of the community but of the local or central governments. Presently, nobody spearheads investigation to get the fire starters. Community's fire extinguishing initiatives exist no more, and fire set on in one village moves to another and it can be on for days. Above this, hunters and honey gatherers had had the responsibility of informing their grassroots leader about their activity, places of operation and time, such that they were not held responsible for fires they did not cause. Such procedures no longer exist; they disappeared with their corresponding indigenous institutions. The government through the Ministry of Natural Resources and Tourism has been spending resources in a country-wide campaign against fires (e.g. Fire and Environment campaign of 1991), but fires are on than ever.

Grazing was not stressed much as a threat to diversity of medicinal plants except as a cause of land degradation and its relation to tree cutting to go away with tse tse fly. This is probably due to the fact that although generally Tabora region is overstocked, Tabora rural district sustains a reasonable number of livestock as compared to Nzenga and Igunga districts (Section 3.1.7). As it was observed during these sessions, grazing problem appears only during dry seasons when livestock from Shinyanga region are brought to Tabora region to rescue them.

The Nyamwezi people give little attention to logging and hive making as threat to medicinal plants and/or their habitats. The reason is the fact that the two activities are selective and they have been sustained for long in Tabora without recording any detrimental effect to medicinal plants and/or their habitats. Though this can be true, but as shown under section 3.1.6 (Table 3) beekeeping and logging lie in the list of form of encroachment which has brought damage to protected areas in Tabora. Therefore, although no study has been attempted to investigate the effect of logging on the diversity of medicinal plants in Tabora, it has been reported elsewhere that it reduces plant diversity (Johns, 1992;Okafor and Ladipo, 1992) (Section 2.2.4). Therefore medicinal plants in Tabora as any other plants are likely to suffer negatively as a result of logging. It was also observed during specimen collection that, many debarked trees e.g. *Julbernardia globiflora* had died in Urumwa forest reserve.

As habitat fragmentation and change continue at high rate in Nyamweziland, traditional practitioners observed that medicinal plants are scattered almost in every habitat in Tabora. They also ascertain that some important medicinal plants are restricted to some habitats (Section 5.5). This means that all habitats are important as source of medicinal plants and that they all need protection. If this is not observed, it is likely that medicinal plants will be exposed to threats and those with restricted distribution may suffer local extinction.

It was not easy to come up with a list of threatened medicinal plants in Tabora as generally no study has so far been done in Tanzania, leave alone Tabora, to ascertain the status of plants (Section 2.2). Tanzania ranks second out of the 48 countries in Afrotropical realm in terms of number of plant species with not less than 11,000 distinct species (Stuart *et al.* cited in Government of Tanzania, 1997) and with high endemism. Tabora on the other hand falls in the 'Miombo' woodland zone (Section 3.1.5.1) located in the Zambesian regional centre of endemism with the floral composition estimated to 8,500 species. This is the richest phytochorion interms of flora diversity in the continent (Stuart *et al.* cited in Government of Tanzania, 1997). Considering the fact that up to 60% of 'Miombo' plants species are medicinal, it is no doubt that there are medicinal plants in Tabora today which are either at the verge of extinction, endangered, vulnerable, rare or indeterminate.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In the light of the present study the following conclusions can be made:

- Nyamwezi people use traditional healing and formal systems in their health care system. Medicinal plants hold a central position in the health care system of the people.
- Tobacco farming is the major threat to the diversity of medicinal plants in Tabora and as a result of this activity the supply of medicinal plants shows a declining trend.
- Some of the indigenous knowledge and practice systems can be put into use for effective conservation of biodiversity of the traditional medicinal plants along side the modern conservation options. In this regard the most significant traditional practice and knowledge system include respecting taboos and beliefs, maintaining sacred groves, reinstitution of indigenous regulations and promoting home gardens.
- Medicinal plants are collected almost from every habitat in Tabora.
- There is an indication of overexploitation of some important medicinal plant species in Tabora due to the growing market of these plants in Shinyanga region.
- Nyamwezi people consider harvesting of medicinal plants, hive making and firewood collection to be less dangerous to medicinal plant conservation.

7.2 General Recommendations

Basing on the results of this study the following recommendations are made:

1. Medicinal plants need to be conserved, as they are important in primary health care system. This is an important initiative, as it will ensure sustainable utilisation. Priority has to be given to plants that face a risk of overexploitation today. It is important that local people and their knowledge be involved in such undertakings.

2. Indigenous knowledge plays a great role in conservation of biodiversity but it is currently getting lost with the biodiversity it used to conserve. To avoid the disappearance of the knowledge appropriate for conservation of biodiversity there is a need for exploring the indigenous knowledge of indigenous groups in Tanzania, document it and blend it with the formal techniques. There is a need for involving

indigenous groups and their knowledge in planning, implementation and evaluation of the success or failure of conservation programmes.

3. It is recommended that tobacco growers be encouraged to start tree farming especially faster maturing species alongside their tobacco farms. Tree farms will serve as a source of firewood for curing tobacco, thus reducing the pressure on public woodlots and rate of encroachment. Alongside tree farming, efficiency of tobacco curing barns also needs to be improved in order to reducing firewood consumption. These two are important steps if tobacco cultivation has to be a sustainable undertaking while conservation of biodiversity is also effected in Tabora.

