EFFECTS OF HUMAN DISTURBANCES ON ENDEMIC AND THREATENED PLANT SPECIES IN AMANI NATURE RESERVE, TANGA REGION

BY

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ABSTRACT

This study was carried out in Amani Nature Reserve (ANR), Tanga Region, Tanzania to assess the effects of human disturbances on endemic and threatened plant species. Both socio-economic and ecological aspects of human disturbance on endemic and threatened plant species were studied. The socio-economic study involved interviewing 101 households selected at random in five out of 18 villages adjacent to ANR. The ecological survey used a systematic sampling design to acquire these data. A total of 278 (10mx50m) sample plots in five transects were laid out in the reserve. Results showed that, a total of 15 endemic and/or threatened species were used by local communities for making domestic items, 10 for house construction and selling, 7 for medicine, 10 as fuel wood and about 84 tonnes of seed were collected from endemic/threatened tree species. About 93% of respondents had no idea that endemic and threatened plant species occurred in their area. There was evidence of poles and timber cutting of threatened and/or endemic tree species in the reserve. Out of 4001 tree stems evaluated, 3474 (87%) trees were alive, 207 (5%) were recently cut, 90 (2%) were old cut and 230 (6%) had died naturally. The average number of timber-sized trees cut per ha in the intact and disturbed forest areas was 18.5 and 24.3 respectively. Out of 3959 evaluated poles, 3515 (88.8%) were alive, 282 (7.1%) were recently cut, 113 (2.9 %) were old cut and 56 (1.4%) were naturally dead. The average cut poles per ha was 23.7 in the intact forest and 29.1 in the disturbed forest area. The Shannon-Wiener index of diversity was 3.778 and 4.190 for intact and disturbed forest strata respectively. The Indices of Dominance (ID) were 0.0445 and 0.0273 for intact

and disturbed forest strata respectively. Making people more aware of the importance of threatened and endemic plant species, suggesting alternative species and providing off-forest alternative livelihood strategies is recommended for alleviating human disturbances on threatened plant species in ANR.

DECLARATION

I RAYMOND ROMAN KILLENGA, do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is a result of my own original work and it has never been submitted for higher degree award in any other University.

……. ……
MSc Candidate Date

…… ……..
Professor Seif Madoffe (Supervisor) Date

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DEDICATION

This document is dedicated to:

- My parents Roman Fundi Mosoy Kimboy Ksamo Killenga and Sibila Lazaro Shirima, that they tuned my youth in favour of education

- My children Ron, Fern and Nike, that they may be inspired to get higher education in their life-time.

- My wife Sophy who understands what continuing education means.

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ABBREVIATIONS AND SYMBOLS

ABG	Amani Botanical Garden
AFIMP	Amani Forest Inventory and Management Plan Project
ANR	Amani Nature Reserve
CI	Conservation International
CIMMTYT	CentroInternacionalde Mejorameinto de Maiz'y Trigo
CITES	Convention on International Trade in Endangered Species
CR	Critically endangered
DBH	Diameter at Breast Height

EAMs	Eastern Arc Mountains
EN	Endangered
EUCADP	East Usambara Conservation and Agriculture Development Programme
EUCAMP	East Usambara Conservation Area Management Programme
EUCFP	East Usambara Catchment Forest Project
EUMs	East Usambara Mountains
EUTCO	East Usambara Tea Company
FAO	Food and Agriculture Organization of the United Nations
FBD	Forestry and Beekeeping Division
FINNIDA	Finnish International Development Agency
GAPEX	Ground-based Atmospheric Profiling Experiment
GPS	Global Positioning System
H’	Shannon Wiener Index of Diversity
ID	Index of Dominance
IUCN	The World Conservation Union
JFM	Joint Forest Management
LEAP	Least of East African Plants
MNRT	Ministry of Natural Resources and Tourism
SPSS	Statistical Package for Social Science
SUA	Sokoine University of Agriculture
TAS	Tanzania Shilling
UNEP	United Nations Environment Program
URT	United Republic of Tanzania
VU	Vulnerable
WWF	World Wildlife Foundation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

All forests, whether temperate, tropical or boreal are rich and complex, whose vast array of products and benefits touch our lives in many fundamental ways. Tanzania fully recognizes the role of biological diversity in providing the natural resource base for social and economic development, as well as for fundamental benefits. Many communities living within or near these forests rely on them for their survival. They benefit greatly from the locally important goods and services such as food, wood products, saleable commodities, wildlife products and recreational opportunities (Sharma *et al.*, 1992; Lovett and Pocs, 1993). Forests also provide important defence against global climate change and contain tremendous species diversity for bio prospecting in the pharmaceutical industries.

Despite these values, the 20th century was reported to encompass one of the greatest waves of extinction of biological resources to occur on the planet. For instance, during the 1980s, 7.3 million hectares of tropical forests were cleared annually for agriculture purposes, while 4.4 million hectares were degraded each year through selective logging (Crump, 1991). Sharma *et al.* (1992) and Vanclay (1993) estimated that the world lost about 17 million hectares of tropical forest per year in 1980s. On the other hand, FAO (1996) reported that the world lost about 450 million hectares of its tropical forest cover between 1960 and 1990 with most being from developing

countries. In 2000, FAO (2000) reported a new rate of deforestation at 9.4 million ha/year.

In Tanzania, various authors have provided a number of figures about the rate of deforestation. FAO and UNEP (1981) gave an annual deforestation rate of about 130 000 hectares of which, 10 000 hectares were from closed forest while the rest was from woodlands for the period of 1976-80. The Ministry of Natural Resources and Tourism (1998) estimated 130 000-500 000 ha/year as the annual rate of deforestation while (FAO, 2000; MNRT, 2002) estimated the rate of deforestation to be about 91 000 ha/year.

The Eastern Arc Mountain (EAMs) forests, which are part of closed forests in Tanzania are very important interms of forest resources supply to the adjacent communities. They are also source of water for hydro-electric power, domestic and industrial production. The Arc is one of 34 biodiversity hotspots in the world due to its biodiversity richness. The Eastern Arc Mountains (EAMs) was estimated to have originally supported around 23 000 km^2 of forest, of which around 15 000km^2 was left by 1900, and about 5340km^2 remained by mid 1990's (Newmark, 1998; Burgess *et al.*, 2005). Forest area decline is primarily due to land being cleared for agriculture. Logging, charcoal production and wild fires have also contributed to the decline.

1.1.1 Overview of forests in the East Usambara Mountains

The East Usambara Mountains (EUMs) are located near the north east coast of Tanzania. They are considered to be one of the most important forests blocks in Africa because of their biodiversity (Tye, 1994), and have been linked to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rodgers and Homewood, 1982; Howell, 1989). These mountains are essentially 'Islands' of forest (Lovett, 1989), that are the home for at least 3450 species of vascular plants of which over one quarter are endemic or near-endemic (Iversen, 1991). In spite of this richness, the area is under serious encroachment (IUCN, 1990; Lovert and Pocs, 1993; Bohero, 1997; Frontier Tanzania, 2001). The forests in the East Usambara Mountains are threatened by indiscriminate land use practices. For instance, it is claimed that some 50% of public forest land in 30 sq km around Amani are estimated to have been cleared since 1954, mainly for agriculture and building materials aggravated by rapid population growth and immigration (Bohero, 1997). Furthermore, there is continued degradation of forests through pit sawing and clearing for agriculture. This degradation of forest land continues because of the failure to enforce control on land use practices and lack of incentives for the local communities to practice sustainable resource management. The latest survey of the EUMs, conducted by Johansson and Sandy (1996) shows that approximately 45 137 ha of the East Usambara Mountains remain as natural forest. This can be divided into three parts: Submontane rain forest, lowland forest and plantation forest (Table 1). Altitude

is the factor differentiating these two forest types (Hamilton, 1989), with submontane forest generally occurring above 850m above sea level.

Table 1: Forest types in the East Usambara Mountains

Forest type	Area (ha)	% of area
Lowland forest	29 497.4	62.9
Submontane forest	12 916.6	30.6
Forest plantation	2723.6	6.5
Total	45 137.6	

Source: Johansson and Sandy (1996)

1.1.2 Status of forests in the East Usambara Mountains.

The ownership or legal status of forested areas in the EUMs can be categorized as follows:

Gazetted forests- These include forest reserves owned and managed by the Forestry and Beekeeping Division (FBD) commonly referred to as catchment forests. Access to these forests is highly prohibited by laws and the forests are mainly managed as catchment areas. Parts of these reserves formed the Amani Nature Reserve (ANR). However, access to the existing forest reserves including ANR for collection of particular forest products can be obtained through a special permit. For example, with a permit a person is allowed to collect fire wood (from dead and fallen branches or snags) from the reserves twice a week.

Estate forests- These include forests growing on Estate land. Management and control of these forests has been under the estates. There are two kinds of Estates in the area, namely the tea and sisal Estates located on the highlands and lowlands

respectively. While sisal estates only own small portion of forests, the tea estates have bigger portions of forests. Most of these forests are growing naturally, but in the tea estate forests, there is some planting of exotic tree species (especially *Eucalyptus* spp*).* In one case, the (FBD) has taken over the management of some forests from the tea estates to form part of ANR through covenant agreement.

Public land Forests- These are located within close proximity to private small holder-farms. The forests form the major source of wood fuel for the majority of people; although they contain some endemic and threatened tree species as well as trees that have value for timber, crafting and other general purposes. Administratively, the forests are controlled by District Councils. The Tanga Regional Catchment Office regulates harvesting of forest products from these forests, although in other regions of Tanzania, the control is under District Forest Offices. The unfortunate situation is that the public land forests are less protected by forest laws making them more prone to misuse.

1.2 Problem statement and justification

Amani Nature Reserve is one of the richest forest areas in terms of endemic plant species in the EAMs (Iversen, 1991; Frontier Tanzania, 2001). Some of these species were categorized as threatened due to high utilization pressure (IUCN, 2002). Despite the declaration of threatened plant species, communities are still utilizing most of them for house construction, timber, fuel wood and medicines. Kessy (1998) and

Frontier Tanzania (2001), reported on illegal poles and timber cutting in the Reserve, but did not indicate species used. The gold rush started in the EUMs especially ANR in early 2000s opened a new page of deforestation in that important and the only Nature Reserve in Tanzania. Many trees were cut for construction of temporary settlements and wood fuel. Not only that but also some of the trees were uprooted during the mining process. Continuation of uncontrolled exploitation of these resources will affect more plant species that may lead to their extinction. The Government stopped mining in the ANR in 2004 but it continues illegally.

Several studies have reported about deforestation and disturbance in Amani Nature Reserve (AFIMP (1988); Hamilton and Bensted-Smith (1989); Katigula (1999); Frontier Tanzania (2001); Madoffe and Munishi (2005)); but still there is no adequate information on the extent to which endemic and threatened species are utilized and for what purposes. Munishi *et al.* (2004) suggested further surveys were needed in the forests of the EAMs to quantify the manner and type of use of the forest resources by surrounding local communities to determine their possible impacts on species distribution. In 1997, the second international conference on the EAMs concluded that this unique ecosystem was undergoing an accelerated rate of destruction and that there was an urgent need for documentation of the problem if changes were to be made to reverse or slow the process (Burgess *et al*., 1998)

The issue of threatened and endemic plant species is recognized internationally but is not well known at the local level. Recently a total of 176 taxa from the families of Amaranthaceae, Anacardiaceae, Ancistroclaceae, Annonaceae, Apiaceae, Apocynaceae, Arecaceae, Araliaceae, Arecaceae, Asreraceae Canellaceae, Caricaceae and Cucurbitaceae were evaluated during four days of red listing workshop, conducted in Dar es Salaam from 27 February to 3 March 2006, organized by IUCN. In that workshop, 123 (71%) taxa were assessed as threatened: 30 critically endangered, 53 endangered, 40 vulnerable and 12 near threatened. Among the threatened taxa are a number of Annonaceae including *Sanrafaelia ruffonammari*, a recently described genus and species endemic to the foothills of the East Usambara Mountains. *S.ruffonammari* was assessed as critically endangered. Another Usambara endemic, *Annonidium usambarense* (Annonaceae) has not been seen since the type collection in 1910 despite extensive searchers, and was therefore assessed as extinct. *Cylicomorpha parviflora* (Caricaceae) was assessed as endangered (IUCN, 2006).

This study was designed to create more baseline information on recent forest disturbance and to determine effects of that disturbance on IUCN-listed threatened and endemic plant species in the area. This database will help to solve some management and conservation problems facing ANR. The study results suggest alternative strategies and management objectives for sustainable use of forest resources (including ecosystem services) and conservation of threatened plant species for the benefit of local, regional and national needs. Also, designing off-forest

alternative interventions that may help reduce negative impacts on threatened species and other forest resources and developing an environment for sustainable community based forest resource management.

1.3 Objectives

1.3.1 Overall objective

The overall objective of this study was to assess human disturbances on endemic and threatened plant species in the Amani Nature Reserve.

1.3.2 Specific objectives

i) To investigate on how aware are the adjacent communities about endemic and threatened plant species.

ii) To quantify the use of endemic and threatened plants in ANR.

iii) To determine the effects of human disturbances on species diversity in ANR

iv) To recommend appropriate strategies and tactics for sustainable conservation of threatened and endemic plant species in ANR.

1.4 Study questions

The study was guided by the following questions

i) What is the knowledge of local people on endemic and threatened plant species?

ii) What are the types and causes of human disturbance in the study area?

iii) What species are preferred and why?

iv) What are the effects of human disturbance on species diversity?

v) What is the amount/number of trees removed from ANR annually?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The concept of threatened and endemic species

Threatened plant or animal species include critically endangered (CR), endangered (EN) and vulnerable (VU) (IUCN, 2002). Threatened species is a plant or animal that is in danger of becoming extinct in all or part of the area where it occurs. If a species becomes extinct, it is completely lost and can never be replaced (Nantucket Conservation Foundation, 2002). The Red Data Books categorize species in terms of their threat. Most heavily impacted species by man are those species, which are extinct in the wild (critically endangered) for 50 years or more, but may still be kept alive in botanical gardens, or even be a popular garden plant, or simply be irrevocably lost to mankind. Then there are those species in imminent danger of extinction unless something is done to reduce the threats: these endangered species form the focus of conservation strategies. Also threatened, but not in imminent danger of extinction, are vulnerable species: here the threats are operative, so the species can become endangered if the causes continue (Stevens, 1998; IUCN, 2002; Protea Atlas, 2005).

It is estimated that, between 3000 and 30 000 of Earth's estimated 10 million species are disappearing each year (Healey, 2002). Between one and two thirds of all plant and animal species are predicted to become extinct, mainly in the tropics, during the second half of the next century largely due to human impacts. This is inevitable if the current trends continue. The current extinction rate is now approaching 1000 times the

background rate, i.e. what would occur in a natural environment without human impact, and may climb to 10 000 times the background rate during the next century, if present trends continue.

2.2 The Eastern Arc Mountains

The Eastern Arc Mountains (EAMs) are a chain of isolated mountains (5340km^2) in Kenya and Tanzania surrounded by arid woodlands and influenced by the Indian Ocean. The mountains, which include East Usambara stretch from Taita Hills in southeast Kenya to the Makambako gap just to the southeast of the Udzungwa mountains in Tanzania. In 1900 there was three times the amount of forest cover there is today in these mountains (Madoffe *et al.*, 2006). Much of the original forests have been converted into agriculture production. These mountains are recognized as one of 34 globally important 'hot spots' by the World Wildlife Foundation and the World Conservation Union (IUCN) for forest biodiversity and are major national, regional and local source of hydropower, water and wide array of forest based benefits and agriculture production (Mittermeier, 2004; Burgess, 2005; Madoffe *et al.*, 2006)

The EAMs and Coastal Forests "hotspot" harbour a remarkable concentration of widely diverse and endemic plant and animal species. There are at least 4000 vascular plant species in the Eastern Arcs and coastal forests "hotspot", and undoubtedly more await discovery. Of the total plant diversity, 1400 species (35%) are endemic; 800 of

those are in the Eastern Arcs and 600 in the Coastal Forests (Conservation International, 2004; Mittermeier, 2004). The “hotspot” is largely unexplored and many of its species are as yet unknown. More than fifty new species have been discovered in the last decade in the Udzungwa Mountains of Tanzania alone while a new genus of tree that can grow as high as 15 meters was recently found in the Usambara Mountains (Conservation International, 2004). Many surveys on endemism and diversity of species in the EAMs continue resulting in frequently updated numbers of species and their conservation status

(Table 2).

Table 2: Species diversity and endemism in the Eastern Arc Mountains

Taxonomic group	Species	Endemic species	Percent endemism
Plants	7598	2356	31.0
Mammals	490	104	21.2
Birds	1299	106	8.2
Reptiles	347	93	26.8
Amphibians	229	68	29.7
Fresh water fishes	893	617	69.7

Source: Conservation International (2006)

The forests are the centers of global endemism for the African violet (*Saintpaulia spp*) and Busy Lizzies (*Impatiens* spp), which have been widely cultivated for house and garden plants in Europe and America. When considered together with the Northern Zanzibar-Inhambane coastal mosaic ecoregion, the density of plant species endemism is among the highest in the world (Myers *et al.*, 2000). There are also high rates of

endemism in the non-vascular bryophytes, including 32 known strict endemics and a number of near-endemics, some shared with Madagascar (Pócs 1998). These endemic plants are not only found in the forests, but also in the montane grasslands, wetland areas, and on rocky outcrops.

Bird endemism in the Eastern Arc forests is high, with both strict and near-endemic species. Some of the near-endemic species exhibit disjunct distribution patterns indicating formerly widespread populations in the mountains of eastern Africa. Species with limited distributions include the Taita thrush (*Turdus helleri*, CR*)* and Taita apalis (*Apalis fuscigularis*, CR*)* which only occur in a few square kilometers of forest in the Taita hills. The Udzungwa partridge (*Xenoperdix udzungwensis*, VU) is known only from a single forested area on the Udzungwa Mountains (Dinesen *et al*. 1994), and the Uluguru bush shrike (*Malaconotus alius*, EN) is confined to one forest reserve on the Uluguru Mountains, of less than 100 km^2 forest area (Shipper and Burgess, 2001). Others occur on several mountains. These include the Usambara eagle-owl (*Bubo vosseleri*, VU*)*, banded sunbird (*Anthreptes rubritorques*, VU*)*, and Mrs Moreaus warbler (*Bathmocercus winifredae*, VU). Other more wide ranging species are generally shared with mountain forests further to the south in Malawi and Zimbabwe, or with lowland coastal forests of the Zanzibar-Inhambane coastal mosaic (Stattersfield *et al.*, 1998, Burgess *et al.*, 1998).

Mammalian endemism is also high, considering the relatively small area of these montane forest patches. There are no endemic large mammals, however, presumably

because the areas and structure of forest are insufficient to permit the persistence of unique large forest-dwelling mammal species. Six strictly endemic small mammals are known, including five species of shrews *(Crocidura tansaniana* (VU), *Crocidura telfordi* (CR), *Crocidura usambarae* (VU), *Myosorex geata* (EN) and *Sylvisorex howelli* (VU)*)*, and one species of galago *(Galagoides orinus)*. Other threatened mammals which occur in these forests include Abbot's duiker (*Cephalophus spadix*, VU), eastern tree hyrax (*Dendrohyrax validus*, VU), and the black and rufous elephant-shrew (*Rhynchocyon petersi*, EN).

Amphibians and reptiles also exhibit high levels of species endemism. Notable among the 25 species of strictly endemic amphibians are species within the reed frogs (*Hyperolius* – five endemic species), forest treefrogs (*Leptopelis* - two endemic species), tree toads (*Nectophrynoides* – five endemic species), species in the Microhylidae family (four endemic species), and the Caeciliaidae family (five endemic species). New species continue to be discovered in this ecoregion; for example, the newly described Kihansi spary toad (*Nectophrynoides asperginis*) (Poynton *et al*., 1998), which is extremely threatened with extinction due to the diversion of water to a hydroelectricity generating plant. Other new species await description from the Udzungwa, Ukaguru, Uluguru and West Usambara mountains.

The high rates of endemism seen in other groups of vertebrates are also found in the reptiles. The strictly endemic reptiles include ten species of chameleons (seven *Chamaeleo* and three *Rhampholeon*), three species of worm snakes (*Typhlops*), and

six species of colubrid snakes in four genera. The invertebrates of the Eastern Arc also contain very high rates of endemism. Available compiled information illustrates that up to 80% of the invertebrate fauna of a single eastern Arc Mountain can be strictly endemic, with the next mountain along containing a similar high rate of strictly endemic species (Hoffman, 1993; Scharff, 1992)

The high density of endemics in the small area in the EAMs makes many of the plants and animals in the hotspot threatened with global extinction. The Eastern Arc is reported to have 237 globally threatened plant species (Hoffman 1993; Scharff 1992) which is regarded as a great underestimate. Appendix 2 gives results of globally threatened species from 1996-2006. There is an increase of the numbers of threatened species from 1996/98 period, where the number of threatened plant species was 909, 1197 and 3222 for critically endangered (CR), Endangered (EN) and Vulnerable (VU) respectively. In 2006 the number increased to 1541, 2258 and 4591 for CR, EN and VU respectively.

2.2.1 Endemism in the East Usambara Mountains

The East Usambara forests have been linked to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rodgers and Homewood, 1982; Howell, 1989). Currently, at least 3450 species of vascular plants have been recorded and over one quarter are endemic or near endemic (Iversen, 1991). The mammals of the East Usambara Mountains show limited endemism (Frontier Tanzania, 2001). However, there are several species of special interest. These include:

the restricted Zanj elephant shrew, *Rhynchocyon petersi*, which is common in the Usambara Mountains (Collar and Stuart, 1987) yet listed as globally endangered by IUCN due to the decline of habitat extent and quality; eastern tree hyrax, *Dendrohyrax validus*, listed as vulnerable by IUCN (Hilton-Taylor, 2000) and the lesser pouched rat, *Beamys hindei* which is also considered vulnerable by IUCN (Hilton-Taylor, 2000)

There are at least 11 species of reptiles and amphibians endemic to the East and West Usambara mountains (Howell, 1993). A new species of snake *Prosymna semifasciata* was recently found in Kwamgumi and Segoma forest reserves (Frontier Tanzania, 2001). A recently described amphibian species *Stephopaedes usambarae* has been recorded in Mtai and Kwamgumi forest reserves (Frontier Tanzania, 2001)

The Forest avifauna of the East Usambara Mountains has a high diversity with at least 110 species (Stuart, 1989). Six species occurring in the lowland forests are considered vulnerable to global extinction: Sokoke scops owl, *Otus ireneae*; the endemic Usambara eagle owl, *Bubo vosseleri*; Swynnerton's robin, *Swynnertonia swinertoni*; East coast akalat, *Sheppardia gunningi*; Amani sunbird, *Anthreptes pallidigaster* and the Banded green sunbird, *Anthreptes rubritorques* (IUCN, 2002).

The Usambara Mountains harbour many species that have been geographically separated from their closest relatives for a long time. They also serve as a refuge for

formerly wide spread flora and fauna that have become extinct in much of their former habitat (Iversen, 1991)

2.3 Human disturbances in the Eastern Arc Mountains

Human disturbance on the Eastern Arc Mountains forests may date back to more than 2000 years ago (Schmidt, 1989). The impacts were probably severe as early as the early Iron Age. However, the most serious degradation in most parts of the Eastern Arc forests has undoubtedly taken place in the second half of the 20th century (Hamilton and Mwasha, 1989; Bjondalein, 1992). The most serious human disturbances include logging, mining, farming, pit sawing, medicine extraction, grazing, wood fuel extraction, construction poles extraction, fire and extraction of non-woody forest products (Bjondalein, 1992; Zahabu and Malimbwi, 1998; Maliondo *et al*., 2000; Malimbwi and Mugasha, 2001; Burgess et al, 2002; Madoffe and Munishi, 2005). Mineral exploitation is a recent problem in some parts of the Eastern Arc forests like ANR, Semdoe, Mtai, Segoma and Nilo forest reserves in the EUMs. A study conducted by Bjondalein (1992), showed that the destruction of the forest through mining was very obvious because the soil is stripped off down to the bedrock to follow presumed mineral veins. This process completely destroys the regenerative capacity of the area.

Further more, Bjøndalein (1992) found that one of the major impacts is illegal pit sawing activity. Tree species mostly affected are *Milicia excelsa*, *Newtonia buchananii*, *Ocotea usambarensis*, *Podocarpus usambarensis*, *Beilschmiedia kweo*,

Allanblackia stuhlmannii, Cephalospphaera usambarensis, and *Juniperus excelsa.* Munishi *et al.,* (2004) reported a disturbance caused by collection of firewood, building poles and debarking of trees for medicinal uses. His study further reported that most communities surrounding the reserves use it as a sole source of building materials. The lifespan of the house is a determinant factor with regard the rate of forest harvesting. Short life spans will tend to create more frequent pressure on forest harvesting. On the other hand, permanent houses (made from bricks) require fewer materials from the forests. Decision to build with bricks is good for forest conservation.

2.3.1 Current status of the remaining forests in the EAMs

Using 1: 250 000 land cover and use maps, and 1:500 000 topographic maps, Newmark (1998) examined natural forest area, fragmentation and loss in the EAMs. Results showed that remaining blocks of forest habitat (Fig 1) were: Taita Hills (6 km^2), Pare Mountains (484 km^2), West Usambaras (328 km^2), East Usambaras (413 km^2), Nguru (647 km^2, including Nguu), Ukaguru (184 km^2), Uluguru (527 km^2), Rubeho (499 km^2), Udzungwa (1960 km^2) and Mahenge (291 km^2)

FBD (2006) reported that detailed analysis of land cover maps showed that the total size of all forest blocks in the EAMs is 3 679 480 ha, of which forests occupy 353 180 ha and woodlands 282 590 ha. The largest forest areas occur in the Udzungwa block while Malundwe has the smallest forest cover. It is reported further that overall, 23

885 ha of forest and 212 300 ha of woodlands were lost in the EAMs between 1970s and 2000 across all blocks, which is equivalent to a loss of 6% and 43% of forest and woodlands, respectively.

Figure 1: Remaining blocks of forest habitat in the Eastern Arc Mountains
Source: (CMEAMF, 2006)

2.4 Threatened and endemic plant species conservation strategies

Recent studies have revealed that household level decisions might have positive impacts on forest resources (Auld and Scott, 1996). Such positive impacts arise from household decisions that result into less dependence of households on forest resources or wise use of forests. Such decisions include decisions to plant trees on farmlands for different purposes, to build permanent houses, to domesticate certain plant species, to value the forest for other intangible benefits like hydrological values, climatic values, and spiritual values. Although at times the decisions come out as community level decisions, in essence they are aggregations of complex individual household decisions.

In Galapagos, the Charles Darwin Research station found that although only three Galapagos endemic plants are thought to have so far gone extinct, many others have experienced dramatic decline in recent years (Galapagos, 2005). The assessment revealed that 20 out of 230 endemic plant species are facing immediate extinction. The information raised awareness for the local communities and conservation authorities and started a recovery programme, which resulted into positive impact on the endemic and threatened species survival.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area description

3.1.1 Location and climate

Amani Nature Reserve with an area of 8380 ha, which was gazetted in 1997 is situated in the Southern area of the East Usambara Mountains approximately 55 km by road from Tanga town (Fig 2). The reserve, which is in Muheza and Korogwe districts-Tanga region, lies between 5°14’10’’ - 5°04’30’’ S and 38°30’34’’ - 38°40’06’’ E., with the altitude ranging between 190 and 1130 m. a. s. l. Amani Nature Reserve is the largest block of forest in the East Usambara Mountains; it is an amalgamation of six former forest reserves (Amani Zigi, Amani East, Amani west, Kwamsambia, Kwamkoro and Mnyuzi), 1068 ha of forest donated by the East Usambara Tea Company (EUTCO) and public land. The land donated by EUTCO is one of the areas with intact forest.

The rainfall distribution is bi-modal, peaking between March and May and between September and December. Rainfall is greatest at higher altitudes and in the southeast of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at higher altitudes (Hamilton and Bensted-Smith, 1989). The dry seasons are from June to August and January to March.

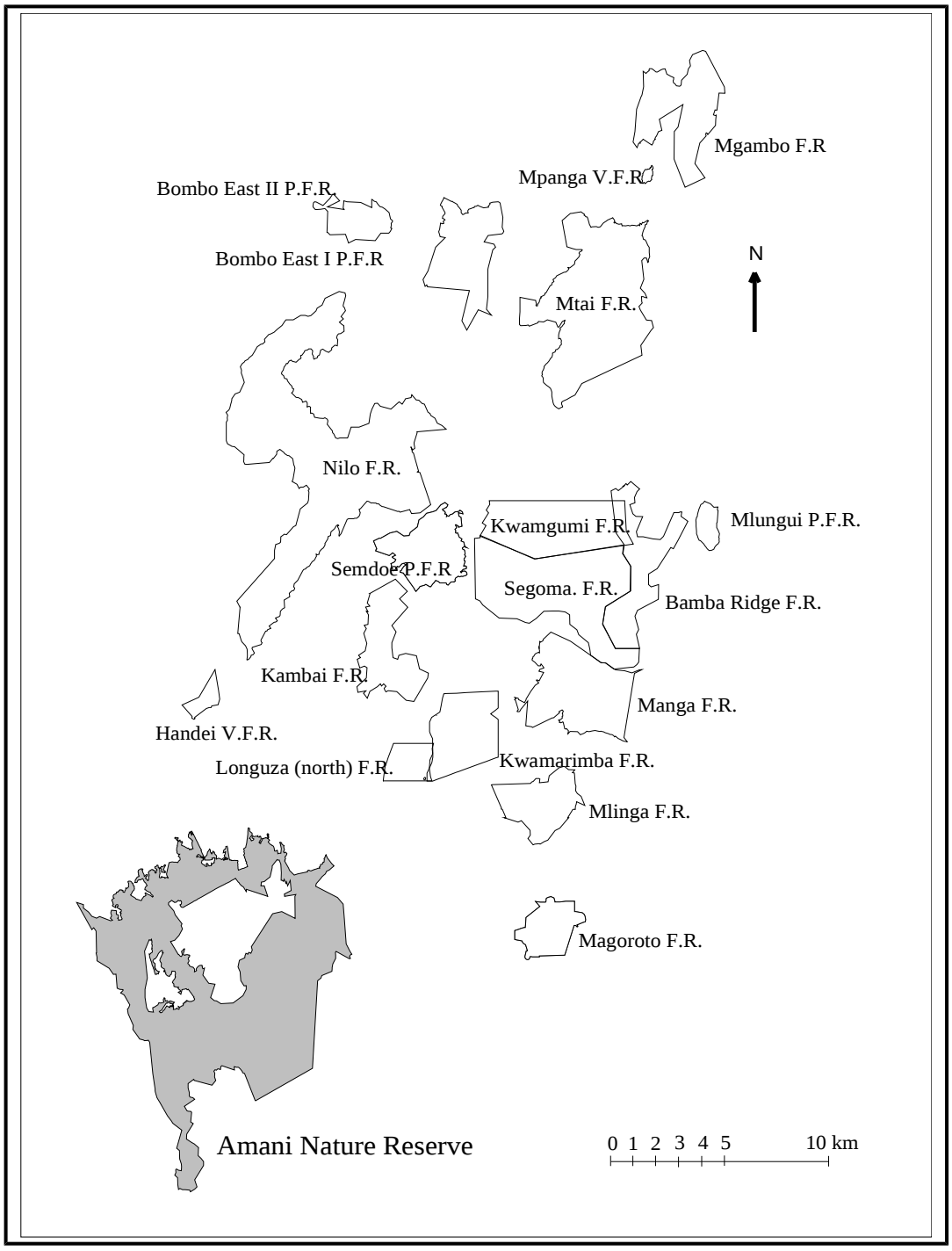

Figure 2: Location of ANR in relation to other East Usambara Forest blocks

Source: Frontier Tanzania (2001)

3.1.2 Population

The area is inhibited by different ethnic groups, the main groups being Sambaa, Bondei, and Zigua. Others are the Pare, Hehe, Digo, Chagga, Kisii, Kamba, Nyamwezi, Nyiramba, Sukuma and Luguru (Kajembe and Mwaseba, 1994; Bohero, 1997). A population growth rate of 1.6% per year was reported by Kessy, (1998), while URT (2004) reported a growth rate of 1.4%.

3.1.3 Socio-economic activities

Semi-subsistence farming is the main economic activity. This includes agriculture, livestock keeping in which they practice zero grazing and off- farming activities. Main food crops grown are yams, bananas, cassava, maize and beans. Cardamom and black pepper are the main cash crops produced in the area. Other cash crops include coffee, cinnamon, sugarcane, cocoa, bananas and cloves (Msikula, 2003).

3.2 Data collection

Both primary and secondary data were collected through forest inventory, questionnaire and participatory observation. Reconnaissance survey was conducted to provide a general picture of the research area. During this survey, the key issues were to pre-test questionnaires and training research assistants.

3.2.1 Primary data

3.2.1.1 Forest inventory

The forest was stratified into disturbed areas (Kwamkoro, Kwamsambia and Mnyuzi) with three transects and 153 plots, and areas with primary/intact forest (Touraco trail and Amani Zigi) with a total number of 125 plots from two transects. The sampling unit was a (10mx50m) plot. The same plot size was used by previous researchers for disturbance assessment in the Eastern Arc Mountains (Frontier Tanzania, 2001; Madoffe and Munishi, 2005) so it was possible to compare the results. A sampling intensity of 0.2% was used whereby 278 plots were laid out. Forest disturbance was assessed in continuous plots of 50 m long and 10 m wide strip (5m on either side of the 50m portion) along systematic transect lines running from the edge of the forest. The first plot along each transect, were georeferenced using GPS and direction of transects determined using a compass.

A team of three people was required for the method (one recorder and two walkers). The following information was recorded along the transect lines: live timber trees, cut timber trees (stumps), live poles and cut poles (stumps). Stumps were differentiated whether new or old through assessing the level of darkness at cut point, whereby newly cut timber trees were assumed that they were cut within one-year period. Timbers/trees were all standing woody plants with straight stems of at least 3m and DBH equal to or above 15cm while poles/saplings were all standing woody plants with straight trunks at least 2m in length and DBH of 5cm to less than 15cm. (Frontier

Tanzania, 2001; Madoffe and Munishi, 2005). All timbers and poles whether dead or alive were identified by a botanist in order to know the intensity and species utilisation priority. Specimens, that could not be identified in the field were photographed, pressed, dried and sent to Lushoto herbarium for identification. Notes on other forest disturbances such as fire, trees debarking and uprooting were taken.

3.2.1.2 Social-economic data

A minimum of 5% of the households in five out of 18 villages selected at random adjacent to the ANR were interviewed. In social economic studies random sample should at least constitute 5% of the total population for it to be representative (Boyd *et al.*, 1981). The following technique was used to collect social economic data: Structured questionnaire, participant observation and interview with key informants. The information collected included types and causes of disturbance in the study area, people's knowledge on threatened and endemic plant species, presence of threatened and endemic plant species on the farms, uses of endemic and threatened plant species, willingness to plant threatened and endemic plant species on their farms and willingness to use alternative plant species.

Prior to the actual survey, the questionnaires were pre-tested in Mlesa village, Amani Tanga by the research team after which it was modified to suit local conditions. A copy of the final version of the questionnaire is included (Appendix 5)

3.2.1.3 The sampling procedure and the actual survey

Selection of the households was done randomly from the list of household heads obtained from village registers. A household was identified by the name of household head, which might be male or female. The sampling fraction was 5%. In total, 101 households were surveyed in the five case study villages. The researcher conducted interviews with assistance of research assistants and for each household, respondent was either husband or wife. However, other members of the households especially adults, were sometimes inevitably called by the household head to join the discussions especially on issues related to forest product utilisation. The head of the household is normally the main decision maker at household level but not always the most knowledgeable especially on issues related to household wood fuel consumption.

3.2.2 Secondary data

Secondary data was obtained from the internet, libraries, government and non-governmental offices. Offices visited included Amani Nature Reserve, Tanga Catchment Forestry, Frontier Tanzania, Uniliver International and the Eastern Arc Endowment Fund. Data collected include useful plants of the East Usambara Mountains, List of IUCN threatened plant species of the Eastern Arc Mountains ,amount of *Allanblackia stuhlmannii* seed collected by ANR adjacent villages, *Beilschmiedia kweo* sawn timber obtained illegally from the Nature Reserve and illegal mining activities in ANR.

3.3. Data analysis

Both descriptive and inferential statistical analysis were undertaken

3.3.1 Forest inventory data analysis

The excel computer programme was used to analyse quantitative data for the following forest parameters: Live trees and poles per ha, new cut trees and poles per ha, old cut trees and poles per ha and naturally dead trees and poles per ha.

3.3.1.1 Resource utilisation pressure gradient

Utilization pressure gradient of the forest resources was determined in order to know current status and the intensity of resource utilisation. The use intensity was computed as:

$U=(C/S) \times 100\%$,

Where: U= Use intensity

C= Cut trees and poles

S= Stocking/density

(Frontier Tanzania, 2001; Madoffe and Munishi, 2005)

3.3.1.2 The t-test

T-test at 5% level of significance was used to compare means of observations of plant species diversity between disturbed and intact forest areas. It was also used to

undertake statistical tests for old cut and new cut poles and timber trees, naturally dead poles and timber trees and cut poles and timber trees.

