TECHNICAL PAPER 30

Magoroto Forest

A biodiversity survey

Frontier-Tanzania
University of Dar es Salaam
Society for Environmental Exploration

East Usambara Catchment Forest Project

Technical Paper 30

Magoroto Forest

A biodiversity survey

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East Usambara Catchment Forest Project (EUCFP)
The East Usambara rain forests are one of the most valuable conservation areas in Africa. Several plant and animals are found only in the East Usambara mountains. The rain forests secure the water supply of 200,000 people and the local people in the mountains depend on these forests. The East Usambara Catchment Forest Project aims at establishing the Amani Nature Reserve; protecting water sources; establishing and protecting forest reserves; sustaining villager's benefits from the forest; and rehabilitating the Amani Botanical Garden. The project is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the Finnish Forest and Park Service. To monitor the impact of the project, both baseline biodiversity assessments and development of a monitoring system are needed. The present activity is aimed at establishing baseline information on biological diversity in selected East Usambara forests.

The University of Dar es Salaam (UDSM)
The University of Dar es Salaam was established in July 1970 as a centre for learning and research in the arts and the physical, natural, earth, marine, medical and human sciences. The University is surveying and mapping the flora and fauna of Tanzania and is conducting research into the maintenance and improvement of the environment and the sustainable exploitation of Tanzania's natural resources.

The Society for Environmental Exploration (SEE)
The Society is a non-profit making company limited by guarantee and was formed in 1989. The Society's objectives are to advance field research into environmental issues and implement practical projects contributing to the conservation of natural resources. Projects organised by The Society are joint initiatives developed in collaboration with national research agencies in co-operating countries.

Frontier Tanzania Forest Research Programme (FT FRP)
The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of the Frontier Tanzania Forest Research Programme (FT FRP). Since July 1994, the FT FRP has been working in the forests of the East Usambara mountains in collaboration with the East Usambara Catchment Forest Project (EUCFP). This survey of selected forests collects baseline biodiversity data and assists the EUCFP in the management of the East Usambara forests.

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FOREWORD

The East Usambara forests in north-eastern Tanzania are part of the Eastern Arc mountains. More than one hundred years of biological interest and research has shown that these forests have a unique diversity of flora and fauna, and an exceptionally high degree of endemism. They are globally listed as one of the biodiversity hotspots and centres of plant diversity, and recognized as among the most valuable conservation areas in Africa. Since 1990, the East Usambara Catchment Forest Project (EUCFP) has worked in the East Usambaras mountains with the mission to protect these natural forests. The project is implemented by the Forestry and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism (MNRT) with financial support from the Government of Finland, and implementation support from the Finnish Forest and Park Service (FPS).

Although a considerable amount of biological information exists from the East Usambaras much of this is restricted to the Amani area and systematic surveys are few. In order to get more comprehensive information on the forests biodiversity surveys were initiated and contracted by EUCFP in July 1995. The surveys are conducted by Frontier Tanzania, a joint venture between the University of Dar es Salaam and the Society for Environmental Exploration, together with EUCFP. The aim of the surveys is to provide systematic baseline information on the biological values of different forests as a basis for management planning and long-term monitoring, as well as training forestry staff in the use of biological inventory techniques. They will also help setting of priorities in the conservation of this valuable area.

The surveys have been carried out over ten-week field phases. The programme involves short-term expatriate volunteer research assistants, permanent EUCFP, Frontier, University of Dar es Salaam, and Tanzania Forestry Research Institute staff, as well as an international network of taxonomists and other experts. The surveys have become progressively more systematic and quantitative, and have already resulted in the discovery of several previously unknown taxa. This will further raise awareness of the unique conservation values of the East Usambaras. EUCFP has also commisioned the development of a biodiversity database, a work which also contributed the maps to these reports. All data collected during the surveys will be entered in this database, which is linked to the national biodiversity database and will become operational in 1997.