4. Home gardens are one of the methods used by traditional practitioners to conserve medicinal plants and are their own initiatives. Forestry and Beekeeping Division and other relevant institution should capitalise on these and assist the healers to obtain seed or seedling of indigenous plants of their choice for planting. In addition, ways should be instituted to train the traditional healers on simple silvicultural practices which will enable them to maintain their home gardens.

5. While home gardens will act as both *ex-situ* and *in-situ* conservation measures, other ways involving both indigenous and formal techniques must also be employed. Identification of areas with high diversity of medicinal plants and protecting them as medicinal plant reserves by law to regulate their harvesting can save medicinal plants from overexploitation and extinction. It is also necessary to start local medicinal plant botanical gardens that will serve as gene banks. At the moment legal framework of controlling biopiracy, harvesting of medicinal plants and export needs to be put in place.

6. The Joint Forest Management initiative should involve indigenous groups in planning how to manage forest resources for the betterment of all stakeholders.

6.3. Recommendations for Further Research

The present study managed to establish the activities that threaten medicinal plants in Tabora region as perceived by the Nyamwezi people. The effect of each of these activities to of medicinal plants and/or their habitats biodiversity was not examined in the field, as it was not part of the study. Specific plant species, which face risk of being extinct, were not established, as they require time, funds and coverage of vast area.

This study also recorded indigenous knowledge of Nyamwezi people related to conservation of diversity of medicinal plants, but Tanzania is made up of more than one hundred ethnic groups and loss of indigenous knowledge and biodiversity is evident everywhere.

It was claimed by traditional healers that some diseases/conditions that cannot be dealt with easily by modern health system can be treated efficiently by traditional healers. Traditional practitioners claimed to treat diseases/conditions like snakebites, sterility in females, impotence in men, hernia bewitched and evil spirit efficiently. It is hereby therefore recommended that:

1.A study be carried out to ascertain the real effect of human activities to medicinal plants not only in Tabora but even in other places where medicinal plants are important. Traditional healers should be part of the research teams as they have a detailed knowledge of medicinal plants under threat.

2.To be able to justify traditional healers claims of usefulness of their medicinal plants over modern ones, phytochemical studies are needed to ascertain efficacy and safety of these medicinal plants so that they can be incorporated in formal health system.

3.Indigenous knowledge held by indigenous groups is important in conservation of biological diversity, but this knowledge in tremendously getting lost today. There is a need therefore, of undertaking a countrywide study to document this indigenous knowledge before it is lost.

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9. APPENDICES.

Appendix 1:Schedule for semi-structured interview

1.Village _____ Ward _____

2.Name of respondent _____

3.Sex Male ___ Female ___

4.Age _____

5.Level of education [1]Higher ___ middle ___ Lower ___

6.Do you know disease a,b,c Yes ___ No ___

7.Do you treat it? If yes, what plant do you use?

8.What other diseases do you treat

9.What part of the plant do you use

10.Where do you collect it (habitat)

11.Do you think generally that more time is needed now to obtain medicinal plants than it is used to be 10 years ago? Yes ___ No ___

12.Have you taken any step (e.g. planting) to ensure availability?

13.Do you know any plants that are being collected from your village for Commercial purposes?

Key:

[1]High (Diploma-Degree level)
Midle (Certificate-Ordinary level)
Lower (Up to primary level)

Appendix 2: Paired Comparison Field Data collection Form

House Hold Number.....

Serial No.	Order	Activities	Individual 1.	Individual 2.	Individual 3.
1	4,5	Logging, Tobacco cultivation			
2	2,4	Charcoal making, Logging			
3	2,8	Charcoal making, Firewood collection			
4	1,4	Fires, Logging			
5	5,8	Tobacco cultivation, Medicine collection			
6	7,8	Hive making, Firewood collection			
7	2,3	Charcoal making, Grazing			
8	5,6	Tobacco cultivation, Medicine collection			
9	4,6	Logging, Medicine collection			
10	1,2	Fires, Charcoal making			
11	1,8	Fires, Firewood collection			
12	2,5	Charcoal making, Tobacco cultivation			
13	2,7	Charcoal making, Hive making			
14	4,8	Logging, Firewood collection			
15	6,7	Medicine collection, Hive making			
16	1,7	Fires, Hive making			
17	3,6	Grazing, Medicine collection			
18	2,6	Charcoal making, Medicine collection			
19	1,5	Fires, Tobacco cultivation			
20	3,7	Grazing, Hive making			
21	1,3	Fires, Grazing			
22	5,7	Tobacco, Hive making			
23	3,4	Grazing, Logging			
24	1,6	Fires, Medicine collection			
25	3,8	Grazing, Firewood collection			
26	6,8	Medicine collection, Firewood collection			
27	4,7	Logging, Tobacco cultivation			
28	3,5	Grazing, Tobacco cultivation			

Appendix 3:Pairwise matrix for household responses

Fires	Charcoal	Grazing	Logging	Tobacco	Medicine	Hives --	Fire Wood		Mean score	Rank
								Fires		
								Charcoal		
								Grazing		
								Logging		
								Tobacco		
								Medicine		
								Hives		
								Firewood		