3.3.1.3 Species diversity indices

(i) Shannon-Wiener index of diversity

A large number of indices of diversity have been devised, each of which seeks to express the diversity of a sample or quadrate by a single number. However, according to Magguran (1988), of the various indices of diversity, the most frequently used is the simple totalling of species to give species richness. As for the fair indices which combine both species richness and evenness, the mostly widely used is the Shannon Wiener index of diversity also called Shannon-Wiener index of diversity. The Shannon Wiener diversity index (*H'*) accounts for both abundance (richness) and evenness of the species present and is not affected by sample size (Pielou, 1975; Krebs,1989; Kent and Coker, 1992; FAO, 2000; Zahabu, 2001, Munishi *et al*., 2004) and in addition it puts more emphasis on rare species (Krebs, 1989).

The Shannon Wiener index of diversity is derived from the information theory and the concept that the diversity or information in a sample or community can be measured in the same way as the information contained within a message or code. It is a measure of the information content of sample (bits per individual) and since the information content is the measure of uncertainty, so the larger the value of H', the greater the uncertainty (Krebs, 1989). The proportion of species *i* relative to the total

number of species (p_i) is calculated, and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The resulting product is summed across species, and multiplied by -1.

Thus:

$$H' = -\sum_{i=1} (pi)(In\ pi)$$

Where: H'= Shannon's diversity index;

∑ = the summation symbol

s = total number of species in the community (richness);

pi= proportion of *s* made up of the i^{th} species;

In= logarithm to the base e

The Shannon-wiener measure (H') increases with the number of species in the community but in practice, for biological communities H' does not exceed 5.0 (Krebs, 1989). The larger the value of H' the greater is the diversity and vice versa.

(ii) Index of dominance

The Index of Dominance (ID) is used to measure the distribution of individuals among the species in a community. It is calculated using the following formula (Krebs, 1989, Misra,1989):

$$ID = \Sigma (ni / N)^2$$

Where: ID is the Index of Dominance;

ni is the number of individuals of species in a sample

N is the total number of individuals (all species) in the sample

This index is also called the Simpson's Index of diversity (Krebs, 1989) and is equal to the probability of picking two organisms at random that are of the same species. It is inversely related to the probability that two individuals picked at random belong to different species. Therefore the greater the value of dominance index, the lower is the species diversity in community and vice versa.

3.3.2 Socio-economic data analysis

The Statistical Package for Social Science (SPSS) was used in the analysis the social economic quantitative data to obtain descriptive statistical analysis. The information concerned were: types and causes of disturbance in the study area, awareness on threatened and endemic plant species, presence of threatened and endemic plant species on the farms, uses of endemic and threatened plant species, willingness to plant threatened and endemic plant species on their farms and willingness to use alternative plant species.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-economic factors and forest threats affecting endemic and threatened plant species in Amani Nature Reserve

4.1.1 Social-economic factors

In any community, social and economic factors play an important role in resource utilization with the goal to improve its livelihood. If carried out without consideration of environmental/ecological impacts, most often it leads to unsustainable natural resources utilization resulting into resource depletion. The main social-economic factors evaluated in this study were demographics, gender, age distribution, household education level, and land tenure and farm size of the respondents.

4.1.1.1 Characteristics of the sample population

Table 3 describes the main characteristics of the sampled population. According to 2002 census (URT, 2005), population density for the surveyed villages with the number of households in brackets was 2235(518), 1333(334), 2157(463), 1661(295) and 2299(631) for Mlesa, Shebomeza, Mbomole, Kisiwani and Potwe Ndondondo respectively. This gives a total population of 9685 inhabitants (Village average of 1937); close to a figure reported by Kessy (1998). This could be explained by the fact that population in Amani area is so dynamic due to the presence of tea estates, sisal estates research institutions and mining activities. For example when there is serious

drought, tea production drops and therefore reduces labour chances as a result tea pickers migrate to other areas to look for new job opportunities. Kessy (1998) reported that there was established family planning programme at Amani, which also implies population control. Population growth rate in the area dropped from 1.6% in 1988 to 1.4% in 2002 (URT, 2004).

4.1.1.2 Gender

About 72.3% of 101 household heads selected at random for five villages were men. A study on local people's involvement in biodiversity conservation in the Uluguru Mountains revealed that 66% of the respondents were male while 34% were female (Paulo, 2004). Gender imbalance especially when women are fewer than men has a negative impact on the conservation and management of threatened and endemic plant species because women, who are main users of forests through their daily activities such as fuel wood and vegetable collection, are not the main decision makers. Paulo (2004) reported a negative correlation between gender and readiness to participate in biodiversity conservation in the Uluguru Mountains. This means that males and females do not equally participating in biodiversity conservation.

4.1.1.3 Age distribution

Table 3 also shows age distribution of respondents in the study area. The results revealed that, 83.2% of the interviewed households were in the age of 20-60 years old, while 16.9% were people above 60 years. People of the age group of 18 to 60 years are regarded as energetic people, active and participative in productive activities in the community (CIMMTY, 1993)

Table 3: Sex, age distribution and education level of the communities around ANR

		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
(a) Sex (household head)							
Male	Count	14.0	12.0	17.0	14.0	16.0	73.0
	% of Total	13.9	11.9	16.8	13.9	15.8	72.3
Female	Count	6.0	5.0	5.0	7.0	5.0	28.0
	% of Total	5.9	5.0	5.0	6.9	5.0	27.7
(b) Age							
20-30	Count	3.0	5.0	4.0	4.0	6.0	22.0
	% of Total	3.0	5.0	4.0	4.0	5.9	21.8
31-40	Count	8.0	2.0	5.0	4.0	3.0	22.0
	% of Total	7.9	2.0	5.0	4.0	3.0	21.8
41-50	Count	4.0	3.0	9.0	5.0	5.0	26.0
	% of Total	4.0	3.0	8.9	5.0	5.0	25.7
51-60	Count	0.0	5.0	2.0	2.0	5.0	14.0
	% of Total	0.0	5.0	2.0	2.0	5.0	13.9
61-70	Count	4.0	2.0	1.0	3.0	2.0	12.0
	% of Total	4.0	2.0	1.0	3.0	2.0	11.9
>70	Count	1.0	0.0	1.0	3.0	0.0	5.0
	% of Total	1.0	0.0	1.0	3.0	0.0	5.0
(c)Education							
No formal education	Count	1.0	2.0	5.0	4.0	4.0	16.0
	% of Total	1.0	2.0	5.0	4.0	4.0	15.8
Adult education	Count	1.0	0.0	0.0	0.0	0.0	1.0
	% of Total	1.0	0.0	0.0	0.0	0.0	1.0
Primary education	Count	13.0	0.0	13.0	16.0	12.0	63.0
	% of Total	12.9	8.9	12.9	15.8	11.9	62.4
Second.education	Count	5.0	6.0	4.0	1.0	5.0	21.0
	% of Total	5.0	5.9	4.0	1.0	5.0	20.8
(d)Population							
		2235	1333	2157	1661	2299	9685
	Tatal %	23.1	13.8	22.3	17.2	23.7	100.0
Total	Count (n)	20.0	17.0	22.0	21.0	21.0	101.0

This implies most of the people in the study area could participate in the conservation and management activities of endemic and threatened plant species. They could also be involved in domestication and planting alternative plant species. However, a well developed awareness programme would be needed to achieve this. Paulo (2004) reported that older people are more willing to engage in biodiversity conservation activities because they own more land. Mbwambo (2000) observed that older people in the Udzungwa Mountains planted more trees than younger people. Unfortunately, this same elders group is involved in activities that cause forest destruction. Mature people are active and energetic in providing labour force which can be invested in the exploitation of forest resources and therefore affect threatened and endemic plant species so they need education on sustainable use of the resources.

4.1.1.4 Household head education level

Education refers to formal education attained by the respondents in the study area. The results show that 83.2% had primary education level and/or above (Table 3). This indicates that majority of the people in the study area can write and read. This high literacy rate suggests that the community could understand about threatened and endemic plant species if awareness programmes were in place. The results further revealed a correlation ($p<0.01$) between education level of respondents and their knowledge/awareness on threatened and endemic plant species. This indicates that people with more education are more aware on endemic and threatened plant species. Paulo (2004) reported a correlation between the numbers of the people who participated in biodiversity conservation in the Uluguru Mountains and education

meaning that villagers with more education are less reluctant in adopting conservation oriented practices. Kajembe and Mwaseba (1994) indicated that formal education is an important tool for creating awareness, positive attitudes, values and motivations; stimulating self-confidence, self-reliance and expanding aspiration of the rural poor. Mayeta (2004) reported illiteracy as one of the causes of forest disturbances. In his study he revealed that increase in education of the household head tends to increase people's awareness on the importance of natural resources conservation for sustainable development and also increases their willingness to participate in conservation and management of natural resource activities. This reduces the chances of involvement in destructive practices and hence improving the conservation status of the forest. Power and benefit sharing, balances conservation and livelihood of the local communities. This in turn improves the relationship between local communities and the protected area authorities.

4.1.1.5 Land tenure and farm size of respondent

The majority (76%) of the households own 1-5 ha of land, but some households (3%) reported to have up to more than 10 ha (Table 4). This implies that land scarcity is not a major problem in the East Usambara Mountains. This is comparable to other reported findings in the East Usambara Mountains (Bohero, 1997; Kessy, 1998 and Msikula, 2003). Furthermore, most (55%) of the interviewed households did not use fertilizer on their farms (Table 4). The results compare well with Bohero (1997), who reported that land use practices of most East Usambara farmers are both unproductive

and environmentally unsustainable. The auther further reported on cultivation of annual crops on steep slopes with neither terraces nor contour banding. Farmers are not using the highly yielding crops or use fertilizer, therefore more forest land is needed for agriculture. Munishi *et al.* (2004) reported that agricultural expansion, in form of both shifting and permanent agriculture reduces forest cover. Continued use of a piece of land without proper conservation measures in fragile ecosystems like mountainous terrain, results into deterioration of soil fertility and reduced productivity. This is a serious problem in the Eastern Arc region.

Decline in soil fertility forces farmers to clear forest lands which are relatively virgin and fertile resulting in decrease in forest area. Such pressure normally comes from outside the forest pushing in the forest boundaries. De-gazzettement of forest reserves for agriculture in the West Usambaras Mountains is a good example of negative impacts resulting from population pressure and low land production (Munishi *et al.,* (2004). However, these observations are in contrast to some other scientists Bjondalein (1992) and Kajembe and Mwaseba (1994), who reported that there was a land scarcity in the east Usambara due to overpopulation. Bohero (1997) and Kessy (1998) reported that most of the land in villages in the study area is owned under customary tenure conditions (acquisition through the local chiefs followed by inheritance). Most villages were affected by villagelization policy where all the land within the village is categorized as village land but individuals can own plots acquired customarily and thus feel that the land belongs to them.

Table 4: Farm size (ha) and fertilizer application around ANR

		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
(a)Farm size							
1-5	Count	13.0	11.0	19	15.0	18.0	76.0
	% of Total	13.0	11.0	19.0	15.0	18.0	76.0
6-10	Count	6.0	6.0	3.0	4.0	2.0	21.0
	% of Total	6.0	6.0	3.0	4.0	2.0	21.0
>10	Count	1.0	0.0	0.0	1.0	1.0	3.0
	% of Total	1.0	0.0	0.0	1.0	1.0	3.0
(b) fertilizer application							
Yes	Count	9.0	11.0	17.0	1.0	7.0	45.0
	% of Total	9.0	11.0	17.0	1.0	7.0	45.0
No	Count	11.0	5.0	5.0	20.0	14.0	55.0
	% of Total	11.0	5.0	5.0	20.0	14.0	55.0
Total	Count (n)	20.0	17.0	22	21.0	21.0	101.0

4.1.2 Forest threats

The main forest threats identified in ANR were pit sawing (69%), pole cutting (41.6%), mining (26.7%), fire (23.8%), grazing (3%) and collection of non-wood forest products (3%) (Table 5). Bjondalein (1992); Munishi and Temu (1992) and Madoffe and Munishi (2005) reported that the major types of human impacts on the Eastern Arc Mountain forests especially at household level, are cultivation and grazing , general consequences of increasing population pressure, small scale logging, collection of firewood and non wood forest products, charcoal making and in some cases mineral exploitation.

Table 5: Main Forest threats in ANR

Destructive activity	Count	Percentage of responses	Percentage of cases
Pit sawing	70.0	9.9	69.3
Mining	27.0	3.8	26.7
Fire	24.0	3.4	23.8
Grazing	3.0	0.4	3.0
Pole cutting	42.0	5.9	41.6
Collection of non wood forest products	3.0	0.4	3.0
Not applicable	538.0	76.1	532.7
Total responses	707.0	100.0	700.0

For the purpose of this study; emphasis will be made on those activities which have an implication or direct effect on threatened and endemic plant species namely collection of poles, lumber (pit sawing), firewood, medicine, *Allanblackia Stuhlmannii* seeds as well as mining and forest fires.

4.1.2.1 Extraction of building poles

The East Usambara forests provide a range of products such as fuel wood, building material, lumber, medicine, edible materials, home utensils and minerals for surrounding communities to their daily running of household life. Findings from this study showed that most of forest products for daily household use come from the ANR mainly illegally. For the case of building poles, about 43% of respondents obtain them from the public land whereas 32% obtain building poles both from public land and Nature Reserve (Table 6).

Table 6: Sites of building poles extraction by villagers around ANR

Site		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Public land	Count	10.0	140	16.0	3.0	0.0	43.0
	% of Total	9.9	13.9	15.8	3.0	0.0	42.6
Nature Reserve	Count	3.0	3.0	4.0	12.0	2.0	24.0
	% of Total	3.0	3.0	4.0	11.9	2.0	23.8
Both reserve &public land	Count	6.0	0.0	2.0	6.0	18.0	32.0
	% of Total	5.9	0.0	2.0	5.9	17.8	31.7
Not applicable	Count	1.0	0.0	0.0	0.0	1.0	2.0
	% of Total	1.0	0.0	0.0	0.0	1.0	2.0
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

The study results revealed further that 24% of respondents obtain their building poles only from the Nature Reserve alone. Conversely, Kessy (1998) reported that 70% of respondents obtained their building poles from the Reserve. The reduction of dependency of the reserve for building poles, could be explained by on farm tree planting efforts introduced by the East Usambara Conservation and Agriculture Development Project (EUCADP) under IUCN support and the East Usambara Catchment Forest Project (EUCFP) (later called the East Usambara Conservation Area Management Programme) (EUCAMP) under FINNIDA support, (late 1980's through 2002). The main species planted were *Grevillea robusta*, *Cedrella odorata* and *Tectona grandis* which are used as pole and therefore reduce pressure from the Reserve. Another reason could be the introduction of Joint Forest Management Programme (JFM) which started in ANR in late 1990s. In this programme adjacent villages are paid 20% of revenue accrued from entry fees for ecotourism. Wily (2002)

reported on reduction of forest illegal activities such as timber and poles cutting, forest fires and animal poaching through JFM in more than thirty national forest reserves in Tanzania. To many rural communities, local people's demand for forest products, especially building material is very high. Alternatives do not exist and/or are too expensive. The implication is that people will continue to collect forest products illegally unless more attention is given to meeting their daily needs from other sources such as planting trees on their farms.

4.1.2.2 Extraction of building lumber (Pit sawing)

Eighty three percent of the villagers get their lumber from the public land, 7% from the ANR and 10% from both (Table 7). This could not be true because some of the main species (*Milicia excelsa, Beilscmiedia kweo* and *Newtonia buchanannii*) used for building lumber and making domestic items were not found outside the ANR. Only about 30% and 10% of respondents were recorded to have domesticated *M. excelsa* and *N. buchanannii* respectively. Conversely, there were no respondent had *B. kweo* on their farms (Appendix 4) although it ranked very high for making window and door frames and shutters as well as domestic items such as beds, chairs, tables and mortar. The reason for hiding the truth is likely due to the fact that they were obtained from ANR illegally. Evidence of fresh cutting of *M. excelsa* and *B.kweo* for lumber was observed in Kisiwani and Mlesa villages respectively. The researcher observed more than 100 pieces of *B. kweo* (Plate 1) sawn timber at ANR headquarters, which were confiscated by ANR management for being harvested illegally from the Nature Reserve. Lumber production from the Nature Reserve is strictly prohibited (MNRT,

2002). FBD (2006) reported that, whereas deforestation for agriculture has stopped at the forest borders, illegal harvesting inside the EAMs forest is in progress.

Table 7: Sites of building lumber collection around ANR

Site		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Public land	Count	16.0	13.0	21.0	16.0	18.0	84.0
	% of Total	15.8	12.9	20.8	15.8	17.8	83.2
Nature reserve	Count	1.0	2.0	0.0	3.0	1.0	7.0
	% of Total	1.0	2.0	0.0	3.0	1.0	6.9
Both	Count	3.0	2.0	1.0	2.0	2.0	10.0
	% of Total	3.0	2.0	1.0	2.0	2.0	9.9
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Munishi *et al.* (2004) pointed out that pit sawing is one of the major impacts in almost all the forests of the EAMs. Though pit sawing may represent a more careful harvesting method than industrial logging, it may create some imbalances in the forest structure due to large gaps that may have adverse impacts on forest regeneration. Normally, regeneration of different tree species in the mountain forests may be suppressed in gaps formed by felling large trees. This is because dense growth of pioneer species such as climbers and stranglers of different types tend to grow in gaps and suppress the regeneration of other species. He further reported that selective forest harvesting may result into genetic erosion especially where no regeneration is assured.

Plate 1: ***Beilschmiedia kweo*** **lumber harvested illegally from ANR**

Harvesting in the EAMs forests usually selects a few species of timber value such as *Milicia excelsa, Newtonia buchananii, Beilschmiedia kweo, Ocotea usambarensis, Podocarpus spp*. and *Cephalosphaera usambarensis*. If this selective harvesting is not done carefully it might erode the gene pool of these species. For example large trees of *Cephalosphaera usambarensis* (which is endemic to the Usambaras and Ngurus) are almost extinct. Other species susceptible to gene pool erosion are *Allanblackia stuhlmanii*, *Beilschmedia kweo*, and *Juniperus excelsa*. Such impacts may be a hindrance to future plant breeding and regeneration programs using indigenous species (Bjøndalein, 1992).

(i) Use of endemic and threatened tree species for building lumber and poles in ANR

About ten endemic and/or threatened tree species were reported being used for house construction (Table 8). *Beilschmiedia kweo* and *Allanblackia stuhlmannii*, which are both endemic to the Eastern Arc and threatened tree species IUCN (2001) ranked the highest with percentage use of 57.4% and 55.4% respectively. In another study, Kessy (1998) reported a substantial use of endemic tree species in the area. He pointed out that, collection of building materials, which can be described as the most destructive form of forest product collection, involved about 30 species, of which 20% were endemic. The study further indicated that 12% of encountered coppiced trees and 9% of dead stumps were of endemic forest tree species.

Table 8: Endemic and threatened tree species used for house construction by the communities around ANR

Species	Village											
	Mlesa		Shebomeza		Mbomole		Kisiwani		Potwe		Total	
	Use	Not use	Use	Not use	Use	Not use	Use	Not use	Use	Not use	Use	Not use
Beilscmiedia kweo	16.8	3.0	16.8	0.0	18.8	3.0	3.0	17.8	2.0	18.8	57.4	42.6
Allanblackia stuhlmannii	17.8	2.0	16.8	0.0	20.8	1.0	0.0	20.8	0.0	20.8	55.4	44.6
Cephalosphaera usambarensis	13.9	5.9	14.9	2.0	8.9	12.9	0.0	20.8	0.0	20.8	37.6	62.4
Annickia kummeriae	7.9	10.9	4.0	12.9	11.9	9.9	3.0	17.8	3.0	17.8	29.7	69.3
Greenwayodendron suaveolens	8.9	10.9	4.0	12.9	8.9	12.9	1.0	19.8	3.0	17.8	25.7	74.3
Anisophyllea obtusifolia	3.0	16.8	2.0	14.9	11.9	9.9	0.0	20.8	0.0	20.8	16.8	83.2
Cynometra spp	8.9	10.9	1.0	15.8	5.9	15.8	0.0	20.8	0.0	20.8	15.8	84.2
Cola usambarensis	7.9	11.9	1.0	15.8	5.9	5.8	0.0	20.8	0.0	20.8	14.9	85.1
Uvariodendron usambarense	5.0	14.9	0.0	16.8	3.0	18.8	0.0	20.8	3.0	17.8	10.9	89.1
Isoberlinia scheffleri	1.0	18.8	0.0	16.8	0.0	21.8	0.0	20.8	0.0	20.8	1.0	99.0

Observation of the houses in the study area revealed that most of the door and window frames and shutters in the upland areas were made from *B.kweo* indicating that it is highly extracted from the Nature Reserve. *A. stuhlmanni* is mainly used as building poles (Plate 2), withies, roofing material and sometimes frames. The sapwood of the tree is actually removed, the heart wood, which is resistant to decay, is used.

Plate 2: A local house under construction using threatened tree species around ANR. Note that poles are *Allanblackia stuhlmannii* while roofing materials are *Cephalosphaera usambarensis*

Both species are submontane and they are mainly used by submontane households. About 19% of surveyed households in Mbomole used *B. kweo* while 21% used *A. stuhlmannii* for house construction. Many households use both species in Mlesa and

Shebomeza with percentage use of 17.8% and 16.8% for *A. stuhlmannii* and *B. kweo* respectively. All surveyed households in Shebomeza village used *B. kweo* for house construction. In the lowland villages i.e. Kisiwani and Potwe, the situation was different. Only 3% of households used *B. kweo* in Kisiwani village and 2% in Potwe. There was no any report on use of *A. stuhlmannii* in both Kisiwani and Potwe, probably due to unavailability of such species close to their areas. Both villages depend much on plantation trees for their construction mainly *Tectona grandis*, *Cedrella odorata* and *Melia adzedarach*, which are readily available in the surroundings. The former two are mainly planted by the households on their farms following trees planting campaigns initiated by the EUCAMP in early 1990s. Kessy (1998) reported that *C. odorata* and *T. grandis* trees are planted and used widely in Kisiwani and Potwe villages. He further reported that farmers in the lowland villages collected or sometimes bought teak poles from the Longuza Teak Project for house building. This study compares well with Kessy's findings that most of the households interviewed in the lowland villages reported to have used *T. grandis* and *C. odorata* as their main building poles and lumber. The researcher observed several *C.odorata* of various ages planted on respondents' farms. Pit sawing of this species for domestic consumption and selling was also observed.

Greenwayodendron suaveolens and *Uvariodendron usambarense*, are both endemic and threatened tree species in the East Usambara Mountains (IUCN 2001). Both species are widely used for making beams and roofing and sometimes poles due to their straightness. About 25% of the interviewed households in the highland areas

used *Greenwayodendron suaveolens* while 10.9% used *Uvariodendron usambarense* for house construction. Lowland villages hardly use these species because of the availability of alternative species from the surrounding plantations.

Cephalosphaera usambarensis and *Annickia kummeriae* are submontane tree species endemic to the EAMs and are threatened. They are used in making beams, roofing, poles and withies. About 38% of the households in the study area used *C. usambarensis* and 30% used *A.kummeriae* for house construction. *A.kummeriae* is used in all villages surveyed indicating high preference whereas *C. usambarensis* is used in submontane villages of Mlesa, Shebomeza and Mbomole only. No user was reported from Kisiwani and Mbomole villages for this particular species although it is available in Amani Zigi forest area, which borders Kisiwani. Amani Zigi forest is one of the ANR intact forest areas which were not logged mechanically because of difficult terrain.

Other endemic and/or threatened tree species used for construction purposes in the study area include *Anisophyllea obtusifolia* (16.8%), *Cynometra spp* (15.8%) *Cola usambarensis* (14.9%) and *Isoberlinia scheffleri* (1%). All of them are mainly used as building poles. *Cola usambarensis* and *Cynometra* spp are both threatened and endemic.

4.1.2.3 House rebuilding cycle in villages adjacent Amani Nature Reserve

Table 9 gives a summary of lifetime for houses built in the surveyed households. House re-building cycle plays an important role in sustainability of threatened and endemic tree species in ANR. About 50.5% of respondents estimated the life time of their houses to be less than 10 years while 43.6% reported a life time of between 11-15 years, meaning that about (94.1%) of all respondents re-built their houses in less than 15 years period. This result is comparable to other studies for example Luoga (2000) who reported the longevity of houses of 3-15 years depending on natural resistance of the poles to termites and other bio-degraders. Munishi *et al.* (2004) reported that house construction uses poles and other small round wood from natural forests when these products are not available on the farm. Most communities surrounding natural forest reserves use the natural forest as a sole source of building material. The lifespan of houses in such cases is a determinant factor with regard to forest harvesting. Short life spans in situations where the old material is not re-used will tend to create more frequent pressure on forest harvesting.

On the other hand, permanent houses built from bricks require less frequency of inputs of material from the forests and the impacts of such decisions on forest resources are always positive towards forest conservation. Owen (1992), as cited by Kessy, (1998) estimated that a typical three-room house requires about 2.4 cubic meters of wood. For the 18 villages adjacent to the ANR, which have about 8068 households, 19 363 cubic meters of wood would be used every 15 years. This is a

substantial volume of trees for a small area like that of Amani Nature Reserve, taking into consideration that many species in that area are endemic and/or threatened. This projection assumes that each household had only one house but the reality is that, most of them had more than one house.

Table 9: House rebuilding cycle among communities around ANR

Life span		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
<10 years	Count	11.0	8.0	13.0	11.0	8.0	51.0
	% of Total	10.9	7.9	12.9	10.9	7.9	50.5
11-15 years	Count	8.0	6.0	9.0	10.0	11.0	44.0
	% of Total	7.9	5.9	8.9	9.9	10.9	43.6
16-20 years	Count	0.0	3.0	0.0	0.0	0.0	3.0
	% of Total	0.0	3.0	0.0	0.0	0.0	3.0
>20 years	Count	1.0	0.0	0.0	0.0	0.0	1.0
	% of Total	1.0	0.0	0.0	0.0	0.0	1.0
Not applicable	Count	0.0	0.0	0.0	0.0	2.0	2.0
	% of Total	0.0	0.0	0.0	0.0	2.0	2.0
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Kessy (1998) further revealed that about (16%) and (14%) of all species used as withies and poles respectively in the East Usambara Mountains were endemic. This means that since endemic plant species are geographically restricted in small areas, continuation of using them in such rates may adversely affect their survival resulting into their extinction from the wild. IUCN (2001) reported an extinction of *Anonidium*

usambarense from the wild which was endemic to the East Usambara Mountains due to high utilization pressure and habitat destruction.

4.1.2.4 Making domestic items

Fifteen endemic and/or threatened plant species are used for making domestic items such as furniture, mortar, tool handles and dye in the study area (Table 10). The most common used species were *Beilschmiedia kweo* (72.3%), *Annickia kummeriae* (68%), *Cynometra brachyrrhachis* (55.6%) and *Cynometra longipedicellata* (55.5%). Most of them were more commonly used in the highland villages due to their local abundance. All interviewed villages in the study area used these species except Kisiwani village. Other plant species which had high utilization pressure for use as domestic items (Table 10) include *Greenwayodendron suaveolens* (48.5%), *Allanblackia stuhlmannii* (46.5%), *Cephalosphaera usambarensis* (43.6%) and *Cola usambarensis* (41.6%). The least used species were *Anisophyllea obtusifolia* (8.9%), *Rauvolfia sp* (10.9%), *Sorindeia madagascariensis* (11.9%) and *Impatiens sp* (14.9%).

(i) Domestic items made using *B. kweo*

Beilschmiedia kweo, which is both endemic and threatened tree species, (IUCN, 2001), had the highest frequency of users. About 72% of households interviewed used this species for making domestic items (Table 10). Although the species grows in submontane

Table 10: Threatened and/or endemic plant species used for making domestic items by villagers around ANR

Species	Village%											
	Mlesa		Shebomeza		Mbomole		Kisiwani		Potwendondondo		Total	
	Use	Not	Use	Not	Use	Not	Use	not	use	not	use	not
Beilschmiedia kweo	19.8	0.0	16.8	0.0	21.8	0.0	8.9	11.9	5.0	15.8	72.3	27.7
Annickia kummeriae	14.9	5.0	15.8	1.0	21.8	0.0	8.9	11.9	6.9	13.9	68.3	31.7
Cynometra brachyrhachis	17.8	2.0	13.9	3.0	19.8	2.0	0.0	20.8	5.0	15.8	55.6	44.4
Cynometra longipedicellata	15.8	4.0	13.9	3.0	19.8	2.0	1.0	19.8	5.0	15.8	55.5	44.5
Greenwayodendron suaveolense	11.9	7.9	14.9	2.0	16.8	5.0	1.0	19.8	4.0	16.8	48.5	51.5
Allanblackia stuhlmannii	12.9	6.9	16.8	0.0	16.8	5.0	0.0	20.8	0.0	20.8	46.5	53.5
Cephalosphaera usambarensis	15.8	4.0	13.9	3.0	13.9	7.9	0.0	20.8	0.0	20.8	43.6	56.4
Cola usambarensis	12.9	6.9	12.9	4.0	13.9	7.9	0.0	20.8	2.0	18.8	41.6	58.4
Uvariodendron usambarense	8.9	10.9	5.9	10.9	8.9	12.9	1.0	19.8	3.0	17.8	27.7	72.3
Englerodendron usambarense	8.9	10.9	8.9	7.9	8.9	12.9	0.0	20.8	0.0	20.8	26.7	75.3
Isoberlinia scheffleri	8.9	10.9	3.0	13.9	11.9	9.9	0.0	20.8	0.0	20.8	23.8	76.2
Impatiens sp	4.0	15.8	4.0	12.9	6.9	14.9	0.0	20.8	0.0	20.8	14.9	85.1
Sorindeia madagascariensis	4.0	15.8	2.0	14.9	4.0	17.8	1.0	19.8	1.0	19.8	11.9	88.1
Rauvolfia sp	2.0	17.8	2.0	14.9	3.0	18.8	0.0	20.8	4.0	16.8	10.9	89.1
Anisophyllea obtusifolia	2.0	17.8	1.0	15.8	5.9	15.8	0.0	20.8	0.0	20.8	8.9	91.1

forest it was used by both submontane and lowland villagers. In Mlesa, Shebomeza and Mbomole villages all interviewed households used *B. kweo*, despite that the species was not recorded as one of domesticated trees (Appendix 4). This implies that the species is highly demanded by communities in the study area for making domestic items due to its high strength and attractive properties. It also indicates that most of *B. kweo* lumber used for making domestic items came from the ANR. Mbomole and

Mlesa villages were leading with percentage use of 21.8% and 19.8% respectively (Table 10). The researcher observed a crosscutting saw and some pieces of *B. kweo* lumber in Mlesa village office confiscated by the village committee after the culprits disappeared. Also, boards from the same species were observed at most of the carpentry shops in the area. Carpenters having *B. kweo* boards should be asked to verify how they obtained them. This tree species is in a danger of disappearing taking into account that it has a limited geographical range and also receives very high utilization pressure from the adjacent local community through illegal harvesting.

The primary items being made using this species were chairs, tables, beds, mortars and tool handles (Table 11). About 47.5% of the households used this species for making chairs, tables and beds. Other groups of items made using the species include chairs, tables, beds, mortar and tool handles (22.8%); mortar and tool handles (1%) and chairs, table, mortar (1%). Only 27.7% of all surveyed households which did not use *B. kweo* for making domestic items. The results further revealed that the species was used even by lowland villages of Kisiwani (8.9%) and Potwe (5%) although it does not grow in such areas. This implies that when the issue of species priority comes into utilization, distance is not a limiting factor so the species is under threat due to high consumption by the adjacent communities

Table 11: Types of domestic items made using *Beilschmiedia kweo* by theVillagers around ANR

Group of items		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Chairs/tables+beds +mortar+tool handles	Count	7.0	6.0	10.0	0.0	0.0	23.0
	% of Total	6.9	5.9	9.9	0.0	0.0	22.8
Mortar+tool handles	Count	0.0	0.0	0.0	1.0	0.0	1.0
	% of Total	0.0	0.0	0.0	1.0	0.0	1.0
chairs/tables+beds	Count	12.0	11.0	12.0	8.0	5.0	48.0
	% of Total	11.9	10.9	11.9	7.9	5.0	47.5
Chairs/tables+mortar	Count	1.0	0.0	0.0	0.0	0.0	1.0
	% of Total	1.0	0.0	0.0	0.0	0.0	1.0
Not applicable	Count	0.0	0.0	0.0	12.0	16.0	28.0
	% of Total	0.0	0.0	0.0	11.9	15.8	27.7
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

(ii) Domestic items made using *A. kumeriae*

Another species, which showed a high consumption rate (68.3%) of households was *A.kumeriae* (Table 10), mostly used for making dye due to its attractive yellow colour in the bark (Plate 3) in addition to uses as medicine. The species is both endemic to the Eastern Arc and threatened basing on IUCN categories of threatened species (IUCN, 2001). It is commonly used for making tool handles due to its hardness and straightness properties. The species is mostly used in Mbomole and Shebomeza villages with percentage use of 21.8% and 15.8% respectively (Table 10). All

households interviewed in Mbomole village used *A. kummeriae* whereas 1% of households in Shebomeza did not use this species. The reason of having many users in these two villages in comparison with lowland villages of Kisiwani and Potwe Ndondondo, which had 8.9% and 6.9% users respectively, could be accessibility because the species is mostly found near Mbomole and Shebomeza villages. *A. kummeriae* was not recorded as domesticated tree in the study area (Appendix 4), suggesting that the species is obtained illegally from the Reserve.

Table 12: Types of domestic items made using *Annickia kummeriae* by the villagers around ANR

Group of items		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Dye	Count	8.0	7.0	10.0	3.0	2.0	30.0
	% of Total	7.9	6.9	9.9	3.0	2.0	29.7
Tool handles	Count	0.0	0.0	3.0	1.0	1.0	5.0
	% of Total	0.0	0.0	3.0	1.0	1.0	5.0
Dye+tool handles	Count	7.0	9.0	9.0	5.0	4.0	34.0
	% of Total	6.9	8.9	8.9	5.0	4.0	33.7
Not appl.	Count	5.0	1.0	0.0	12.0	14.0	32.0
	% of Total	5.0	1.0	0.0	11.9	13.9	31.7
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Two main domestic items are made from *A. kummeriae* namely tool handles and dye. A total of 33.7% of respondents in the study area used *A. kummeriae* for making tool handles and dye production whereas 29.7% reported to have used it for dye production only while 5% used this species for making tool handles only. The main

types of tool handles made were hoe and axe handles. Large scale harvesting of this species was observed in the ANR during the inventory work.

Plate 3: ***Annickia kummeriae*** **barks extracted for dye and medicine production in ANR**

(iii) Domestic items made using *C. longpedicellata* and *C.brachyrrhachis*

Cynometra brachyrrhachis and *C. longipedicellata*, which are both threatened and endemic to the East Usambara Mountains (Iversen, 1991; IUCN, 2001), are equally utilized for making domestic items i.e. 55.6% and 55.5% respectively (Table 10). *Cynometra longipedicellata* was used in all villages. These species have lots of physiological similarities. Mbomole village was the main user of both *C. brachyrrhachis* and *C. longipedicellata* both used by 18% of the households (Table 10). In Kisiwani village, only 1% of respondents used *C.longipedicellata* while no household used *C. brachyrrhachis*. In Potwe Ndondondo, 5% of the households used

both species. This implies that the species are mostly used in submontane areas because they are available closer to the users in comparison with lowland villages, which are located far from the source. Both species were not recorded in the list of domesticated trees, which suggests that they are harvested illegally from the Nature Reserve or in the small patches of public forests remained.

Table 13: Types of domestic items made using *Cynometra longipedicellata* and *Cynometra brachyrhachis* in the villages around ANR

(a)Cynometra longipedicellata							
Group of items		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Tool handles	Count	16.0	14.0	20.0	0.0	5.0	55.0
	% of Total	15.8	13.9	19.8	0.0	5.0	54.5
Not applicable	Count	4.0	3.0	2.0	21.0	16.0	46.0
	% of Total	4.0	3.0	2.0	20.8	15.8	45.5
(b*) Cynometra brachyrhacis*							
Tool handles	Count	18.0	14.0	20.0	1.0	5.0	58.0
	% of Total	17.8	13.9	19.8	1.0	5.0	57.4
Not applicable	Count	2.0	3.0	2.0	20.0	16.0	43.0
	% of Total	2.0	3.0	2.0	19.8	15.8	42.6
Total	Count (n)	20.0	17.0	22.0	21.0	21.0	101.0

The study results revealed further that both *C.longipedicellata* and *C.brachyrrhachis* are mainly used for making hoe and axe handles (Table 13). A total of 54.5% of respondents in the study area used *C.longipedicellata* while 57.4% used *C.bachyrrhachis*.

(iv) Domestic items made using *G. suaveolens* and *U.usambarense*

Greenwayodendron suaveolens and *U.usambarense* are endemic to the East Usambara Mountains and threatened. They are used in all five villages surveyed. About 48.5% and 27.7% of respondents used *G. suaveolens* and *U. usambarense* respectively (Table10 and 14). During inventory work, several stumps of *U. usambarense* trees with DBH between 10 and 20 were encountered cut for making tool handles. The trees are cross cut into the specified length (Plate 4) depending on the tool handle required, sub-divided into several pieces then the finishing work is done outside the reserve, in that case a very short time is spent in the forest to avoid being caught by patrol guards.