The reports are the result of the work of many people – too many to be listed here. We would like to thank all of them for their invaluable effort. We hope that the surveys will make yet another contribution to the long historic chain of efforts to study and understand these unique forests. Perhaps even more than that we hope that this information will contribute to a better management and conservation of the East Usambaras so that the beauty of the area will continue to amaze coming generations and that the light in the tunnel will become the bright future.

M.I.L. Katigula
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Abstract

Magoroto forest is situated in the East Usambara mountains in north-east Tanzania. The East Usambaras form part of the mountain chain called the Eastern Arc which ranges from southern Kenya to southern Tanzania. These mountains are known for their high levels of species endemism and rich floral and faunal diversity (Hamilton, 1989). To investigate further this biodiversity, a biological survey of Magoroto forest reserve was conducted with a socio-economic component between July and September 1994 for a total of 50 research-days.

This report summarises the findings of the survey in terms of floral and faunal inventories. Notes on ecological requirements and degree of endemism for each species is presented to provide an indication of the number of (a) forest dependent species as opposed to forest non-dependent and non-forest species; (b) threatened and rare species (using IUCN 1994 criteria[1]) and (c) endemics and near-endemics[2] to the Usambara mountains. These are presented to highlight the importance of Magoroto forest in a national and international context. These two categories are then combined to assess which species are considered at high risk of becoming locally extinct if the forest continues to be further degraded and fragmented.

The survey of Magoroto identified 109 species of tree and shrub, 27 species of mammal, 82 species of bird, 29 species of reptile and 29 species of amphibian.

Flora

Five shrub and tree species were recorded which are endemic to the Usambara mountains and 30 which have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Forty-eight species are dependent on primary forest, and of these species, 24 are also endemic or near endemic to the Usambara mountains. Seven non-forest tree and shrub species are established within the reserve boundaries.

Species of particular interest encountered during this survey include:

- *Dolichometra leucantha* and *Rinorea scheffleri* were recorded in Magoroto which are endemic only to the East Usambaras;

- *Zimmermannia capillipes, Englerodendron usambarense* and *Vitex ferruginea* were recorded in Magoroto which are endemic only to the East and West Usambaras;

1 All IUCN notes are based on IUCN 1994 criteria for species as compiled by the National Biodiversity Database in the Department of Zoology and Marine Biology, UDSM, Dar es Salaam. Definitions are as follows:
Endangered - a species facing a very high risk of extinction in the wild in the near future.
Vulnerable - a species facing a high risk of extinction in the wild in the medium-term future.
Near threatened - species which are close to qualifying for the status 'Vulnerable.'

2 Endemic - Species occurring only in the Usambara mountains
Near-endemic - Species with limited ranges in the Eastern Arc mountains and/or the East African lowlands between Somalia and Mozambique (Iversen, 1991b).

- *Psychotria megistantha*, a shrub typical of rain forest habitats known only from southern Tanzania;

- *Zanthoxylum milbraedii*, a tree recorded from rain forests of Uganda, Kenya, Zaire, and Rwanda. This is a new record for Tanzania;

- *Cola stelacantha*, a forest dependent tree limited to five locales in southern and east-central areas of Tanzania.

Fauna

No species were recorded which are endemic to the Usambara mountains but 29 species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. Fifty-three species are dependent on primary forest, and of these species, 24 are also near endemic to the Usambara mountains. Thirty-eight non-forest species are established in the estate. Of these, four are established within the forested areas. Species of particular interest encountered during this survey include:

- The Mops Free-tailed bat, *Tadarida brachyptera,* is a third record for Tanzania and the first for the East Usambaras;

- The paratype of a new species of blind snake, *Leptotyphlops macrops*, was collected which represents a range extension;

- *Nectophrynoides tornieri* is listed as a CITES I amphibian species;

- *Varanus niloticus, Bradypodion fisheri* and *Bradypodion tenue* are CITES II reptile species*;*

- *Dendrohyrax validus* and *Rhampholeon temporalis* are listed as 'Endangered' by IUCN;