Appendix 4:Some medicinal plants commonly used by Nyamwezi people in Tabora

Disease/Condition	Plant local Name	Botanical Name	Family	Part used
Anaemia	Mvungwa	*Kigelia africana*	Bignoniaceae	Fruit
	Msana	*Combretum zeyheri*	Combretaceae	Bark
	Mnene	*Xeroderris stuhlmanii*	Papilionaceae	Bark
	Mwembepori	*Ozoroa insignis*	Anacaridaceae	Bark/Roots
	Mninga	*Pterocarpus angolensis*	Papilionaceae	Roots
	Mkulungu	*Pterocarpus ticntorius*	Papilionaceae	Roots
	Msalasi	*Friesodilsia obovata*	Annonaceae	Roots
	Mhina	*Lawsonia inermis*	Lythraceae	Leaves
	Mkalalwang'huba	*Erythrina abyssinica*	Papilionaceae	Bark
	Mmelambasa	*Dalbergia nitidula*	Papilionaceae	Leaves
	Mgili	*Terminalia stuhlmanii*	Combretaceae	Roots/Bark
	Msalung'unda	*Vismia orientis*	Guttiferae	Leaves
	Mpingo	*Dalbergia melanoxylon*	Papilionaceae	Roots
	Mkondokondo	*Rothmannia anglerana*	Rubiaceae	Roots
	Mkindwanzagamba	*Albizia versicolor*	Mimosaceae	Roots
	Mochangoko	*Catunaregan obovata*	Rubiaceae	Roots
	Mbinzandimi	*Flueggea virosa*	Euphorbiceae	Leaves
	Mkuwa	*Hexalobus monopetalus*	Annonaceae	Roots
Diarrhoea	Mtopetope	*Annona senegalensis*	Annonaceae	Bark
	Mlugara	*Cassipourea mollis*	Rhizopharaceae	Roots
	Msana	*Combetum zeyheri*	Combretaceae	Roots
	Mninga	*Pterocarpus angolensis*	Papilionaceae	Roots
	Mzima	*Terminalia kaiserana*	Combretaceae	Roots
	Mbinzandimi	*Fluggea virosa*	Euphorbiceae	Leaves
	Mwembedodo	*Mangifera indica*	Anacaridaceae	Leaves
	Mtundulu	*Dichrostachys cinerea*	Mimosaceae	Leaves
	Mkomamangapori	*Strychnos pugens*	Loganiaceae	Roots
	Mhina	*Lawsonia inermis*	Lythraceae	Roots
	Msalasi	*Friesodielsia obovata*	Annonaceae	Roots
	Mkwaju	*Tamarindus indica*	Caesalpinaceae	Leaves
	Ilundelyahansi	*Emilia coccinea*	Compositae	Roots
	Mwemepori	*Ozoroa insignis*	Anacaridaceae	Leaves/Bark
	Mpera	*Psidium guajava*	Myrtaceae	Leaves
	Mlumba	*Ficus thonningii*	Moraceae	Bark
Anal sours	Mkwaju	*Tamarindus indica*	Caesalpinaceae	Bark
Rectum prolopsy	Mtongamwaka	*Cyphostemma sp.*	Vitaceae	Roots/Whole
	Mgumbumunga	*Lannea humilis*	Anacaridaceae	Roots
	Lukubalwahansi	*Ochna katangensis*	Ochnaceae	Whole/Roots
URTI				
Tuberculosis	Mmondo	*Entandrophragma busei*	Meliaceae	Roots
	Mkalalwang'huba	*Erythrina abyssinica*	Papilionaceae	Roots
	Mtindambogo	*Piliostigma thonningii*	Caesalpinaceae	Roots
	Mkalya	*Zanha africana*	Sapindaceae	Roots
	Mfubata	*Diospyros usambarensis*	Ebenaceae	Roots
	Mninga	*Pterocarpus angolensis*	Papilionaceae	Bark