G. suaveolens and *U.usambarense* are commonly used to make tool handles (Table 14). *G. suaveolens* is used more in comparison with *U.usambarense*. Both species are restricted to the EAMs and are threatened (IUCN, 2001)**.** Most of respondents in the upland villages used both *G. suaveolens* and *U. usambarense* for making tool handles much more than the lowland villages. Mbomole village had the highest number of respondents using both species with 16.8% and 8.9% for *G. suaveolens* and *U. usambarense* respectively.

Plate 4: ***Uvariodendron usambarense*** **tree species cut for tool handles making in ANR**

Kisiwani village had the least users for both species, each with respondent of 1%, which could be explained by availability of alternative plantation tree species mainly *Cedrella odorata, Tectona grandis, Melia adzedarach* and *Grevillea robusta.*

Table 14: Types of domestic items made using *Greenwayodendron suaveolens* and *Uvariodendron usambarense* by villagers around ANR

Group items		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
(a) Greenwayodendron suaveolens							
Tool handles	Count	12.0	15.0	17.0	1.0	4.0	49.0
	% of Total	11.9	14.9	16.8	1.0	4.0	48.5
Not applicable	Count	8.0	2.0	5.0	20.0	17.0	52.0
	% of Total	7.9	2.0	5.0	19.8	16.8	51.5
(b)Uvariodendron usambarense							
Tool handles	Count	9.0	6.0	9.0	1.0	3.0	28.0
	% of Total	8.9	5.9	8.9	1.0	3.0	27.7
Not applicable	Count	11.0	11.0	13.0	20.0	18.0	73.0
	% of Total	10.9	10.9	12.9	19.8	17.8	72.3
	Count (n)	20.0	17.0	22.0	21.0	21.0	101.0

(v) Domestic items made using *A. stuhlmannii* and *C. usambarensis*

Allanblackia stuhlmannii and *C. usambarensis* are both endemic to the EAMs and are threatened (Lovert and Clarke, 1998). They are extensively used by the adjacent communities. Both species have lots of uses in the area due to their high strength properties. *C. usambarensis* is mostly used for making tool handles and dye production while *A.stuhlmannii* has some other uses such as mortar making due to its hard heartwood. Results show that 46.5% and 43.6% of the households used *A.stuhlmannii* and *C.usambarensis* respectively for making domestic items (Table 10). The main users of *A. stuhlmannii* were Shebomeza and Mbomole villages both with 16.8% while for *C.usambarensis* it was Mlesa village with 15.8%. Both Potwe Ndondondo and Kisiwani villages had no users of either *A.stuhlmannii* or *C.usambarensis* for making domestic items. Although these species were

domesticated by the households in their farms (Appendix 4), yet they were cut illegally from the nature reserve, implying that the retained trees are not enough to sustain their needs.

Table 15 shows domestic items made using *A. stuhlmannii* and *C.usambarensis*. *A. stuhlmannii* has various uses around ANR. Domestic items made using this species include mortar and tool handles (16.8%); tool handles alone (15.8%); mortar alone (4%); dye for decoration (4%); dye and tool handles (5.9%) and chairs, tables and beds (1%). Domestic items made using *C. usambarensis* were mainly tool handles and dye. About 34% of respondents used this species for dye production, while 3% of the households interviewed used *C. usambarensis* for tool handles making and 6% for both dye production and tool handles.

Table 15: Types of domestic items made using *Allanblackia stuhlmannii* and *Cephalosphaera usambarensis* by villagers around ANR

Type		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
(a)Allanblackia stuhlmannii							
mortar	Count	1.0	1.0	2.0	0.0	0.0	4.0
	% of Total	1.0	1.0	2.0	0.0	0.0	4.0
Dye	Count	3.0	0.0	1.0	0.0	0.0	4.0
	% of Total	3.0	0.0	1.0	0.0	0.0	4.0
Tool handles	Count	5.0	5.0	6.0	0.0	0.0	16.0
	% of Total	5.0	5.0	5.9	0.0	0.0	15.8
Mortar+tool handles	Count	5.0	6.0	6.0	0.0	0.0	17.0
	% of Total	5.0	5.9	5.9	0.0	0.0	16.8
Dye+tool handles	Count	0.0	5.0	1.0	0.0	0.0	6.0
	% of Total	0.0	5.0	1.0	0.0	0.0	5.9
chairs/tables+beds	Count	0.0	0.0	1.0	0.0	0.0	1.0
	% of Total	0.0	0.0	1.0	0.0	0.0	1.0
Not applicable	Count	6.0	0.0	5.0	21.0	21.0	53.0
	% of Total	5.9	0.0	5.0	20.8	20.8	52.5
(b) *Cephalosphaera usambarensis*							
Dye	Count	10.0	12.0	13.0	0.0	0.0	35.0
	% of Total	9.9	11.9	12.9	0.0	0.0	34.7
Tool handles	Count	3.0	0.0	0.0	0.0	0.0	3.0
	% of Total	3.0	0.0	0.0	0.0	0.0	3.0
Dye+tool handles	Count	3.0	2.0	1.0	0.0	0.0	6.0
	% of Total	3.0	2.0	1.0	0.0	0.0	5.9
Not applicable	Count	4.0	3.0	8.0	21.0	21.0	57.0
	% of Total	4.0	3.0	7.9	20.8	20.8	56.4
Total	Count (n)	20.0	17.0	22.0	21.0	21.0	101

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Cola usambarensis is both endemic to the East Usambara Mountains and is threatened (IUCN 2001). It is one of widely used species for making tool handles and also as poles for local houses construction. In this study, 41.6% of the households surveyed used *C.usambarensis* for making domestic items (Table 10). On average,14% of respondents in Mbomole village used *Cola usambarensis* for making

tool handles, followed by Mlesa and Shebomeza villages both with 12.9% users each. No use of the species was recorded in Kisiwani village while only 2% of users were reported from Potwe village. Kessy (1998) indicated that tool handles form the largest portion of items used in the households in the East Usambara Mountains, which reflects that the main activity of the rural people in the area is farming. He further reported that these handles were found in Muheza and Tanga markets, an evidence of large scale extraction of trees for making tool handles from the surrounding forests.

4.1.2.5 Mining activities in ANR

Mineral exploitation is a recent problem in some parts of the Eastern Arc forests like Nguu Mountains in Kilindi District; Mtai, Nilo, Semdoe and Segoma Forest Reserves and ANR in the East Usambara Mountains and Balangai Forest Reserve in the West Usambara Mountains (Madoffe and Munishi, 2005). In the current study, 26.7% of interviewed households in ANR ranked mining activities the third most important forest threat after pit sawing and poles cutting (Table 5). The destruction of the forest through mining is very obvious because trees are uprooted and the soil is stripped off down to the bedrock to follow presumed mineral veins Bjondalein, (1992). This process completely deprives the regenerative capacity of the forest. In ANR, serious destruction was done in several rivers and streams by diverging their direction to give room for mining in alluvial soils (Plate 5). Trees were also uprooted for the same purpose.

Plate 5: **(left) Gold mining in water stream and (right) uprooted trees to give room for mining areas in ANR**

Amani Nature Reserve management reported more than 50 mining pits in the reserve where hundreds of trees were uprooted. Furthermore the management reported 124 court cases related to illegal mining in 2005 and 2006. A total of 50% of ANR management staff interviewed reported mining activities to be the main threat to the forest. This is a serious problem when one takes into account that most gold mining in the ANR is conducted in water sources, which secure the water supply for more than 200,000 people in Tanga city as well as local communities adjacent to these reserves (Frontier Tanzania, 2001). Some of permanent streams for example Kihara, a Zigi river branch completely dried up due to mining activities. Kessy (1998) reported on gemstones such as green tomaline, red garnet, blue sapphire, almandine, armload and yellow tomaline on the northern parts of the East Usambara Mountains. He cautioned

on the possibility of expansion of this illegal activity due to lucrative nature of the business, poor economic status of the local people and remoteness of the mining sites, which makes it difficult for foresters to police the areas. This has now happened in a large quantity in ANR, but this time is not gemstone mining but gold mining. Amani Nature Reserve Conservator reported that it was difficult to stabilize the situation due to the fact that mining activities in the forest take place during the night. Local communities were involved in the arresting illegal miners in the ANR, but this did not work due to the fact that some of villages are involved directly in illegal mining or hosting immigrant miners. The researcher observed mining activities taking place less than ten metres from Sangarawe sub village chairperson's residence indicating that even some of village leaders are either involved in the business or they are not ready to arrest the situation.

Hundreds of endemic and/or threatened plant species were destroyed along the river banks as a result of illegal mining. The most impacted taxa were *Saintpaulia spp* which grow on rocks mainly along rivers and streams, where most of gold mining activities have been conducted. Kolehmainen *et al*., (2005) reported river and stream banks as the main habitat for *Saintpaulia* spp in the East Usambara Mountains. Opening up forest canopy poses a negative impact on these species due to the fact that they cannot tolerate excessive light.

4.1.2.6 Collection of firewood from the nature reserve

Almost all, (99%) respondents in the study area relied on firewood as the main source of energy (Table 16 and plate 6). In Tanzania, more than (80%) of people usewood fuel as the main source of energy (MNRT, 1998). Paulo (2004) reported that 84% of people in the Uluguru Mountains use fuelwood as the main source of energy. The figure is lower than results from this study indicating that people in the East Usambara depend on fuelwood energy much more than in the Uluguru.

Table 16: Types of fuel wood used by the communities around ANR

	Fuelwood type		Respondent village					Total
			Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
	Firewood	Count	20.0	17.0	22.0	21.0	20.0	100.0
		% of Total	19.8	16.8	21.8	20.8	19.8	99.0
	Firewood and charcoal	Count	0.0	0.0	0.0	0.0	1.0	1.0
		% of Total	0.0	0.0	0.0	0.0	1.0	1.0
Total	Count		20.0	17.0	22.0	21.0	21.0	101.0
	% of Total		19.8	16.8	21.8	20.8	20.8	100.0

About 55% of the households obtained their firewood both from the Nature Reserve and public land while others, (10.9%) from the nature reserve only and 33.7% from the public land (Table 17). Paulo (2004) reported that 35% of the people in the Uluguru Mountains collect fuel wood from the reserve while 65% obtained from the public land. Most of the households in Shebomeza and Mbomole obtain their firewood from the public land because they are located far from the reserve boundary.

In addition, Mbomole has a public forest, which is a source of fuelwood. Farm trees whether planted or retained were reported as another source of fuel wood.

Table 17: Sites of firewood collection around ANR

Firewood site		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Public land	Count	1.0	15.0	17.0	1.0	0.0	34.0
	% of Total	1.0	14.9	16.8	1.0	0.0	33.7
Nature reserve	Count	1.0	1.0	4.0	3.0	2.0	11.0
	% of Total	1.0	1.0	4.0	3.0	2.0	10.9
Both	Count	18.0	1.0	1.0	17.0	19.0	56.0
	% of Total	17.8	1.0	1.0	16.8	18.8	55.4
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Although the forest act No 14, MNRT (2002) restrict cutting and removing of any tree or part of it from the reserve, ANR has a local arrangement with surrounding community where, households are allowed to enter the reserve for firewood collection purposes under supervision of foresters. Bohero (1997) and Kessy (1998) reported that local people were allowed to enter the reserve once a week for fuel wood collection but were restricted from carrying wood cutting tools. This study revealed some flexibility of ANR management such that villagers are allowed to enter the reserve twice a week carrying their cutting tools such as axes and machetes. This flexibility came in after the introduction of Joint Forest Management (JFM) in the area

where, local communities are involved in decision making. Majority (77.2%) of the respondents reported to have been using an average of 3-5 head loads of firewood per week (Table 18). The collection of firewood is not a major cause of deforestation since dead branches, naturally dying trees and unused material from trees that are harvested illegally for other uses such as timber and poles are collected. Luoga *et al.*, (2000) and Monela (1995) make similar observations in Kitulangalo forest and Nguru Mountains respectively.

Table 18: Amount of firewood spent by villagers in a week around ANR

Firewood head loads		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
1-2 head loads	Count	1.0	2.0	5.0	4.0	4.0	16.0
	% of Total	1.0	2.0	5.0	4.0	4.0	15.8
3-5 head loads	Count	17.0	14.0	15.0	15.0	17.0	78.0
	% of Total	16.8	13.9	14.9	14.9	16.8	77.2
>5 head loads	Count	2.0	0.0	1.0	2.0	0.0	5.0
	% of Total	2.0	0.0	1.0	2.0	0.0	5.0
Not applicable	Count	0.0	1.0	1.0	0.0	0.0	2.0
	% of Total	0.0	1.0	1.0	0.0	0.0	2.0
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

About 34 tree species are used by households for firewood around ANR (Table 19). *Allanblackia stuhlmannii* ranked the highest followed by *Albizia* sp, *Cephalosphaera usambarensis* and *Maranthes geetzeana* with 26.7%, 23.8%, 21.8% and 21.8% respectively. Most of the respondents (51.5%) reported that they used any dry tree species i.e. they don’t have special priority.

Plate 6: Firewood collection in ANR

Table 19: Main tree species used for firewood by villagers around ANR

Species	Mlesa		Shebomeza		Mbomole		Kisiwani		Potwe		Total	
	Use	Not	Use	Not	Use	Not	Use	Not	Use	Not	Use	Not
Any dry wood	6.9	12.9	8.9	7.9	14.9	6.9	12.9	7.9	7.9	12.9	51.5	48.5
Allanblackia stuhlmannii	11.9	7.9	7.9	8.9	6.9	14.9	0.0	20.8	0.0	20.8	26.7	73.3
Albizia sp	4.0	15.8	6.9	9.9	5.0	16.8	6.9	13.9	1.0	19.8	23.8	76.2
Cephalosphaera usambarensis	11.9	7.9	5.9	10.9	4.0	17.8	0.0	20.8	0.0	20.8	21.8	78.2
Maranthes goetzeana	9.9	9.9	6.9	9.9	4.0	17.8	1.0	19.8	0.0	20.8	21.8	78.2
Isoberlinia scheffleri	6.9	12.9	6.9	9.9	5.9	15.8	0.0	20.8	0.0	20.8	19.7	80.2
Tectona grandis	0.0	19.8	0.0	16.8	0.0	21.8	5.9	14.9	12.9	7.9	18.8	81.2
Bridelia micranntha	2.0	17.8	4.0	12.9	5.0	16.8	5.0	15.8	0.0	20.8	16	84.1
Milletia sacleuxii	4.0	15.8	3.0	13.8	4.0	17.8	1.0	19.8	1.0	19.8	13	87.0
Milletia dura	5.0	14.8	1.0	15.8	2.0	19.8	3.0	17.8	2.0	18.8	13	87.0
Myrianthus holstii	4.0	15.8	5.0	11.9	2.0	19.8	1.0	19.8	0.0	20.8	12	88.1
Cynometra spp	5.9	13.9	2.0	14.9	2.0	19.8	2.0	18.8	0.0	20.8	11.9	88.2
Maesopsis eminii	6.9	12.9	1.0	15.8	2.0	19.8	0.0	20.8	0.0	20.8	9.9	90.1
Syzygium guinense	3.0	16.8	2.0	14.9	4.0	17.8	0.0	20.8	0.0	20.8	9.0	91.1
Sorindeia madagascariensis	3.0	16.8	1.0	15.8	2.0	19.8	2.0	18.8	1.0	19.8	9.0	91.0
Anisophyllea obtusifolia	5.0	14.9	0.0	16.8	4.0	17.8	0.0	20.8	0.0	20.8	9.0	91.1
Cremaspora triflora	3.0	16.8	3.0	13.9	3.0	18.8	0.0	20.8	0.0	20.8	9.0	91.1
Melia adzedarach	0.0	19.8	0.0	16.8	0.0	21.8	0.0	20.8	8.9	11.9	8.9	91.1
Strombossia scheffleri	1.0	18.8	1.0	15.8	0.0	21.8	4.0	16.8	1.0	19.8	7.0	93.0
Combretum sp	0.0	19.8	0.0	16.8	2.0	19.8	3.0	17.8	2.0	18.8	7.0	93.0
Newtonia buchananii	2.0	17.8	3.0	13.9	1.0	20.8	0.0	20.8	0.0	20.8	6.0	94.1
Milicia excelsa	1.0	18.8	1.0	15.8	0.0	21.8	3.0	17.8	1.0	19.8	6.0	94.0
Celtis wightii	1.0	18.8	0.0	16.8	0.0	21.8	3.0	17.8	1.0	19.8	5.0	95.0
Schefflerodendron usambarense	1.0	18.8	2.0	14.9	1.0	20.8	0.0	20.8	0.0	20.8	4.0	96.1
Morinda asteroscepa	2.0	17.8	1.0	15.8	1.0	20.8	0.0	20.8	0.0	20.8	4.0	96.0
Synsepalum msolo	1.0	18.8	0.0	16.8	0.0	21.8	3.0	17.8	0.0	20.8	4.0	96.0
Parinari excelsa	4.0	16.8	0.0	16.8	0.0	21.8	0.0	20.8	0.0	20.8	4.0	97.0
Englerodendron usambarense	0.0	19.8	1.0	15.8	2.0	19.8	0.0	20.8	0.0	20.8	3.0	97.0
Annickia kummeriae	2.0	17.8	0.0	16.8	0.0	21.8	1.0	19.8	0.0	20.8	3.0	97.0

Euphorbia hirta	0.0	19.8	1.0	15.8	1.0	20.8	0.0	20.8	0.0	20.8	2.0	98.0
Terminalia sp	0.0	19.8	0.0	16.8	0.0	21.8	2.0	18.8	0.0	20.8	2.0	98.0
Diospyros mespiliformis	0.0	19.8	0.0	16.8	0.0	21.8	1.0	19.8	0.0	20.8	1.0	99.0
Zehrella natalense	0.0	19.8	0.0	16.8	0.0	21.8	1.0	19.8	0.0	20.8	1.0	99.0
Harungana madagascariensis	1.0	18.8	0.0	16.8	0.0	21.8	0.0	20.8	0.0	20.8	1.0	99.0
Beilschmiedia kweo	0.0	19.8	1.0	15.8	0.0	21.8	0.0	20.8	0.0	20.8	1.0	99.0

The reasons given for fire wood tree species preference (Table 20) were long duration of burning (18.8%) and accessibility (32.7%). Most respondents in the lowland villages, Kisiwani (5.9%) and Potwe Ndondondo (11.9) prioritized their firewood requirements basing on accessibility. These villages are surrounded by *Tectona grandis* and *Melia adzedarach* plantations owned by Longuza teak plantation project where, dead branches resulting from logging are readily available for collection. This was further confirmed by the fact that 12.9% of respondents in Potwe Ndondondo used *T. grandis* as their priority tree species (Table 19). It implies that once the households have alternatives they reduce pressure on the Nature Reserve.

Table 20: Reasons for fire wood tree species preference around ANR

Reasons		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Accessibility	Count	1.0	0.0	0.0	6.0	12.0	19.0
	% of Total	1.0	0.0	0.0	5.9	11.9	18.8
Duration of burning	Count	14.0	8.0	8.0	2.0	1.0	33.0
	% of Total	13.9	7.9	7.9	2.0	1.0	32.7
Not applicable	Count	5.0	9.0	14.0	13.0	8.0	49.0
	% of Total	5.0	8.9	13.9	12.9	7.9	48.5
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

(i) Use of endemic and threatened tree species as firewood

Table 21 below describes endemic and/or threatened tree species used for fuelwood in ANR. About 30% of tree species used for fuelwood in the area are endemic and/or threatened. Species with the highest use frequency are *Allanblackia stuhlmannii* (26.7%) *Cephalosphaera usambarensis* (21.8%), *Isoberlinia scheffleri* (19.8%), *Milletia sacleuxii* (12.9%) and *Cynometra spp* (11.9%). These species were mostly used in Mlesa, Shebomeza and Mbomole where they are readily available. Again this could be explained by the fact that lowland villages are surrounded by forest plantations mainly *Tectona grandis*, *Cedrella odorata* and *Melia adzedarach*, which supply fuel wood for the adjacent communities through dead branches resulting from logging activities. These results imply that utilization pressure on endemic and threatened tree species could be reduced through establishing alternative sources of energy mainly planting enough trees on people's farms.

Table 21: Endemic and threatened tree species (by %) used for firewood by villagers around ANR

Species	Village											
	Mlesa		Shebomeza		Mbomole		Kisiwani		Potwe		Total	
	Use	Not	Use	Not	Use	Not	Use	Not	Use	Not	Use	Not
Allanblackia stuhlmannii	11.9	7.9	7.9	8.9	6.9	14.9	0.0	20.8	0.0	20.8	26.7	73.3
Cephalosphaera usambarensis	11.9	7.9	5.9	10.9	4.0	17.8	0.0	20.8	0.0	20.8	21.8	78.2
Isoberlinia scheffleri	6.9	12.9	6.9	9.9	5.9	15.8	0.0	20.8	0.0	20.8	19.8	80.2
Milletia sacleuxii	4.0	15.8	3.0	13.9	4.0	17.8	1.0	19.8	0.0	19.8	12.9	87.1
Cynometra spp	5.9	13.9	2.0	14.9	2.0	19.8	2.0	18.8	0.0	20.8	11.9	88.1
Anisophyllea obtusifolia	5.0	14.9	0.0	16.8	4.0	17.8	0.0	20.8	0.0	20.8	8.9	91.1

Sorindeia madagascariensis	3.0	16.8	1.0	15.8	2.0	19.8	2.0	18.8	1.0	19.8	8.9	91.1
Annikia kummeriae	2.0	17.8	0.0	10.8	0.0	21.8	1.0	19.8	0.0	20.8	3.0	97.0
Englerodendron usambarense	0.0	19.8	1.0	15.8	2.0	19.8	0.0	20.8	0.0	20.8	3.0	97.0
Beilschmiedia kweo	0.0	19.8	1.0	15.8	0.0	21.8	0.0	20.8	0.0	20.8	1.0	99.0

4.1.2.7 Collection of traditional medicine from the nature reserve

About 23.8% of the households reported that they obtain their traditional medicine from the nature reserve. Others (3%) collect from the public land, 47.5% from both nature reserve and public land while 25.7% were not involved directly in traditional medicine collection (Table 22). They either visit the traditional healers or dispensaries for their treatment. Traditional medicine collection from the forests was reported as one of activities tolerated by the FBD in forest reserves (Kessy, 1998). This tolerance is due to the fact that most of plants used as medicine involve only parts (Table 23 and Plate 7) such as roots, barks, leaves and fruits and not the whole plant.

Table 22: Sites of traditional medicine collection by the villagers around ANR

Collection Site		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Public land	Count	0.0	1.0	1.0	1.0	0.0	3.0
	% of Total	0.0	1.0	1.0	1.0	0.0	3.0
Nature reserve	Count	8.0	4.0	5.0	6.0	1.0	24.0
	% of Total	7.9	4.0	5.0	5.9	1.0	23.8
Both	Count	11.0	10	14.0	4.0	9.0	48.0
	% of Total	10.9	9.9	13.9	4.0	8.9	47.5
Not applicable	Count	1.0	2.0	2.0	10.0	11.0	26.0
	% of Total	1.0	2.0	2.0	9.9	10.9	25.7
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

In the current study, there was no serious plants destruction observed through medicine collection. Despite that all villages surveyed have dispensaries,and most of the households (75%) use traditional medicine. Katigula (1999) reported about 164

species of flora used to treat 34 diseases is in the East Usambara Mountains. Luoga (2000) reported that 62% of communities adjacent to Kitulang'alo forest reserve in Morogoro-Tanzania use traditional medicine more than modern medical services because of lack of government hospitals and/or health centres. This indicates that local communities adjacent to ANR depend more on traditional medicine because of either cultural attachment to the traditional medicine or high costs of modern medicine.

Table 23: Plant parts used for medicine around ANR

Plant part	% of response
Roots	3.2
Leaves	0.9
Roots and leaves	0.4
Bark	0.4
Stem	0.1
Bark and roots	0.1
Not applicable	94.8
Total	100.0

Roots form the biggest source of medicines followed by leaves and the combination of roots/leaves (Table 23). In a survey conducted by Mahunnah and Mtotomwema (1988) in several parts of Tanzania, the use of roots as important medicinal plant part

for treating diseases was found to be dominant. Hedberg (1983) in his ethno-pharmacological survey in North-Eastern Tanzania revealed the same findings.

Plate 7: Collection of roots of *Piper capensis* for medicine in ANR

(i) Endemic and threatened plant species used as medicine in ANR

About eight endemic and/or threatened plant species are used as traditional medicine around ANR (Table 24). Plant species with the highest frequency of use were *Allanblackia stuhlmannii* (26.7%), *Aloe spp* (14.9%) and *Saintpaulia spp* (9%). *Aloe* spp is one of the plant species which are under Convention on International Trade of Endangered Species (CITES) conservation category i.e. they are not allowed to be traded due to overexploitation for making medicine and cosmetics. *Saintpaulia spp* which are endemic in the forests of Eastern Arc Mountains are highly threatened due

to habitat destruction resulting from extensive deforestation that occurred in the Eastern Arc Mountains.

Table 24: Endemic and threatened plant species (by %) used for traditional medicine around ANR

Species	Village											
	Mlesa		Shebomeza		Mbomole		Kisiwani		Potwe		Total	
	Use	Not	Use	Not	Use	Not	Use	Not	Use	Not	Use	Not
Aloe spp	5.0	15.8	3.0	13.9	4.0	17.8	2.0	18.8	2.0	17.8	14.9	84.2
Allanblackia stuhlmannii	1.0	18.8	0.0	16.8	2.0	19.8	0.0	20.8	0.0	20.8	3.0	97.0
Anosophyllea obtusifolia	2.0	17.8	0.0	16.8	2.0	19.8	0.0	20.8	0.0	20.8	4.0	96.0
Cephalosphaera usambarensis	1.0	18.8	2.0	14.9	2.0	19.8	0.0	20.8	0.0	20.8	5.0	95.0
Saintpaulia spp	4.0	16.0	1.0	16.0	1.0	21	0.0	20.8	3.0	17.0	9.0	91.0
Annickia kummeriae	0.0	19.8	0.0	16.8	2.0	19.8	0.0	20.8	1.0	19.8	3.0	97.0
Allanblackia stuhlmannii	11.9	7.9	7.9	8.9	6.9	14.9	0.0	20.8	0.0	20.8	26.7	73.3

Walter and Gillet (1998), cited by Kolehmainen *et al.* (2005) reported that of the 24 described *Saintpaullia spp*, 20 are currently in the IUCN red list of threatened plants because most of the *Saintpaulia* spp populations that inhibit the remaining forest fragments are reported to be isolated and small. These species are some of the most popular ornamental plants in the developed countries. It thus has considerable commercial value in the horticultural market. From horticultural point of view, the wild species are an important resource for the improvement of commercial cultivars. *Saintpaulia spp* are also an indicator of forest health since it strives in natural forest with little human disturbance. Habitats that host *Saintpaullia* spp are likely to provide

a habitat for many other rare and endemic species that depend on natural forest. Thus, conserving *Saintpaulia* spp habitats would have a major overall conservation impact. Kolehmainen *et al*. (2005) reported on the use of *Saintpaulia* spp as traditional medicine in the East Usambara Mountains. Although it is used in small quantity, it could pose a big impact to these species due to its limited populations and habitat loss.

4.1.2.8 Collection of *Allanblackia stuhlmannii* seeds from the ANR

Allanblackia stuhlmannii seed collection is a new non-wood forest produce business started in ANR. For the first time, this business was introduced in the East Usambara Mountains in early 1980s where, a company called GAPEX purchased the seed collected by villagers. The business was closed down in late 1980s and then re-opened in 2003 by another company known as Uniliver International, which exports oil from the seed for manufacturing margarine. The agreement between the company and FBD was to purchase seed collected from the public land, but since there is no effective control mechanism, most of the people (38.6%) who were involved in the business reported to have collected the seed from both nature reserve and in the public land (Table 25). Only 9.9% of respondents collected their seed from the public land. *A. stuhlmannii* is one of the endemic and threatened tree species which also receives high pressure for other uses such as house construction, firewood and making domestic items. The seed are also used by the local community to manufacture cooking fat. Monela (1995) reported on *Allanblackia stuhlmannii* seed collection by local community in the Nguru Mountains for the manufacturing of soap, candle and cooking fat. Records from year 2004-06 showed an increase in amount of seed

collected from the forest (Fig. 3). A total of 84 tonnes of seed were collected from Mlesa, Shebomeza and Mbomole villages from year 2004-06 (Fig. 3).

Table 25: Sites of *Allanblackia stuhlmanii* seeds collection by the villagers around ANR

Collecting Site		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Public land	Count	2.0	4.0	4.0	0.0	0.0	10.0
	% of Total	2.0	4.0	4.0	0.0	0.0	9.9
Nature reserve	Count	2.0	4.0	4.0	0.0	0.0	10.0
	% of Total	2.0	4.0	4.0	0.0	0.0	9.9
Both	Count	16.0	9.0	14.0	0.0	0.0	39.0
	% of Total	15.8	8.9	13.9	0.0	0.0	38.6
Not applicable	Count	0.0	0.0	0.0	21.0	21.0	42.0
	% of Total	0.0	0.0	0.0	20.8	20.8	41.6
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Despite the business being one of conservation incentives for the local community, a control mechanism is needed in order to maintain its biological diversity and to avoid genetic erosion. Continuation of collection a large amount of *A.stuhlmannii* seeds from the forest can affect its regeneration potential and therefore reduce its population, which may lead to extinction due to its geographic restriction. Mugasha (1978) and Sawe (1997) reported on poor regeneration of *A. stuhlmannii* both “in-situ” and “ex-situ”. *A. stuhlmannii* fruits are also eaten by bush pigs and other forest animals so once most of the fruits are removed from the forest, these animals and other predators might invade adjacent cultivated farms for alternative feed consequently increasing conflicts between wild animals and adjacent communities.

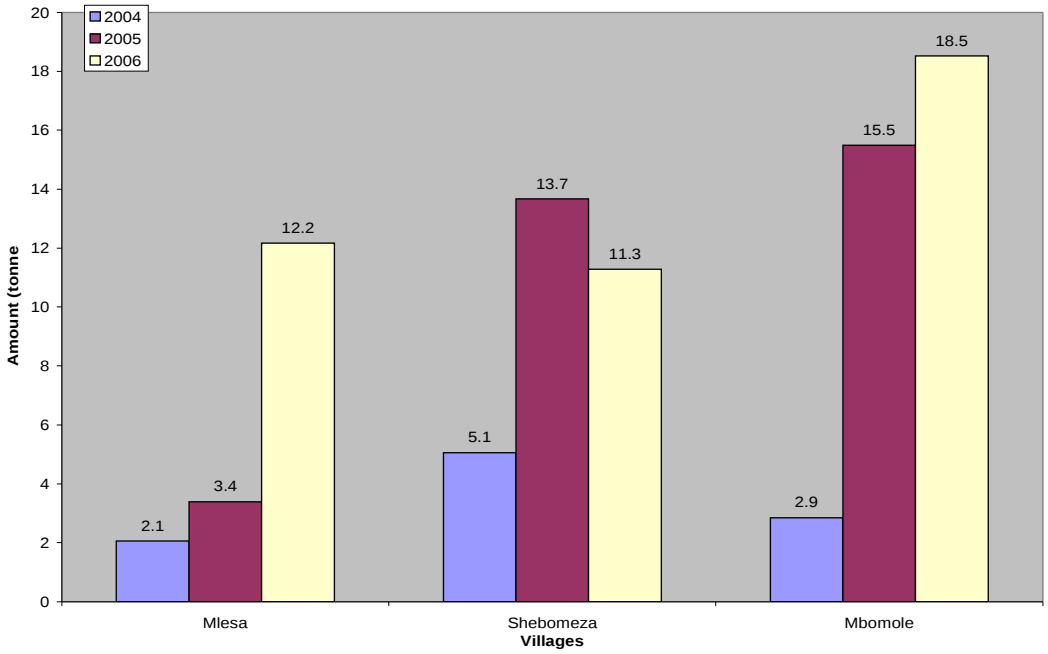

Figure 3: ***Allanblackia stuhlmannii*** **seed collected by the villagers around ANR 2004-06**

Some people collect the seeds during fire wood collection (Plate 7 (a)); two women were captured by the researcher carrying *A. stuhlmannii* fruits in their back in addition to head-load of fire wood. There is a saying in local vernacular language (Sambaa) that states that "*Mweta kwenkhuni, na kwe Mbogha*". Literally, it is extremely suprising for she who goes for fuelwood in the forest, to come out of the forest without vegetables (Katigula, 1999). According to his survey, all interviewed households, reported to have used vegetables from the reserves, collected during firewood collection trips.

Several incidences of *A. stuhlmannii* fruits crushed by villagers were observed in the nature reserve (Plate 7 (b)). This confirms illegal collection of *A. stuhlmannii* seed from the nature reserve. Kessy (1998) also reported several illegal activities in the reserve during fire wood collection days such as collection of vegetables and fruits.

(a) (b)

Plate 8: (a) Illegal collection of *Allanblackia stuhlmannii* seed from ANR (b) crushed *Allanblackia stuhlmannii* fruits in ANR

4.1. 2.9 Forest fire

Forest fire was ranked fourth forest threat in ANR after pit sawing, construction material cutting and mining (Table 5). In this study, 23.8% of respondents reported fire as the main forest destruction agent in ANR (Table 26). Most of the forests in Southern and Western parts of the Reserve in Mnyuzi scarp were highly burnt (Plate

9) probably due to dense accumulation of grass and farming activities in the adjacent villages. These areas have very high concentration of non forest species and very few endemic and forest dependent plant species. Frontier Tanzania (2001) also reported evidence of fire in these parts of the ANR.

Table 26: Fire as forest threat in ANR

Fire as a threat		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Yes	Count	2.0	0.0	0.0	1.0	21.0	24.0
	% of Total	2.0	0.0	0.0	1.0	20.8	23.8
No	Count	18.0	17.0	22.0	20.0	0.0	77.0
	% of Total	17.8	16.8	21.8	19.8	0.0	76.2
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

In Potwe Ndondondo village, 20.8% of respondents, reported fire as the main forest threat in their area (Table 26). This could be explained by the fact that the area is very dry and is dominated by wooded grassland. No respondent reported fire problems in Shebomeza and Mbomole villages where the forest type is moist submontane with very limited litter. Madoffe and Munishi (2005) and Burgess *et al.* (2005), reported fire as the most dominant threat in the EAMs. In their study on threat assessment, they revealed that fire appeared in 23 out of 25 study forests, which threatens long term survival of biodiversity in the area. FAO (2000) reported an evidence of increase in wild fire incidences in the world from 1990-2000 in those countries where long-term data are available, which seriously affect species diversity. The main source of fire in

ANR was reported to be farming activities outside the reserve. Some farmers use fire for clearing bushes as one of indigenous farm preparation mechanisms. Once the fire is out of control it enters and spreads in the nature reserve. Monela *et al.* (1995) argued that the fires originating from farm preparations frequently spread into some parts of natural forest and cause ecological devastation.

Plate 9: Forest part destroyed by fire in Mnyuzi scarp, ANR

Other sources of fire in the EAMs are honey gatherers, loggers, charcoal makers, hunters and herders (Paulo, 2004; Burgess *et al.*, 2005,). Fire has a very negative impact on forest biodiversity. The researcher observed *Saintpaulia spp* sites seriously burnt by fire in Ndola area. Ndola is one of areas in ANR, which is rich in *Saintpaulia spp*. Kolehmainen *et al.* (2005) recorded eight populations of these species in that particular area. Habitat degradation was reported to be one of important agents for species extinction. Luoga *et al.* (2004) reported a very low percentage (6%) of fires in

Kitulang'alo forest reserve in Morogoro attributed to the land preparation due to the success of fire seminars whereby villagers were educated on fire control especially when preparing land for farming. This kind of approach could also be used in ANR to reduce uncontrolled fires which put threatened species at risk.

4.1.3 Domestication of endemic and threatened plant species

4.1.3.1 Land preparation methods

There are two main methods used by the communities adjacent to ANR for agricultural land preparation. One is retaining some trees on farms and the other is clearing all vegetation. Most respondents (75.3%) retain some trees on their farms while the rest (25.7%) cleared all vegetation (Table 27). Paulo (2004) reported that 73% of local people in the Uluguru Mountains clear all the vegetation during land preparation while 27% retained a few trees. This difference could be explained by the different type of crops grown in both areas. In the East Usambara, many people grow shade loving crops such as Cardamom, which requires shade to have good production while in the Ulugurus they grow mostly maize and beans which requires open areas.

Table 27: Methods used for agriculture land preparation by the communities adjacent to the ANR

Land preparation method		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Clearing all vegetation	Count	2.0	3.0	3.0	2.0	16.0	26.0
	% of Total	2.0	3.0	3.0	2.0	15.8	25.7
Retaining a few trees	Count	18.0	14.0	19.0	19.0	5.0	75.0
	% of Total	17.8	13.9	18.8	18.8	5.0	74.3
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

About 23 tree species were retained by respondents (Appendix 4). Some of endemic tree species encountered were *Cephalosphaera usambarensis* (33.7%), *Allanblackia stuhlmannii* (49.5%) *Anisophyllea obtusifolia* (4.0%) and *Bombax rhodognaphalon* (1%). The number of trees retained is given in Table 28. It varies from less than 10 to 100 trees per household. Most respondents retained less than 10 trees of a particular species indicating their dependence to the ANR and surrounding forests for their daily forest resources requirement. There was only one respondent retained more than 100 trees.