- *Typhlops gierrai, Leptosiaphos kilimensis, Agama montana, Rhampholeon brevicaudatus, Bradypodion tenue, Bradypodion fisheri, Bufo brauni, Nectophrynoides tornieri, Leptopelis barbouri, Leptopelis uluguruensis, Afrixalus ulugurensis, Callulina kreffti, Arthroleptides martiensseni* and *Phrynobatrachus krefftii* are listed as 'Vulnerable' by IUCN;

- *Rhyncocyon petersi, Cnemaspis africana, Leptopelis vermiculatus, Probeviceps macrodactylus* are listed as 'Near-threatened' by IUCN;

- The Banded Green Sunbird, *Anthreptes rubritorques,* is listed as 'Vulnerable' and the Amani Sunbird, *Anthreptes pallidigaster,* is listed as 'Near-threatened' by IUCN.

Soils

The soil analysis indicates that the soils under forest and those under oil palm trees are similar due to the permanence of the vegetation cover in the plantation. This suggests that the soils would be suitable if the plantation was left to regenerate to forest.

Disturbance

All areas assessed recorded high levels of pole and timber cutting. Because of this, the forests surrounding Magrotto Estate appear to be under immediate threat due to human extraction of forest resources.

Socio-economics

People living in the vicinity of Magoroto Hill still rely heavily on forest products. Although many people see that degradation of the forest has occurred due to human disturbance there are no alternatives available for forest products.

1.0 INTRODUCTION: EAST USAMBARA AND FOREST DIVERSITY

The East Usambara mountains are situated in north-east Tanzania, close (40 km) to the coastal town of Tanga between $4^{O}48'$-$5^{O}13'$S and $38^{O}32'$-$38^{O}48'$E. These mountains form part of a chain known as the Eastern Arc which stretches down the coast of East Africa from Southern Kenya to Southern Tanzania. This is a chain of isolated mountains composed of Precambrian rock exposed by block faulting and slow uprise (Griffiths, 1993). Being adjacent to the Indian Ocean, considerable orographic rainfall occurs in this area. The rainfall distribution is bi-modal, peaking between March and May and between September and December. Conversely, the dry seasons are from June to August and January to March. Precipitation occurs in all months. Rainfall is greatest at higher altitudes and in the south-east of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at the higher altitudes. Because of the topographical and climatic interactions, the western slopes are drier compared to the eastern slopes. Due to their age, isolation and their function as condensers of the moisture from the Indian Ocean, they support ancient and unique forests, rich in endemic species (Hamilton, 1989).

Research in the East Usambara mountains began in the late 1890's with substantial botanical collections being undertaken. Later, in 1928, surveys were undertaken on amphibians and by the 1930's detailed ornithological work had begun. Biological research in the mountains has steadily increased over the years. More recently, work in the area has also included an attempt to understand the drainage and catchment value of the mountain's forests (Bruen, 1989; Litterick, 1989).

The East Usambara forests have been likened to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rogers & Homewood, 1982; Howell, 1989). They are considered to be one of the most important forest blocks in Africa, if not the most important (Tye, 1994). Currently, around 2,800 taxa of plants have been recorded of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991). Many are threatened (Rodgers, 1996).

In addition to the biodiversity value is the drainage and catchment value of the East Usambara forests. The forests play an important role in maintaining the hydrological cycle which feeds the Sigi river. The Sigi river is a vital water source for the local communities as well as supplying water for the large coastal town of Tanga. Deforestation in the area will lead to increased soil erosion particularly from the steeper slopes. Soil erosion is liable to result in more irregular run off and in a deterioration in water quality due to siltation.

The latest survey of the area, conducted by Johansson & Sandy (1996) shows that approximately 45,137 ha of the East Usambaras remain as natural forest. This can be divided into two types: submontane rain forest and lowland forest. Altitude is the factor differentiating these two forest types (Hamilton, 1989), with submontane forest generally occurring above 850 m.