	Ukuluwamti	*Aristolochia hockii*	Aristolochiacae	Roots
	Ukuluwamti	*Ochna katangensis*	Ochnaceae	Roots
Coughing	Msanzwambeke	*Crossopteryx febrifuga*	Rubiaceae	Leaves/Roots
	Ugagati	*Margaritaria discoidea*	Euphorbiaceae	Roots/Branch
	Mfutwambula	*Entada abyssinica* --	Mimosaceae	Roots
	Ntulatu	*Solanum incanum*	Solanaceae	Roots
	Igangula	*Indigofera rhychocarpa*	Papilionaceae	Roots
	Malebe	*Pistia stratiotes*	Araceae	Roots
	Mlavumba	*Plectranthus laxiflorus*	Labiatae	Leaves
	Mkalitusi	*Eucalyptus sp.*	Myrtaceae	Leaves
	Mputika	*Schrebrera trichodata*	Oleaceae	Leaves
Asthma	Mtunguja	*Solanum incanum*	Solanaceae	Roots
	Matula	*Solanum dasyphllum*	Solanaceae	Roots
	Mlungushigiti	*Teclea nobilis*	Rutaceae	Roots
Hi-cough	Mgogondi	*Phyllanthus engleri*	Euphorbiaceae	Roots
	Mfutwambula	*Entada abyssinica*	Mimosaceae	Roots
	Malumbalumba	*Ocimum basilicum*	Labiatae	Leaves
	Mtundulu	*Dichrostachys cinerea*	Mimosaceae	Roots
	Mtowo	*Azanza garkeana*	Malvaceae	Leaves
	Lugobi	*Cynodon dactylon*	Poaceae	Whole
Gonorrhoea	Msalasi	*Friesodielsia obovata*	Annonacea	Roots
	Igangula	*Indigofera rhynchocarpa*	Papilionaceae	Roots
	Msana	*Combretum zeyheri*	Combretaceae	Roots
	Msalun'gunda	*Vismia orientalis*	Guttiferae	Roots
	Mfubata	*Diospyros usambarensis*	Ebenaceae	Roots
	Mgogondi	*Phyllanthus engleri*	Euphorbiaceae	Roots
	Mlundalunda	*Cassia abbreviata*	Caesalpinaceae	Roots
	Mbaazi	*Cajanus cajan*	Papilionaceae	Roots
	Msambila	*Senna singuena*	Caesalpinaceae	Roots
	Mchunga	*Launea cornuta*	Compositae	Roots
	Makonge	*Aloe sp.*	Aloaceae	Roots
	Mkoma	*Grewia bicolor*	Tiliaceae	Roots
	Mgando	*Burkea africana*	Caesalpinaceae	Roots/Bark
	Mpuguswa	*Flacourtia indica*	Flacourticeae	Roots
	Mkindwanzagamba	*Albizia versicolor*	Mimosaceae	Roots
	Mkelenge	*Terminalia mollis*	Combretaceae	Roots
	Kasatokangoko	*Asparagus buchananii*	Asparagaceae	Roots
	Mzima	*Terminalia kaiserana*	Combretaceae	Roots
Chronic gonorrhoea	Mwembepori	*Ozoroa insignis*	Anacaridaceae	Roots
	Kasasalya	*Cucumis metuliferus*	Curcubitaceae	Fruit
	Mninga	*Pterocarpus angolensis*	Papilionaceae	Roots
	Mfutwambula	*Entada abyssinica*	Mimosaceae	Roots
	Mgili	*Terminalia stuhlmanii*	Combretaceae	Roots
	Makonge	*Aloe sp.*	Aloaceae	Roots
	Mchunga	*Launea cornuta*	Compositae	Roots
Ear diseases	Mtindambogo	*Piliostigma thonningii*	Caesalpinaceae	Roots
Ear discharge	Ukuluwamti	*Aristolochia hockii*	Aritolochiaceae	Roots
	Mgwegwe	*Strychnos potatorum*	Loganiaceae	Roots
	Mputika	*Schrebera tricodata*	Oleaceae	Leaves
	Mpala	*Hymenocardia acida*	Euphorbiaceae	Roots/Bark

	Mkale	*Ricinus communis*	Euphorbiaceae	Bark
	Mkola	*Afzelia quanzensis*	Caesalpinaceae	Roots
	Ekihahankuba	*Cactus sp.*	Cactaceae	Branch
Eye diseases	Mkoma	*Grewia bicolor*	Tiliaceae	Bark
Cataract	Mnyaa	*Euphorbia turicalii* __	Euphorbiaceae	Branch
	Mninga	*Pterocarpus angolensis*	Papilionaceae	Leaves
	Kalelalela	*Boscia angustifolia*	Capparidaceae	Leaves
	Mtundulu	*Dichrostachys cineria*	Mimosaceae	Leaves
Intestinal worms	Mnung'hwahala	*Premna senensis*	Verbenaceae	Leaves
	Mshenene	*Xylopia entunensii*	Annonaceae	Roots
	Msalasi	*Friesodielsia obovata*	Annonaceae	Roots
	Lugaka	*Aloe sp.*	Aloaceae	Roots
	Mdulwansongo	*Thevetia peruviana*	Apocynaceae	Roots
	Msekela	*Antidesma venosin*	Euphorbiaceae	Roots
	Mbinzandimi	*Flueggea virosa*	Euphorbiaceae	Roots
	Kavumbe	*Hyptis suaveolens*	Labiatae	Leaves
	Malumbalumba	*Ocimum basilicum*	Labiatae	Leaves
	Mteyu	*Securidaca longipendunculata*	Polygaceae	Roots
	Mchichapori	*Amaranthus graecizans*	Amaranthaceae	Leaves/Roots
	Mlundalunda	*Cassia abbreviata*	Caesalpinacaea	Roots/Bark
	Mkindwanzagamba	*Albizia versicolor*	Mimosaceae	Roots
	Mnyenye	*Trichilia emetica*	Meliaceae	Roots
	Mtopetope	*Annona senegalensis*	Annonaceae	Roots
	Msungululu	*Strophanthus eminii*	Apocynaceae	Roots
Malaria	Mharobaini	*Azadrachta indica*	Meliaceae	Leaves
	Lonzwi	*Euphorbia sp.*	Euphorbiaeceae	Branch
Ringworm	Mbuyu	*Ficus sycomorus*	Moraceae	Leaves
	Ndimundogo	*Citrus aurantifolia*	Rutaceae	Fruits
Prolonged bleeding	Mlugara	*Cassipourea mollis*	Rhizophoraceae	Roots
during monthly periods	Kantyentye	*Abrus prectarius*	Papilionaceae	Roots
in women	Kalelalela	*Boscia angustifolia*	Capparaceae	Whole
	Ugagati	*Margaritaria discoidea*	Euphorbiaceae	Roots
	Mpingo	*Dalbergia melanoxylon*	Papilionaceae	Roots
	Mwembepori	*Ozoroa insignis*	Anacardaceae	Roots
	Mlungulungu	*Zanthoxylum chalybeum*	Rutaceae	Roots
	Mmelambasa	*Dalbergia nitidula*	Papilionaceae	Roots
	Mninga	*Pterocarpus angolensis*	Papilionaceae	Roots
	Mfubata	*Diospyros usambarensis*	Ebenaceae	Roots
Syphilis	Msongaluguka	*Hallorrhena pubescence*	Apocynaceae	Roots
	Myombo	*Brachystergia boehmii*	Caesalpinaceae	Roots
	Mlundalunda	*Cassia abbreviata*	Caesalpinaceae	Roots
	Mochangoko	*Cutanaregan obovata*	Rubiaceae	Roots
	Mgogondi	*Phyllanthus engleri*	Euphorbiaceae	Roots
	Mlungulungu	*Zanthoxylum chalybeum*	Rutaceae	Roots
Dysentry	Mlugara	*Cassipourea mollis*	Rhizophorae	Roots