The amount of trees left uncut during farm preparation depends much on types of crops cultivated by the household and the farm size. There was correlation ($p<0.05$) between farm size of respondents and land preparation methods indicating that people with large farms retained some trees while those with small farms cleared all vegetation. It is difficult to leave many trees on a small agricultural land for the

household consumption due to space and nutrients competition. Crop type on the other hand plays an important role in deciding the number of trees to domesticate because different crop types require different shade intensity. Table 29 gives reasons for on farm tree retention. The main reasons for retaining trees were: provide shade for crops (3%), fire wood (3%), timber for selling (2%), building material (5%), shade for crops and building material (16%) and shade for crops and firewood (42%). Most respondents in Potwe Ndondondo village (15.8%) cleared all vegetation.

Table 28: Amount of trees retained by households in their farms around ANR

Amount	Count	% of responses
<10	147.0	5.6
10-20	47.0	1.8
21-30	4.0	0.2
31-40	5.0	0.2
41-50	4.0	0.2
51-60	7.0	0.3
71-80	2.0	0.1
81-90	1.0	0.0
91-100	3.0	0.1
>100	1.0	0.0
Not applicable	2404.0	91.6
Total responses	2625.0	100.0

This could be due to the nature of their main crops cultivated i.e. maize which does not need much shade. Only 5% of the respondents retain trees in Potwe Ndondondo. Other villages studied retained many more trees. For example, Mbomole 18.8%, Kisiwani 18.8%, Mlesa 17.8% and Shebomeza 13.9% to favour their shade baring crops. Kessy (1998) reported that the forests in the area are important to farmers as far as household food security is concerned, because a lot of farming activities take place

under the forest canopy, especially outside the forest reserves. This study found that farmers prefer this kind of farming because some crops grown such as cardamom are shade loving, but also during years of low rains crops under canopy cover stand a better chance of survival. Some food crops such as beans, yams, fruit trees, coconut and potatoes perform well in these shady/farm marginal areas contributing substantially to household food security. That being the case, farmers are willing to domesticate some of native tree species to provide shade for crops. In this way, they contribute indirectly in conservation of endemic tree species such as *Allanblackia stuhlmannii* and *Cephalosphaera usambarensis*, which are mostly left uncut.

Table 29: Reasons for retaining trees by the villagers around ANR

Reasons		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Crops shading	Count	0.0	0.0	0.0	3.0	0.0	3.0
	% of Total	0.0	0.0	0.0	3.0	0.0	3.0
Fire wood	Count	0.0	1.0	2.0	0.0	0.0	3.0
	% of Total	0.0	1.0	2.0	0.0	0.0	3.0
Building material	Count	0.0	0.0	2.0	2.0	1.0	5.0
	% of Total	0.0	0.0	2.0	2.0	1.0	5.0
Timber for selling	Count	0.0	0.0	2.0	0.0	0.0	2.0
	% of Total	0.0	0.0	2.0	0.0	0.0	2.0
Crops shading and building material	Count	2.0	2.0	2.0	8.0	3.0	17.0
	% of Total	2.0	2.0	2.0	7.9	3.0	16.8
Crops shading and firewood	Count	16.0	11.0	10.0	5.0	1.0	43.0
	% of Total	15.8	10.9	9.9	5.0	1.0	42.6
Not applicable	Count	2.0	3.0	4.0	3.0	16.0	28.0
	% of Total	2.0	3.0	4.0	3.0	15.8	27.7
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	9.8	16.8	21.8	20.8	20.8	100.0

4.1.3.2 Number of endemic and threatened plant species retained by Respondents on their farms

Only four endemic and/or threatened tree species namely *Cephalosphaera usambarensis*, *Allanblackia stuhlmannii*, *Anisophyllea obtusifolia* and *Bombax rhodognaphalon* were retained in people's farms. A total of 33.7% of respondents retained *C. usambarensis* (Table 30). About 28.8% of all respondents retained less than 20 trees of this species and only 1% retained more than 100 trees. *C. usambarensis* is widely used for firewood, house construction, making domestic items and medicine. It was highly logged by the Sikh sawmills company in 1980s for making plywood. The species was recorded in Mlesa, Shebomeza and Mbomole

villages only. Inspite of high abundance in forest reserve, most trees were located very far away from the village areas in higher altitudes.

Table 30: *Cephalosphaera usambarensis* retained by households around ANR

Amount		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
<10 trees	Count	5.0	4.0	6.0	0.0	0.0	15.0
	% of Total	5.0	4.0	5.9	0.0	0.0	14.9
10-20	Count	7.0	3.0	4.0	0.0	0.0	14.0
	% of Total	6.9	3.0	4.0	0.0	0.0	13.9
21-30	Count	0.0	1.0	0.0	0.0	0.0	1.0
	% of Total	0.0	1.0	0.0	0.0	0.0	1.0
31-40	Count	1.0	0.0	0.0	0.0	0.0	1.0
	% of Total	1.0	0.0	0.0	0.0	0.0	1.0
51-60	Count	0.0	1.0	0.0	0.0	0.0	1.0
	% of Total	0.0	1.0	0.0	0.0	0.0	1.0
91-100	Count	0.0	1.0	0.0	0.0	0.0	1.0
	% of Total	0.0	1.0	0.0	0.0	0.0	1.0
>100	Count	0.0	1.0	0.0	0.0	0.0	1.0
	% of Total	0.0	1.0	0.0	0.0	0.0	1.0
Not appl.	Count	7.0	6.0	12.0	21.0	21.0	67.0
	% of Total	6.9	5.9	11.9	20.8	20.8	66.3
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

About 46.5% of the respondents retained less than 20 trees of *Allanblackia stuhlmannii* in their farms (Table 31). The highest number of this species retained was 51-60, and it was recorded in only one household (Shebomeza village) accounting for 1%. Mlesa village had the highest number (17.9%) of households domesticating *A. stuhlmannii* followed by Mbomole village (17.8%) and Shebomeza village (12.9%). This species is used by the community for construction poles, withies, fuelwood and

oil production. It also provides shade for shade tolerant crops such as cardamom and yams. *A. stuhlmannii* seeds is one main source of income for the local communities around ANR. The seed are mostly purchased by Uniliver Company for making margarine. This tangible benefit of the species to the local communities is motivation for its domestication. However, in spite of its importance, the number of trees retained is still too small in relation to the demand.

Table 31: *Allanblackia stuhlmanii* retained by households around ANR

Amount		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
<10 trees	Count	14.0	6.0	17.0	0.0	0.0	37.0
	% of Total	13.9	5.9	16.8	0.0	0.0	36.6
10-20	Count	4.0	5.0	1.0	0.0	0.0	10.0
	% of Total	4.0	5.0	1.0	0.0	0.0	9.9
21-30	Count	0.0	1.0	0.0	0.0	0.0	1.0
	% of Total	0.0	1.0	0.0	0.0	0.0	1.0
51-60	Count	0.0	1.0	0.0	0.0	0.0	1.0
	% of Total	0.0	1.0	0.0	0.0	0.0	1.0
Not applicable	Count	2.0	4.0	4.0	21.0	21.0	52.0
	% of Total	2.0	4.0	4.0	20.8	20.8	51.5
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Anisophyllea obtusifolia is one of the endemic tree species domesticated by local communities in the study area. It is a very hard tree used for various purposes such as fuel wood, house construction and domestic items. Only 5% of the households surveyed retained less than 10 trees of this species in their farms (Table 32). It was found in two villages namely Shebomeza and Mbomole with percentage responses of 2% and 3% respectively. Its unavailability in Mlesa, which is one of submontane

areas, could be explained by types of crop cultivated. Most farmers cultivate Cloves and Cinnamon, which are trees by nature and therefore the size of *A.obtusifolia* could minimize space and create competition. There were no respondent retaining more than 10 trees of this species in the study area.

Table 32: *Anisophyllea obtusifolia* retained by households around ANR

Amount		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
<10 trees	Count	0.0	2.0	3.0	0.0	0.0	5.0
	% of Total	0.0	2.0	3.0	0.0	0.0	5.0
Not appl.	Count	20.0	14.0	19.0	21.0	21.0	95.0
	% of Total	20.0	14.0	19.0	21.0	21.0	95.0
Total	Count	20.0	16.0	22.0	21.0	21.0	100.0
	% of Total	20.0	16.0	22.0	21.0	21.0	100.0

Table 33 shows that *Bombax rhodognaphalon* received the lowest priority of all endemic and threatened tree species domesticated around ANR. Only 1% of households interviewed in Kisiwani village retained this species. This is one of the timber species, used for house roofing purposes due to its low weight. The low number of trees domesticated suggests that most of them have been extracted already.

Table 33: *Bombax rhodognaphalon* retained by households around ANR

Amount		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
<10 trees	Count	0.0	0.0	0.0	1.0	0.0	1.0
	% of Total	0.0	0.0	0.0	1.0	0.0	1.0
Not appl	Count	20.0	17.0	22.0	20.0	21.0	100.0
	% of Total	19.8	16.8	21.8	19.8	20.8	99.0
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

4.1.4 People's awareness on endemic and threatened plant species in ANR

In order to get a picture on existing knowledge of local community adjacent to the ANR about endemic and threatened plant species in their area, some endemic and/or threatened plants, common to their area were shown to respondents. They were asked to identify the species and tell if they were aware that the selected species were endemic or threatened. Most of them managed to identify the species in vernacular names (Table 34). *Beilschmiedia kweo, Annickia kummeriae, Cola usambarensis, Saintpaulia* spp, *Greenwayodendron suaveolens* and *Cephalosphaera usambarensis* were the most identified species

Table 34: Endemic and/or threatened plant species identified by respondents Around ANR

	Species	Count	% of responses
Vernacularname(Sambaa)	Scientific name		
Mfimbo	*Beilschmiedia kweo*	53	4.0
Ng'waka	*Annickia kumeriae*	35	2.7
Muungu	*Cola usambarensis*	31	2.4
Dughulishi	*Saintpaulia spp*	22	1.7
Ng'waati/Ng'walati	*Greenwayodendron suaveolens*	22	1.7
Mtambaa	*Cephalosphaera usambarensis*	20	1.5
Mkwe	*Cynometra longipedicellata*	17	1.3
Msambu	*Allanblackia stuhlmannii*	14	1.1
Mkwe	*Cynometra brachyrhachis*	12	0.9
Mkenene	*Uvariodendron usambarense*	10	0.8
Jamto/Tunanga/Tunalange	*Impatiens spp*	3	0.2
Mruwati/Mngaza	*Dombeya sp*	2	0.2
Churwa/Chwata	*Bergonia spp*	1	0.1
	Not applicable	1071	81.4
	Total	1313	100.0

However, the majority (93.1%) had no idea whether the identified species were endemic or threatened (Table 35). Only 6.9% of respondents knew the conservation status of those species shown. Most of interviewed households who had knowledge on threatened and/or endemic plant species were from Mlesa village (3%) and Shebomeza village (2%). Mbomole and Potwe villages had only 1% whereas no respondent had such knowledge in Kisiwani village. The results suggest that the issue of threatened and endemic plant species is not well known at the level of local community, which manages and use the plants. This could be due to the fact that categorization of threatened species is done at high levels by institutions such as IUCN, CITES and LEAP and there is no feedback to the local communities who are the main stakeholders and managers of such species. It was surprising to find that this was a new concept even to some of ANR, Districts and Regional foresters.

Table 35: People's awareness on endemic and threatened plant species around ANR

Awareness		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Yes	Count	3.0	2.0	1.0	0.0	1.0	7.0
	% of Total	3.0	2.0	1.0	0.0	1.0	6.9
No	Count	17.0	15.0	21.0	21.0	20.0	94.0
	% of Total	16.8	14.9	20.8	20.8	19.8	93.1
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Lack of policy statement on conservation of threatened and or endemic plant species in the National Forest Policy (MNRT, 1998) and Forest Act (URT, 2002), may have contributed to the poor knowledge of most of the stakeholders concerning threatened species. In the United States of America, species that are in danger of becoming extinct within the foreseeable future are listed as threatened and protected by the law (Stevens, 1998). The Endangered Species Act of 1973 protects these species from any actions that may harm or destroy them or their habitat. California's rare plants are managed under a tangled web of laws, regulations, policies, and agencies (Stevens, 1998). In Australia, involving the general public in the recovery of endangered plant species and ecological communities provides discrete short-term benefits for conservation programmes and long-term gains in developing social responsibility for Australia's natural heritage (Williams, 1996). Guidelines for successful engagement of the community in the species recovery process, based on personal experience, are outlined. It is suggested that government agencies provide community endeavours with honest support, expertise and sensitivity to the community's concerns for

conservation. This will help to develop effective partnership in species recovery initiatives (Williams, 1996).

4.1.5 Willingness of respondents to conserve and manage threatened and/or endemic plant species on their farms

4.1.5.1 Local community's concern on endemic and threatened plant species around ANR

In order to know the concern of respondents on threatened and endemic plant species, they were asked to give their opinion on whether they would consider such species more important once they realize that they are threatened to extinction. Most of the respondents (90.1%) showed positive response (Table 36 (a)) but this would depend on additional benefits they would get from those species. About 10% of households showed negative response. The results suggest that awareness creation on endemic and threatened plant species would result into their conservation hence reduce rate of wild extinction.

4.1.5.2 Willingness of respondents to plant endemic and/or threatened plant species on their farms

As shown in section 4.1.3, most of the households in the study area domesticate trees in their farms. About 17% of the trees species domesticated were endemic and/or threatened such as *Allanblackia stuhlmannii*, *Cephalosphaera usambarensis*, *Anisophyllea obtusifolia* and *Bombax rhodognaphallon*. The reasons given were

different from being endemic or threatened implying that these species were domesticated for other purposes such as shading for crops and household consumption.

Table 36: Willingness of respondents to conserve and manage threatened and/or endemic plant species on their farms around ANR

Concern			Respondent village					
			Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	Total
(a)Respondent's concern on threatened and endemic plant species								
	Yes	Count	17.0	16.0	20.0	19.0	19.0	91.0
		% of Total	16.8	15.8	19.8	18.8	18.8	90.1
	No	Count	3.0	1.0	2.0	2.0	2.0	10.0
		% of Total	3.0	1.0	2.0	2.0	2.0	9.9
(b)Willingness of respondents to plant endemic and/or threatened plant species on their farms								
Willingness								
	Yes	Count	17.0	16.0	20.0	19.0	17.0	89.0
		% of Total	16.8	15.8	19.8	18.8	16.8	88.1
	No	Count	3.0	1.0	2.0	2.0	4.0	12.0
		% of Total	3.0	1.0	2.0	2.0	4.0	11.9
(c)Willingness of respondents to use alternative plant species								
	Yes	Count	17.0	16.0	21.0	18.0	12.0	84.0
		% of Total	16.8	15.8	20.8	17.8	11.9	83.2
	No	Count	3.0	1.0	1.0	3.0	9.0	17.0
		% of Total	3.0	1.0	1.0	3.0	8.9	16.8
Total	Count (n)		20.0	17.0	22.0	21.0	21.0	101.0
	% of Total		19.8	16.8	21.8	20.8	20.8	100.0

In this survey, 88.1% of respondents showed willingness to plant endemic and/or threatened plant species on their farms once they realize benefits (Table 36 (b)). For example most of the people in the study area have shown interest to plant *Allanblackia stuhlmannii* on their farms simply because they have realized financial

earning from selling of seed. A total of 11.9% (mostly in Potwe Ndondondo 4%) of respondents had no interest. This response could be contributed by the kind of crop they grow. Most people in Potwe village grow maize in large quantity as their main cash and food crop. Maize is light demanding.

4.1.5.3 Use of alternative plant species instead of threatened and endemic Plant species

About 83.2% of surveyed households were willing to use alternative tree species for their daily activities such as building and making domestic items (Table 36 (c)). In Potwe Ndondondo, 8.9% of respondents were not willing to use alternative tree species. This could be explained by the fact that Potwe Ndondondo villagers depend much on plantation trees mainly *Tectona grandis, Cedrella odorata Melia adzedarach* for their daily uses except for special interests such as medicine, dye and sometimes furniture, so they have alternative already. This suggests that it is possible for the community adjacent to ANR to use alternative tree species once they are available in their surroundings.

4.1.5.4 Tree planting as alternative to endemic and/or threatened species

Tree planting around ANR is not a new practice. The East Usambara Catchment Forest Project (EUCFP), and the East Usambara Conservation and Agriculture Development (EUCADEP), supported the community in tree planting program from late 1980s to early 2000s. This was after the natural forest in the area was heavily destroyed through mechanical logging. These projects sensitized the community to

plant trees after the government had closed harvesting in the Reserve. About 81.2% of the interviewed households were willing to plant trees on their farms as alternative to endemic and threatened species in their area (Table 37). The researcher observed trees of various species and sizes such as *Cedrela odorata*, *Tectona grandis and Grevillea robusta* on their farms. Munishi *et al*. (2004) reported that on farm tree planting, means at least some of the desired forest products such as fuelwood and poles can be obtained from on farm sources. This action will therefore reduce pressure on the natural forests at least locally.

Table 37: Willingness of respondents to plant alternative tree species around ANR

Willingness to plant		Respondent village					Total
		Mlesa	Shebomeza	Mbomole	Kisiwani	Potwe Ndondondo	
Yes	Count	13.0	12.0	17.0	20.0	20.0	82.0
	% of Total	12.9	11.9	16.8	19.8	19.8	81.2
No	Count	7.0	5.0	5.0	1.0	1.0	19.0
	% of Total	6.9	5.0	5.0	1.0	1.0	18.8
Total	Count	20.0	17.0	22.0	21.0	21.0	101.0
	% of Total	19.8	16.8	21.8	20.8	20.8	100.0

Table 38 gives tree species planted and the number of households involved around ANR. The dominant tree species planted was *Grevillea robusta* (75.2%), *Cedrella odorata* (50.5%) and *Tectona grandis* (30.7). Others were fruit tree species such as *Artocarpus herterophyllus* and *Persea americanus*.

Table 38: Tree species planted (by %) by households around ANR

Species	Village											
	Mlesa		Shebomeza		Mbomole		Kisiwani		Potwe		Total	
	Pl	Not	Pl	Not	Pl	Not	Pl	Not	Pl	Not	Pl	Not
Grevillea robusta	15.8	4.0	15.8	1.0	16.8	5.0	16.8	4.0	9.9	10.8	75.2	28.8
Cedrella odorata	5.0	14.9	6.9	9.9	11.9	9.9	19.8	2.0	6.9	13.9	50.5	49.5
Tectona grandis	0.0	19.8	0.0	16.8	9.0	21.8	13.9	6.9	16.8	4.0	30.7	69.3
Eucalyptus spp	6.9	12.9	1.0	15.8	2.0	19.8	0.0	19.8	0.0	20.8	10.9	89.1
Persea americanus	4.0	15.8	3.0	13.9	0.0	21.8	1.0	19.8	0.0	20.8	7.9	92.1
Artocarpus herterophylus	4.0	15.8	2.0	14.9	1.0	20.8	1.0	19.8	0.0	20.8	6.9	93.2

PL=planted %. Not=not planted %

Most of *G.robusta* trees were planted in Kisiwani and Mbomole villages, each with 16.8% of households involved. Kisiwani village was dominated by *C. odorata* (19.8%). Kessy (1998) revealed that many house holds in Kisiwani used to plant this species due to the fact that it is fast growing and planting material is easily available in the Amani Botanical Garden (ABG) and/or ANR. Despite *C. odorata* being an important species for wood resources requirements for the local community, it has been reported as a serious invasive species in ANR and Kimboza forest reserve in the EAMs (Madoffe, S.S. personal communication, 2006). The number of trees planted varies from one household to another. Most households planted less than 10 while very few planted more than 100 trees. Species planted in large quantity were *G.robusta*, *C.odorata* and *T. grandis*, which are the main species used as a source of income from timber selling in the area. The researcher observed various pit sawing sites on people's farms for *C.odorata* as well as *T. grandis* stumps. A cubic meter of

teak logs with DBH of 35cm and above is sold at TAS 80 000 (URT, 2002). This implies that tangible benefits motivates tree planting by the local communities.

4.2 Forest inventory

4.2.1 Forest disturbance assessment

In order to assess forest disturbance and the amount of endemic and threatened plant species extracted from the ANR, five transects were established with a total of 278, (10mx50m) plots. Transects number 2 and 5 had a total of 125 plots with an area of 6.25 ha, established in intact and relatively undisturbed forests around 'Turaco bird trail' and Amani Zigi Trail forests. Transects number 1, 3 and 4 had 153 plots with an area of 7.65 ha, were laid in disturbed forest in Kwamkoro area, where mechanical logging was conducted in the 1980s and in the southern parts of the Reserve, where there have been frequent forest fires.

4.2.1.1 Timber use intensity in ANR

Timber use intensity in ANR is summarized in table 39 and appendix 1. A total of 4001 trees with DBH equal to or greater than 15cm were evaluated in five transects having a total length of 13 900m and a width of 10m, (13.9ha.). Out of these, 3474 (86.8%) trees were alive, 207 (5.2%) were recently cut, 90 (2.3%) were old cut and 230(5.7%) trees had died naturally. The average live trees was 203.92 stems per ha for the intact forest and 292.86 stems per ha for the disturbed forest area (overall average of 247.5 stems per ha.) This result is comparable with a survey conducted in the same forest by Frontier Tanzania (2001) who reported an average of about 264 stems per

ha. The results further show that the average timber cut per ha in the intact and disturbed forest areas was 18.46 and 24.26 respectively (overall average of 21.36 stems per ha.). This result is three times more than the average reported by Frontier Tanzania (2001), who recorded an average timber cut of 6.7 stems per ha in ANR.

Table 39: Timber use intensity in ANR

Trans. No	Area of transect (Ha)	Trees >14.9cm DBH	Live timb.	Aver. live timb./ha	New cut timb.	Old cut timb.	Aver. cut timb./ha	Nat. dead timb.	Aver.. nat. dead timb./ha	Use intensity (%) for timber
1	3.40	1163	1010	297.06	83	31	33.53	39	11.47	9.80
2	4.10	1006	875	213.41	30	26	13.66	75	18.29	5.57
3	2.45	537	468	191.02	14	10	9.80	45	18.37	4.47
4	1.80	798	703	390.50	47	6	29.44	42	23.33	6.64
5	2.15	497	418	194.42	33	17	23.26	29	13.49	10.06
Total	13.90	4001	3474		207	90		230		

Trans=transect. Timb=timber. Aver=average. Nat=natural

This difference could be explained by a rampant illegal pit sawing which has been going on in the area during this study. A number of fresh pit sawing sites including temporary pit sawyer's huts were observed (Plate 10). The highly affected trees species were *Milicia excelsa* in the lowlands and *Beilschmiedia kweo* in the highland. Evidence of using chainsaws in this illegal pit sawing was observed where machine noise was detected from a distance and also observation of petrol containers in the pit sawing sites. This is a new innovation of illegal pit sawing in ANR. Very short time is spent in the forest to have many trees cut. Conversely, previous researchers in the area (Kessy (1998) and Frontier Tanzania (2001)) did not record any fresh pit sawing site in the ANR. About 5.2% of sampled trees were recently cut while 2.2% were old cut. The presence of fresh pit sawing suggests an increase of illegal pit sawing.

The increased logging in ANR could be partly due to termination of donor financial support. FINNIDA supported ANR from late 1980s to 2002. The reserve is also constrained with manpower to patrol the entire area. During data collection, there was no a forest guard at Kisiwani, Mashewa, Kimbo and Potwe villages where most of illegal harvesting took place.

(a) (b)

Plate 10: Illegal pit sawing in ANR

(a) A pit sawyer's hut in the nature reserve. (b) *Milicia excelsa* log ready for sawing in ANR-Mashewa area

Another reason could be the influx immigrants for mining. These people needed poles for construction of temporary shelter while some of them might have done illegal pit sawing to supplement their income.

The highest timber utilization pressure was along transect 5 (one of intact forest areas) where, 10.1% of sampled timber-sized trees were removed, followed by transect 1 (disturbed forest area) with of 9.8 %. Transect 3 had the least removed (4.5%). This suggests that both intact and disturbed forest areas in ANR were under utilization pressure from adjacent communities. The intact forest is one of the remaining areas

with large trees because it could not be logged due to the steep terrain (Amani Zigi forest) and the fact that the area around Turaco Bird Trail was owned by a private company (EUTCO), and is managed by ANR under a special contract (covenant) between the two stakeholders.

Appendix 1 gives the intensity of annually extracted tree species in ANR. The most affected tree species were *Annickia kummeriae, Beilschmiedia kweo, Cephalosphaera usambarensis, Milicia excelsa, Leptonychia usambarensis, Englerodendron usambarense, Uvariodendron usambarense, Greenwayodendron suaveolens, Funtumia africana, Strombossia scheffleri and Newtonia buchanannii.* This result confirms people's species preference as discussed in section 4.1. For some tree species, the number of live trees per ha was less than cut trees. For example in transect 2, live trees for *B. kweo* were 0.5 per ha while cut trees were 1.5 per ha. In transect 4, 5.6 and 11.1 *M.excelsa* trees per ha were recorded as live and cut respectively. The same trend was observed in transect 5 where 0.5 live *M. excelsa* trees were recorded in comparison with 6.5cut stems per ha. This trend indicates that these species is under serious utilization pressure.

When new cut and old cut timbers were subjected to statistical T-test at 5% level, there was no significant difference between the two although the obtained probability value of (P= 0.0776) was very close to 0.05 significance level. This indicates that if the disturbance trend continues it may result into significant extraction of timbers in the near future in ANR.

The findings further revealed a serious mortality of *B. kweo* tree species (Plate 11). In transect 1, 1.2 dead stems per ha of *B. kweo* trees were observed out of 2.1live trees per ha recorded. In transect 2, the number of live *B. kweo* trees per ha (0.5) was equal to the number of naturally dead trees. In transect 3 the situation was worse. The number of naturally dead (4.1 trees per ha) in this transect was greater than live trees (0.4 trees per ha).

On the other hand, Sawe (1997) reported on poor regeneration of *Beilschmiedia kweo*, *Cola usambarensis* and *Greenwayodendron usambarensis* in the East Usambara Mountains due to poor competition for the resources especially light, high seed predation and availability of seedling enemies. Mugasha (1978) reported on reduction of *Allanblackia stuhlmannii* seed in the East Usambara hence affecting its population. He further pointed out that the low regeneration of *A. stuhlmannii* in the East Usmbara forests has been attributed to the sporadic and prolonged germination period which exposes the seed or seedlings to detrimental conditions. The low regeneration of these species, high mortality and high utilization pressure, suggest a high population drop hence a high risk of extinction from the wild.

Plate 11: Dead *Beilschmiedia kweo* trees in ANR

When naturally dead poles and timber were subjected to T- test at 0.05% statistical level, it was revealed that there was a significant difference between dead poles and timbers (p=0.009). The significant mortality of timber trees was due to age and high mortality of *B. kweo* trees. It implies that there is high mortality of trees with DBH greater or equal to 15cm in ANR in comparison with poles.

4.2.1.2 Poles use intensity in ANR

A total of 3959 poles with DBH equal or greater to 5cm but less than 15cm were recorded in five transects (13.9ha.) (Table 40). Out of them, 3515 (88.8%) poles were alive, 282 (7.1%) recently cut, 113 (2.9 %) old cut and 56 (1.4%) poles died naturally. Analysis of variance revealed significant difference ($p<0.05$) between new cut and old cut poles. The difference showed severe cutting of new cut poles than old cut suggesting an increase of poles extraction in ANR. Madoffe *et al.*, (2005) revealed

more old cut than new cut poles in 25 forests in the EAMs. However, individual forests might have different extraction intensity. The average live poles per ha was 195 stems for the intact forest and 300 stems per ha for the disturbed forest.

Table 40: Poles use intensity in ANR

Trans. No	Sampled area (Ha)	No of sampled poles	No of alive poles	No of aver. live poles/ha	No of new cut poles	No of old cut poles	No of aver. cut poles/ha	No of nat. dead poles	No of aver. Nat. dead poles/ha	Use intensity (%) for poles
1	3400	1256	1078	317.06	117	48	48.53	13	3.82	13.14
2	4100	1044	920	244.39	81	31	27.31	12	2.93	10.73
3	2450	604	572	233.47	12	8	8.16	12	4.90	3.30
4	1800	689	628	348.89	42	13	30.56	13	7.22	7.98
5	2150	366	317	147.44	30	13	20.00	6	2.79	11.75
Total	13900	3959	3515		282	113		56		

Trans.=transect. Aver.=average. Nat.=natural

The reason for having more poles in disturbed areas than in the intact forest could be disturbance, which activates germination from the seed bank as a consequence of exposure to light. In the intact forest light is very limited and most of the trees are mature, which provides a closed canopy so that regeneration of most seed from the seed bank is limited. The results further revealed that, cut poles per ha were 24 in the intact forest and 29 in the disturbed forest area (overall poles extraction of 27 stems per ha). Frontier Tanzania (2001) reported an average poles extraction of 26.9.per ha In Uluguru north forest reserve in the EAMs, Frontier Tanzania, (2005) reported poles extraction of 15.8 per ha. This suggests higher poles use intensity in the East Usambara Mountains in comparison with the Uluguru Mountains. The intensity of

poles cutting in transect 1 (disturbed forest) was very high (13.14%) followed by transect 5 (intact forest) (11.75%). Transect 3 (disturbed area) had the (3.3%). The minimum poles cutting in transect 3 could be explained by the fact that it is located far from human settlements and there is a buffer zone of teak plantation on the eastern side which could be used as alternative source of building poles.

Overall (10%) of the pole-sized trees were cut. This has a serious impact on the species survival considering that many species in the area are threatened. Appendix 1 summarizes the results for utilization status of all species recorded. The most affected pole species were *Alchornea hirtella, Cephalosphaera usambarensis, Greenwayodendron suaveolens, Leptonychia usambarensis, Strombossia scheffleri, Uvariodendron usambarense, Cynometra brachyrhachis and Cynometra longipedicellata*. These are the species mentioned mostly by the households in section 4.1.2.2.1 and 4.1.2.4 used for building poles and making domestic items respectively. Exploitation of poles for building has severe impact on endemic and threatened tree species as well as biological diversity of the forest, in addition to causing forest degradation (Rodgers and Hall, 1986). Harvesting of poles is more destructive to the forest ecosystems because only selected prime specimens of straight, strong species are taken out. In the long run this may lead to a lower quality of growing stock and a depletion of the gene pool of the preferred species. The selection of some species often involves removal of the future seed trees for high quality species which is detrimental to species diversity.

4.2.2 Species distribution and richness in ANR

A total of 235 tree species were recorded in ANR. Sixty seven (30%) species are endemic to the Eastern Arc and or Coastal Forests of Tanzania and Kenya while 36 species (15%) are classified by IUCN as threatened with extinction (Appendix 10). The findings indicate further that 54% of endemic species recorded in the study area are threatened with extinction. Twenty three endemic and/or threatened plant species, each with less than ten individuals, are at a high risk of extinction (Table 41). The survey recorded 151 species in the intact forest stratum (64% of the total species) and 211 species (90% of all species) in disturbed forest. A total of 118 species were recorded in both intact and disturbed areas (Appendix 3). Analysis of variance on the diversity of threatened plant species revealed no significant difference ($p>0.05$) between intact and disturbed forest strata suggesting an equal importance of the sampled Nature Reserve in terms of threatened species diversity. Frontier Tanzania (2001) recorded about 246 tree species in ANR. The difference in number of species recorded by Frontier Tanzania and this study could be explained by the fact that Frontier Tanzania conducted more intensive survey in ANR than this study.

Table 41: List of threatened and/or endemic tree species under high risk of extinction in ANR

Species	Endemism Status	IUCN threat category
Allophyllus meliodorus	E	
Aoranthe punduliflora	E	VU
Bombax rhodognaphalon	E	
Chytranthus obliquinervis	E	
Cola scheffleri	E	VU
Cola usambarensis	E	EN
Combretum schumannii	E	
Craibia zimmermanii	E	
Cynometra engleri	E	VU
Cynometra Sp A	E	
Ficus usambarensis	E	
Isolana heinsenii	E	EN
Lannea welwitschii	w	EN
Lettowianthus stellatus	E	EN
Memecylon semsei	E	
Morinda asteroscepa	E	VU
Newtonia paucijuga	w	EN
Platypterocarpus scheffleri	w	VU
Platypterocarpus tanganyikensis	E	VU
Rauvolfia mombasiana	E	
Tricalysia pallens	E	
Uvariodendron oligocarpum	E	VU
Zenkerella egregia	E	VU

E=Endemic, VU=Vulnerable, EN=endangered

The most dominant tree species sampled was *Leptonychia usambarensis*, which had 1136 and 990 individuals in the intact and disturbed forest stratum respectively (Table 42). *Maesopsis eminii* followed, with 763 individuals in the disturbed area and 680 in the intact forest. The presence of almost equal number of *Maesopsis eminnii* individuals in both strata indicates the outcome of forest disturbances in ANR. Both *L.usambarensis* and *M. eminnii* are pioneer species in ANR. Disturbance in the intact forest was a result of pit sawing while in the disturbed stratum it was caused by

mechanical logging. *C. usambarensis* which is one of tree species heavily logged was the second most dominant tree species in the disturbed forest stratum. This is because the species was planted in some of heavily logged areas.

Table 42: Dominant tree species recorded in ANR

Species recorded in the disturbed forest	No of Indiv.	Species recorded in the intactforest	No of indiv.
Leptonychia usambarensis	990	*Leptonychia usambarensis*	1136
Maesopsis eminii	763	*Maesopsis eminii*	680
Cephalosphaera usambarensis	692	*Sorindeia madagascariensis*	517
Sorindeia madagascariensis	471	*Allanblackia stuhlmannii*	510
Alchornea hertella	468	*Strombossia scheffleri*	428
Allanblackia stuhlmannii	423	*Myryanthus holstii*	395
Synsepalum Msolo	399	*Cephalosphaera usambarensis*	301
Myrianthus holstii	294	*Mesogyne insignis*	244
Trilepsium madagascariensis	276	*Greenwayodendron suaveolens*	240
Greenwayodendron suaveolens	275	*Annickia kummeriae*	199
Tabernaemontana pachyciphone	266	*Trilepsium madagascariensis*	196
Strombossia scheffleri	254	*Alchornea hertella*	187
Macaranga capensis	252	*Tabernaemontana pachyciphone*	138
Mesogyne insignis	241	*Synsepalum Msolo*	137
Quasia undulata	231	*Quasia undulata*	134
Funtumia africana	225	*Synsepalum cerasiferum*	133
Antiaris toxicaria	187	*Cremaspora triflora*	131
Newtonia buchanannii	151	*Macaranga capensis*	109
Annickia kummeriae	147	*Chrysophyllum perpulchrum*	108
Drypetes garardii	137	*Funtumia africana*	106
Tabernaemontana ventricosa	132	*Rawsonia lucida*	100
Rawsonia lucida	131		
Milicia excelsa	130		
Sapium ellipticum	128		
Synsepalum cerasiferum	127		
Alsodeiopsis schumannii	120		
Anthocleista grandiflora	118		
Rinorea albersii	105		
Melia adzedarach	104		

Indiv.=individuals

4.2.2.1 Index of Dominance (ID)

The index of dominance measures the distribution of individuals among the species in the community. The greater the value of the ID the lower the species diversity in the

community and vice versa. In this study, the ID were 0.0445 and 0.0273 in intact and disturbed forest strata respectively (Appendix 11 and 12). This indicates that there is relatively higher species richness in the disturbed forest stratum compared to the intact forest. This could be explained by the intermediate disturbance hypothesis, which refers to a situation where disturbances renew resources at a rate or intensity sufficient to allow continued recruitment and persistence of species that would otherwise be excluded (Connel, 1978; Huston, 1979; Abugov, 1982; Pickett and White, 1985, Hobbie *et al*., 1993), as cited by Luoga (2000). According to this theory, periodic or recurrent disturbance at this intermediate level perpetuates both pioneer and primary species. Under these conditions, species with different life history strategies are able to co-exist and consequently high levels of species richness are maintained. If the frequency/intensity of disturbance increases beyond the intermediate level, only colonizing species with high growth or dispersal rates, pioneer species are able to co-exist. This represents lower species diversity.

On the other hand, if the disturbance decreases beyond the intermediate level, only the highly competitive ‘climax’ species which are better at maintaining resources would exist and equilibrium would be excluded and consequently species richness would be maintained at a low level. Although the intermediate disturbance hypothesis is widely supported, it has its limitations namely: (i) the hypothesis do not specify which community and ecosystem parameters will behave in the expected way. (ii) The concept of maximum level of disturbance is a relative term and needs to be explicit

according to the goals of the study. (ii) It assumes deterministic equilibrium for the trends in species richness rather than mechanisms based on stochastic processes, path dynamics and non equilibrium states.