Hyytiäinen (1995) classifies these two forest types into three categories[3]: (1) dense forest; (2) poorly stocked forest; and (3) cultivated forest, according to the density of the forest and the degree of human involvement. In the East Usambaras, submontane forest occupies 12,916.6 ha (30.7%), lowland forest occupies 29,497.4 ha (62.9%), and forest plantations occupy 2,723.6 ha (6.5%). 21,900 ha are presently gazetted forest reserves. The remainder, 35,909 ha (43%) of the East Usambaras is classified as agricultural land; woodland; grassland; ponds; rivers; barren land; and settlements (Johansson & Sandy, 1996).

The mammals of the East Usambaras show limited endemism (Collar & Stuart, 1987). However, there are several species of special interest. These include: the restricted Black and Rufous Elephant Shrew, *Rhynchocyon petersi,* which is common in the Usambaras (Collar & Stuart, 1987) yet listed as globally 'Endangered' by IUCN due to a decline in habitat extent and quality; Abbott's Duiker, *Cephalophus spadix*, listed as 'Vulnerable'(Groombridge, 1993); and the Lesser Pouched Rat, *Beamys hindei* about which insufficient information is available to determine its status (IUCN 1996).

There are at least 24 species of reptiles and amphibians endemic to the East Usambaras (Rodgers & Homewood, 1982). This series of surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata,* was recently found in Kwamgumi forest reserve (Broadley, 1995), and a range extension for the endemic frog, *Hoplophryne rogersi,* was recorded at Bamba Ridge forest reserve (Cunneyworth & Stubblefield, 1996).

The forest avifauna of the East Usambaras is remarkable in its diversity with 110 species, the highest recorded in this part of Africa (Stuart, 1989). Six species occurring in the lowland forests are considered threatened with global extinction: Sokoke Scops Owl, *Otus ireneae*; the endemic Usambara Eagle Owl, *Bubo vosseleri*; Swynnerton's Robin, *Swynnertonia swynnertoni*; East Coast Akalat, *Sheppardia gunningi*; Amani Sunbird, *Anthreptes pallidigaster*; and the Banded Green Sunbird, *Anthreptes rubritorques* (Collar *et al.,* 1994).

The East Usambaras are essentially forest 'islands' (Lovett, 1989). There has been natural forest in the area for thousands, if not millions, of years. These forests have been under continuous exploitative human pressure for at least 2,000 years (Schmidt, 1989). Until recently, especially in the past 50 years, (Kikula, 1989), this pressure has been sustainable. However, the growing human population in the area is leading to increased pressure on the remaining natural forest, and represents the main threat to their survival (Collar & Stuart, 1987). The Usambaras harbour many species which have been geographically separated from their closest relatives for long periods. They also serve as a refuge for formerly widespread flora and fauna that have become

[3]
1. Dense forest: uneven-aged, more or less disturbed natural forest which has a species composition characteristic to the original forest type & has an unbroken crown cover.
2. Poorly stocked forest: a variety of primary or secondary forests which are poorly stocked because of various natural or man-made reasons. They are forests with low density, fairly open crown cover, modest volume and dominant height less than in dense forests belonging to the same forest type.
3. Cultivation under forest: encroached areas which still have at least moderate forest cover.

After Hyytiainen (1995)

extinct over much of their former area (Iversen, 1991). The conservation and preservation of this unique area of biodiversity should be given high priority.

2.0 AIMS OF THE SURVEY

The specific aims of the surveys as outlined in the Terms of Reference between Frontier Tanzania Forest Research Programme and the East Usambara Catchment Forest Project are:

- to conduct biological baseline surveys in selected gazetted forests and in forests which are proposed for gazettement;
- to provide information on the biological value and importance of these forests in order to assist in the development of management plans and practices for these forests;
- to develop a system for monitoring aspects of forest biodiversity, both on a general as well as a forest-specific level.

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of six forests of the East Usambaras using systematic sampling techniques along systematically located vegetation transects, which sample approximately 0.5% in area of each forest reserve;
- to assess levels of disturbance by systematically sampling the incidence of tree cutting, animal trapping and other illegal activities along the vegetation transects;
- to use standard and repeatable methods to record biodiversity values of the forest in terms of small mammal species, reptiles, amphibians, and invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists resulting from this will be compared against standard appraisals of species rarity and other values in order to assess the overall biodiversity values of each forest.
- to undertake a socio-economic appraisal of the impact of resource-use activities by human communities in the vicinity of each forest and produce a brief assessment of how these activities affect the integrity of the forests.