	Mwebepori	*Ozoroa insignis*	Anacaridaceae	Roots
	Mkomamangapori	*Strychnos pugens*	Loganiceae	Leaves
	Mpera	*Psidium guajava*	Myrtaceae	Leaves
	Mzima	*Terminalia kaiserana*	Combretaceae	Roots/bark
	Msana	*Combretum zeyheri*	Combretaceae	Roots
	Mfutwambula	*Entada abyssinica*	Mimosaceae	Leaves
	Mtopetope	*Annona senegalensis*	Annonaceae	Roots
Epilepsy	Mtuja	*Ekebergia banguelensis*	Meliaceae	Roots
	Mochangoko	*Cutunaregan obovata*	Rubiaceae	Leaves
	Mteyu	*Securidaca longipendunculata*	Polygalaceae	Fruits
	Mgando mkalati	*Burkea africana*	Caesalpinaceae	Roots
	Mvivi	*Dalbergia boehmii*	Papilionaceae	Roots
	Mkalya	*Zanha africana*	Sapindaceae	Roots
	Mgogondi	*Phyllanthus engleri*	Euphorbiceae	Roots
	Msanzwambeke	*Crossopteryx febrifuga*	Rubiaceae	Bark
	Mnyonyo	*Ricinus communis*	Euphorbiceae	Seeds
	Kavumbe	*Hyptis suaveolens*	Labitae	Leaves
	Mpala	*Hymenocardia acida*	Euphorbiceae	Leaves/Roots
	Mkomamanga	*Strychnos sp.*	Loganiaceae	Leaves/Bark
	Mkavumkavu	*Orthosiphon ribicundus*	Labitae	Whole
Yellow fever	Mkalalwang'huba	*Erythrina abyssinica*	Papilionaceae	Bark
	Mtundwa	*Kigelia africana*	Bignoniaceae	Fruits
	Msalung'unda	*Vismia orientalis*	Guttifrae	Roots/Bark
	Kasanda	*Swartizia madascariensis*		Roots
Convulsion	Msalasi	*Friesodilsia obovata*	Annonaceae	Bark
	Mnyongwamembe	*Stegnotaenia aruriaceae*	Umbelliferae	Bark
	Mshenene	*Xylopia antunensii*	Annonaceae	Roots
	Mtuzya	*Ekebergia benguelinsis*	Meliceae	Roots
	Mteyu	*Securidaca longipendunculata*	Polygalaceae	Roots
	Mochangoko	*Cutanaregan obovata*	Rubiaceae	Roots
	Mtunguru	*Pseudolachnotylis maprouneifolia*	Euphorbiaceae	Roots
	Mkalya	*Zanha africana*	Caesalpinaceae	Roots
	Mtundulu	*Dichrostachys cinerea*	Mimosaceae	Fruits
	Msanzwambeke	*Crossopteryx febrifuga*	Rubiaceae	Roots
	Mmbula	*Parinari curratellifolia*	Chrysobalaceae	Roots
	Mliwafwengi	*Vitex doniana*	Verbenaceae	Roots
	Mwembepori	*Ozoroa insignis*	Anacaridaceae	Roots
	Mbaazi	*Cajanus cajan*	Papilionaceae	Leaves
	Mfutwambula	*Entada abyssinica*	Mimosaceae	Roots
	Mgongwa	*Acacia mellifera*	Mimosaceae	Roots
	Mlundalunda	*Cassia abbreviata*	Caesalpinaceae	Roots
	Kasatokangoko	*Asparagus buchananii*	Asparagaceae	Roots
Infertility in Women	Mwembepori	*Ozoroa insignis*	Anacaridaceae	Roots
	Mshenene	*Xylopia antunensii*	Annonaceae	Roots
	Mkunganilwa	*Albizia tanganyikensis*	Mimosaceae	Roots
	Mtowo	*Azanza garkeana*	Malvaceae	Roots
	Msalasi	*Friesodielsia obovata*	Annonaceae	Roots
	Kamborambora	*Tapiphyllum burnetii*	Rubiaceae	Roots
	Myogoyogo	*Multidentia crassa*	Rubiaceae	Roots