4.2.2.2 Shannon-Wiener Index of Diversity (H')

Shannon –Wiener Index of Diversity is a commonly used index because it combines species richness and evenness and is not affected by sample size. The larger the value of H' the greater is the diversity of the community. The calculated H'in this study were 3.778 and 4.190 for the intact and disturbed forest strata respectively (Annex 10 and 11). These results, suggest high species diversity in ANR. However, the disturbed forest area, which was heavily logged about 15 years ago, had higher species diversity than the intact forest area. The difference can be explained by intermediate disturbance theory already discussed in section 4.2.2.1. Zahabu (2001) reported higher species diversity in a less disturbed forest than a highly disturbed forest in Kitulangalo area. This could be explained by the fact that if the frequency/intensity of disturbance increases beyond the intermediate level, only colonizing species with high growth or dispersal rates, pioneer species are able to co-exist resulting into lower species diversity (Luoga, 2000).

However, Shannon-Wiener diversity values were subjected to T-test for the two strata, and the results revealed no significant difference in species diversity between disturbed and intact forest areas ($p>0.05$). This could be explained by the fact that most of the disturbed forest which was previously heavily logged has recovered. On the other hand, illegal pit sawing has been taking place in the intact forest, which creates a kind of equilibrium between the two strata.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Despite concerted efforts by the Government, International Institutions and the Local communities to strengthen protection and conservation of the ANR through law enforcement and joint forest management, local people still enter the forest illegally and extract forest resources for domestic and commercial purposes. The study provides evidence that threatened and endemic plant species are used. A total number of 15 endemic/threatened plant species are used for making domestic items. Ten are used for house construction and selling, seven for medicine and another 10 for fuelwood. About 84 tonnes of seed were collected from endemic and/or threatened tree species.

The concept of endemic and threatened plant species is not known to the local communities around the ANR. The IUCN, red listed species is not clear to foresters, district and regional decision makers and does not get to the grass root levels (local communities), who use these species for their livelihoods. The result is unsustainable utilization and eventually extinction. Lack of policy statements concerning threatened and/or endemic species in the National Forest Policy and legislation could be contributing to low awareness. Incidentally, there was a positive response for the local communities of using alternative tree species and also willingness to plant

endemic and or threatened plant species on their farms. This was confirmed by a large proportion of the respondents willing to use alternative plant species (83.2%) and to plant endemic and or threatened tree species (88.1%).

The study revealed an increase in illegal timber extraction of valuable tree species mainly *Beilschmiedia kweo* and *Milicia excelsa* in ANR. Existance of fresh cut tree stumps, sawing benches, temporary huts for shading, fresh cut logs ready for sawing, fresh sawn timber of threatened tree species, chainsaw noise and petrol containers in the ANR, confirmed rampant illegal pit sawing in the Nature Reserve especially in Mashewa area.

There was forest disturbance (poles and timber cutting) in both historically intact and disturbed forests. This was confirmed by observation of 23.66 and 29.08 cut poles per ha in the intact and disturbed forest strata respectively, and 18.46 and 24.26 cut timber per ha for intact and disturbed forest respectively. The intact forest in ANR has been set aside strictly for biodiversity conservation. No cutting of any kind is allowed. ANR Management should meet with the villagers living near the intact forest and raise awareness on Government policy and law in regard to these forests. Efforts should be intensified to develop sustainable alternatives. There was no significant difference on species diversity between disturbed and intact forest strata. The Shannon-Wiener index values of 4.190 and 3.778 for disturbed and intact strata respectively, and the ID values of 0.0273 and 0.0445 for the disturbed and intact strata

respectively concludes high species diversity for both strata. However the indices indicate relatively higher species diversity in disturbed stratum than the intact area. Also, there was no significant difference of threatened plant species diversity between the strata.

There was serious forest disturbance through mining in ANR. This was confirmed by more than 50 mining pits in the Reserve, 124 mining court cases and hundreds of trees uprooted to give room for mining. Since gold mining in the area took place in river banks, it caused a serious impact on *Saintpaulia spp.* All *Saintpaulia spp* are endemic to the EAMs and most of them are threatened to extinction because of habitat loss.

There was evidence of mortality of timber and poles in ANR, confirmed by a record of 230 (6%) and 56(1.4%) dead stems for timber and poles respectively. *B.kweo*, an endemic species has highest rate of mortality. The reason(s) for the mortality are unknown. Human utilization pressure, a high mortality rate and geographical restriction put this species at high risk of wild extinction.

5.2 Recommendations

The Amani Nature Reserve is National treasure that is being exploited at an alarming rate. This study has generated some baseline information on the local knowledge about endemic and threatened plant species and how forest adjacent communities use them. This information will allow other researchers to make further comparative

assessment for conservation and management of endemic and threatened plant species. In light of the outcomes of this research work, the following recommendations are made:

- Awareness creation on importance of endemic and threatened plant species should be done at all levels among the local people adjacent to the protected areas to the national policy makers.
- Since endemic and threatened tree species with high use values are mostly preferred and the frequency at which they are utilized is high, planting of such trees outside the ANR should be emphasized so as to offset the resource use pressure.
- A large scale extraction of building poles from endemic and threatened trees was observed. It is recommended that ANR and other stakeholders should sensitize and if possible could support local adjacent communities to build their houses using mud bricks which are more permanent.
- Amani Nature Reserve management should sensitize adjacent community to use lesser known species such as *Grevillea robusta* and *Tectona grandis* for making domestic items instead of threatened tree species.
- Threatened species conservation guideline and strategies should be included in the national forestry policy and legislations for sustainable conservation and management.
- Since *Allanblackia stuhlmannii* seed collection in ANR is an incentive to the adjacent community for conservation, strategies for domestication of this

species should be sought including more research on its germination and production of provenances of short rotations. However, it is crucial to carry out ecological impact assessment for *A.stuhlmannii* seed collection in ANR.

- Illegal mining activities inside ANR and in the water sources should be arrested through involvement of all stakeholders. Furthermore the Ministry of Natural Resources and Tourism should advise the Ministry of Mineral and Energy, to stop issueing prospecting licences around ANR.
- ANR management must conduct frequent patrols and low enforcement to arrest illegal pit sawing in the area. However more research on why illegal activities continue in the Nature Reserve even after involvement of adjacent communities through JFM is recommended.
- Research is needed to determine the causes of *Beilschmiedia kweo* mortality. Furthermore, the Ministry of Natural Resources and Tourism should ban extraction of *B. kweo* until its population stabilizes.

REFERENCES

AFIMP (1988). East Usambara Mountains. Final report of the Amani Forest Inventory and Management Plan Project (AFIMP), FBD and Finnmap-Silvestria, Helsinki. 56 pp

Andrua, J. A. (1995). Common property forest resources management. A case study of Msasa IBC, East Usambara Mountains, Tanzania. Dissertation for award of MSc Degree at ITC, Enschede. The Netherlands. 84 pp

Auld, T. D. and Scott, J. A., (August 1996). Conservation of the endangered plant *Grevillea caleyi* in urban fire prone habitats. Australian Nature Conservation Agency. [http://deh.gov.au/biodiversity/threatened/index.htm] site visited on 14/03/2005

Bjondalein, E.R. (1992). Tanzania's vanishing rainforest - assessment of nature conservation values, biodiversity, and importance for water catchment. *Agricultural Ecosystems and Environment Journal* 40: 313-334.

Bohero, A. A. (1997). Management of public forests by local communities in the East Usambara Mountains, Tanzania. Dissertation for award of MSc Degree at Agriculture University of Norway. 162 pp

Boyd, H. K. (1981). *Marketing research, text and cases*. Richard D. Publisher Illinois. 813 pp

Burgess, N., Kilahama, F., Madoffe, S. S., Munishi, P., Doody, K., Nyagawa, S., Kahemela, A. and Nderuaki, M. (2005). What are the main threats facing the

Eastern Arc Mountain forests and how serious are they? *The Arc Journal* 19:16-17

Burgess, N. D., Nummelin, M., Fjeldsa, J., Howell, K. M., Lukumbyzya, K., Mhando, L., Philipson, P. and Vanden Berghe, E. (1998) Eastern Arc Mountains. *Journal of East Africa Natural History*. 87: Viii-xxii

Chapman, C.A. and Chapman, L.J. (1996). Mid-elevation Forests: A history of disturbance and regeneration. In: *East African Ecosystems and their Conservation:* (Edited by McClanahan, T.R. and Young, T.P.) Oxford University Press, New York. pp 385-400

CIMMTYT Economic Programme (1993). The adoption of agricultural technology. *A guide for survey design.* Mexico, D. F.88 pp

CMEAMF, (October 2006). Conservation and Management of Eastern Arc Mountains Forests. [http:www.easternarc.or.tz] site visited on 19/10/06

Collar, N.J. and Stuart, S.N. (1987). *Priorities for conservation action*. *Key forests for threatened birds in Africa.* International Council for Birds Preservation (ICBP) Monograph No 3. 1988. Cambridge, UK. 18pp

Conservation International (CI), (May 2004). Biodiversity Hotspots, Eastern Arc Mountains and Coastal Forests. [http://www.cepf.net/xp/. xml] site visited on 22/02/2005

Conservation International (CI), (October 2006). Biodiversity Hotspots. Hot spots science [http:www.conservation.org/xp/ciweb] site visited on 12/09/2006]

Crump, A. (1991). *Dictionary and development people places, ideas and organisations*. Earth Scans Publishers Limited, London, pp74-75

Dinesen, L., T. Lehmberg, J.O. Svendsen, L.A. Hansen and J. Fjeldså. (1994). A new genus and species of perdicine bird (Phasianidae, Perdicini) from Tanzania: a relict form with Indo-Malayan affinities. *Ibis* 136: 2–11.

FAO & UNEP (1981). Tropical forest resource assessment project (in the framework of Gems). *Forest Resource of Tropical Africa*. Part 1. Regional Synthesis FAO, Rome 108 pp

FAO (1996). The nature of food security problem in mainland Tanzania. Assessment and Issue Paper. 166pp

FAO (2000). *A Statistical Manual for Forestry Research*. Forestry research support programme for Asia and Pacific (FORSPA), Food and Agriculture Organisation of the United Nations, Bangkok. 239pp

FAO (2001). *Global forest resources assessment* 2000. Main report. FAO forestry paper No 140. Food and Agriculture Organisation of the United Nations, Rome. 479pp.

Frontier Tanzania (2001). Doody, K. Z., Howell, K.M. and Fanning, E. (eds). *Amani Nature Reserve: A biodiversity Survey*. East Usambara Conservation Area Management Programme. Technical Paper No 52. Dar es salaam Tanzania. 144pp

Frontier Tanzania (2002). Baharrel, N. K., Fanning, E. and Howell, K. (eds) *Nilo forest reserve A biodiversity survey*. East Usambara Conservation Area Management Programme, Technical paper 53. Dar es salaam, Tanzania. 160pp

Frontier Tanzania (2005). Bracebridge, C., Fanning, E. Howell, K. M., Rubio, P. and John, F. A. V (eds) *Uluguru component biodiversity survey* (volume III). Dar es salaam Tanzania. 150pp

Galapagos, (June 2005). Back from the brick, saving the endangered plants of Galapagos. [http://www.gcl.org/botany.htm] site visited on 24/02/2005

Hamilton, A. C. and Bensted-Smith, R. (1989). *Forest Conservation in the East Usambara Mountains Tanzania*. IUCN-The World Conservation Union Forest Division, Ministry of Lands, Natural Resources and Tourism, United Republic of Tanzania. 392pp

Hamilton, A. C. (1989). The place and the problem. A survey of forest types on the East Usambara Mountains using the variable-area tree plot method. In: *Forest conservation in the East Usambara Mountains Tanzania*. (*Edited by Hamilton and Bensted-Smith*) IUCN, Gland.pp 213-226.

Hamilton, A. C. and Mwasha, I. V. (1989). History of resource utilisation and management after independence. In: *Forest conservation in the East Usambara Mountains Tanzania* (*Edited by Hamilton and Bensted-Smith*). IUCN, Grand. Pp 45-56.

Healey, J., (January 2002). Endangered and introduced species. Issue in society, Vol.174. [http://www.spinneypress.com.an/brouse_list.htm] site visited on 12/04/2005

Hedberg, I. (1983). Inventory of plants used in traditional medicine in Tanzania. Plants of the families Dilleniaceae-Opiliaceae. *Journal of Ethno pharmacology*, 9: 105-128

Hilton-Taylor, C. (2000). *2000 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland and Cambridge, UK. 61 pp

Hoffman, R.L. (1993). Biogeography of East African montane forest millipedes. In: *Biogeography and Ecology of the Rain Forests of Eastern Africa* (*Edited by Lovett and Wasser*). Cambridge University Press, Cambridge. 103-115

Howell, K. M. (1989). The East Usambara Fauna. In: *Forest conservation in the East Usambara Mountains Tanzania* (*Edited by Hamilton and Bensted-Smith*) IUCN, Grand pp 315-355.

Howell, K. M. (1993). Herpetofauna of the Eastern Africa forests. In: *Biogeography and ecology of the rain forests of Eastern Africa* (*Edited by Lovett and Wasser*) Cambridge University Press, Cambridge pp 173-201.

IUCN (1990). *The management of tropical moist forest lands. Ecological guidelines.* Gland 330 pp.

IUCN (2001). Species. Newsletter of the species survival Commission. IUCN-The World Conservation Union, No 36, July-December 2001

IUCN, (July 2006).Plants redlisting.[http:www.iucn.org/en/news/archive/2006/03/09-plants.htm] site visited on 9/10/2006

IUCN, (March 2002). IUCN red list of threatened species. IUCN, Switzerland Grand. [http://www.cepf.net/xp/. xml] site visited on 24/03/2005

Iversen, S. T. (1991). *The Usambara Mountains, NE Tanzania*: *Phytogeography of the Vascular Plant Flora*. Uppsala University, Uppsala. 234pp

Johansson, S. and Sandy, R. (1996). Updated forest area information in the East Usambara Mountains. East Usambara Conservation Area Management Programme (EUCAMP). Tanga Tanzania 50pp

Kajembe, G. C. and Mwaseba, D. (1994). The Extension and communication programme for the East Usambara Catchment Forest Project. Technical Paper No 11. East Usambara Catchment Forest Project, Tanga, pp 35-38

Katigula, M. I. L. (1999). Dependence of local communities on protected forests as source of non-timber forest products and its role in forest management. A case study of the East Usambara Mountains. Dissertation for award of MSc degree at International Institute for Aerospace Survey and Earth Sciences Enschede, The Netherlands, 116pp

Kent, M. and Coker, P. (1992). *Vegetation description and analysis, A practical approach*. Belhaven press, 25 Floral Street, London. 363pp

Kessy, J. F. (1998). Conservation and utilisation of natural resources in the East Usambara forest reserves. Convention views and local perspectives. Doctoral dissertation, Wageningen Agricultural University, the Netherlands. 168pp

Kolehmainen, J., Nieminen, J., Killenga, R. R. , Hahkala, V. and Koponen, P. (2005) Saintpaulia (African violet) conservation project Phase I final report. East Usambara Mountains and adjacent lowlands, Tanga, Tanzania. 36pp

Krebs, C. J. (1989). *Ecological methodology*. Harper Collins publishers, New York. 654pp

Lovert, J. and Clarke, J. P. (1998). *Allanblackia stuhlmannii*. In: 2006 IUCN red list of threatened species. [http://www.iucnredlist.org] site visited on 25/07/2006

Lovett, J. C. (1989). The botanical importance of the East Usambara forests in relation to other forests in Tanzania. In: *Forest conservation in the East Usambara Mountains Tanzania (Edited by Hamilton and Bensted-Smith*). IUCN, Grand. pp 207-212.

Lovett, J. C. and Pocs, T. (1993). *Assessment of the condition of catchment forest reserves botanical appraisal*. The Catchment Forestry Projects, Dar es salaam, Tanzania 190 pp.

Luoga, E. J. (2000). The effects of human disturbances on diversity and dynamics of Eastern Tanzania miombo arborescent species. Doctoral thesis at University of the Witwatersrand, Johannesburg. 250 pp

Luoga, E.J., Balkwill, K. and Witkowski, E.T.F (2000). Differential utilization and ethnobotany of trees in Kitulangalo forest reserve and surrounding communal lands, Eastern Tanzania. *Economic Botany* 54:328-343.

Luoga, E.J., Balkwill, K.B, and Witkowski, E. T. F. (2004). Land use and cover changes in relation to institutional framework and tenure of land and resources

in Eastern Tanzania Miombo Woodlands. *Journal of Environment, Development and Sustainability* 7:71-93

Madoffe, S. S., Hertel, G., Rodgers, P., O'Connel, B. and Killenga, R. R. (2006). Monitoring the health of selected Eastern Arc forests in Tanzania. *Africa Journal of Ecology* 44:171-177

Madoffe, S. S. and Munishi, P. T. K. (2005). *Eastern Arc Mountains forest management and forest condition assessment*. Conservation and management of the Eastern Arc Mountain Forests: Eastern Arc Mountain Strategy. GEF/UNDP. Morogoro, Tanzania.116pp

Madoffe, S. S.; Munishi, P.; Burgess, N. (2005). How disturbed by human activities are the Eastern Arc Mountain forests? *The Arc Journal* 19:13-15

Magurran, A. E. (1988). *Ecological diversity and its measurement*. Princeton University press, Princeton. 179 pp

Mahunnah, R. L. A. and Mtotomwema, K. (1988). Ethnobotany of Clutia (Euphorbiaceae) in Tanzania. *Journal of economic and taxonomic botany*. 13: 505-511.

Malimbwi, R. E and Mugasha, A.G. (2000). Forest inventory report for the Rufiji forests. Consultant report, FORCONSULT, Faculty of Forestry and Nature Conservation, SUA Morogoro. 48pp

Maliondo, S. M. S., Malimbwi, R. E., Constantine, E., and Zahabu, E. (2000). Fire impact on population structure and diversity of tree species in West Usambara camphor zones forest. *Journal of Tropical Forest Science* 12 (3): 472-481

Mayeta, L. (2004). The Role of Local Institutions in Regulating Natural Resource Use and Conflict Management in Mpanga/Kipengere Game Reserve, Iringa, Tanzania. Dissertation for award of MSc Degree at Sokoine University of Agriculture. Morogoro. 150pp.

Mbwambo, S.J. (2000). The role of local communities and organizations in sustainable conservation of biodiversity: A case study of Udzungwa Mountains, Tanzania. 133pp.

Mittermeier, R.A., Robles Gill, P., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C. G., Lamoreux, J. and da Fonseca, G. A.B (December 2004).Hotspot revisited. Earths biologically richest and most endangered terrestrial ecoregions. [http://www.worldwildlife.org/wildworld/profiles.htm] site visited on 25/07/2006

MNRT (1998). *National Forest Policy.* Ministry of Natural Resources and Tourism, Dar es Salaam 59pp

MNRT(2002). *Forestry in figures.* Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism, Dar es salaam.15pp

Monela, G. C. (1995). Tropical rain forest deforestation, biodiversity benefits and sustainable landuse: Analysis of economic and ecological aspects related to the Nguru Mountains, Tanzania. Doctoral dissertation at Department of forest sciences, Agriculture University of Norway. 395 pp

Msikula, S. N. (2003). The Economics of improved agroforestry systems for income, food security and biodiversity conservation in the East Usambara Mountains. Dissertation for award of MSc degree at SUA, Morogoro. 105pp

Mugasha, A. G. (1978). Tanzania natural forests silviculture research. *Review report* (new series) No 39. Ministry of natural resources and tourism. Forest division, silvicultural research institute, Lushoto, Tanzania. 19pp

Munishi, P. K. T., Shear, T. H. ,Wentworth, T., Temu, R. P. C. and Maliondo, S. M. S. (2004). Sparse distribution pattern of some plant species in two afromontane rain forests of the Eastern Arc Mountains of Tanzania. *Tanzania journal of forestry and nature conservation*. 10: 74-90

Munishi, P. K. T., Shear, T. H. and Temu, R. P. C., (December 2004). Household level impact on forest resources and the feasibility of using market based incentives for sustainable management of the forest resources of the Eastern Arc Mountains. Sokoine University of Agriculture, Morogoro. [http://www4.ncsu.edu/unity/. htm] site visited on 20/04/2005

Munishi, P.K.T. and Temu, R.P.C. (1992). The Natural Forests and Environmental Conservation in the Southern Highlands of Tanzania. In: *Proceedings of an International Workshop on Agricultural Research, Training and Technology Transfer in the Southern Highlands of Tanzania: Past Achievements and Future Prospects*. (Edited by Ekpere E. A *et al*.) Uyole Agricultural Centre, Mbeya Tanzania. 115pp

Nantucket Conservation Foundation, (March 2002). Endangered species. [http://www.nantucketconservation.com] site visited on 20/02/2005

Newmark, W. (1998). Forest area fragmentation and loss in the Eastern Arc Mountains. Implication for the conservation of biological diversity. *Journal of Eastt Africa Natural History Society*. 87: 29-36

Paulo, W. (2004). Extenct and constraints of local peoples' involvement in biodiversity conservation in Uluguru mountains, Morogoro, Tanzania. Dissertation for award of MSc. Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 90 pp

Pielou, E. C. (1975). *Ecological diversity*. John Wiley & Sons, Inc. ,New York. 165 pp.

Protea Atlas, (May 2005). Why some species rare? National botanical institute Kirstenbosch, Cape Town. [http://www.protea.worldonline.co.za.htm] site visited on 15/02/2005

Pócs, T. (1998). Distribution of bryophytes along the Eastern Arc Mountains. *Journal of the East African Natural History Society* 87: 75-84.

Poynton, J.C., Howell, K.M., Clarke, B.T., and Lovett, J.C. 1998. A critically endangered new species of Nectophrynoides (*Anura bufonida*) from the Kihansi Gorge, Udzungwa Mountains, Tanzania. *African Journal of Herpetology* 47: 59-67.

Queensland, (June 2004). The state of Queensland environmental protection agency. [http://www.doh.clot.state.nc.us]site visited on 15/02/2005

Rodgers, W. A. and Homewood, K. M. (1982). The conservation of the East Usambara Mountains, Tanzania: A review of biological values and land use pressures. *Biol. L. Linn. Soc*. 24: 285-304

Rodgers, W. A. and Hall, J.B. (1986). Poles cutting pressure in Tanzania forests. *Forest ecology and management* 14: 133-140

Sawe, C. T. (1997). The regeneration status of indigenous trees species in the forests East Usambara Mountains, Tanzania. Dissertation for award of MSc degree at Sokoine University of Agriculture, Morogoro, Tanzania. 108pp

Scharff, N. 1992. The Linyphiid Fauna of Eastern Africa (Araneae: Linyphiidae)—distribution patterns, diversity and endemism. *Biological Journal of the Linnean Society of London* 45: 117–154.

Schimidt, P. (1989). Early exploitation and settlement in the East Usambara Mountains. In: *Forest Conservation in the East Usambara Mountains Tanzania* (*Edited by Hamilton and Bensted-Smith*) IUCN, Grand. Pp 357-361.

Sharma, N. P., Rowe, R., Openshaw, K. and Jacobson, J. (1992). World forests in perspectives. In: *Managing the world's forests. Looking for balance between conservation and development. (Edited by Sharma, N. P.)* Kandall/Hut publishers company, Lowa, pp17-32.

Stattersfield, A.J., Crosby, M.J, Long, A.J. and Wege, D.C (June 1998). Endemic Bird Areas of the World. Priorities for Biodiversity Conservation. BirdLife Conservation Series. [http://www.worldwildlife.org/wildworld/profiles.htm] site visited on 25/07/2006.

Stevens, W. K., (December 1998). Plant survey revealed many species threatened with extinction. [http://www.well.com/user/davidu/plantextinction.htm] Site visited on 15/4/2005

Tye, A. (1994). Magorotto rain forest conservation-proposal for establishment of a new reserve. *EUCDP, IUCN, Amani, Tanzania (unpublished)* 20pp

URT (2002). The United Republic of Tanzania. *Forest Acts No 14 of 2002*. Fourteenth schedule. Made under regulation 29 (i). Dar es salaam, Tanzania. 16 pp

URT (2004). The United Republic of Tanzania. 2002 population and housing cencus. Regional and District census data in brief. Volume IV. Central census office, National Bureau of Statistics. Dar es salaam. 52pp

URT (2005). The United Republic of Tanzania. 2002 population and housing census.Village and street statistics. Age and sex distribution. Tanga Region. Volume VIII. Cental census office, National Bureau of Statistics, Dar es salaam.154pp

Vanclay, J. K. (1993). Saving the tropical forest: needs and prognosis. *Ambio* 22 (4): 225-231

Williams, S., (February 1996). Community Involvement in the Species Recovery Process: insight into successful partnership. [http://www.deh.gov.au/index.htm] site visited on 12/03/2005

Wily, L. A, (September 2002). Participatory forest management in Africa. An overview of progress issue. [http://www.cbnrm.net] Site visited on 15/01/2006

Zahabu, E. and Malimbwi, R. E. (1997). Structure and comparison of tree species in Amani Nature Reserve. Faculty of Forestry SUA, Record No 67, pp259-266

Zahabu, E. (2001). Impact of charcoal extraction on the miombo woodlands. The case of Kitulangalo area, Tanzania. Dissertation for award of MSc. Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 106 pp

APPENDICES

Appendix 1: Intensity of annually extracted tree species in ANR

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
1	*Alangium chinense*	3	3	0.88	0	0	0.00	0	0.00	0	1	0.29	0	0	0.00	0	0.00
1	*Albizia glaberima*	2	2	0.59	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Albizia gummifera*	3	3	0.88	0	0	0.00	0	0.00	12	10	2.94	1	1	0.59	0	0.00
1	*Alchornea hirtella*	6	3	0.88	1	2	0.88	0	0.00	104	93	27.35	5	6	3.24	0	0.00
1	*Allanblackia stuhlmnnii*	109	105	30.88	2	1	0.88	1	0.29	51	50	14.71	1	0	0.29	0	0.00
1	*Allophylus melliodorus*	2	1	0.29	0	0	0.00	1	0.29	6	5	1.47	0	1	0.29	0	0.00
1	*Alsodoiepsis schummannii*	7	6	1.76	1	0	0.29	0	0.00	41	37	10.88	4	0	1.18	0	0.00
1	*Anisophylea obtusifolia*	0	26	7.65	0	0	0.29	1	0.29	11	9	2.65	1	1	0.59	0	0.00
1	*Annickia kumeriae*	29	22	6.47	7	0	2.06	0	0.00	10	5	1.47	4	1	1.47	0	0.00
1	*Anthocleista grandiflora*	12	12	3.53	0	0	0.00	0	0.00	8	8	2.35	0	0	0.00	0	0.00
1	*Antiaris toxicaria*	4	4	1.18	0	0	0.00	0	0.00	3	2	0.59	1	0	0.29	0	0.00
1	*Antidesma membranaceum*	2	2	0.59	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Aoranthe penduliflora*	1	1	0.29	0	0	0.00	0	0.00	3	2	0.59	1	0	0.29	0	0.00
1	*Beilschmiedia kweo*	18	7	2.06	5	2	2.06	4	1.18	2	2	0.59	0	0	0.00	0	0.00
1	*Bersama abysinica*	7	7	2.06	0	0	0.00	0	0.00	6	5	1.47	0	0	0.00	1	0.29
1	*Blighia unijugata*	5	5	1.47	0	0	0.00	0	0.00	6	5	1.47	1	0	0.29	0	0.00
1	*Bombax rhodognaphalon*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Bridelia micrantha*	3	2	0.59	1	0	0.29	0	0.00	5	3	0.88	1	0	0.29	1	0.29
1	*Camelia sinnensis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Casearia batiscoidea*	1	1	0.29	0	0	0.00	0	0.00	5	5	1.47	0	0	0.00	0	0.00
1	*Celtis africana*	3	2	0.59	1	0	0.29	0	0.00	4	3	0.88	0	1	0.29	0	0.00
1	*Celtis gomphophylla*	1	1	0.29	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Cephalosphaera usambarensis*	43	38	11.18	4	1	1.47	0	0.00	46	28	8.24	14	3	5.00	1	0.29
1	*Chrysophillum purpcrum*	23	23	6.76	0	0	0.00	0	0.00	4	3	0.88	1	0	0.29	0	0.00
1	*Cleistanthus amaniensis*	1	1	0.29	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Cleistanthus polystachys*	3	3	0.88	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Coffea arabica*	0	0	0.00	0	0	0.00	0	0.00	4	2	0.59	2	0	0.59	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
1	*Cola geenwayi*	5	4	1.18	1	0	0.29	0	0.00	13	11	3.24	1	1	0.59	0	0.00
1	*Cola scheffleri*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Cola usambarensis*	0	0	0.00	0	0	0.00	0	0.00	3	1	0.29	2	0	0.59	0	0.00
1	*Craibia zimmermannii*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Cremaspora triflora*	8	8	2.35	0	0	0.00	0	0.00	7	7	2.06	0	0	0.00	0	0.00
1	*Croton silvaticus*	2	2	0.59	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Cyathea manniana*	1	0	0.00	1	0	0.29	0	0.00	23	19	5.59	2	2	1.18	0	0.00
1	*Cylicomorpha parviflora*	16	16	4.71	0	0	0.00	0	0.00	8	8	2.35	0	0	0.00	0	0.00
1	*Cynometra brachyrachis*	11	7	2.06	3	0	0.88	1	0.29	2	1	0.29	1	0	0.29	0	0.00
1	*Cynometra longipedicelata*	3	2	0.59	1	0	0.29	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Cynometra SP A*	3	3	0.88	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Dasylepis integra*	0	0	0.00	0	0	0.00	0	0.00	11	11	3.24	0	0	0.00	0	0.00
1	*Deinbolia kilimandscharica*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Diospyros abyssinica*	2	1	0.29	1	0	0.29	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Drypetes garardii*	26	22	6.47	1	1	0.59	2	0.59	6	6	1.76	0	0	0.00	0	0.00
1	*Drypetes usambarica*	4	3	0.88	0	0	0.00	1	0.29	2	2	0.59	0	0	0.00	0	0.00
1	*Engleredendron usambarense*	13	9	2.65	3	1	1.18	0	0.00	5	5	1.47	0	0	0.00	0	0.00
1	*Erythrophloem suaveolens*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Fernandoa magnifica*	1	1	0.29	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Ficus capensis*	0	0	0.00	0	0	0.00	0	0.00	1	0	0.00	0	1	0.29	0	0.00
1	*Ficus exasperata*	3	3	0.88	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Ficus lutea*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Ficus sur*	6	6	1.76	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Ficus sycomorus*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Ficus valischoudae*	1	1	0.29	0	0	0.00	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Funtumia africana*	5	4	1.18	1	0	0.29	0	0.00	7	4	1.18	2	1	0.88	0	0.00
1	*Garcinia buchananii*	1	1	0.29	0	0	0.00	0	0.00	3	3	0.88	0	0	0.00	0	0.00
1	*Greenwayodendro suaveolens*	68	39	11.47	16	8	7.06	5	1.47	24	14	4.12	8	2	2.94	0	0.00
1	*Harungana madagascariensis*	6	2	0.59	3	1	1.18	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Isoberlinia scheffleri*	20	19	5.59	0	0	0.00	1	0.29	5	3	0.88	2	0	0.59	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
1	*Keetia Sp*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Lannea welwitschii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Leptaulus holstii*	1	1	0.29	0	0	0.00	0	0.00	2	1	0.29	0	1	0.29	0	0.00
1	*Leptonychia usambarensis*	22	18	5.29	3	1	1.18	0	0.00	37	23	6.76	13	1	4.12	0	0.00
1	*Macaranga capensis*	33	30	8.82	1	0	0.29	2	0.59	33	31	9.12	1	0	0.29	1	0.29
1	*Maesopsis eminii*	110	98	28.82	1	5	1.76	6	1.76	42	33	9.71	4	2	1.76	3	0.88
1	*Magnistipula butayei*	3	3	0.88	0	0	0.00	0	0.00	5	4	1.18	1	0	0.29	0	0.00
1	*Maranthes goetzeana*	17	17	5.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Maytenus undata*	0	0	0.00	0	0	0.00	0	0.00	14	14	4.12	0	0	0.00	0	0.00
1	*Memecylon semseii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Mesogyne insignis*	5	5	1.47	0	0	0.00	0	0.00	83	80	23.53	0	3	0.88	0	0.00
1	*Milicia excelsa*	4	4	1.18	0	0	0.00	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Milletia dura*	5	4	1.18	1	0	0.29	0	0.00	4	2	0.59	2	0	0.59	0	0.00
1	*Mimusops kummel*	5	5	1.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Morinda asteroscepa*	4	4	1.18	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Morus mesozygia*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Myrianthus holstii*	71	70	20.59	0	0	0.00	1	0.29	32	30	8.82	2	0	0.59	0	0.00
1	*Newtonia buchananii*	23	15	4.41	6	1	2.06	1	0.29	10	10	2.94	0	0	0.00	0	0.00
1	*Ochna holstii*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Ocotea usambarensis*	2	0	0.00	0	0	0.00	2	0.59	0	0	0.00	0	0	0.00	0	0.00
1	*Odyendea zimmermanii*	13	13	3.82	0	0	0.00	0	0.00	5	5	1.47	0	0	0.00	0	0.00
1	*Olea capensis*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Oxyanthus speciosus*	0	0	0.00	0	0	0.00	0	0.00	3	3	0.88	0	0	0.00	0	0.00
1	*Parinari excelsa*	22	21	6.18	0	0	0.00	1	0.29	8	7	2.06	1	0	0.29	0	0.00
1	*Parkia felicoidea*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Pauteria adolfifriedericii*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Placodiscus amaniensis*	2	2	0.59	0	0	0.00	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Pleiocarpa picnantha*	1	1	0.29	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Polyalthia stuhlmannii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Polyceratocarpus scheffleri*	20	20	5.88	0	0	0.00	0	0.00	9	9	2.65	0	0	0.00	0	0.00