Consequently, this survey will provide standardised and repeatable methods to assess the biodiversity values of the forests to enable their importance to be determined and permit biodiversity value to be monitored through time.

3.0 DESCRIPTION OF THE FOREST

3.1 General description

Magoroto forest is located in the East Usambara Mountains, Tanzania at the grid reference 38°45'E 5°07'S. Administratively, Magoroto falls under the Muheza District.

Magoroto forest is part of the Magrotto oil palm estate, situated on the Mlinga-Magoroto ridge, an eastern outlier of the East Usambara mountains. The estate itself is located on a small plateau at 650-770 m. It is surrounded on the east, north and west sides by a ring of higher ridges. The slopes of Magoroto Hill are now deforested while the majority of forest is found within the estate between 700 and 800 m. The forested ridgetops reach an altitude of 880 m. The forest within the estate is a small remnant patch which, together with Mlinga Peak forest reserve (190 ha), comprise the last remaining forest fragments on the Mlinga-Magoroto ridge. The ridge is unique in that it carries its own endemic plant species, *Saintpaulia magungensis* (Tye, 1994). The forest consists of lowland and submontane forest types. This forest remnant is all that is left of the original vegetation which was cleared for plantations, such as the Magrotto estate, at the beginning of this century. Further disturbance has been caused by extensive pole cutting and timber extraction which has created large gaps in the forest canopy. Agricultural encroachment by the surrounding communities has also led to forest clearance (Mwasumbi, 1994).

The estate is approximately hexagonal in shape and covers an area of 591 ha. The distribution of forest within the estate is shown in Figure 1. The forest on the eastern boundary is comprised of approximately 40 ha with an additional 2 ha planted with cardamom. This forest patch is about 250 m wide but has recently been damaged by pitsawing. Tye (1994) suggests that with adequate protection the natural forest would regenerate in this area unaided. The forest on the northern boundary is 20.5 ha in size with an additional 0.5 ha of cardamom under forest. This forest patch is about 200 m wide and is located on a steep slope which reduces its accessibility.

The stand of trees in the north-west of the estate consists largely of Eucalyptus and agricultural encroachment. The largest forest block within the estate is located along the western boundary and comprises approximately 86 ha. It is in reasonable condition though subject to some agricultural encroachment in the north-west section. The south-west section of this forest block is located on steep slopes. As a result of this inaccessibility the forest is in good condition (Tye, 1994).

The forest block on the south-central part of the estate comprises approximately 60 ha of forest suject to different levels of disturbance. Towards the centre of the estate disturbance is greater with much evidence of pitsawing. This has resulted in a low, patchy canopy in the central area (Tye, 1994).

Table 1. Land use distribution (Amboni Group, 1991).

Forest Class	Area (ha)	Percent (%)
Oil palm - mature	268.6	45.5
Hybrid oil palm	35.2	6.0
Cloves	0.5	0.1
Cardamom - mature	10.3	1.7
Cardamom - immature	10.0	1.7
Cardamom - fallow	51.0	8.6
Natural forest	215.5	36.5
Total for the reserve	**591.0**	**100.1**

3.1.1 History and Status

The estate is pronounced and spelt Magrotto, while the forest locality is pronounced Magoroto. Opened one hundred years ago, in 1896, the estate began as a rubber plantation converting to oil palms in 1921. Originally German owned, Magrotto was taken over by the Swiss Amboni Group at the time of independence. At the time of writing, Magrotto estate is still owned by the Amboni Group. The harvesting of oil palm nuts ceased in 1993 as costs of production were too great. The World Conservation Union are proposing to acquire the estate and manage it as a nature reserve to promote the regeneration of forest on degraded land (Tye, 1994).

Table 2. Status of Magoroto forest.