	Ilundelyahansi	*Emilia coccinea*	Compositae	Whole
	Mvivi	*Dalbergia boehmii*	Papilionaceae	Roots
	Msana	*Combretum zeyheri*	Combretaceae	Roots
	Mmondo	*Entadrophragma busei*	Meliaceae	Roots
	Mhiyabana	*Paveta schumanniana*	Rubiaceae	Roots
	Igangula	*Indigofera rhychocarpa*	Papilionaceae	Bark/Roots
	Mpala	*Hymenocardia acida-*	Euphorbiaceae	Roots
	Mmbula	*Parinari curattefolia*	Chrysobalaceae	Roots
	Ntulatu	*Solanum incanum*	Solanaceae	Roots
	Mtundwa	*Kigelia africana*	Bignoniaceae	Roots
	Mkalalwang'huba	*Erythrina abyssinica*	Papilionaceae	Roots
	Msisigulu	*Albizia brachycalyx*	Mimosaceae	Roots
	Kinywanzuki	*Becium albostellatum*	Labitae	Roots
	Matunyagantumbili	*Leptactina benguelensis*	Rubiaceae	Roots
	Mnung'hwahala	*Premna sinensis*	Verbenaceae	Roots
	Mtalali	*Vitex mombassae*	Vebenaceae	Roots
	Mkola	*Afzelia quanzensis*	Caesalpinaceae	Roots
	Kamborambora	*Tapiphyllum discolor*	Rubiaceae	Roots
	Ndagondago	*Cyperus articulatum*	Cyperaceae	Rhizome
Schistosomosis	Mtowo	*Azanza garkeana*	Malvaceae	Bark
	Mkwaju	*Tamarindus indica*	Caesalpinaceae	Roots
	Ndimundogo	*Citrus aurantifolia*	Rutaceae	Roots
	Mmbula	*Parinari curattefolia*	Chrysobalaceae	Bark
Hernia	Mshenene	*Xylopia antunensii*	Annonaceae	Roots
	Mkalatusi	*Eucalyptus sp.*	Myrtaceae	Roots
	Mbaazi	*Cajanus cajan*	Papilionaceae	Roots
	Mlundalunda	*Cassia abbreviata*	Caesalpinaceae	Roots
	Ntulantu	*Solanum incanum*	Solanaceae	Roots
	Mvivi	*Dalbergia boehmii*	Papilionaceae	Roots
	Mochangoko	*Catunaregan obovata*	Rubiaceae	Roots
	Mtunguja	*Solanum dasyphylum*	Solanaceae	Roots
	Mliwafwengi	*Vitex doniana*	Verbenaceae	Roots
	Msongaluguka	*Hallorrhena pubescence*	Apocynaceae	Roots
	Mtundwa	*Kigelia africana*	Bignoniaceae	Roots
	Vindwe	*Acacia horkii*	Mimosaceae	Roots
	Mlewabana	*Paveta schumanniana*	Rubiaceae	Roots
	Mfutwambula	*Entada abysinica*	Mimosaceae	Roots
	Ugoweko	*Combretum obovatum*	Combretaceae	Roots
	Mteyu	*Securidaca longipendunculata*	Polygalaceae	Roots
Impotence	Mpingo	*Dalbergia melanoxylon*	Papilionaceae	Roots
	Msisigulu	*Albizia brachycalyx*	Mimosaceae	Roots
	Mbapa	*Markhamia obtusifolias*	Bignoniaceae	Roots
	Mbaazi	*Cajanus cajan*	Papilionaceae	Roots
	Mpuguswa	*Flacourtia indica*	Flacourtaceae	Roots
	Mkola	*Afzelia quanzensis*	Caesalpinaceae	Bark
	Ugagati	*Margaritaria discoidea*	Euphorbiaceae	Roots
	Mshenene	*Xylopia antunensii*	Annonaceae	Roots
	Mbanga	*Pericopsis angolensis*	Papilionaceae	Bark
	Kantyentye	*Abrus prectarius*	Papilionaceae	Roots
Pelvic inflamatory	Mpugambu	*Clerodendrum uncinatum*	Verbenaceae	Roots

disease (PID)	Myogoyogo	*Multidentia crassa*	Rubiaceae	Roots
	Mtundwa	*Kigelia africana*	Bignoniaceae	Roots
	Msana	*Combretum zeyhri*	Combrtaceae	Roots
	Mfutwambula	*Entada abyssinica*	Mimosaceae	Roots
	Kasanda	*Swartizia madascariensis*	Leguminosae	
Snakebite	Mgumbu	*Lannea schimperi* --	Anacaridaceae	Bark
	Mfubata	*Diosypyros usambarensis*	Ebenaceae	Leaves
	Mnyongwamembe	*Stegnotaenia arariaceae*	Umbeliferae	Bark
	Mkunganilwa	*Cissampelus pereira*	Menisparmaceae	Roots
	Mlama	*Combretum molle*	Combretaceae	Roots
	Mkoma	*Grewia bicolor*	Combretaceae	Leaves
	Mtundulu	*Dichrosrachys cinerea*	Mimosaceae	Leaves
	Mgando mkalati	*Burkea africana*	Caesalpinaceae	Bark/Leaves
Ovulatis	Kilindilamgunda	*Gardenia ternifoila*	Rubiaceae	Roots
	Mfubata	*Diospyyros usambarensis*	Ebenaceae	Roots
	Malebe	*Pistia stratiotes*	Araceae	Leaves
Elephantiasis	Mkuyu	*Ficus sycomorus*	Maraceae	Leaves
	Mharobaini	*Azadirachta indica*	Meliaceae	Leaves
	Mkola	*Afzealia quanzensis*	Caesalpinaceae	Leaves
	Kalelalela	*Boscia angustifolia*	Papilionacea	Leaves
Deliving evil spirit	Msoniya	*Loeseneriella sp.*	Celestraceae	Roots
	Mwangajini	*Polyalthia stulhmanii*	Annonaceae	Roots
	Mtuzya	*Ekbergia benguelensis*	Meliaceae	Roots
	Mkungulanga	*Sterculia quinqueloba*	Sterculiaceae	Bark
	Mhuzauza	*Allophyllus afriacanus*	Sapindaceae	Leaves
	Mfutwambula	*Entada abyssinica*	Mimosaceae	Bark/Leaves
	Mkola	*Afzelia quanzensis*	Caesalpinaceae	Bark
Bewitched	Mtunguru	*Pseudolachnostylis sp.*	Euphorbiaceae	Roots
	Mtundulu	*Dichrostachys cinerea*	Mimosaceae	Leaves
	Muba	*Julbernadia globiflora*	Caesalpinaceae	Leaves
	Mlundalunda	*Cassia abbreviata*	Caesalpinaceae	Leaves
	Kagowole	*Ziziphus mucronata*	Rhamnaceae	Leaves
	Mliwafwengi	*Vitex doniana*	Verbenaceae	Leaves
	Mlama	*Combretum molle*	Combrataceae	Leaves
	Msana	*Combretum zeyheri*	Combrataceae	Leaves
	Mkindwanzagamba	*Albizia vesicolor*	Mimosaceae	Leaves
	Mkola	*Afzelia quanzensis*	Caesalpinaceae	Bark
	Mvungwa	*Kigelia africana*	Bignoniaceae	Bark
	Mbanga	*Pericopsis angolensis*	Papilionaceae	Bark
	Ilogolelo	*Sesamum angolense*	Pedaliceae	Roots
	Mmellambasa	*Dalbergia nitidula*	Papilionaceae	Roots
Oodema	Lugaka	*Aloe sp.*	Aloaceae	Leaves
Diabetes	Mlundalunda	*Cassia abbreviata*	Caesalpinaceae	Roots
	Msungululu	*Strophanthus emmii*	Apocynaceae	Roots
	Mkindwanzagamba	*Albizia versicolor*	Mimosaceae	Roots
	Mlungulungu	*Zanthoxylum chalybeum*	Rutaceae	Roots