Appedix 1 continues

Trans No	SPECIES	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
1	*Polyscias fulva*	9	8	2.35	0	0	0.00	1	0.29	10	10	2.94	0	0	0.00	0	0.00
1	*Polysphaeria parviflora*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Poterandia penduliflora*	11	11	3.24	0	0	0.00	0	0.00	8	7	2.06	1	0	0.29	0	0.00
1	*Psychotria peteri*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Pterocarpus mildbraedii*	1	1	0.29	0	0	0.00	0	0.00	3	3	0.88	0	0	0.00	0	0.00
1	*Quasia undulata*	21	19	5.59	0	0	0.00	2	0.59	16	11	3.24	4	1	1.47	0	0.00
1	*Rausonia lucida*	8	8	2.35	0	0	0.00	0	0.00	15	14	4.12	1	0	0.29	0	0.00
1	*Ricinodendron heudelotii*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Rinorea albersii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Rothmania manganjae*	1	1	0.29	0	0	0.00	0	0.00	4	4	1.18	0	0	0.00	0	0.00
1	*Rytigynia stuhlmannii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Sapium ellipticum*	9	9	2.65	0	0	0.00	0	0.00	11	11	3.24	0	0	0.00	0	0.00
1	*Schefflerodendron usambarense*	14	10	2.94	1	1	0.59	2	0.59	6	4	1.18	2	0	0.59	0	0.00
1	*Sorindeia madagascariensis*	67	66	19.41	1	0	0.29	0	0.00	216	202	59.41	4	8	3.53	2	0.59
1	*Spathodea nilotica*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Strombosia cheffleri*	22	13	3.82	6	3	2.65	0	0.00	35	23	6.76	8	4	3.53	0	0.00
1	*Suregada zanzibarense*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Symsepalum cerasiferum*	20	19	5.59	1	0	0.29	0	0.00	11	10	2.94	1	0	0.29	0	0.00
1	*Synsepalum msolo*	17	17	5.00	0	0	0.00	0	0.00	3	3	0.88	0	0	0.00	0	0.00
1	*Syzigium guinense*	3	3	0.88	0	0	0.00	0	0.00	3	3	0.88	0	0	0.00	0	0.00
1	*Tabernaemontana pachysiphon*	5	5	1.47	0	0	0.00	0	0.00	35	28	8.24	4	0	1.18	3	0.88
1	*Tabernaemontana Staphyana*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Tarrena nigrensis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Teclea nobilis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Terminalia sambesiaca*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Tricalysia anomala*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Tricalysia myrtifolia*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Tricalysia Sp*	0	0	0.00	0	0	0.00	0	0.00	4	4	1.18	0	0	0.00	0	0.00
1	*Trichilia dregeana*	1	1	0.29	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
1	*Trichilia emetica*	4	4	1.18	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Triclysia elegans*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Trilepsium madagascariensii*	11	11	3.24	0	0	0.00	0	0.00	11	11	3.24	0	0	0.00	0	0.00
1	*Uvariodendron digocarpum*	2	1	0.29	1	0	0.29	0	0.00	2	2	0.59	0	0	0.00	0	0.00
1	*Uvariodendron usambarense*	23	16	4.71	6	1	2.06	0	0.00	44	23	6.76	14	7	6.18	0	0.00
1	*Vepris nobilis*	3	3	0.88	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Voacanga africana*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Voacanga thouarsii*	6	6	1.76	0	0	0.00	0	0.00	10	10	2.94	0	0	0.00	0	0.00
1	*Xylopia aethiopica*	5	3	0.88	1	0	0.29	1	0.29	5	4	1.18	0	0	0.00	1	0.29
1	*Xymalos monospora*	18	12	3.53	1	2	0.88	3	0.88	18	18	5.29	0	0	0.00	0	0.00
1	*Zanha golungensis*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Zanthoxylum gilletii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.29	0	0	0.00	0	0.00
1	*Zanthoxylum usambarensis*	1	1	0.29	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
1	*Zenkerela grotei*	1	1	0.29	0	0	0.00	0	0.00	3	3	0.88	0	0	0.00	0	0.00
2	*Alangium chinense*	1	1	0.24	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Albizia gummifera*	1	1	0.24	0	0	0.00	0	0.00	5	5	1.22	0	0	0.00	0	0.00
2	*Alchornea hertela*	3	2	0.49	0	1	0.24	0	0.00	72	61	14.88	6	4	2.44	1	0.24
2	*Allanblackia stuhlmanii*	112	106	25.85	0	1	0.24	5	1.22	61	60	14.63	1	0	0.24	0	0.00
2	*Allophylus callophylus*	5	4	0.98	0	0	0.00	1	0.24	0	0	0.00	0	0	0.00	0	0.00
2	*Allophylus rubifolius*	1	0	0.00	0	0	0.00	1	0.24	0	0	0.00	0	0	0.00	0	0.00
2	*Alsodeiopsis schumannii*	3	3	0.73	0	0	0.00	0	0.00	15	13	3.17	0	2	0.49	0	0.00
2	*Aningeria adolfi-friedericii*	12	6	1.46	0	1	0.24	5	1.22	1	1	0.24	0	0	0.00	0	0.00
2	*Anisophylea obtusifolia*	24	21	5.12	1	2	0.73	0	0.00	16	16	3.90	0	0	0.00	0	0.00
2	*Annickia kumeriae*	11	6	1.46	2	3	1.22	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Anthocleista grandiflora*	6	6	1.46	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Antidesma membraneseum*	0	0	0.00	0	0	0.00	0	0.00	3	3	0.73	0	0	0.00	0	0.00
2	*Aoranthe penduliflora*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Beilschmiedia kweo*	10	2	0.49	5	1	1.46	2	0.49	1	1	0.24	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
2	*Bersama abyssinica*	1	1	0.24	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Blighia unijugata*	4	2	0.49	0	0	0.00	2	0.49	13	12	2.93	1	0	0.24	0	0.00
2	*Bridelia micrantha*	1	1	0.24	0	0	0.00	0	0.00	1	0	0.00	1	0	0.24	0	0.00
2	*Celtis africana*	4	3	0.73	0	1	0.24	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Celtis gomphophylla*	1	1	0.24	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Cephalosphaera usambarensis*	42	33	8.05	6	1	1.71	2	0.49	45	30	7.32	13	1	3.41	1	0.24
2	*Cheilanthes bergiana*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Chrysophyllum perpulchrum*	21	17	4.15	0	0	0.00	4	0.98	19	17	4.15	2	0	0.49	0	0.00
2	*Chrysophylum gorungonosum*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Chytranthus obliquinervis*	1	1	0.24	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Cleistanthus amaniensis*	0	0	0.00	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Cleistanthus polystachyus*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Coffea Sp*	0	0	0.00	0	0	0.00	0	0.00	4	4	0.98	0	0	0.00	0	0.00
2	*Cola greenwayi*	16	10	2.44	6	0	1.46	0	0.00	2	0	0.00	0	1	0.24	1	0.24
2	*Cola usambarensis*	6	3	0.73	2	1	0.73	0	0.00	16	11	2.68	4	1	1.22	0	0.00
2	*Coloncoba schweinfurthii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Cordia sinensis*	0	0	0.00	0	0	0.00	0	0.00	1	0	0.00	1	0	0.24	0	0.00
2	*Cremaspora triflora*	19	17	4.15	1	0	0.24	1	0.24	19	19	4.63	0	0	0.00	0	0.00
2	*Cyathea manniana*	0	0	0.00	0	0	0.00	0	0.00	5	4	0.98	0	1	0.24	0	0.00
2	*Cylicomorpha parviflora*	7	7	1.71	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Cynometra brachyrrhachis*	8	7	1.71	0	1	0.24	0	0.00	13	5	1.22	6	2	1.95	0	0.00
2	*Cynometra engleri*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Cynometra fischeri*	0	0	0.00	0	0	0.00	0	0.00	1	0	0.00	1	0	0.24	0	0.00
2	*Cynometra longipedidicellata*	3	3	0.73	0	0	0.00	0	0.00	3	3	0.73	0	0	0.00	0	0.00
2	*Cynometra webberi*	1	1	0.24	0	0	0.00	0	0.00	5	4	0.98	1	0	0.24	0	0.00
2	*Diospyros amaniensis*	1	1	0.24	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Drypetes garardii*	24	24	5.85	0	0	0.00	0	0.00	14	13	3.17	1	0	0.24	0	0.00
2	*Englerodendron usambarense*	8	7	1.71	0	1	0.24	0	0.00	10	8	1.95	1	1	0.49	0	0.00

Appendix 1 continiues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
2	*Entandrophragma excelsium*	1	1	0.24	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Ficus sur*	2	2	0.49	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Funtumia africana*	4	4	0.98	0	0	0.00	0	0.00	4	4	0.98	0	0	0.00	0	0.00
2	*Garcinia buchananii*	1	1	0.24	0	0	0.00	0	0.00	4	4	0.98	0	0	0.00	0	0.00
2	*Garcinia volkensii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Greenwayodendron suaveolens*	55	50	12.20	2	2	0.98	1	0.24	45	31	7.56	13	1	3.41	0	0.00
2	*Harungana madagascariensis*	5	5	1.22	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Isoberlinia scheffleri*	19	17	4.15	1	0	0.24	1	0.24	6	4	0.98	0	1	0.24	1	0.24
2	*Isolana heinsenii*	1	1	0.24	0	0	0.00	0	0.00	6	5	1.22	1	0	0.24	0	0.00
2	*Jambosa jambos*	0	0	0.00	0	0	0.00	0	0.00	3	3	0.73	0	0	0.00	0	0.00
2	*Lannea schweinfurthii*	1	1	0.24	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Leptonychia usambarensis*	11	10	2.44	0	0	0.00	1	0.24	31	24	5.85	4	3	1.71	0	0.00
2	*Macaranga capensis*	11	9	2.20	0	0	0.00	2	0.49	10	10	2.44	0	0	0.00	0	0.00
2	*Maesopsis eminii*	170	154	37.56	0	0	0.00	16	3.90	82	77	18.78	2	1	0.73	2	0.49
2	*Magnistipula butayei*	3	3	0.73	0	0	0.00	0	0.00	6	6	1.46	0	0	0.00	0	0.00
2	*Maranthes goetzeana*	12	10	2.44	0	0	0.00	2	0.49	3	3	0.73	0	0	0.00	0	0.00
2	*Maytenus acuminata*	6	6	1.46	0	0	0.00	0	0.00	5	4	0.98	0	0	0.00	1	0.24
2	*Maytenus senegalensis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Maytenus Sp*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Maytenus Sp*	0	0	0.00	0	0	0.00	0	0.00	9	9	2.20	0	0	0.00	0	0.00
2	*Maytenus undata*	3	3	0.73	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Memecylon semseii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Mesogyne insignis*	11	5	1.22	1	0	0.24	5	1.22	80	77	18.78	2	0	0.49	1	0.24
2	*Michelia champaca*	1	1	0.24	0	0	0.00		0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Mimusops kummel*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Morinda asterocepa*	2	2	0.49	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Myrianthus holstii*	62	57	13.90	0	0	0.00	5	1.22	33	33	8.05	0	0	0.00	0	0.00
2	*Newtonia buchananii*	13	10	2.44	0	2	0.49	1	0.24	5	4	0.98	1	0	0.24	0	0.00
2	*Ochna holstii*	2	2	0.49	0	0	0.00	0	0.00	7	7	1.71	0	0	0.00	0	0.00

Appendis 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
2	*Ocotea usambarensis*	1	0	0.00	0	1	0.24	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Odyendea zimermannii*	4	4	0.98	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Oxyanthus speciosus*	1	1	0.24	0	0	0.00	0	0.00	7	6	1.46	1	0	0.24	0	0.00
2	*Parinari excelsa*	13	12	2.93	0	0	0.00	1	0.24	8	8	1.95	0	0	0.00	0	0.00
2	*Phylanthus inflatus*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Phyllanhus Sp*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Placodiscus amaniensis*	0	0	0.00	0	0	0.00	0	0.00	3	3	0.73	0	0	0.00	0	0.00
2	*Polyceratocarpus scheffleri*	3	3	0.73	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Polyscias fulva*	4	2	0.49	0	0	0.00	2	0.49	2	2	0.49	0	0	0.00	0	0.00
2	*Pouteria adolfifriedericii*	1	1	0.24	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Pterocarpus tinctorius*	0	0	0.00	0	0	0.00	0	0.00	3	3	0.73	0	0	0.00	0	0.00
2	*Quassia undulata*	31	26	6.34	0	0	0.00	5	1.22	6	6	1.46	0	0	0.00	0	0.00
2	*Rauvolfia mombasiana*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Rawsonia lucida*	15	15	3.66	0	0	0.00	0	0.00	35	35	8.54	0	0	0.00	0	0.00
2	*Rinorea albersii*	0	0	0.00	0	0	0.00	0	0.00	12	12	2.93	0	0	0.00	0	0.00
2	*Rytiginia flavida*	1	1	0.24	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Rytingynia xanthotricha*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Sapium ellipticum*	8	8	1.95	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Schefflerodendron usambarense*	6	4	0.98	0	0	0.00	2	0.49	12	8	1.95	1	2	0.73	1	0.24
2	*Sorindeia madagascariensis*	62	58	14.15	1	0	0.24	3	0.73	113	110	26.83	2	0	0.49	1	0.24
2	*Spathodea nilotica*	0	0	0.00	0	0	0.00	0	0.00	5	3	0.73	2	0	0.49	0	0.00
2	*Strombosia scheffleri*	34	26	6.34	2	5	1.71	1	0.24	40	24	5.85	9	7	3.90	0	0.00
2	*Suregada zanzibarense*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Synsepalum cerasiferum*	20	18	4.39	1	0	0.24	1	0.24	14	12	2.93	1	1	0.49	0	0.00
2	*Synsepalum msolo*	1	0	0.00	0	0	0.00	1	0.24	0	0	0.00	0	0	0.00	0	0.00
2	*Syzigium guinense*	3	1	0.24	0	0	0.00	2	0.49	3	3	0.73	0	0	0.00	0	0.00
2	*Tabernaemontana pachysiphon*	4	3	0.73	1	0	0.24	0	0.00	19	15	3.66	1	2	0.73	1	0.24
2	*Tarenna nigrenscens*	2	2	0.49	0	0	0.00	0	0.00	5	5	1.22	0	0	0.00	0	0.00
2	*Teclea mespiliformis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
2	*Teclea nobilis*	0	0	0.00	0	0	0.00	0	0.00	3	3	0.73	0	0	0.00	0	0.00
2	*Tricalysia anomala*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Tricalysia pallens*	1	1	0.24	0	0	0.00	0	0.00	6	6	1.46	0	0	0.00	0	0.00
2	*Trichilia dregeana*	7	7	1.71	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Trichilie emetica*	2	2	0.49	0	0	0.00	0	0.00	2	2	0.49	0	0	0.00	0	0.00
2	*Trilepsium madagascariensis*	4	4	0.98	0	0	0.00	0	0.00	4	4	0.98	0	0	0.00	0	0.00
2	*Uvariodendron usambarense*	5	3	0.73	2	0	0.49	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Vepris amaniensis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Vepris simplicifolia*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Voacanga africana*	0	0	0.00	0	0	0.00	0	0.00	1	0	0.00	1	0	0.24	0	0.00
2	*Voacanga lutescens*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.24	0	0	0.00	0	0.00
2	*Xylopia aethiopica*	11	11	2.68	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Xymolos monospora*	12	7	1.71	2	2	0.98	1	0.24	5	5	1.22	0	0	0.00	0	0.00
2	*Zanha golungensis*	1	1	0.24	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Zanthoxyllum gilletii*	1	1	0.24	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
2	*Zanthoxylum usambarense*	3	3	0.73	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Alangium chinense*	2	2	0.82	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Albizia adianthifolia*	2	2	0.82	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Albizia gummifera*	2	2	0.82	0	0	0.00	0	0.00	3	3	1.22	0	0	0.00	0	0.00
3	*Alchornea hirtella*	4	0	0.00	1	3	1.63	0	0.00	106	105	42.86	0	0	0.00	1	0.41
3	*Allanblackia stuhlmannii*	38	36	14.69	0	0	0.00	2	0.82	16	16	6.53	0	0	0.00	0	0.00
3	*Allophyllus melliodorus*	1	1	0.41	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Alsodeiopsis schumannii*	2	2	0.82	0	0	0.00	0	0.00	22	21	8.57	0	0	0.00	1	0.41
3	*Aningeria adolfi-friedericii*	2	2	0.82	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Anisophyllea obtusifolia*	14	13	5.31	0	0	0.00	1	0.41	3	3	1.22	0	0	0.00	0	0.00
3	*Anthocleista grandiflora*	14	13	5.31	0	0	0.00	1	0.41	4	4	1.63	0	0	0.00	0	0.00
3	*Antidesma membranaceum*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Aoranthe penduliflora*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
3	*Beilschmiedia kweo*	13	1	0.41	1	1	0.82	10	4.08	2	2	0.82	0	0	0.00	0	0.00
3	*Bersama abyssinica*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.22	0	0	0.00	0	0.00
3	*Blighia unijugata*	1	1	0.41	0	0	0.00	0	0.00	4	4	1.63	0	0	0.00	0	0.00
3	*Bridelia micrantha*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Bridelia micrantha*	3	3	1.22	0	0	0.00	0	0.00	8	7	2.86	0	0	0.00	1	0.41
3	*Cassipourea gummiflua*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Celtis africana*	2	2	0.82	0	0	0.00	0	0.00	1	0	0.00	0	1	0.41	0	0.00
3	*Cephalosphaera usambarensis*	43	36	14.69	4	2	2.45	1	0.41	74	65	26.53	7	2	3.67	0	0.00
3	*Chrysophyllum perpulchrum*	7	5	2.04	0	0	0.00	2	0.82	6	6	2.45	0	0	0.00	0	0.00
3	*Cleistanthus amaniensis*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Coffea pseudozanguebariae*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*Cola greenwayi*	4	4	1.63	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Cremaspora triflora*	2	2	0.82	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Cyathea manniana*	1	1	0.41	0	0	0.00	0	0.00	19	17	6.94	1	1	0.82	0	0.00
3	*Cylicomorpha parviflora*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Cynometra brachyrrhachis*	7	6	2.45	1	0	0.41	0	0.00	5	3	1.22	1	0	0.41	1	0.41
3	*Cynometra longipedidicellata*	4	4	1.63	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Dasylepis integra*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Drypetes gerardii*	26	26	10.61	0	0	0.00	0	0.00	8	8	3.27	0	0	0.00	0	0.00
3	*Drypetes usambarica*	13	13	5.31	0	0	0.00	0	0.00	4	4	1.63	0	0	0.00	0	0.00
3	*Englerodendron usambarense*	13	10	4.08	1	0	0.41	2	0.82	9	8	3.27	1	0	0.41	0	0.00
3	*Entandrophragma excelsum*	2	2	0.82	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Ficus sur*	1	1	0.41	0	0	0.00	0	0.00	5	5	2.04	0	0	0.00	0	0.00
3	*Ficus vallis-choudae*	4	4	1.63	0	0	0.00	0	0.00	5	5	2.04	0	0	0.00	0	0.00
3	*Garcinia buchananii*	2	2	0.82	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Garcinia grotei*	4	4	1.63	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Greenwayodendron suaveolens*	31	21	8.57	6	2	3.27	2	0.82	9	9	3.67	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
	Harungana madagascariensis	1	1	0.41	0	0	0.00	0	0.00	2	1	0.41	0	0	0.00	1	0.41
3	*Ilex mitis*	2	2	0.82	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Isoberlinia scheffleri*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Isoberlinia scheffleri*	5	4	1.63	0	0	0.00	1	0.41	7	7	2.86	0	0	0.00	0	0.00
3	*Isolana heinsenii*	1	1	0.41	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Julbernardia globiflora*	3	3	1.22	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Leptonychia usambarensis*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*Macaranga capensis*	22	16	6.53	0	0	0.00	6	2.45	14	10	4.08	1	0	0.41	3	1.22
3	*Maesa lanceolata*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Maesopsis eminii*	88	84	34.29	0	0	0.00	4	1.63	26	23	9.39	0	1	0.41	2	0.82
3	*Magnistipula butayei*	1	1	0.41	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*Maranthes goetzenina*	3	3	1.22	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Margaritaria discoidea*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Maytenus acuminata*	2	2	0.82	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*Mesogyne insignis*	7	7	2.86	0	0	0.00	0	0.00	31	31	12.65	0	0	0.00	0	0.00
3	*Mimusops kummel*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*Morinda asteroscepa*	3	3	1.22	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Myrianthus holstii*	17	15	6.12	0	0	0.00	2	0.82	12	11	4.49	0	1	0.41	0	0.00
3	*Newtonia buchananii*	11	7	2.86	0	2	0.82	2	0.82	20	20	8.16	0	0	0.00	0	0.00
3	*Ocotea usambarensis*	1	0	0.00	0	0	0.00	1	0.41	0	0	0.00	0	0	0.00	0	0.00
3	*Oxyanthus pyriformis*	3	3	1.22	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Oxyanthus speciosus*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.22	0	0	0.00	0	0.00
3	*Parinari excelsa*	2	2	0.82	0	0	0.00	0	0.00	2	1	0.41	0	1	0.41	0	0.00
3	*Platypterocarpus scheffleri*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Platypterocarpus tanganyikensis*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Polyscias fulva*	11	11	4.49	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Polysphaeria macrantha*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
3	*psychotria usambarensis*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.22	0	0	0.00	0	0.00
3	*Quassia undulata*	19	19	7.76	0	0	0.00	0	0.00	10	9	3.67	1	0	0.41	0	0.00
3	*Rawsonia lucida*	9	9	3.67	0	0	0.00	0	0.00	10	10	4.08	0	0	0.00	0	0.00
3	*Rinorea albersii*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.22	0	0	0.00	0	0.00
3	*Rytigynia stuhlmannii*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*Sapium ellipticum*	7	7	2.86	0	0	0.00	0	0.00	11	11	4.49	0	0	0.00	0	0.00
3	*Schefflerodendron usambarense*	3	3	1.22	0	0	0.00	0	0.00	9	8	3.27	0	0	0.00	1	0.41
3	*Sorindeia madagascariensis*	5	5	2.04	0	0	0.00	0	0.00	41	41	16.73	0	0	0.00	0	0.00
3	*Spathodea campanulata*	1	1	0.41	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
3	*Strombosia scheffleri*	6	6	2.45	0	0	0.00	0	0.00	6	6	2.45	0	0	0.00	0	0.00
3	*Synsepalum cerasiferum*	5	5	2.04	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*Synsepalum msolo*	0	0	0.00	0	0	0.00	0	0.00	5	3	1.22	1	1	0.82	0	0.00
3	*Syzygium guineense*	9	7	2.86	0	0	0.00	2	0.82	4	4	1.63	0	0	0.00	0	0.00
3	*Tabernaemontana pachysiphon*	1	1	0.41	0	0	0.00	0	0.00	6	6	2.45	0	0	0.00	0	0.00
3	*Tarenna nigrenscens*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Teclea trichocarpa*	4	4	1.63	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Tricalysia anomala*	1	1	0.41	0	0	0.00	0	0.00	9	9	3.67	0	0	0.00	0	0.00
3	*Trichilia dregeana*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Trilepsium mdagascariensis*	1	1	0.41	0	0	0.00	0	0.00	3	3	1.22	0	0	0.00	0	0.00
3	*Vepris amaniensis*	1	1	0.41	0	0	0.00	0	0.00	1	1	0.41	0	0	0.00	0	0.00
3	*Xylopia aethiopica*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.22	0	0	0.00	0	0.00
3	*Xymolos monospora*	6	3	1.22	0	0	0.00	3	1.22	8	7	2.86	0	0	0.00	1	0.41
3	*Zanthoxylum usambarense*	1	1	0.41	0	0	0.00	0	0.00	2	2	0.82	0	0	0.00	0	0.00
3	*zenkerella egregia*	3	3	1.22	0	0	0.00	0	0.00	10	10	4.08	0	0	0.00	0	0.00
4	*Alangium chinense*	5	5	2.78	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Albizia glaberima*	3	2	1.11	0	0	0.00	1	0.56	1	1	0.56	0	0	0.00	0	0.00
4	*Alchornea hirtella*	1	0	0.00	0	1	0.56	0	0.00	6	6	3.33	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
4	*Allanblackia stuhlmanii*	18	17	9.44	0	0	0.00	1	0.56	7	7	3.89	0	0	0.00	0	0.00
4	*Allophyllus melliodorus*	3	3	1.67	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Anglocalyx braunii*	0	0	0.00	0	0	0.00	0	0.00	4	4	2.22	0	0	0.00	0	0.00
4	*Aningeria adolfi-friedericii*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Anisophyllea obtusifolia*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Annickia kummeriae*	16	15	8.33	1	0	0.56	0	0.00	11	11	6.11	0	0	0.00	0	0.00
4	*Annona senegalensis*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Anthocleista grandiflora*	11	11	6.11	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Antiaris toxicaria*	30	26	14.44	0	0	0.00	4	2.22	15	14	7.78	1	0	0.56	0	0.00
4	*Antidesma membranaceum*	2	2	1.11	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Barringtonia racemosa*	1	1	0.56	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Blighia unijugata*	3	3	1.67	0	0	0.00	0	0.00	8	7	3.89	1	0	0.56	0	0.00
4	*Bombax rhodognaphalon*	2	2	1.11	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Bridelia micrantha*	2	0	0.00	0	1	0.56	1	0.56	0	0	0.00	0	0	0.00	0	0.00
4	*Celtis africana*	4	4	2.22	0	0	0.00	0	0.00	4	3	1.67	1	0	0.56	0	0.00
4	*Celtis gomphophylla*	8	7	3.89	1	0	0.56	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Celtis phillipensis*	2	1	0.56	0	1	0.56	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Celtis wightii*	3	2	1.11	1	0	0.56	0	0.00	3	2	1.11	1	0	0.56	0	0.00
4	*Cephalosphaera usambarensis*	37	34	18.89	0	0	0.00	3	1.67	26	26	14.44	0	0	0.00	0	0.00
4	*Cheilanthes bergiana*	1	0	0.00	0	0	0.00	1	0.56	2	2	1.11	0	0	0.00	0	0.00
4	*Chrysophyllum perpulchrum*	5	5	2.78	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Cinnamomum zeilanicum*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Coffea pseudozanguebariae*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Coffea robusta*	0	0	0.00	0	0	0.00	0	0.00	6	6	3.33	0	0	0.00	0	0.00
4	*Coffea sp*	0	0	0.00	0	0	0.00	0	0.00	5	5	2.78	0	0	0.00	0	0.00
4	*Cola clavata*	2	2	1.11	0	0	0.00	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Cola discoglypremnaphylla*	1	0	0.00	1	0	0.56	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Cola greenwayi*	1	1	0.56	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Cola scheffleri*	3	3	1.67	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00

Appendix I continues

rans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
4	*Combretum schumannii*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Cremaspora triflora*	0	0	0.00	0	0	0.00	0	0.00	4	4	2.22	0	0	0.00	0	0.00
4	*Croton sylvaticus*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Croton sylvaticus*	7	6	3.33	1	0	0.56	0	0.00	4	4	2.22	0	0	0.00	0	0.00
4	*Cussonia spicata*	5	5	2.78	0	0	0.00	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Cylicomorpha parviflora*	2	2	1.11	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Cynometra brachyrrachis*	0	0	0.00	0	0	0.00	0	0.00	3	1	0.56	2	0	1.11	0	0.00
4	*Dialium holtsii*	2	2	1.11	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Diospyros mespiliformis*	1	0	0.00	1	0	0.56	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Diospyros natalensis*	4	4	2.22	0	0	0.00	0	0.00	9	7	3.89	0	2	1.11	0	0.00
4	*Diospyros squarrosa*	1	1	0.56	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Diospyros usambarensis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Dombeya shupangae*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Dorstenia hildebrandtii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Drypetes garardii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Drypetes subdentata*	3	2	1.11	1	0	0.56	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Drypetes usambarica*	2	2	1.11	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Englerodendron usambarense*	0	0	0.00	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Englerophytum natalense*	3	3	1.67	0	0	0.00	0	0.00	10	7	3.89	2	1	1.67	0	0.00
4	*Entandrophragma excelsum*	1	0	0.00	1	0	0.56	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Erythrococca kirkii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Erythrococca usambarica*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Erythrophloem suaveolens*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Fernandoa magnifica*	1	1	0.56	0	0	0.00	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Ficus exasperata*	3	3	1.67	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Ficus sur*	2	2	1.11	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Ficus sycomorus*	3	3	1.67	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Ficus usambarensis*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
4	*Ficus vallis-choudae*	3	1	0.56	0	0	0.00	2	1.11	0	0	0.00	0	0	0.00	0	0.00
4	*Funtumia africana*	28	26	14.44	2	0	1.11	0	0.00	19	18	10.00	1	0	0.56	0	0.00
4	*Funtumia elastica*	1	1	0.56	0	0	0.00	0	0.00	3	2	1.11	0	1	0.56	0	0.00
4	*Gerocarpus americanus*	1	1	0.56	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Greenwayodendron suaveolens*	8	7	3.89	1	0	0.56	0	0.00	7	5	2.78	2	0	1.11	0	0.00
4	*Grewia bicolor*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Grewia goetzeana*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Harrisonia abyssinica*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Hoslundia opposita*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Isoberlinia scheffleri*	4	4	2.22	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Isolana cauliflora*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Keetia guienzii*	1	1	0.56	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Khaya anthotheka*	9	6	3.33	1	1	1.11	1	0.56	5	4	2.22	1	0	0.56	0	0.00
4	*Lannea welwitschii*	5	5	2.78	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Lecaniodiscus fraxinifolius*	7	5	2.78	0	0	0.00	2	1.11	6	6	3.33	0	0	0.00	0	0.00
4	*Leptonychia usambarensis*	83	78	43.33	3	0	1.67	2	1.11	148	132	73.33	13	3	8.89	0	0.00
4	*Lettowianthus stestellatus*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Lonchocarpus capassa*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Macaranga capensis*	16	15	8.33	0	0	0.00	1	0.56	2	2	1.11	0	0	0.00	0	0.00
4	*Maesopsis eminii*	46	38	21.11	1	0	0.56	7	3.89	20	20	11.11	0	0	0.00	0	0.00
4	*Manilkara obovata*	1	1	0.56	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Maranthes goetzenina*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Markhamiia lutea*	4	4	2.22	0	0	0.00	0	0.00	12	10	5.56	0	0	0.00	2	1.11
4	*Melia adzedarach*	4	1	0.56	2	0	1.11	1	0.56	22	12	6.67	6	3	5.00	1	0.56
4	*Mesogyne insignis*	0	0	0.00	0	0	0.00	0	0.00	9	9	5.00	0	0	0.00	0	0.00
4	*Milicia excelsa*	31	10	5.56	19	1	11.11	1	0.56	0	0	0.00	0	0	0.00	0	0.00
4	*Millettia usaramensis*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Mimusopis aedificatoria*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Morus mesozygia*	3	3	1.67	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
4	*Myrianthus holstii*	22	21	11.67	0	0	0.00	1	0.56	4	3	1.67	0	0	0.00	1	0.56
4	*Nersogodonia holtsii*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Newtonia buchananii*	6	5	2.78	0	0	0.00	1	0.56	1	1	0.56	0	0	0.00	0	0.00
4	*Olea capensis*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Oxyanthus speciosus*	3	3	1.67	0	0	0.00	0	0.00	15	15	8.33	0	0	0.00	0	0.00
4	*Parinari excelsa*	5	5	2.78	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Parkia filicoidea*	2	1	0.56	0	0	0.00	1	0.56	0	0	0.00	0	0	0.00	0	0.00
4	*Pentadesma butyraceae*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Placodiscus amaniensis*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Polyscias fulva*	3	3	1.67	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Polysphaeria macrantha*	0	0	0.00	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Pouteria adolfi-friederici*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Pouteria alnifolia*	11	11	6.11	0	0	0.00	0	0.00	4	4	2.22	0	0	0.00	0	0.00
4	*Premna chhrysoclada*	4	4	2.22	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Psychotria peteri*	2	2	1.11	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Pterocarpus tinctorius*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Quassia undulata*	22	21	11.67	0	0	0.00	1	0.56	8	8	4.44	0	0	0.00	0	0.00
4	*Rausonia lucida*	5	5	2.78	0	0	0.00	0	0.00	7	7	3.89	0	0	0.00	0	0.00
4	*Ricinodendron heudelotii*	7	7	3.89	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Rinorea albersii*	1	1	0.56	0	0	0.00	0	0.00	22	20	11.11	1	1	1.11	0	0.00
4	*Rinorea ilicifolia*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Rothmania manganjae*	7	7	3.89	0	0	0.00	0	0.00	11	10	5.56	1	0	0.56	0	0.00
4	*Rytigynia stuhlmannii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Sapium ellipticum*	12	12	6.67	0	0	0.00	0	0.00	2	2	1.11	0	0	0.00	0	0.00
4	*Schefflerodendron usambarensis*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Sorindeia madagascariensis*	2	1	0.56	1	0	0.56	0	0.00	12	11	6.11	0	0	0.00	1	0.56
4	*Stereospermum kunthianum*	4	4	2.22	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Strombosia scheffleri*	26	22	12.22	2	1	1.67	1	0.56	15	11	6.11	2	2	2.22	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
4	*Synsepalum cerasiferum*	9	8	4.44	1	0	0.56	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Synsepalum msolo*	66	63	35.00	2	0	1.11	1	0.56	30	25	13.89	2	0	1.11	3	1.67
4	*Syzygium guineense*	2	2	1.11	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
4	*Tabernaemontana pachysiphon*	15	14	7.78	0	0	0.00	1	0.56	36	30	16.67	2	0	1.11	4	2.22
4	*Tabernaemontana ventricosa*	7	5	2.78	0	0	0.00	2	1.11	25	25	13.89	0	0	0.00	0	0.00
4	*Tarenna nigrenscens*	2	2	1.11	0	0	0.00	0	0.00	9	9	5.00	0	0	0.00	0	0.00
4	*Terminalia sambesiaca*	4	4	2.22	0	0	0.00	0	0.00	3	3	1.67	0	0	0.00	0	0.00
4	*Trema orientalis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Tricalysia anomala*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Trichilia dregeana*	5	5	2.78	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Trichilia emetica*	4	4	2.22	0	0	0.00	0	0.00	1	1	0.56	0	0	0.00	0	0.00
4	*Trilepsium madagascariensis*	41	39	21.67	0	0	0.00	2	1.11	20	17	9.44	3	0	1.67	0	0.00
4	*Uvariodendron pycnophyllum*	13	8	4.44	4	1	2.78	0	0.00	14	14	7.78	0	0	0.00	0	0.00
4	*Zanha golungensis*	8	7	3.89	0	0	0.00	1	0.56	2	2	1.11	0	0	0.00	0	0.00
4	*Zanthoxylum usambarense*	1	1	0.56	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Alangium chinense*	1	1	0.47	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Albizia glaberrima*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Albizia gummifera*	2	2	0.93	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Albizia petersiana*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Alchornea hertella*	0	0	0.00	0	0	0.00	0	0.00	7	7	3.26	0	0	0.00	0	0.00
5	*Allanblackia stuhlmanii*	23	20	9.30	0	1	0.47	2	0.93	9	9	4.19	0	0	0.00	0	0.00
5	*Annickia kumeriae*	26	14	6.51	9	3	5.58	0	0.00	9	7	3.26	2	0	0.93	0	0.00
5	*Anthocleista grandiflora*	3	3	1.40	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Antiaris toxicaria*	10	10	4.65	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Aoranthe penduliflora*	1	0	0.00	0	0	0.00	1	0.47	0	0	0.00	0	0	0.00	0	0.00
5	*Blighia unijugata*	3	3	1.40	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Bombax rhodognaphalon*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Celtis africana*	1	1	0.47	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
5	*Celtis gomphophylla*	0	0	0.00	0	0	0.00	0	0.00	2	2	0.93	0	0	0.00	0	0.00
5	*Celtis mildbraedii*	2	2	0.93	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Cephalosphaera usambarensis*	15	13	6.05	1	0	0.47	1	0.47	10	7	3.26	2	1	1.40	0	0.00
5	*Chrysophyllum perpulchrum*	3	2	0.93	0	0	0.00	1	0.47	3	3	1.40	0	0	0.00	0	0.00
5	*Cola scheffleri*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Cola usambarensis*	0	0	0.00	0	0	0.00	0	0.00	1	0	0.00	1	0	0.47	0	0.00
5	*Cremaspora triflora*	7	7	3.26	0	0	0.00	0	0.00	4	4	1.86	0	0	0.00	0	0.00
5	*Croton silvaticus*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Cynometra brachyrrhachis*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Deinbolia kilimandscharica*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Dracaena usambarensis*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Drypetes gerandii*	1	1	0.47	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Englerodendro usambarensis*	2	2	0.93	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Entandrophragma excelsum*	3	2	0.93	0	1	0.47	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Erythrophloem suaveolens*	3	2	0.93	0	1	0.47	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Fernandoa magnifica*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Ficus exasperata*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Ficus lutea*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Ficus sur*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Ficus sycomorus*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Ficus usambarensis*	2	2	0.93	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Ficus valischoudae*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Funtumia africana*	14	11	5.12	0	2	0.93	1	0.47	5	4	1.86	1	0	0.47	0	0.00
5	*Greenwayodendron suaeolens*	1	0	0.00	0	0	0.00	1	0.47	0	0	0.00	0	0	0.00	0	0.00
5	*Greenwayodendron suaeolens*	5	2	0.93	1	0	0.47	2	0.93	3	2	0.93	1	0	0.47	0	0.00
5	*Keetia Sp*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Khaya anthotheka*	5	5	2.33	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Lannea welwitschii*	2	2	0.93	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
5	*Leptonychia usambarensis*	67	66	30.70	1	0	0.47	0	0.00	142	116	53.95	15	9	11.16	2	0.93
5	*Macaranga capensis*	9	9	4.19	0	0	0.00	0	0.00	5	5	2.33	0	0	0.00	0	0.00
5	*Maesopsis eminii*	26	23	10.70	0	0	0.00	3	1.40	8	7	3.26	0	0	0.00	1	0.47
5	*Magnistipula butayei*	3	3	1.40	0	0	0.00	0	0.00	2	2	0.93	0	0	0.00	0	0.00
5	*Manilkara zanzibariensis*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Maranthes goetzenina*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Maytenus holstii*	3	3	1.40	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Mesogyne insignis*	1	1	0.47	0	0	0.00	0	0.00	11	11	5.12	0	0	0.00	0	0.00
5	*Milicia excelsa*	1	0	0.00	1	0	0.47	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Milicia excelsa*	15	1	0.47	12	2	6.51	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Mimusopis aedificatoria*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Myrianthus holstii*	32	31	14.42	0	0	0.00	1	0.47	9	9	4.19	0	0	0.00	0	0.00
5	*Newtonia buchananii*	11	4	1.86	1	2	1.40	4	1.86	0	0	0.00	0	0	0.00	0	0.00
5	*Newtonia paucijuga*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Oxyanthus speciosus*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.40	0	0	0.00	0	0.00
5	*Parinari excelsa*	3	3	1.40	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Polyceratocarpus cheffleri*	2	2	0.93	0	0	0.00	0	0.00	3	3	1.40	0	0	0.00	0	0.00
5	*Poterandea penduliflora*	2	2	0.93	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Pouteria adolfifriederecii*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Pouteria alnifolia*	7	7	3.26	0	0	0.00	0	0.00	7	7	3.26	0	0	0.00	0	0.00
5	*Psychotria peteri*	0	0	0.00	0	0	0.00	0	0.00	3	3	1.40	0	0	0.00	0	0.00
5	*Pterocarpus tinctorius*	1	0	0.00	0	1	0.47	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Quasia undulata*	12	11	5.12	0	0	0.00	1	0.47	0	0	0.00	0	0	0.00	0	0.00
5	*Rauvolfia caffra*	1	1	0.47	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Ricinodendron heudelotii*	3	2	0.93	0	0	0.00	1	0.47	0	0	0.00	0	0	0.00	0	0.00
5	*Rinorea albersii*	0	0	0.00	0	0	0.00	0	0.00	7	6	2.79	0	0	0.00	1	0.47
5	*Rothmania manganjae*	4	4	1.86	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Rytigynia stuhlmannii*	0	0	0.00	0	0	0.00	0	0.00	2	1	0.47	1	0	0.47	0	0.00

Appendix 1 continues

Trans No	*SPECIES*	Tot.T	LT	LT/Ha	NCT	OCT	CT/Ha	NDT	NDT/ Ha	Tot.S	LS	LS/Ha	NCS	OCS	CS/Ha	NDS	NDS/ Ha
5	*Sapium ellipticum*	10	9	4.19	0	0	0.00	1	0.47	1	1	0.47	0	0	0.00	0	0.00
5	*Schefflerodendron usambarensis*	1	0	0.00	0	1	0.47	0	0.00	0	0	0.00	0	0	0.00	0	0.00
5	*Sorindeia madagascariensis*	11	11	5.12	0	0	0.00	0	0.00	22	22	10.23	0	0	0.00	0	0.00
5	*Stereospermum kunthianum*	3	2	0.93	0	0	0.00	1	0.47	5	4	1.86	0	1	0.47	0	0.00
5	*Strombosia scheffleri*	42	31	14.42	7	3	4.65	1	0.47	14	10	4.65	4	0	1.86	0	0.00
5	*Synsepalum cerasiferum*	8	8	3.72	0	0	0.00	0	0.00	5	5	2.33	0	0	0.00	0	0.00
5	*Synsepalum msolo*	23	20	9.30	1	0	0.47	2	0.93	4	4	1.86	0	0	0.00	0	0.00
5	*Syzygium guineense*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Tabernaemontana pachysiphon*	2	2	0.93	0	0	0.00	0	0.00	16	14	6.51	0	1	0.47	1	0.47
5	*Tabernaemontana ventricosa*	0	0	0.00	0	0	0.00	0	0.00	1	0	0.00	0	0	0.00	1	0.47
5	*Tarrena nigrensis*	1	1	0.47	0	0	0.00	0	0.00	2	2	0.93	0	0	0.00	0	0.00
5	*Tricalysia anomala*	1	1	0.47	0	0	0.00	0	0.00	3	3	1.40	0	0	0.00	0	0.00
5	*Tricaysia Sp*	1	1	0.47	0	0	0.00	0	0.00	2	2	0.93	0	0	0.00	0	0.00
5	*Trichilia emetica*	9	9	4.19	0	0	0.00	0	0.00	2	2	0.93	0	0	0.00	0	0.00
5	*Trilepsium madagascariensis*	28	26	12.09	0	0	0.00	2	0.93	8	7	3.26	1	0	0.47	0	0.00
5	*Uvariodendron usambarense*	5	4	1.86	0	0	0.00	1	0.47	9	6	2.79	2	1	1.40	0	0.00
5	*Vepris nobilis*	0	0	0.00	0	0	0.00	0	0.00	1	1	0.47	0	0	0.00	0	0.00
5	*Xymolos monospora*	3	1	0.47	0	1	0.47	1	0.47	0	0	0.00	0	0	0.00	0	0.00
5	*Zenkerela egregia*	2	2	0.93	0	0	0.00	0	0.00	0	0	0.00	0	0	0.00	0	0.00

Tot. T=Total number of trees. LT=Live trees. NCT=New cut trees. OCT=Old cut trees. NDT=Naturally dead trees. ToS=Total number of saplings/poles. LS=Live saplings/poles. NCS=New cut saplings/poles. OCS=Old cut saplings/poles. NDS=Naturally dead saplings/poles.