Name	Status	Size (ha)	Gazettement Notice
Magoroto Hill	Proposed and surveyed for forest reserve status	1,124	proposed

No Map Currently Available in Digital Format

Figure 1. The location of Magoroto forest in relation to other East Usambara forests.

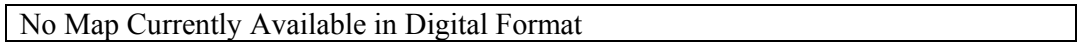

Figure 2. Topographical map.

4.0 SOILS

4.1 Introduction

Soil sample transects were carried out to determine the nature of the soils within the estate and to enable comparison between soils under different vegetation types.

4.2 Methods

Two soil sample transects, each approximately 100 m in length, were randomly located within the study area. These are located in plots 7 and 15 (see Figure 8). The first transect was situated on a south-west facing slope; this transect started at the lake shore stretched upslope through oil palms and secondary forest. The second transect started at the top of a west facing slope of secondary forest and moved down slope into oil palm plantations.

Along each transect, a soil profile was dug approximately every 20 m. A sample of soil was collected at the surface and every 20 cm down to a depth of one m, or until bedrock was reached. At each site the humus layer depth and soil texture was recorded and soil sample pH was tested using an electronic pH meter.

4.3 Results

In general, the soil throughout Magoroto Estate was moderately to slightly acid, with a pH of approximately six. The colour of the sub-soil was predominantly red, and the majority of soils were clays. Toward the surface, the soils were more silty in texture and darker in colour. All the profiles had a thin humus layer, with an average depth of about two cm, and showed some degree of biological activity in terms of rooting and the presence of soil fauna.

Although the soil was relatively moist, there were no signs of waterlogging and all soils were freely drained except in one area of marsh. There were no abrupt horizon changes recorded in any of the profiles, rather a gradual change in colour and texture was observed on the soil catenas. There was a small amount of gravel found in the profiles at various sites which consisted largely of quartz. At several sites, bedrock was reached within a metre of the surface. Evidence of erosion is minimal. However, some deforestation on the sides of hills has occurred which, by increasing soil exposure, may lead to a greater risk of erosion and soil impoverishment.

4.4 Discussion

In general, the characteristics of the soils sampled, in terms of colour, texture and pH, were typical of sedentary soils developed on weathered material that is still in contact with the parent rock, granitoid gneiss (Holmes, 1995). The pH test results reflect the parent material with the relatively high quartz content of gneiss, resulting in acidic soils. This influence is further pronounced as subsoils generally had a higher pH than surface horizons where the incorporation of organic matter reduced soil acidity. The red clays dominating the surface (A) horizons of sample sites are also a product of the tropical climate in that they are subjected to heavy weathering. They are

characteristically dominated by aluminium and iron sesquioxides, as other more soluble salts are washed down the soil profile, and are of low nutrient status (FAO, 1977; Bunnett, 1989).

The influence of slope on soil formation is evident from the catenary sequences. Steep mid-slopes had significantly shallower soil profiles. This is typical of the influence of topography on soil formation, where soil on higher and steeper slopes is constantly being moved towards lower slopes and valley bottoms by normal erosional processes (Holmes, 1995).

As would be expected, towards the surface, the soils were slightly more silty and darker in colour. This is due to the natural incorporation of surface organic matter. Thin humic layers are common in tropical countries where much of the surface organic matter is removed by termites or quickly oxidised due to high temperatures.

Humic layers in the tropics however, are best developed in forests (Holmes, 1995). This was observed during the survey. This incorporated organic matter is important in maintaining soil structure and nutrient levels, and is necessary in supporting the soil fauna which convert soil humus into simple mineral and nitrogen substances that provide nutrients for plants (Holmes, 1995).

Thus, the vegetation types present within the estate would be expected to influence soil properties, in terms of organic matter input. It was, therefore, interesting to note that the soils sampled under secondary forest and plantation showed no marked differences in colour, texture and pH. The possible reason for the similarity in soil types is because the oil palms are a tree crop and, once planted, remain as permanent vegetative cover. The results of this survey, therefore, indicate that the soils of the Magoroto Estate would support the regeneration of natural forest in areas previously cultivated for oil palm nuts.