Blood pressure	Mpumbula	*Calotropis procera*	Asclepiadaceae	Roots
Preventing arbotion	Mtalali	*Vitex mombassae*	Verbenaceae	Roots
	Mnungh'wahala	*Premna sinensis*	Verbenaceae	Roots
	Shirimba	*Tricalysia ruandensis*	Rubiaceae	Roots
Placental previor	Ilalyanzovu	*Euphorbia sp.*	Euphorbiaceae	Branch

Appendix 5: Botanicals collected

Abrus prectarius	MLK 0100-98
Acacia horkii	MLK 0013-99
Afzealia quanzensis	MLK 0037-98
Albizia brachycalyx	MLK 0090-98
Albizia tanganyikensis	MLK 0024-99
Albizia versicolor	MLK 0041-99
Allophyllus afriacanus	MLK 0062-98
Aloe sp.	MLK 0008-98
Amaranthus graecizans	MLK 0020-99
Annona senegalensis	MLK 0033-98
Antidesma venosin	MLK 0015-99
Aristolochia hockii	MLK 0045-99
Asparagus buchananii	MLK 0116-98
Azadicachta indica	MLK 0016-99
Azanza garkeana	MLK 0047-98
Becicum albostellatum	MLK 0095-98
Berchemia discolor	MLK 0050-98
Boscia angustifolia	MLK 0093/0098-98
Brachystegia boehmii	MLK 0045-98
Burkea africana	MLK 0022-98/0012-99
Cajanus cajan	MLK 007-99
Calotropis procera	MLK 0009-98
Cassia abbreviata	MLK 0025-98/0074-98
Cassipourea mollis	MLK 0031-98
Catunaregan obovata	MLK 0021-98
Cissampelus pereira	MLK 0102-98
Cissus integrifolia	MLK 0001-99
Citrus aurantifolia	MLK 0006-99
Clerodendrum uncinatum	MLK 0083-98
Combretum molle	MLK 0011-99
Combretum obovatum	MLK 0044-98
Combretum zeyheri	MLK 0042-98
Commiphora africana	MLK 0085-98
Crossopteryx febrifuga	MLK 0045-98
Cucumis metuliferus	MLK 0103-98
Cynodon dactylon	MLK 003-99
Cyperus articulatum	MLK 0051-99
Cyphostemma crotaliarioides	MLK 0026-99
Cyphostemma gigantophyllum	MLK 0028-99
Dalbergia boehmii	MLK 0005-98
Dalbergia melanoxylon	MLK 0013-98
Dalbergia nitidula	MLK 0036-98
Dichrosrachys cinerea	MLK 0036-98
Diospyros fischeri	MLK 0029-99
Diospyros usambarensis	MLK 0034-98
Diplorhyncus candylocarpon	MLK 0080-98
Ekbergia benguelensis	MLK 0059-98
Emilia coccinea	MLK 0052-98
Entada abyssnca	MLK 0061-98
Erythrina abyssinica	MLK 0110-98
Eucalyptus camaldulensis	MLK 0044-98