Appendix 2: Changes in numbers of species in the threatened categories (CR, EN, VU) from 1996 to 2006 in the world

	CR						EN						VU					
Group	1996/98	2000	2002	2003	2004	2006	1996/98	2000	2002	2003	2004	2006	1996/98	2000	2002	2003	2004	2006
Mammals	169	180	181	184	162	162	315	340	339	337	352	348	612	610	617	609	587	583
Birds	168	182	182	182	179	181	235	321	326	331	345	351	704	680	684	681	688	674
Reptiles	41	56	55	57	64	73	59	74	79	78	79	101	153	161	159	158	161	167
Amphibians	18	25	30	30	413	442	31	38	37	37	729	738	75	83	90	90	628	631
Fishes	157	156	157	162	171	253	134	144	143	144	160	238	443	452	442	444	470	682
Insects	44	45	46	46	47	68	116	118	118	118	120	129	377	392	393	389	392	426
Molluscs	257	222	222	250	265	265	212	237	236	243	221	222	451	479	481	474	488	488
Plantts	909	1014	1046	1276	1490	1541	1197	1266	1291	1634	2239	2258	3222	3331	3377	3864	4592	4591

CR=Critically Endangered, EN=Endangered, VU=Vulnerable

Source:IUCN 2006

Appendix 3: Tree species recorded in intact forest, disturbed forest and both intact and disturbed strata in ANR

SN	Intact forest spp	Disturbed forest spp	Both intact and disturbed spp
1	*Alangium chinense*	*Alangium chinense*	*Alangium chinense*
2	*Albizia glaberrima*	*Albizia adianthifolia*	*Albizia gummifera*
3	*Albizia gummifera*	*Albizia gummifera*	*Alchornea hirtella*
4	*Albizia petersiana*	*Alchornea hirtella*	*Allanblackia stuhlmnnii*
5	*Alchornea hertela*	*Allanblackia stuhlmnnii*	*Alsodoiepsis schummannii*
6	*Allanblackia stuhlmanii*	*Allophylus melliodorus*	*Aningeria adolfi-friedericii*
7	*Allophylus callophylus*	*Alsodoiepsis schummannii*	*Anisophyllea obtusifolia*
8	*Allophylus rubifolius*	*Anglocalyx braunii*	*Annickia kummeriae*
9	*Alsodeiopsis schumannii*	*Aningeria adolfi-friedericii*	*Anthocleista grandiflora*
10	*Aningeria adolfi-friedericii*	*Anisophyllea obtusifolia*	*Antiaris toxicaria*
11	*Anisophylea obtusifolia*	*Annickia kummeriae*	*Antidesma membraneseum*
12	*Annickia kumeriae*	*Annona senegalensis*	*Aoranthe penduliflora*
13	*Anthocleista grandiflora*	*Anthocleista grandiflora*	*Beilschmiedia kweo*
14	*Antiaris toxicaria*	*Antiaris toxicaria*	*Bersama abyssinica*
15	*Antidesma membraneseum*	*Antidesma membranaceum*	*Blighia unijugata*
16	*Aoranthe penduliflora*	*Aoranthe penduliflora*	*Bombax rhodognaphalon*
17	*Beilschmiedia kweo*	*Barringtonia racemosa*	*Bridelia micrantha*
18	*Bersama abyssinica*	*Beilschmiedia kweo*	*Celtis africana*
19	*Blighia unijugata*	*Bersama abyssinica*	*Celtis gomphophylla*
20	*Bombax rhodognaphalon*	*Blighia unijugata*	*Cephalosphaera usambarensis*
21	*Bridelia micrantha*	*Bombax rhodognaphalon*	*Cheilanthes bergiana*
22	*Celtis africana*	*Bridelia micrantha*	*Chrysophyllum perpulchrum*
23	*Celtis gomphophylla*	*Camelia sinnensis*	*Cleistanthus amaniensis*
24	*Celtis mildbraedii*	*Casearia batiscoidea*	*Cleistanthus polystachyus*
25	*Cephalosphaera usambarensis*	*Cassipourea gummiflua*	*Coffea sp*
26	*Cheilanthes bergiana*	*Celtis africana*	*Cola greenwayi*
27	*Chrysophyllum perpulchrum*	*Celtis gomphophylla*	*Cola scheffleri*
28	*Chrysophylum gorungonosum*	*Celtis phillipensis*	*Cola usambarensis*
29	*Chytranthus obliquinervis*	*Celtis wightii*	*Cremaspora triflora*
30	*Cleistanthus amaniensis*	*C.usambarensis*	*Croton sylvaticus*
31	*Cleistanthus polystachyus*	*Cheilanthes bergiana*	*Cyathea manniana*
32	*Coffea Sp*	*Chrysophyllum perpulchrum*	*Cylicomorpha parviflora*
33	*Cola greenwayi*	*Cinnamomum zeilanicum*	*Cynometra brachyrrhachis*
34	*Cola scheffleri*	*Cleistanthus amaniensis*	*Cynometra longipedidicellata*
35	*Cola usambarensis*	*Cleistanthus polystachys*	*Deinbolia kilimandscharica*
36	*Coloncoba schweinfurthii*	*Coffea arabica*	*Drypetes garardii*
37	*Cordia sinensis*	*Coffea pseudozanguebariae*	*Englerodendron usambarense*
38	*Cremaspora triflora*	*Coffea robusta*	*Entandrophragma excelsum*
39	*Croton silvaticus*	*Coffea sp*	*Erythrophloem suaveolens*
40	*Cyathea manniana*	*Cola clavata*	*Fernandoa magnifica*
41	*Cylicomorpha parviflora*	*Cola discoglypremnaphylla*	*Ficus exasperata*

Appendix 3 continues

SN	Intact forest spp	Disturbed forest spp	Both intact and disturbed spp
42	*Cynometra brachyrrhachis*	*Cola greenwayi*	*Ficus lutea*
43	*Cynometra engleri*	*Cola scheffleri*	*Ficus sur*
44	*Cynometra fischeri*	*Cola usambarensis*	*Ficus sycomorus*
45	*Cynometra longipedidicellata*	*Combretum schumannii*	*Ficus usambarensis*
46	*Cynometra webberi*	*Craibia zimmermannii*	*Ficus vallis-choudae*
47	*Deinbolia kilimandscharica*	*Cremaspora triflora*	*Funtumia africana*
48	*Diospyros amaniensis*	*Croton sylvaticus*	*Garcinia buchananii*
49	*Dracaena usambarensis*	*Cussonia spicata*	*Greenwayodendron suaveolens*
50	*Drypetes garardii*	*Cyathea manniana*	*Harungana madagascariensis*
51	*Englerodendron usambarense*	*Cylicomorpha parviflora*	*Isoberlinia scheffleri*
52	*Entandrophragma excelsium*	*Cynometra SP A*	*Isolana heinsenii*
53	*Erythrophloem suaveolens*	*C.brachyrrhachis*	*Keetia Sp*
54	*Fernandoa magnifica*	*C. longipedicelata*	*Khaya anthotheka*
55	*Ficus exasperata*	*Dasylepis integra*	*Lannea welwitschii*
56	*Ficus lutea*	*Deinbolia kilimandscharica*	*Leptonychia usambarensis*
57	*Ficus sur*	*Dialium holtsii*	*Macaranga capensis*
58	*Ficus sycomorus*	*Diospyros abyssinica*	*Maesopsis eminii*
59	*Ficus usambarensis*	*Diospyros mespiliformis*	*Magnistipula butayei*
60	*Ficus valischoudae*	*Diospyros natalensis*	*Maranthes goetzeana*
61	*Funtumia africana*	*Diospyros squarrosa*	*Maytenus acuminata*
62	*Garcinia buchananii*	*Diospyros usambarensis*	*Maytenus undata*
63	*Garcinia volkensii*	*Dombeya shupangae*	*Memecylon semseii*
64	*Greenwayodendron suaveolens*	*Dorstenia hildebrandtii*	*Mesogyne insignis*
65	*Harungana madagascariensis*	*Drypetes garardii*	*Milicia excelsa*
66	*Isoberlinia scheffleri*	*Drypetes subdentata*	*Mimusopis aedificatoria*
67	*Isolana heinsenii*	*Drypetes usambarica*	*Mimusops kummel*
68	*Jambosa jambos*	*Engleredendron usambarense*	*Morinda asteroscepa*
69	*Keetia Sp*	*Englerophytum natalense*	*Myrianthus holstii*
70	*Khaya anthotheka*	*Entandrophragma excelsum*	*Newtonia buchananii*
71	*Lannea schweinfurthii*	*Erythrococca kirkii*	*Ochna holstii*
72	*Leptonychia usambarensis*	*E. usambarica*	*Ocotea usambarensis*
72	*Macaranga capensis*	*Erythrophloem suaveolens*	*Odyendea zimmermanii*
74	*Maesopsis eminii*	*Fernandoa magnifica*	*Oxyanthus speciosus*
75	*Magnistipula butayei*	*Ficus capensis*	*Parinari excelsa*
76	*Manilkara zanzibariensis*	*Ficus exasperata*	*Placodiscus amaniensis*
77	*Maranthes goetzeana*	*Ficus lutea*	*Polyceratocarpus scheffleri*
78	*Maytenus acuminata*	*Ficus sur*	*Polyscias fulva*
79	*Maytenus holstii*	*Ficus sycomorus*	*Poterandia penduliflora*
80	*Maytenus senegalensis*	*Ficus usambarensis*	*Pouteria adolfi-friederici*
81	*Maytenus Sp*	*Ficus vallis-choudae*	*Pouteria alnifolia*
82	*Maytenus undata*	*Funtumia africana*	*Psychotria peteri*
83	*Memecylon semseii*	*Funtumia elastica*	*Pterocarpus tinctorius*
84	*Mesogyne insignis*	*Garcinia buchananii*	*Quassia undulata*

Appendix 3 continues

SN	Intact forest spp	Disturbed forest spp	Both intact and disturbed spp
85	*Michelia champaca*	*Garcinia grotei*	*Ricinodendron heudelotii*
86	*Milicia excelsa*	*Gerocarpus americanus*	*Rinorea albersii*
87	*Mimusopis aedificatoria*	*Greenwayodendron suaveolens*	*Rothmania manganjae*
88	*Mimusops kummel*	*Grewia bicolor*	*Rytigynia stuhlmannii*
89	*Morinda asterocepa*	*Grewia goetzeana*	*Sapium ellipticum*
90	*Myrianthus holstii*	*Harrisonia abyssinica*	*Schefflerodendron usambarense*
91	*Newtonia buchananii*	*Harungana madagascariensis*	*Sorindeia madagascariensis*
92	*Newtonia paucijuga*	*Hoslundia opposita*	*Spathodea nilotica*
93	*Ochna holstii*	*Ilex mitis*	*Stereospermum kunthianum*
94	*Ocotea usambarensis*	*Isoberlinia scheffleri*	*Strombosia scheffleri*
95	*Odyendea zimermannii*	*Isolana cauliflora*	*Suregada zanzibarense*
96	*Oxyanthus speciosus*	*Isolana heinsenii*	*Synsepalum cerasiferum*
97	*Parinari excelsa*	*Julbernardia globiflora*	*Synsepalum msolo*
98	*Phylanthus inflatus*	*Keetia guienzii*	*Syzygium guineense*
99	*Phyllanhus Sp*	*Keetia Sp*	*Tabernaemontana pachysiphon*
100	*Placodiscus amaniensis*	*Khaya anthotheka*	*Tabernaemontana ventricosa*
101	*Polyceratocarpus cheffleri*	*Lannea welwitschii*	*Tarrena nigrensis*
102	*Polyscias fulva*	*Lecaniodiscus fraxinifolius*	*Teclea nobilis*
103	*Poterandea penduliflora*	*Leptaulus holstii*	*Tricalysia anomala*
104	*Pouteria adolfifriederecii*	*Leptonychia usambarensis*	*Trichilia dregeana*
105	*Pouteria alnifolia*	*Leptonychia usambarensis*	*Trichilia emetica*
106	*Psychotria peteri*	*Lettowianthus stestellatus*	*Trilepsium mdagascariensis*
107	*Pterocarpus tinctorius*	*Lonchocarpus capassa*	*Uvariodendron usambarense*
108	*Quassia undulata*	*Macaranga capensis*	*Vepris amaniensis*
109	*Rauvolfia caffra*	*Maesa lanceolata*	*Vepris nobilis*
110	*Rauvolfia mombasiana*	*Maesopsis eminii*	*Voacanga africana*
111	*Rawsonia lucida*	*Magnistipula butayei*	*Xylopia aethiopica*
112	*Ricinodendron heudelotii*	*Manilkara obovata*	*Xymolos monospora*
113	*Rinorea albersii*	*Maranthes goetzeana*	*Zanha golungensis*
114	*Rothmania manganjae*	*Margaritaria discoidea*	*Zanthoxylum gilletii*
115	*Rytiginia flavida*	*Markhamiia lutea*	*Zanthoxylum usambarense*
116	*Rytigynia stuhlmannii*	*Maytenus acuminata*	*Zenkerela grotei*
117	*Rytingynia xanthotricha*	*Maytenus undata*	*zenkerella egregia*
118	*Sapium ellipticum*	*Melia adzedarach*	
119	*Schefflerodendron usambarense*	*Memecylon semseii*	
120	*Sorindeia madagascariensis*	*Mesogyne insignis*	
121	*Spathodea nilotica*	*Milicia excelsa*	
122	*Stereospermum kunthianum*	*Milletia dura*	
123	*Strombosia scheffleri*	*Millettia usaramensis*	
124	*Suregada zanzibarense*	*Mimusopis aedificatoria*	
125	*Synsepalum cerasiferum*	*Mimusops kummel*	
126	*Synsepalum msolo*	*Morinda asteroscepa*	

Appendix 3 continues

SN	Intact forest spp	Disturbed forest spp	Both intact and disturbed spp
127	*Syzigium guinense*	*Morus mesozygia*	
128	*Tabernaemontana pachysiphon*	*Myrianthus holstii*	
129	*Tabernaemontana ventricosa*	*Nersogodonia holtsii*	
130	*Tarenna nigrenscens*	*Newtonia buchananii*	
131	*Tarrena nigrensis*	*Ochna holstii*	
132	*Teclea mespiliformis*	*Ocotea usambarensis*	
133	*Teclea nobilis*	*Odyendea zimmermanii*	
134	*Tricalysia anomala*	*Olea capensis*	
135	*Tricalysia pallens*	*Oxyanthus pyriformis*	
136	*Tricaysia Sp*	*Oxyanthus speciosus*	
137	*Trichilia dregeana*	*Parinari excelsa*	
138	*Trichilia emetica*	*Parkia felicoidea*	
139	*Trilepsium madagascariensis*	*Pauteria adolfifriedericii*	
140	*Uvariodendron usambarense*	*Pentadesma butyraceae*	
141	*Vepris amaniensis*	*Placodiscus amaniensis*	
142	*Vepris nobilis*	*Platypterocarpus scheffleri*	
143	*Vepris simplicifolia*	*Platypterocarpus tanganyikensis*	
144	*Voacanga africana*	*Pleiocarpa picnantha*	
145	*Voacanga lutescens*	*Polyalthia stuhlmannii*	
146	*Xylopia aethiopica*	*Polyceratocarpus scheffleri*	
147	*Xymolos monospora*	*Polyscias fulva*	
148	*Zanha golungensis*	*Polyscias fulva*	
149	*Zanthoxyllum gilletii*	*Polysphaeria macrantha*	
150	*Zanthoxylum usambarense*	*Polysphaeria parviflora*	
151	*Zenkerela egregia*	*Poterandia penduliflora*	
152		*Pouteria adolfi-friederici*	
153		*Pouteria alnifolia*	
154		*Premna chhrysoclada*	
155		*Psychotria peteri*	
156		*psychotria usambarensis*	
157		*Pterocarpus mildbraedii*	
158		*Pterocarpus tinctorius*	
159		*Quasia undulata*	
160		*Rausonia lucida*	
161		*Ricinodendron heudelotii*	
162		*Rinorea albersii*	
163		*Rinorea ilicifolia*	
164		*Rothmania manganjae*	
165		*Rytigynia stuhlmannii*	
166		*Sapium ellipticum*	
167		*Schefflerodendron usambarense*	
168		*Sorindeia madagascariensis*	
169		*Spathodea campanulata*	
170		*Spathodea nilotica*	

Appendix 3 continues

SN	Intact forest spp	Disturbed forest spp	Both intact and disturbed spp
171		*Stereospermum kunthianum*	
172		*Strombosia cheffleri*	
173		*Suregada zanzibarense*	
174		*Synsepalum cerasiferum*	
175		*Synsepalum msolo*	
176		*Syzygium guineense*	
177		*Tabernaemontana pachysiphon*	
178		*Tabernaemontana Staphyana*	
179		*Tabernaemontana ventricosa*	
180		*Tarrena nigrensis*	
181		*Teclea nobilis*	
182		*Teclea trichocarpa*	
183		*Terminalia sambesiaca*	
184		*Trema orientalis*	
185		*Tricalysia anomala*	
186		*Tricalysia myrtifolia*	
187		*Tricalysia Sp*	
188		*Trichilia dregeana*	
189		*Trichilia emetica*	
190		*Triclysia elegans*	
191		*Trilepsium mdagascariensis*	
192		*Uvariodendron digocarpum*	
193		*Uvariodendron pycnophyllum*	
194		*Uvariodendron usambarense*	
195		*Vepris amaniensis*	
196		*Vepris nobilis*	
197		*Voacanga africana*	
198		*Voacanga thouarsii*	
199		*Xylopia aethiopica*	
200		*Xymolos monospora*	
201		*Zanha golungensis*	
202		*Zanthoxylum gilletii*	
203		*Zanthoxylum usambarense*	
204		*Zenkerela grotei*	
205		*zenkerella egregia*	

Appendix 4: Tree species retained by respondents around ANR

Species	Count	%of responses	% of cases
Cephalosphaera usambarensis	34	1.3	33.7
Allanblackia stuhlmanii	50	1.9	49.5
Anisophyllea obtusifolia	4	0.2	4.0
Maesopsis eminii	38	1.4	37.6
Anthocleista grandiflora	5	0.2	5.0
Synsepalum msolo	1	0.0	1.0
Bridelia micrantha	3	0.1	3.0
Albizia sp	22	0.8	21.8
Syzygium guineense	1	0.0	1.0
Milicia excelsa	30	1.1	29.7
Albizia versicolor	3	0.1	3.0
Newtonia buchananii	10	0.4	9.9
Strombossia scheffleri	1	0.0	1.0
Euphorbia hirta	1	0.0	1.0
Ficus sp	2	0.1	2.0
Entandrophragma excelsum	3	0.1	3.0
Terminalia sambesiaca	1	0.0	1.0
Combretum schumannii	1	0.0	1.0
Bombax rhodognaphalon	1	0.0	1.0
Macaranga capensis	1	0.0	1.0
Harrisonia abyssinica	1	0.0	1.0
Acasia sp	2	0.1	2.0
Maranthes goetzeana	6	0.2	5.9
not applicable	2405	91.6	2381.2
Total responses	2626	100	2600.0

Appendix 5: Household questionnaire

VILLAGE…….
DATE……...
ENUMERATOR…….
HOUSEHOLD IDENTIFICATION NUMBER…….

GENERAL INFORMATION
1.0 Name of the household head
1.1 Gender
1. Male……
2. Female……...
1.2 Age…….years
1.3 No of household members
1. Children……..
2. Adult……
1.4 Education
1. No formal education……..
2. Adult education……..
3. Primary education……..
4. Secondary education…….
5. Others……

B.FARMING SYSTEM:
2.0 What crops do you grow on your farm and specify whether grown for food, cash or both.

Crops	Food	Cash	Both
1. 2. 3. . . n			

2.1 Do you apply fertilizer? Yes……..No……..
2.2 How big is the farm?……Ha…….
2.3 How do you prepare your field before planting?
Clearing all vegetation…….
Retaining a few trees……
Burning……

2.4 If you retain some trees, mention species retained, number of individuals and reason for retention.

Tree species retained	No	Reason
1 2 3 4 5 6 7 . . n		

C.FORESTRY PRODUCE UTILISATION

3.0 Where do you get your forest-based products?

Product	Public land	Nature Reserve	Both
1.Firewood 2.Building poles 3.Building timber 4.Fruits 5.Medicine 6.Allanblackia seeds 7.Mushroom 8.Fodder 9.Furnitures 10.others (specify)			

Fuel wood

4.0 What kind of fuel do you use in your household?

1.Firewood…….

2.Charcoal…….

3. Kerosine……..

4.1 If firewood and/or charcoal, which tree species, do you prefer to collect or burn respectively? Give reason for preference.

Type of fuel	Tree species	Size	Reasons for preference
Fire wood 1 2 3			

4 5			
Charcoal 1 2 3 4 5			

4.2 How many head-loads of firewood, tins of charcoal or litres of kerosene do your family consume in a week?

1. Firewood……head-loads
2. Charcoal……tins
3. Kerosene……litres

4.3 What type of wood do you collect?

1. Dry……..
2. Live……..

4.4 If live, which part of tree is cut?

1. Branches……..
2. Whole tree…….

Medicines

5. 0 Which trees/shrubs and what parts of them do you use for medicine?

Tree	Stem	Bark	Roots	Leaves	Fruits
1 2 3 4 5					

5.1 Where do you collect them?

1. Public land
2. Reserve
3. Both

Construction material

6.0 Where do you get material for construction of your houses?

1. Public land

2. Reserve
3. Both

Which species do you use mostly in house construction?

Type of material	Species
Beams Walling poles Roofing poles Frames Withies Ropes Thatch	

6.1 How often do you re-built your houses?…….years

7. 0 Which tree species do you use to make domestic items?

Item	Tree species
Chairs/tables Beds Mortar Baskets, mats and brooms Glue Dye Bows Arrows Walking sticks Tool handles Bee hives Others (specify)	

8.0 Which plant species and which parts of the plants do you use as food?

Plant species	Roots	Fruits	Seeds	Leaves
1 2 3 . . n				

9. 0 Do you have your own-planted trees? Yes…… No……..
9.1 If yes, what did you planted for?
……
……
9.2 Mention plant species you have planted
1……..
2……
3……
4……
5……
..
6……
.
7……
..
8……
..
9……
..
10……
…

10.0 Do you know these species? (Showing a few threatened and endemic species)
…….
…….
10.1 Does your household use these species for different purposes? If yes mention the uses

Threatened species	Uses
1 2 3 4 5 6 7 8 9 10	

10.2 Do you know that these species are threatened and may go extinct? Yes……
No……

10.3 Do you know that they are found in the Usambara Mountains only?
Yes……..No……..
10.4 If you were told that these species are threatened and endemic, and they may go extinct, would you consider them more important then?
Yes……No……

10.5 If yes are you willing to use alternative species? Yes…….No……..

10.6 Are you willing to plant then in your farms? Yes……No…….

10.7 In your opinion what do you think are the most destructive activities to the surrounding forests?

1. Pitsawing
2. Mining
3. Medicinal plants collection
4. Fire
5. Fuel wood collection
6. Grazing
7. Construction material cutting
8. Non wood forest products collection
9. Others (specify)

Appendix 6: Village checklist

General information

Name of village……..

Ward……...

District……

Demographic data

Total village population…….

Actively working adults (male …….; female……)

Children (< 16 yrs)……

Elders (> 60 yrs)……

Number of households……...

Average family size……...

Main economic activities in the village

Farming……..

Livestock keeping……..

Pitsawing……

Mining

Beekeeping…….

Others (specify)……..

How farms are cleared
Burning……..

Clear all vegetation……..

Villagers leaving some few trees

Is farm size adequate?……
If not, why?……

Are local people aware of the threatened and endemic plant species?

Yes……No…….

What is the level of awareness?

Low……

Moderate……

High……

What are the driving forces for poles cutting?

What are the driving forces for pitsawing?

What are the driving forces for mining?

What activities do you consider detrimental to the nature reserve?…….

……..

Appendix 7: Districts and Region checklist

District name……..

Are you aware of the threatened and endemic plant species?Yes…..No…..

What is the level of awareness?

Low……

Moderate……

High……

If you were told that some of plant species in your district are threatened and they may go extinct, would you consider them more important and sensitise for conservation then? Yes…….No……

As a policy maker, what is your opinion concerning conservation of threatened plant species in your Region?……

……

……

……

…..

What are the driving forces for poles cutting?

What are the driving forces for pitsawing?

What are the driving forces for mining?

What activities do you consider detrimental to the nature reserve?…….

……..

Appendix 8: Checklist for ANR management

A. GENERAL INFORMATION

Name of respondent……

Sex…….

Age…….

Occupation…….

Education level

Primary education……..

Secondary education……

Certificate in forestry……

Diploma in forestry…….

Higher education……

B.THREATENED PLANT SPECIES

Are you aware on threatened and endemic plant species?Yes……No….

What is the level of awareness?

Low……

Moderate……

High……

Is there threatened and endemic plant species in ANR?

Yes……..No…….

Which Category?

Critically endangered……

Endangered……

Vulnerable…….

If yes, mention

few……..

How did you know they are threatened?……
……

….

Are there any special strategies for threatened plant species conservation? Specify
……..

…….

……

…

……

…..

What are the main threats to threatened plant species in ANR? (Rank by priority)

Mining……..

Poles and timber cutting……..

Fire…….

Debarking and uprooting (medicine)…….

Animal hunting/trapping……

Fodder cutting……

Others (specify)……..

……..

Are there mining activities in ANR? Yes……..No…….

How many mining pits have you experienced?…….

Are there trees/shrubs destructed through mining activities in ANR?……..

How many? (Rough estimate)……

Out of them, are there threatened and endemic plant species? Yes….no….

What are the driving forces for poles cutting?……..

What are the driving forces for pitsawing?……

What are the driving forces for mining?……..

What activities do you consider detrimental to the nature reserve?…….

……..

What is your own opinion on strategies for conservation of threatened plant species in ANR?…….

…….

Appendix 9: Disturbance survey data sheet

Plot No	Tree/Timber				Poles/Saplings			
	No of	No of natural death	No of new cut	No of	No of live	No of natural death	No of new Cut	No of

Appendix 10: Check list of trees and shrubs identified in ANR showing endemism and threat category

SN	Species	Endemic status	Threat category
1	*Alangium chinense*	W	
2	*Albizia adianthifolia*	W	
3	*Albizia glaberrima*	W	
4	*Albizia gummifera*	W	
5	*Albizia petersiana*	W	
6	*Alchornea hertela*	W	
7	*Allanblackia stuhlmanii*	E	EN
8	*Allophyllus melliodorus*	E	
9	*Allophyllus rubifolius*	W	
10	*Alsodeiopsis schumannii*	E	VU
11	*Angylocalyx braunii*	E	EN
12	*Aningeria adolfi-friedericii*	W	
13	*Anisophyllea obtusifolia*	E	
14	*Annickia kummeriae*	E	EN
15	*Annona senegalensis*	W	
16	*Anthocleista grandiflora*	W	
17	*Antiaris toxicaria*	W	
18	*Antidesma membranaceum*	W	
19	*Aoranthe penduliflora*	E	VU
20	*Barringtonia racemosa*	W	
21	*Beilschmiedia kweo*	E	VU
22	*Bersama abyssinica*	E	
23	*Blighia unijugata*	W	
24	*Bombax rhodognaphalon*	E	
25	*Bridelia micrantha*	W	
26	*Camelia sinnensis*	W	
27	*Casearia batiscoidea*	W	
28	*Cassipourea gummiflua*	W	
29	*Celtis africana*	W	
30	*Celtis gomphophylla*	W	
31	*Celtis mildbraedii*	W	
32	*Celtis phillipensis*	W	
33	*Celtis wightii*	W	
34	*Cephalosphaera usambarensis*	E	EN
35	*Cheilanthes bergiana*	W	
36	*Chrysophyllum gorungonosum*	W	
37	*Chrysophyllum perpulchrum*	W	

Appendix 10 continues

	Species	Endemic status	Threat category
38	*Chytranthus obliquinervis*	E	
39	*Cinnamomum zeilanicum*	W	
40	*Cleistanthus amaniensis*	W	
41	*Cleistanthus polystachys*	W	
42	*Coffea arabica*	W	
43	*Coffea pseudozanguebariae*	E	EN
44	*Coffea robusta*	W	
45	*Coffea Sp*	W	
46	*Cola clavata*	W	
47	*Cola discoglypremnaphylla*	W	
48	*Cola greenwayi*	W	
49	*Cola scheffleri*	E	VU
50	*Cola usambarensis*	E	EN
51	*Coloncoba schweinfurthii*	W	
52	*Combretum schumannii*	E	
53	*Cordia sinensis*	W	
54	*Craibia zimmermannii*	E	
55	*Cremaspora triflora*	W	
56	*Croton silvaticus*	W	
57	*Cussonia spicata*	W	
58	*Cyathea manniana*	W	
59	*Cylicomorpha parviflora*	E	EN
60	*Cynometra brachyrrhachis*	E	EN
61	*Cynometra engleri*	E	VU
62	*Cynometra fischeri*	W	
63	*Cynometra longipedicellata*	E	VU
64	*Cynometra Sp*	W	
65	*Cynometra SP.A*	E	
66	*Cynometra webberi*	E	EN
67	*Dasylepis integra*	E	EN
68	*Deinbolia kilimandscharica*	W	
69	*Dialium holtsii*	E	EN
70	*Diospyros abyssinica*	W	
71	*Diospyros amaniensis*	E	EN
72	*Diospyros mespiliformis*	W	
73	*Diospyros natalensis*	W	
74	*Diospyros squarrosa*	E	
75	*Diospyros usambarensis*	W	
76	*Dombeya shupangae*	E	
77	*Dorstenia hildebrandtii*	W	
78	*Dracaena usambarensis*	W	

Appendix 10 continues

	Species	Endemic status	Threat category
79	*Drypetes garardii*	W	
80	*Drypetes subdentata*	W	
81	*Drypetes usambarica*	E	
82	*Englerodendron usambarense*	E	VU
83	*Englerophytum natalense*	W	
84	*Entandrophragma excelsium*	W	
85	*Erythrococca kirkii*	W	
86	*Erythrococca usambarica*	W	
87	*Erythrophloem suaveolens*	W	
88	*Fernandoa magnifica*	E	
89	*Ficus capensis*	W	
90	*Ficus exasperata*	W	
91	*Ficus lutea*	W	
92	*Ficus sur*	W	
93	*Ficus sycomorus*	W	
94	*Ficus usambarensis*	E	
95	*Ficus valischoudae*	W	
96	*Funtumia africana*	W	
97	*Funtumia elastica*	W	
98	*Garcinia buchananii*	W	
99	*Garcinia grotei*	W	
100	*Garcinia volkensii*	W	
101	*Gerocarpus americanus*	W	
102	*Greenwayodendron suaeolens*	E	EN
103	*Grewia bicolor*	W	
104	*Grewia goetzeana*	E	
105	*Harrisonia abyssinica*	W	
106	*Harungana madagascariensis*	W	
107	*Hoslundia opposita*	W	
108	*Ilex mitis*	W	
109	*Isoberlinia scheffleri*	E	VU
110	*Isolana cauliflora*	W	
111	*Isolana heinsenii*	E	EN
112	*Jambosa jambos*	W	
113	*Julbernardia globiflora*	W	
114	*Keetia guienzii*	W	
115	*Keetia Sp*	W	
116	*Khaya anthotheka*	E	VU
117	*Lannea schweinfurthii*	W	
118	*Lannea welwitschii*	W	EN
119	*Lecaniodiscus fraxinifolius*	W	
120	*Leptaulus holstii*	W	
121	*Leptonychia usambarensis*	E	

Appendix 10 continues

	Species	Endemic status	Threat category
122	*Lettowianthus stesllatus*	E	EN
123	*Lonchocarpus capassa*	W	
124	*Macaranga capensis*	W	
125	*Maesa lanceolata*	W	
126	*Maesopsis eminii*	W	
127	*Magnistipula butayei*	W	
128	*Manilkara obovata*	W	
129	*Manilkara zanzibariensis*	W	
130	*Maranthes goetzeana*	E	
131	*Margaritaria discoidea*	W	
132	*Markhamiia lutea*	W	
133	*Maytenus acuminata*	W	
134	*Maytenus holstii*	W	
135	*Maytenus senegalensis*	W	
136	*Maytenus Sp*	W	
137	*Maytenus undata*	W	
138	*Melia adzedarach*	W	
139	*Memecylon semseii*	E	
140	*Mesogyne insignis*	E	VU
141	*Michelia champaca*	W	
142	*Milicia excelsa*	W	
143	*Milletia dura*	W	
144	*Millettia usaramensis*	W	
145	*Mimusopis aedificatoria*	W	
146	*Mimusops kummel*	W	
147	*Morinda asterocepa*	E	VU
148	*Morus mesozygia*	W	
149	*Myrianthus holstii*	W	
150	*Nersogodonia holtsii*	W	
151	*Newtonia buchananii*	W	
152	*Newtonia paucijuga*	W	EN
153	*Ochna holstii*	W	
154	*Ocotea usambarensis*	W	
155	*Odyendea zimermannii*	E	
156	*Olea capensis*	W	
137	*Oxyanthus pyriformis*	E	
158	*Oxyanthus speciosus*	W	

Appendix 10 continues

	Species	Endemic status	Threat category
159	*Parinari excelsa*	W	
160	*Parkia filicoidea*	W	
161	*Pentadesma butyraceae*	W	
162	*Phylanthus inflatus*	W	
163	*Phyllanhus Sp*	W	
164	*Placodiscus amaniensis*	E	
	Platypterocarpus scheffleri	W	VU
165	*Platypterocarpus tanganyikensis*	E	VU
166	*Pleiocarpa picnantha*	W	
167	*Polyalthia stuhlmannii*	W	VU
168	*Polyceratocarpus cheffleri*	E	EN
169	*Polyscias fulva*	W	
170	*Polysphaeria macrantha*	W	
171	*Polysphaeria parviflora*	W	
172	*Poterandea penduliflora*	E	
173	*Pouteria adolfi-friedericii*	W	
174	*Pouteria alnifolia*	W	
175	*Pouteria cerasifera*	W	
176	*Premna chhrysoclada*	E	
177	*Psychotria peteri*	E	VU
178	*Psychotria usambarensis*	W	
179	*Pterocarpus mildbraedii*	E	
180	*Pterocarpus tinctorius*	E	
181	*Quasia undulata*	E	
182	*Rauvolfia caffra*	W	
183	*Rauvolfia mombasiana*	E	
184	*Rawsonia lucida*	W	
185	*Ricinodendron heudelotii*	W	
186	*Rinorea albersii*	E	
187	*Rinorea angustifolia*	E	
188	*Rinorea ilicifolia*	W	
189	*Rothmania manganjae*	W	
190	*Rytiginia flavida*	E	
191	*Rytigynia stuhlmannii*	W	