5.0 BOTANY

5.1 Introduction

A survey of the major vegetation types within the forest reserve was undertaken. in terms of extent, distribution and species composition to determine the botanical diversity of the reserve. Simple, quantitative and repeatable methods were employed and the results are comparable with other forest surveys undertaken by FT FRP. Human disturbance within the forest was also studied. Data collected by this survey will be entered onto the EUCFP data base in Tanga.

5.2 Methods

The forest block is divided into grid squares which are measured and marked in the field. All methods are based on these transects. The methods used during this survey are detailed in the FT FRP methodologies report (SEE, 1996). A brief description is presented below. The location of disturbance transects are illustrated in Figure 3.

5.2.1 Forest structure

Three methods were used to analyse forest structure: (1) Opportunistic vegetation sampling and (2) disturbance transects.

5.2.1.1 Opportunistic vegetation sampling

Throughout all forest blocks of Magoroto, the botanist from UDSM recorded and when necessary, took samples of vegetation for later identification, to provide a checklist of vegetation to supplement those species recorded in the quantitative vegetation analysis.

5.2.1.2 Disturbance transects

Disturbance transects provide a statistical estimate of pole cutting and logging in a forest block. Each transect consisted of three parallel sub-transects, 250 m long and at least 30 m apart, within a recognised forest type. Every self-standing tree and sapling (i.e. not lianas or creepers) above 1cm dbh was measured within an area 2.5 m either side of each transect line. Each plant was recorded under one of two categories: 'cut' or 'naturally fallen'.

Due to limitations of this method, one number representing the average cut and naturally fallen poles and timber per 100 m is given for the entire transect. The data are unable to be broken down into more meaningful units.

No Map Currently Available in Digital Format

Figure 3. Location of disturbance transects.

5.3 Results

5.3.1 Vegetation analysis

Table 3 presents a checklist of the tree and shrub species recorded in the vegetation plots and the opportunistic. sampling. Species are described, where adequate information exists, in terms of their ecological type, their habitat and their endemic status.

Table 3. Checklist of trees and shrubs.

Species	Ecological type	Habitat[2]	Endemic status
Anacardiaceae			
Sorindeia madagascariensis	f	S	W
Rhizophoraceae			
Anisophyllea obtusifolia	F		N
Annonaceae			
Enantia kummeriae	F	S	N
Isolana heinsenii	F	S	N
Monanthotaxis discrepantinervis	F		N
Monodora grandidieri	f		N
Polyceratocarpus scheffleri	F	S	N
Apocynaceae			
Rauvolfia caffra	F	L & S	W
Rauvolfia oreogiton[1]	?		?
Funtumia latifolia[1]	?		?
Tabernaemontana usambarensis[1]	?		?
Araliaceae			
Schefflera goetzenii	F	S	W
Bignoniaceae			
Fernandoa magnifica	f	L	W
Cactaceae			
Rhipsalis baccifera	f		N
Celastraceae			
Maytenus undata	f	S	W
Salacia leptoclada	F		W
Chrysobalanaceae			
Maranthes goetzeniana	f	S	W
Parinari excelsa	f	S	W
Compositae			
Crassocephalum mannii[1]	?		?
Vernonia amygdalina[1]	?		?
Vernonia brachycalyx	O		W
Vernonia colorata	O		W
Connaraceae			
Agelaea setulosa[1]	f		W
Dracaenaceae			
Dracaena steudneri	F	S (forest gaps)	W
Euphorbiaceae			
Antidesma membranaceum	f	L & S	W
Bridelia micrantha	f	L & S	W
Croton macrostachyus[1]	O	L & S (forest gaps)	W
Drypetes usambarica	f	S	N
Macaranga capensis	F	L & S (forest gaps)	W
Ricinodendron heudelotii	f	L	N