Fadogia obovata	MLK 0022-99
Fadogia stenophylla	MLK 0070-98
Ficus sycomorus	MLK 0040-98
Ficus thonningii	MLK 0043-99
Flacourtia indica	MLK 0017-99
Flueggea virosa	MLK 0019-98
Friesodielsia obovata	MLK 0024-98
Gardenia ternifolia	MLK 0027-98
Grewia bicolor	MLK 0016/0114-98
Hexalobus monopetalus	MLK 0072-98
Holarrhena pubescens	MLK 0111-98
Hymenocardia acida	MLK 0078-98
Hyptis suaveolens	MLK 0099-98
Indigofera rhynchocarpa	MLK 0021-99
Landolphia kirkii	MLK 0087-98
Lannea humilis	MLK 0023-99
Lannea schimperi	MLK 0077-98
Launea cornuta	MLK 0046-98
Lawsonia inermis	MLK 0046-98
Leptactina benguelensis	MLK 0009-99
Loeseneriella africana	MLK 0112-98
Mangifera indica	MLK 0005-99
Margaritaria discoidea	MLK 0049-98
Markhamia obtusifolias	MLK 0035-98
Multidentia crassa	MLK 0060/0076-98
Ochna katangensis	MLK 0050-98
Ochna polyneura	MLK 0104-98
Ochna schweinfurthiana	MLK 0032-98
Ochna stolzii	MLK 0023-98
Ocimum basilicum	MLK 0052-98
Orthosiphon ribicundus	MLK 0026-99
Ozoroa insignis	MLK 0055-99
Parinari curattellifolia	MLK 0088/0071-98
Paveta schumanniana	MLK 0063/0107-98
Pericopsis angolensis	MLK 0048-98
Phyllanthus engleri	MLK 0082-98
Piliostigma thonningii	MLK 0004-99
Pistia stratiotes	MLK 0067-98
Plectranthus laxiflorus	MLK 0008-99
Premna senensis	MLK 0003-98
Pseudolachnostyli maprouneifolia	MLK 0027-98
Psidium guajava	MLK 0041-98
Pterocarpus angolensis	MLK 0065-98
Pterocarpus tinctorius	MLK 0069-98
Ricinus communis	MLK 0066-98
Rothmannia ravae	MLK 0051-98
Rothmnnia anglerana	MLK 0028-98
Schrebera tricodata	MLK 0006-98
Securidaca longipedunculata	MLK 0020-98
Senna siamea	MLK 0097-98
Senna singuena	MLK 0010-99
Sesamum angolense	MLK 0019-99
Solanum dasyphllum	MLK 0047-99
Solanum incanum	MLK 0039-99

Stachytarphela urticifolia	MLK 0049-99
Stegnotaenia arariacea	MLK 0011-98
Sterculia quinqueloba	MLK 0079-98
Strophanthus eminii	MLK 0079-98
Strychnos potatorum	MLK 0106-98
Strychnos pugens	MLK 0083-98
Strychnos sp.	MLK 0081-98
Strychnos spinosa	MLK 0031-98
Swartizia madascariensis	MLK 0030-98
Tamarindus indica	MLK 0056-98
Tapiphyllum burnetii	MLK 0094-98
Tapiphyllum discolor	MLK 0070-98
Vernonia amygdalina	MLK 0048-99
Vitex mombassae	MLK 0017-98
Xeroderris stuhlmanii	MLK 0004-98
Xylopia antunensii	MLK 0038-98
Zanha africana	MLK 0014-98
Zanthoxylum chalybeum	MLK 0014-99
Ziziphus mucronata	MLK 0064-98

Appendix 6 List of Traditional Healers Contacted

No.	NAME	SEX	VILLAGE	WARD
2	Rehema Kapiga	F		
3	Sadda Mshamamba	F		
4	Maulid Kasanzu	M		
5	Juma Mohamed Mlowezi	M	Mayombo	
6	Pungwi Kaburiwazi	M		Magiri
7	Taabu Mohamed Nlowezi	F		
8	Said Mabula	M		
9	Masunga Leonard	M		
10	Nuru Kalekwa	F		
11	Lufungulo Jonh Magai	M	Imalampaka	
12	Njile Masele	M		
14	Mussa Simon Bakary	M		
15	Mohammed Kazuba	M		
16	Juma Suleiman	M		
17	Paulo Kalogihala	M		
18	Jumanne Kipili	M		
19	Joseph Kalogihala	M		
20	Issa Shaaban	M	Majengo	Ikongolo
21	Idd Maziku	M		
22	Athman Saganda	M		
23	Abdallah Suleiman Masunga	M		
24	Matheo Marco Bundala	M	Kanyenye	
25	Nyagwida Seloe	M	Igalula	
26	Ally I. Kiulya	M		
27	Asha Majuto	M		
28	Asha Majuto	F		
29	Mohamed Maganga	M		
30	Ramadhan Mahandamahanya	M		
31	Rehema Ally	F	Kawekapina	Igalula
32	Suleiman M. Mnyalangizi	M		
33	Mr.& Mrs Mussa Omary	M/F		
34	Kashindye A. rajab	M		
35	Ramadhan Salum	M	Ipululu	
36	Gegu Tuma	M		
37	Hidaya Hamis	F		
38	Yasin Ramadhan	M		
39	Asha Said Mrisho	F	Ilolangulu	Ilolangulu
40	Hamis Mahatala	M		
41	Juma S. Liuba	M		
42	Nsimba Mussa	M		
43	Omary mohamed Mlela	M	Isila	
44	Mtoro Suleiman	M	Mpenge	Ilolangulu
45	Asha Malembeka	F	Isila	
46	Haruna Mwanuka	M	Isila	
47	Salum Mduma	M	Mpenge	
48	Jabir S. Mwendoigali	M	Mpenge	
49	Andrea Ntabwa	M	Mpenge	
50	Ally Suleiman Kalukanya	M	Ipululu	Igalula