Appendix 10 continues

	Species	Endemic status	Threat category
192	*Rytingynia xanthotricha*	E	
193	*Sapium ellipticum*	W	
194	*Schefflerodendron usambarense*	W	
195	*Sorindeia madagascariensis*	E	
196	*Spathodea campanulata*	W	
197	*Spathodea nilotica*	W	
198	*Stereospermum kunthianum*	W	
199	*Strombosia scheffleri*	W	
200	*Suregada zanzibarense*	W	
201	*Synsepalum cerasiferum*	W	
	Synsepalum msolo	W	
202	*Syzygium guineense*	W	
203	*Tabernaemontana pachysiphon*	W	
204	*Tabernaemontana ventricosa*	W	
205	*Tarenna nigrenscens*	W	
206	*Teclea mespiliformis*	W	
207	*Teclea nobilis*	W	
208	*Teclea trichocarpa*	W	
209	*Terminalia sambesiaca*	E	
210	*Terminalia superba*	W	
211	*Trema orientalis*	W	
212	*Tricalysia anomala*	W	
213	*Tricalysia myrtifolia*	W	
214	*Tricalysia pallens*	E	
215	*Tricalysia Sp*	W	
216	*Trichilia dregeana*	W	
217	*Trichilia emetica*	W	
218	*Triclysia elegans*	W	
219	*Trilepsium madagascariensis*	W	
220	*Uvariodendron oligocarpum*	E	VU
221	*Uvariodendron pycnophyllum*	E	
222	*Uvariodendron usambarense*	E	VU
223	*Vepris amaniensis*	W	
224	*Vepris nobilis*	W	

Appendix 10 continues

	Species	Endemic status	Threat category
225	*Vepris simplicifolia*	W	
226	*Voacanga africana*	W	
227	*Voacanga lutescens*	W	
228	*Voacanga thouarsii*	W	
229	*Xylopia aethiopica*	W	
230	*Xymolos monospora*	W	
231	*Zanha golungensis*	W	
322	*Zanthoxyllum gilletii*	W	
233	*Zanthoxylum usambarense*	W	
234	*Zenkerela egregia*	E	VU
235	*Zenkerella grotei*	E	

E=Endemic, W=Wide range, EN=Endangered, VU=Vulnerable

Appendix 11: Species abundance and distribution in the intact forest stratum

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
1	*Alangium chinense*	12	0.001421	2.02008E-06	-6.55619	0.00932
2	*Albizia glaberrima*	5	0.000592	3.50709E-07	-7.43166	0.0044
3	*Albizia gummifera*	22	0.002606	6.78972E-06	-5.95005	0.0155
4	*Albizia petersiana*	5	0.000592	3.50709E-07	-7.43166	0.0044
5	*Alchornea hertela*	187	0.022149	0.000490557	-3.80998	0.08439
6	*Allanblackia stuhlmanii*	510	0.060405	0.003648772	-2.80668	0.16954
7	*Allophyllus melliodorus*	10	0.001184	1.40283E-06	-6.73851	0.00798
8	*Allophyllus rubifolius*	2	0.000237	5.61134E-08	-8.34795	0.00198
9	*Alsodeiopsis schumannii*	36	0.004264	1.81807E-05	-5.45757	0.02327
10	*Aningeria adolfi-friedericii*	26	0.003079	9.48316E-06	-5.783	0.01781
11	*Anisophyllea obtusifolia*	80	0.009475	8.97814E-05	-4.65907	0.04415
12	*Annickia kummeriae*	199	0.02357	0.000555536	-3.74779	0.08833
13	*Anthocleista grandiflora*	36	0.004264	1.81807E-05	-5.45757	0.02327
14	*Antiaris toxicaria*	55	0.006514	4.24357E-05	-5.03376	0.03279
15	*Antidesma membraneseum*	6	0.000711	5.0502E-07	-7.24933	0.00515
16	*Aoranthe penduliflora*	9	0.001066	1.1363E-06	-6.84387	0.0073
17	*Beilschmiedia kweo*	22	0.002606	6.78972E-06	-5.95005	0.0155
18	*Bersama abyssinica*	4	0.000474	2.24454E-07	-7.6548	0.00363
18	*Blighia unijugata*	54	0.006396	4.09067E-05	-5.05211	0.03231
20	*Bombax rhodognaphalon*	5	0.000592	3.50709E-07	-7.43166	0.0044
21	*Bridelia micrantha*	2	0.000237	5.61134E-08	-8.34795	0.00198
22	*Bridelia micrantha*	2	0.000237	5.61134E-08	-8.34795	0.00198
23	*Celtis africana*	22	0.002606	6.78972E-06	-5.95005	0.0155
24	*Celtis gomphophylla*	14	0.001658	2.74956E-06	-6.40204	0.01062
25	*Celtis mildbraedii*	10	0.001184	1.40283E-06	-6.73851	0.00798
26	*Cephalosphaera usambarensis*	301	0.035651	0.001270982	-3.33398	0.11886
27	*Cheilanthes bergiana*	4	0.000474	2.24454E-07	-7.6548	0.00363
28	*Chrysophyllum gorungonosum*	4	0.000474	2.24454E-07	-7.6548	0.00363
29	*Chrysophyllum perpulchrum*	108	0.012792	0.000163627	-4.35896	0.05576
30	*Chytranthus obliquinervis*	2	0.000237	5.61134E-08	-8.34795	0.00198
31	*Cleistanthus amaniensis*	2	0.000237	5.61134E-08	-8.34795	0.00198
32	*Cleistanthus polystachyus*	2	0.000237	5.61134E-08	-8.34795	0.00198
33	*Coffea Sp*	8	0.000948	8.97814E-07	-6.96165	0.0066
34	*Cola greenwayi*	34	0.004027	1.62168E-05	-5.51473	0.02221
35	*Cola scheffleri*	5	0.000592	3.50709E-07	-7.43166	0.0044
36	*Cola usambarensis*	49	0.005804	3.36821E-05	-5.14927	0.02988
37	*Coloncoba schweinfurthii*	2	0.000237	5.61134E-08	-8.34795	0.00198
38	*Cordia sinensis*	2	0.000237	5.61134E-08	-8.34795	0.00198
39	*Cremaspora triflora*	131	0.015516	0.00024074	-4.1659	0.06464
40	*Croton silvaticus*	5	0.000592	3.50709E-07	-7.43166	0.0044
41	*Cyathea manniana*	10	0.001184	1.40283E-06	-6.73851	0.00798

Appendix 11 continues

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
42	*Cylicomorpha parviflora*	14	0.001658	2.74956E-06	-6.40204	0.01062
43	*Cynometra brachyrrhachis*	47	0.005567	3.09886E-05	-5.19095	0.0289
44	*Cynometra engleri*	2	0.000237	5.61134E-08	-8.34795	0.00198
45	*Cynometra fischeri*	2	0.000237	5.61134E-08	-8.34795	0.00198
46	*Cynometra longipedicellata*	12	0.001421	2.02008E-06	-6.55619	0.00932
47	*Cynometra webberi*	12	0.001421	2.02008E-06	-6.55619	0.00932
48	*Deinbolia kilimandscharica*	5	0.000592	3.50709E-07	-7.43166	0.0044
49	*Diospyros amaniensis*	4	0.000474	2.24454E-07	-7.6548	0.00363
50	*Dracaena usambarensis*	5	0.000592	3.50709E-07	-7.43166	0.0044
51	*Drypetes gerardii*	86	0.010186	0.000103754	-4.58675	0.04672
52	*Englerodendron usambarensis*	51	0.006041	3.64877E-05	-5.10927	0.03086
53	*Entandrophragma excelsium*	19	0.00225	5.06423E-06	-6.09665	0.01372
54	*Erythrophloem suaveolens*	5	0.000592	3.50709E-07	-7.43166	0.0044
55	*Fernandoa magnifica*	5	0.000592	3.50709E-07	-7.43166	0.0044
56	*Ficus exasperata*	5	0.000592	3.50709E-07	-7.43166	0.0044
57	*Ficus lutea*	5	0.000592	3.50709E-07	-7.43166	0.0044
58	*Ficus sur*	11	0.001303	1.69743E-06	-6.6432	0.00866
59	*Ficus sycomorus*	10	0.001184	1.40283E-06	-6.73851	0.00798
60	*Ficus usambarensis*	5	0.000592	3.50709E-07	-7.43166	0.0044
61	*Ficus valischoudae*	5	0.000592	3.50709E-07	-7.43166	0.0044
62	*Funtumia africana*	106	0.012555	0.000157622	-4.37765	0.05496
63	*Garcinia buchananii*	10	0.001184	1.40283E-06	-6.73851	0.00798
64	*Garcinia volkensii*	2	0.000237	5.61134E-08	-8.34795	0.00198
65	*Greenwayodendron suaeolens*	240	0.028426	0.000808033	-3.56045	0.10121
66	*Harungana madagascariensis*	14	0.001658	2.74956E-06	-6.40204	0.01062
67	*Isoberlinia scheffleri*	52	0.006159	3.79326E-05	-5.08985	0.03135
68	*Isolana heinsenii*	14	0.001658	2.74956E-06	-6.40204	0.01062
69	*Jambosa jambos*	6	0.000711	5.0502E-07	-7.24933	0.00515
70	*Keetia Sp*	5	0.000592	3.50709E-07	-7.43166	0.0044
71	*Khaya anthotheka*	25	0.002961	8.76772E-06	-5.82222	0.01724
72	*Lannea schweinfurthii*	2	0.000237	5.61134E-08	-8.34795	0.00198
73	*Lannea welwitschii*	10	0.001184	1.40283E-06	-6.73851	0.00798
74	*Leptonychia usambarensis*	1136	0.134549	0.018103522	-2.00582	0.26988
75	*Macaranga capensis*	109	0.01291	0.000166671	-4.34975	0.05616
76	*Maesopsis eminii*	680	0.08054	0.006486706	-2.519	0.20288
77	*Magnistipula butayei*	43	0.005093	2.59384E-05	-5.27989	0.02689
78	*Manilkara zanzibariensis*	5	0.000592	3.50709E-07	-7.43166	0.0044
79	*Maranthes goetzeana*	35	0.004145	1.71847E-05	-5.48574	0.02274
80	*Maytenus acuminata*	22	0.002606	6.78972E-06	-5.95005	0.0155
81	*Maytenus holstii*	15	0.001777	3.15638E-06	-6.33304	0.01125
82	*Maytenus senegalensis*	2	0.000237	5.61134E-08	-8.34795	0.00198
83	*Maytenus Sp*	18	0.002132	4.54518E-06	-6.15072	0.01311
84	*Maytenus undata*	10	0.001184	1.40283E-06	-6.73851	0.00798

Appendix 11 continues

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
85	*Memecylon semseii*	2	0.000237	5.61134E-08	-8.34795	0.00198
86	*Mesogyne insignis*	244	0.0289	0.00083519 2	-3.54392	0.10242
87	*Michelia champaca*	2	0.000237	5.61134E-08	-8.34795	0.00198
88	*Milicia excelsa*	75	0.008883	7.89094E-05	-4.7236	0.04196
89	*Mimusopis aedificatoria*	5	0.000592	3.50709E-07	-7.43166	0.0044
90	*Mimusops kummel*	2	0.000237	5.61134E-08	-8.34795	0.00198
91	*Morinda asterocepa*	6	0.000711	5.0502E-07	-7.24933	0.00515
92	*Myrianthus holstii*	395	0.046784	0.00218877 2	-3.06221	0.14326
93	*Newtonia buchananii*	91	0.010778	0.00011616 9	-4.53023	0.04883
94	*Newtonia paucijuga*	5	0.000592	3.50709E-07	-7.43166	0.0044
95	*Ochna holstii*	18	0.002132	4.54518E-06	-6.15072	0.01311
96	*Ocotea usambarensis*	2	0.000237	5.61134E-08	-8.34795	0.00198
97	*Odyendea zimermannii*	8	0.000948	8.97814E-07	-6.96165	0.0066
98	*Oxyanthus speciosus*	31	0.003672	1.34812E-05	-5.60711	0.02059
99	*Parinari excelsa*	57	0.006751	4.55781E-05	-4.99804	0.03374
100	*Phylanthus inflatus*	2	0.000237	5.61134E-08	-8.34795	0.00198
101	*Phyllanhus Sp*	2	0.000237	5.61134E-08	-8.34795	0.00198
102	*Placodiscus amaniensis*	6	0.000711	5.0502E-07	-7.24933	0.00515
103	*Polyceratocarpus cheffleri*	33	0.003909	1.52769E-05	-5.54459	0.02167
104	*Polyscias fulva*	12	0.001421	2.02008E-06	-6.55619	0.00932
105	*Poterandea penduliflora*	15	0.001777	3.15638E-06	-6.33304	0.01125
106	*Pouteria adolfi-friedericii*	11	0.001303	1.69743E-06	-6.6432	0.00866
107	*Pouteria alnifolia*	5	0.000592	3.50709E-07	-7.43166	0.0044
108	*Pouteria cerasifera*	60	0.007106	5.0502E-05	-4.94675	0.03515
109	*Psychotria peteri*	15	0.001777	3.15638E-06	-6.33304	0.01125
110	*Pterocarpus tinctorius*	11	0.001303	1.69743E-06	-6.6432	0.00866
111	*Quasia undulata*	134	0.015871	0.00025189 3	-4.14325	0.06576
112	*Rauvolfia caffra*	5	0.000592	3.50709E-07	-7.43166	0.0044
113	*Rauvolfia mombasiana*	4	0.000474	2.24454E-07	-7.6548	0.00363
114	*Rawsonia lucida*	100	0.011844	0.00014028 3	-4.43592	0.05254
115	*Ricinodendron heudelotii*	15	0.001777	3.15638E-06	-6.33304	0.01125
116	*Rinorea albersii*	59	0.006988	4.88327E-05	-4.96356	0.03469
117	*Rothmania manganjae*	30	0.003553	1.26255E-05	-5.6399	0.02004
118	*Rytiginia flavida*	2	0.000237	5.61134E-08	-8.34795	0.00198
119	*Rytigynia stuhlmannii*	10	0.001184	1.40283E-06	-6.73851	0.00798
120	*Rytingynia xanthotricha*	2	0.000237	5.61134E-08	-8.34795	0.00198
121	*Sapium ellipticum*	73	0.008646	7.4757E-05	-4.75063	0.04108
122	*Schefflerodendron usambarense*	41	0.004856	2.35816E-05	-5.32752	0.02587
123	*Sorindeia madagascariensis*	517	0.061234	0.00374962 2	-2.79305	0.17103
124	*Spathodea nilotica*	10	0.001184	1.40283E-06	-6.73851	0.00798
125	*Stereospermum kunthianum*	40	0.004738	2.24454E-05	-5.35221	0.02536

126	*Strombosia scheffleri*	428	0.050693	0.00256976 8	-2.98197	0.15116
127	*Suregada zanzibarense*	2	0.000237	5.61134E-08	-8.34795	0.00198

Appendix 11 continues

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
128	*Synsepalum cerasiferum*	133	0.015753	0.00024814 7	-4.15074	0.06539
129	*Synsepalum msolo*	137	0.016226	0.00026329 8	-4.12111	0.06687
130	*Syzygium guineense*	15	0.001777	3.15638E-06	-6.33304	0.01125
131	*Tabernaemontana pachysiphon*	138	0.016345	0.00026715 6	-4.11384	0.06724
132	*Tabernaemontana ventricosa*	5	0.000592	3.50709E-07	-7.43166	0.0044
133	*Tarenna nigrenscens*	29	0.003435	1.17978E-05	-5.6738	0.01949
134	*Teclea mespiliformis*	2	0.000237	5.61134E-08	-8.34795	0.00198
135	*Teclea nobilis*	8	0.000948	8.97814E-07	-6.96165	0.0066
136	*Tricalysia anomala*	36	0.004264	1.81807E-05	-5.45757	0.02327
137	*Tricalysia pallens*	2	0.000237	5.61134E-08	-8.34795	0.00198
138	*Tricaysia Sp*	15	0.001777	3.15638E-06	-6.33304	0.01125
139	*Trichilia dregeana*	14	0.001658	2.74956E-06	-6.40204	0.01062
140	*Trichilia emetica*	65	0.007699	5.92698E-05	-4.86671	0.03747
141	*Trilepsium madagascariensis*	196	0.023214	0.00053891 3	-3.76298	0.08736
142	*Uvariodendron usambarense*	80	0.009475	8.97814E-05	-4.65907	0.04415
143	*Vepris amaniensis*	2	0.000237	5.61134E-08	-8.34795	0.00198
144	*Vepris nobilis*	5	0.000592	3.50709E-07	-7.43166	0.0044
143	*Vepris simplicifolia*	2	0.000237	5.61134E-08	-8.34795	0.00198
146	*Voacanga africana*	2	0.000237	5.61134E-08	-8.34795	0.00198
147	*Voacanga lutescens*	2	0.000237	5.61134E-08	-8.34795	0.00198
148	*Xylopia aethiopica*	22	0.002606	6.78972E-06	-5.95005	0.0155
149	*Xymolos monospora*	51	0.006041	3.64877E-05	-5.10927	0.03086
150	*Zanha golungensis*	2	0.000237	5.61134E-08	-8.34795	0.00198
151	*Zanthoxyllum gilletii*	6	0.000711	5.0502E-07	-7.24933	0.00515
152	*Zanthoxylum usambarense*	2	0.000237	5.61134E-08	-8.34795	0.00198
153	*Zenkerela egregia*	10	0.001184	1.40283E-06	-6.73851	0.00798
	Grand Total	8443		0.04451792 7		3.77805

Appendix 12: Species abundance and distribution in the disturbed forest stratum

	Species	Count	Pi	$(Pi)^2$	LN(Pi)	Pi (LN Pi)
1	*Alangium chinense*	34	0.002876	8.26854E-06	-5.85153	0.01683
2	*Albizia adianthifolia*	9	0.000761	5.7937E-07	-7.18066	0.00547
3	*Albizia glaberrima*	10	0.000846	7.15272E-07	-7.0753	0.00598
4	*Albizia gummifera*	38	0.003214	1.03285E-05	-5.7403	0.01845
5	*Alchornea hertella*	468	0.039581	0.001566617	-3.22942	0.12782
6	*Allanblackia stuhlmanii*	423	0.035775	0.001279829	-3.33051	0.11915
7	*Allophyllus melliodorus*	26	0.002199	4.83524E-06	-6.11979	0.01346
8	*Alsodeiopsis schumannii*	120	0.010149	0.000102999	-4.59039	0.04659
9	*AngYlocalyx braunii*	16	0.001353	1.8311E-06	-6.6053	0.00894
10	*Aningeria adolfi-friedericii*	10	0.000846	7.15272E-07	-7.0753	0.00598
11	*Anisophyllea obtusifolia*	98	0.008288	6.86947E-05	-4.79292	0.03972
12	*Annickia kummeriae*	147	0.012432	0.000154563	-4.38745	0.05455
13	*Annona senegalensis*	4	0.000338	1.14444E-07	-7.99159	0.0027
14	*Anthocleista grandiflora*	118	0.00998	9.95945E-05	-4.6072	0.04598
15	*Antiaris toxicaria*	187	0.015815	0.000250123	-4.14678	0.06558
16	*Antidesma membranaceum*	21	0.001776	3.15435E-06	-6.33336	0.01125
17	*Aoranthe penduliflora*	7	0.000592	3.50483E-07	-7.43198	0.0044
18	*Barringtonia racemosa*	12	0.001015	1.02999E-06	-6.89298	0.007
19	*Beilschmiedia kweo*	65	0.005497	3.02202E-05	-5.2035	-.02861
20	*Bersama abyssinica*	22	0.001861	3.46192E-06	-6.28684	0.0117
21	*Blighia unijugata*	70	0.00592	3.50483E-05	-5.12939	0.03037
22	*Bombax rhodognaphalon*	13	0.001099	1.20881E-06	-6.81294	0.00749
23	*Bridelia micrantha*	49	0.004144	1.71737E-05	-5.48607	0.02273
24	*Camelia sinnensis*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
25	*Casearia batiscoidea*	6	0.000507	2.57498E-07	-7.58613	0.00385
26	*Cassipourea gummiflua*	3	0.000254	6.43745E-08	-8.27927	0.0021
27	*Celtis africana*	48	0.00406	1.64799E-05	-5.50669	0.02235
28	*Celtis gomphophylla*	6	0.000507	2.57498E-07	-7.58613	0.00385
29	*Celtis mildbraedii*	40	0.003383	1.14444E-05	-5.68901	0.01925
30	*Celtis phillipensis*	12	0.001015	1.02999E-06	-6.89298	0.007
31	*Celtis wightii*	20	0.001691	2.86109E-06	-6.38215	0.0108
32	*Cephalosphaera usambarensis*	692	0.058525	0.00342518	-2.8383	0.16611
33	*Cheilanthes bergiana*	12	0.001015	1.02999E-06	-6.89298	0.007
34	*Chrysophyllum gorungonosum*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
35	*Chrysophyllum perpulchrum*	85	0.007189	5.16784E-05	-4.93524	0.03548
36	*Cinnamomum zeilanicum*	4	0.000338	1.14444E-07	-7.99159	0.0027
37	*Cleistanthus amaniensis*	5	0.000423	1.78818E-07	-7.76845	0.00329
38	*Cleistanthus polystachys*	4	0.000338	1.14444E-07	-7.99159	0.0027
39	*Coffea arabica*	4	0.000338	1.14444E-07	-7.99159	0.0027
40	*Coffea pseudozanguebariae*	10	0.000846	7.15272E-07	-7.0753	0.00598

Appendix 12 continues

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
41	*Coffea robusta*	24	0.00203	4.11997E-06	-6.19983	0.01258
42	*Coffea sp*	20	0.001691	2.86109E-06	-6.38215	0.0108
43	*Cola clavata*	20	0.001691	2.86109E-06	-6.38215	0.0108
44	*Cola discoglypremnaphylla*	4	0.000338	1.14444E-07	-7.99159	0.0027
45	*Cola greenwayi*	38	0.003214	1.03285E-05	-5.7403	0.01845
46	*Cola scheffleri*	17	0.001438	2.06714E-06	-6.54467	0.00941
47	*Cola usambarensis*	3	0.000254	6.43745E-08	-8.27927	0.0021
48	*Combretum schumannii*	4	0.000338	1.14444E-07	-7.99159	0.0027
49	*Craibia zimmermannii*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
50	*Cremaspora triflora*	37	0.003129	9.79207E-06	-5.76697	0.01805
51	*Croton sylvaticus*	46	0.00389	1.51352E-05	-5.54925	0.02159
52	*Cussonia spicata*	32	0.002706	7.32438E-06	-5.91215	0.016
53	*Cyathea manniana*	87	0.007358	5.41389E-05	-4.91198	0.03614
54	*Cylicomorpha parviflora*	35	0.00296	8.76208E-06	-5.82254	0.01724
55	*Cynometra brachyrrhachis*	58	0.004905	2.40617E-05	-5.31744	0.02608
56	*Cynometra longipedidicellata*	17	0.001438	2.06714E-06	-6.54467	0.00941
57	*Cynometra Sp*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
58	*Cynometra SP.A*	2	0.000169	2.86109E-08	-8.68474	0.00147
58	*Dasylepis integra*	14	0.001184	1.40193E-06	-6.73883	0.00798
60	*Deinbolia kilimandscharica*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
61	*Dialium holtsii*	16	0.001353	1.8311E-06	-6.6053	0.00894
62	*Diospyros abyssinica*	3	0.000254	6.43745E-08	-8.27927	0.0021
63	*Diospyros mespiliformis*	4	0.000338	1.14444E-07	-7.99159	0.0027
64	*Diospyros natalensis*	52	0.004398	1.9341E-05	-5.42664	0.02387
65	*Diospyros squarrosa*	8	0.000677	4.57774E-07	-7.29845	0.00494
66	*Diospyros usambarensis*	4	0.000338	1.14444E-07	-7.99159	0.0027
67	*Dombeya shupangae*	4	0.000338	1.14444E-07	-7.99159	0.0027
68	*Dorstenia hildebrandtii*	4	0.000338	1.14444E-07	-7.99159	0.0027
69	*Drypetes garardii*	137	0.011587	0.000134249	-4.45791	0.05165
70	*Drypetes subdentata*	16	0.001353	1.8311E-06	-6.6053	0.00894
71	*Drypetes usambarica*	73	0.006174	3.81168E-05	-5.08743	0.03141
72	*Englerodendron usambarense*	92	0.007781	6.05406E-05	-4.8561	0.03778
73	*Englerophytum natalense*	52	0.004398	1.9341E-05	-5.42664	0.02387
74	*Entandrophragma excelsum*	10	0.000846	7.15272E-07	-7.0753	0.00598
75	*Erythrococca kirkii*	4	0.000338	1.14444E-07	-7.99159	0.0027
76	*Erythrococca usambarica*	12	0.001015	1.02999E-06	-6.89298	0.007
77	*Erythrophloem suaveolens*	5	0.000423	1.78818E-07	-7.76845	0.00329
78	*Fernandoa magnifica*	22	0.001861	3.46192E-06	-6.28684	0.0117
79	*Ficus capensis*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
80	*Ficus exasperata*	20	0.001691	2.86109E-06	-6.38215	0.0108
81	*Ficus lutea*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
82	*Ficus sur*	41	0.003468	1.20237E-05	-5.66431	0.01964
83	*Ficus sycomorus*	17	0.001438	2.06714E-06	-6.54467	0.00941

Appendix 12 continues

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
84	*Ficus usambarensis*	4	0.000338	1.14444E-07	-7.99159	0.0027
85	*Ficus vallis-choudae*	25	0.002114	4.47045E-06	-6.15901	0.01302
86	*Funtumia africana*	225	0.019029	0.000362106	-3.96179	0.07539
87	*Funtumia elastica*	16	0.001353	1.8311E-06	-6.6053	0.00894
88	*Garcinia buchananii*	8	0.000677	4.57774E-07	-7.29845	0.00494
89	*Garcinia grotei*	12	0.001015	1.02999E-06	-6.89298	0.007
90	*Garcinia volkensii*	2	0.000169	2.86109E-08	-8.68474	0.00147
91	*Gerocarpus americanus*	8	0.000677	4.57774E-07	-7.29845	0.00494
92	*Greenwayodendron suaveolens*	275	0.023258	0.000540924	-3.76112	0.08748
93	*Grewia bicolor*	4	0.000338	1.14444E-07	-7.99159	0.0027
94	*Grewia goetzeana*	4	0.000338	1.14444E-07	-7.99159	0.0027
95	*Harrisonia abyssinica*	12	0.001015	1.02999E-06	-6.89298	0.007
96	*Harungana madagascariensis*	16	0.001353	1.8311E-06	-6.6053	0.00894
97	*Hoslundia opposita*	4	0.000338	1.14444E-07	-7.99159	0.0027
98	*Ilex mitis*	9	0.000761	5.7937E-07	-7.18066	0.00547
99	*Isoberlinia scheffleri*	77	0.006512	4.24085E-05	-5.03408	0.03278
100	*Isolana cauliflora*	4	0.000338	1.14444E-07	-7.99159	0.0027
101	*Isolana heinsenii*	6	0.000507	2.57498E-07	-7.58613	0.00385
102	*Julbernardia globiflora*	12	0.001015	1.02999E-06	-6.89298	0.007
103	*Keetia guienzii*	8	0.000677	4.57774E-07	-7.29845	0.00494
104	*Keetia Sp*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
105	*Khaya anthotheka*	56	0.004736	2.24309E-05	-5.35253	0.02535
106	*Lannea welwitschii*	22	0.001861	3.46192E-06	-6.28684	0.0117
107	*Lecaniodiscus fraxinifolius*	52	0.004398	1.9341E-05	-5.42664	0.02387
108	*Leptaulus holstii*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
109	*Leptonychia usambarensis*	990	0.083728	0.00701038	-2.48018	0.20766
110	*Lettowianthus stestellatus*	4	0.000338	1.14444E-07	-7.99159	0.0027
111	*Lonchocarpus capassa*	4	0.000338	1.14444E-07	-7.99159	0.0027
112	*Macaranga capensis*	252	0.021313	0.000454226	-3.84846	0.08202
113	*Maesa lanceolata*	3	0.000254	6.43745E-08	-8.27927	0.0021
114	*Maesopsis eminii*	763	0.06453	0.004164091	-2.74063	0.17685
115	*Magnistipula butayei*	17	0.001438	2.06714E-06	-6.54467	0.00941
116	*Manilkara obovata*	8	0.000677	4.57774E-07	-7.29845	0.00494
117	*Maranthes goetzeana*	33	0.002791	7.78931E-06	-5.88138	0.01641
118	*Margaritaria discoidea*	4	0.000338	1.14444E-07	-7.99159	0.0027
119	*Markhamiia lutea*	64	0.005413	2.92975E-05	-5.219	0.02825
120	*Maytenus acuminata*	12	0.001015	1.02999E-06	-6.89298	0.007
121	*Maytenus undata*	14	0.001184	1.40193E-06	-6.73883	0.00798
122	*Melia adzedarach*	104	0.008796	7.73638E-05	-4.7335	0.04163
123	*Memecylon semseii*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
124	*Mesogyne insignis*	241	0.020382	0.000415437	-3.89309	0.07935
125	*Milicia excelsa*	130	0.010995	0.000120881	-4.51035	0.04959

Appendix 12 continues

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
126	*Milletia dura*	9	0.000761	5.7937E-07	-7.18066	0.00547
127	*Millettia usaramensis*	4	0.000338	1.14444E-07	-7.99159	0.0027
128	*Mimusopis aedificatoria*	4	0.000338	1.14444E-07	-7.99159	0.0027
129	*Mimusops kummel*	8	0.000677	4.57774E-07	-7.29845	0.00494
130	*Morinda asteroscepa*	14	0.001184	1.40193E-06	-6.73883	0.00798
131	*Morus mesozygia*	13	0.001099	1.20881E-06	-6.81294	0.00749
132	*Myrianthus holstii*	294	0.024865	0.00061825 2	-3.69431	0.09186
133	*Nersogodonia holtsii*	4	0.000338	1.14444E-07	-7.99159	0.0027
134	*Newtonia buchananii*	151	0.012771	0.00016308 9	-4.36061	0.05569
135	*Newtonia paucijuga*	4	0.000338	1.14444E-07	-7.99159	0.0027
136	*Ochna holstii*	2	0.000169	2.86109E-08	-8.68474	0.00147
137	*Ocotea usambarensis*	5	0.000423	1.78818E-07	-7.76845	0.00329
138	*Odyendea zimmermanii*	18	0.001522	2.31748E-06	-6.48751	0.00988
139	*Olea capensis*	5	0.000423	1.78818E-07	-7.76845	0.00329
140	*Oxyanthus pyriformis*	12	0.001015	1.02999E-06	-6.89298	0.007
141	*Oxyanthus speciosus*	83	0.00702	4.92751E-05	-4.95905	0.03481
142	*Parinari excelsa*	62	0.005244	2.74951E-05	-5.25075	0.02753
143	*Parkia filicoidea*	9	0.000761	5.7937E-07	-7.18066	0.00547
144	*Pauteria adolfifriedericii*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
145	*Pentadesma butyraceae*	4	0.000338	1.14444E-07	-7.99159	0.0027
146	*Placodiscus amaniensis*	8	0.000677	4.57774E-07	-7.29845	0.00494
147	*Platypterocarpus scheffleri*	3	0.000254	6.43745E-08	-8.27927	0.0021
148	*Platypterocarpus tanganyikensis*	3	0.000254	6.43745E-08	-8.27927	0.0021
149	*Pleiocarpa picnantha*	2	0.000169	2.86109E-08	-8.68474	0.00147
150	*Polyalthia stuhlmannii*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
151	*Polyceratocarpus scheffleri*	29	0.002453	6.01544E-06	-6.01059	0.01474
152	*Polyscias fulva*	75	0.006343	4.0234E-05	-5.0604	0.0321
153	*Polysphaeria macrantha*	11	0.00093	8.65479E-07	-6.97999	0.00649
154	*Polysphaeria parviflora*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
155	*Poterandia penduliflora*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
156	*Pouteria adolfi-friedericii*	7	0.000592	3.50483E-07	-7.43198	0.0044
157	*Pouteria alnifolia*	60	0.005074	2.57498E-05	-5.28354	0.02681
157	*Pouteria cerasifera*	11	0.00093	8.65479E-07	-6.97999	0.00649
159	*Premna chhrysoclada*	20	0.001691	2.86109E-06	-6.38215	0.0108
160	*Psychotria peteri*	12	0.001015	1.02999E-06	-6.89298	0.007
161	*Psychotria usambarensis*	9	0.000761	5.7937E-07	-7.18066	0.00547
162	*Pterocarpus mildbraedii*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
163	*Pterocarpus tinctorius*	4	0.000338	1.14444E-07	-7.99159	0.0027
164	*Quassia undulata*	231	0.019537	0.00038167 6	-3.93547	0.07689
165	*Rawsonia lucida*	131	0.011079	0.00012274 8	-4.50269	0.04989
166	*Ricinodendron heudelotii*	33	0.002791	7.78931E-06	-5.88138	0.01641

167	*Rinorea albersii*	105	0.00888	7.88587E-05	-4.72393	0.04195

Appendix 12 continues

S/No	Species	Count	Pi	$(Pi)^2$	LN (Pi)	Pi(LN Pi)
168	*Rinorea angustifolia*	4	0.000338	1.14444E-07	-7.99159	0.0027
169	*Rinorea ilicifolia*	12	0.001015	1.02999E-06	-6.89298	0.007
170	*Rothmania manganjae*	73	0.006174	3.81168E-05	-5.08743	0.03141
171	*Rytigynia stuhlmannii*	12	0.001015	1.02999E-06	-6.89298	0.007
172	*Sapium ellipticum*	128	0.010825	0.00011719	-4.52586	0.04899
173	*Schefflerodendron usambarense*	60	0.005074	2.57498E-05	-5.28354	0.02681
174	*Sorindeia madagascariensis*	471	0.039834	0.00158676	-3.22303	0.12839
175	*Spathodea campanulata*	3	0.000254	6.43745E-08	-8.27927	0.0021
176	*Spathodea nilotica*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
177	*Stereospermum kunthianum*	20	0.001691	2.86109E-06	-6.38215	0.0108
178	*Strombosia scheffleri*	254	0.021482	0.00046146	-3.84055	0.0825
179	*Suregada zanzibarense*	2	0.000169	2.86109E-08	-8.68474	0.00147
180	*Synsepalum cerasiferum*	127	0.010741	0.00011536	-4.5337	0.0487
181	*Synsepalum msolo*	399	0.033745	0.00113872	-3.38893	0.11436
182	*Syzygium guineense*	47	0.003975	1.58004E-05	-5.52774	0.02197
183	*Tabernaemontana pachysiphon*	266	0.022497	0.00050609	-3.79439	0.08536
184	*Tabernaemontana ventricosa*	132	0.011164	0.00012462	-4.49508	0.05018
185	*Tarenna nigrenscens*	48	0.00406	1.64799E-05	-5.50669	0.02235
186	*Teclea nobilis*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
187	*Teclea trichocarpa*	3	0.000254	6.43745E-08	-8.27927	0.0021
188	*Terminalia sambesiaca*	29	0.002453	6.01544E-06	-6.01059	0.01474
189	*Terminalia superba*	12	0.001015	1.02999E-06	-6.89298	0.007
190	*Trema orientalis*	4	0.000338	1.14444E-07	-7.99159	0.0027
191	*Tricalysia anomala*	36	0.003045	9.26992E-06	-5.79437	0.01764
192	*Tricalysia myrtifolia*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
193	*Tricalysia Sp*	4	0.000338	1.14444E-07	-7.99159	0.0027
194	*Trichilia dregeana*	32	0.002706	7.32438E-06	-5.91215	0.016
195	*Trichilia emetica*	25	0.002114	4.47045E-06	-6.15901	0.01302
196	*Triclysia elegans*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
197	*Trilepsium madagascariensis*	276	0.023342	0.00054486	-3.75749	0.08771
198	*Uvariodendron oligocarpum*	4	0.000338	1.14444E-07	-7.99159	0.0027
199	*Uvariodendron pycnophyllum*	96	0.008119	6.59195E-05	-4.81354	0.03908
200	*Uvariodendron usambarense*	67	0.005666	3.21086E-05	-5.17319	0.02931
201	*Vepris amaniensis*	6	0.000507	2.57498E-07	-7.58613	0.00385
202	*Vepris nobilis*	4	0.000338	1.14444E-07	-7.99159	0.0027
203	*Voacanga africana*	1	8.46E-05	7.15272E-09	-9.37789	0.00079
204	*Voacanga thouarsii*	16	0.001353	1.8311E-06	-6.6053	0.00894
205	*Xylopia aethiopica*	20	0.001691	2.86109E-06	-6.38215	0.0108
206	*Xymolos monospora*	78	0.006597	4.35171E-05	-5.02118	0.03312
207	*Zanha golungensis*	41	0.003468	1.20237E-05	-5.66431	0.01964
208	*Zanthoxylum gilletii*	1	8.46E-05	7.15272E-09	-9.37789	0.00079

209	*Zanthoxylum usambarense*	14	0.001184	1.40193E-06	-6.73883	0.00798
210	*zenkerella egregia*	3	0.000254	6.43745E-08	-8.27927	0.0021
211	*Zenkerella grotei*	40	0.003383	1.14444E-05	-5.68901	0.01925
		1182		0.02731175		
	Grand Total	4		6		4.19047