Table 3 *cont.*

Species	Ecological type	Habitat[2]	Endemic status
Sapium ellipticum	f	L & S	W
Zimmermannia capillipes	F	S	E (EU & WU)
Guttiferae			
Harungana madagascariensis	F	S	W
Labiatae			
Hoslundia opposita	f		W
Leguminosae subfamily: Caesalpiniaceae			
Cynometra sp.	?		?
Englerodendron usambarense	F	S	E (EU & WU)
Erythrophleum guineense[1]	F		W
Intsia bijuga[1]	O		W
Isoberlinia scheffleri	F	S	N
Leguminosae subfamily: Mimosaceae			
Albizia gummifera	f	S & L	W
Newtonia buchananii	F	S	W
Leguminosae subfamily: Papilionaceae			
Angylocalyx braunii	F	L	N
Dalbergia sp.	?		?
Melastomataceae			
Clidemia hirta	O		W
Memecylon erythranthum	F		N
Memecylon sp.	?		?
Meliaceae			
Pseudobersama abyssinica[1]	?		?
Melianthaceae			
Bersama abyssinica	f	S (forest gaps)	N
Moraceae			
Ficus exasperata	f	L & S	W
Ficus craterostoma	f		W
Ficus natalensis	f	L	W
Ficus kirkii	f	S	W
Mesogyne insignis	F	S	N
Milicia excelsa	f	L & S	W
Treculia africana	F	S	W
Trilepisium madagascariense	f	L	W
Myristicaceae			
Cephalosphaera usambarensis	F	S	N
Myrtaceae			
Syzygium guineense	F	S	W
Syzgium malaccensis[1]	?		?
Rhamnaceae			
Maesopsis eminii	F	L & S	W
Rubiaceae			
Cremaspora triflora	f		W
Chassalia discolor	F		N
Chazaliella abrupta	f		W
Dolichometra leucantha	F		E (EU)
Hallea rubrostipulata	f	S	W
Heinsenia diervilleoides	F		W
Keetia venosa	O		W
Lagynias pallidiflora	f		N
Morinda asteroscepa	f	S (forest gaps)	N
Oxyanthus speciosus	F	S (forest gaps)	W

Table 3 *cont.*

Species	Ecological type	Habitat[2]	Endemic status
Pauridiantha paucinervis	F	S	W
Pavetta stenosepala	F		N
Pauridiantha schliebenii var. *schiliebenii*[1]	?		?
Porterandia penduliflora	?		N
Psychotria griseola	F		N
Psychotria megistantha[1]	F		N
Psychotria tranganyicensis	F		N
Psychotria sp.	?		?
Rothmannia urcelliformis	F	L	W
Rutidea orientalis	f		W
Rytigynia flavida	F		W
Rytigynia uhligii	f		W
Tarenna pavettoides[1]	F		W
Tricalysia pallens	f		W
Rutaceae			
Teclea amaniensis	f		N
Teclea simplicifolia	f	S	W
Zanthoxylum holtzianum[1]	f		W
Zanthoxylum milbraedii[1]	F		W
Sapindaceae			
Allophylus calophylus	f		N
Blighia unijugata	F	L & S	W
Deinbollia borbonica	O		W
Deinbollia kilimandscharica[1]	?		?
Sapindus saponaria[1]	?		?
Sapotaceae			
Afrosersalicia ceracifera	f	S	W
Bequaertiodendron natalense	f	L & S	W
Chrysophyllum gorungosanum	F	S	W
Pachystela brevipes[1]	F		W
Pachystela msolo	F	L & S	W
Simaroubaceae			
Harrisonia abyssinica	f		W
Sterculiaceae			
Cola greenwayi	F		N
Cola stelacantha[1]	F		NT
Leptonychia usambarensis	F	L & S	N
Tiliaceae			
Grewia goetzeana	f	L	N
Grewia sp.	?		?
Ulmaceae			
Celtis gomphophylla	F	L	W
Celtis mildibraedii	F	L & S	W
Verbenaceae			
Vitex ferruginea	F		E (EU & WU)
Violaceae			
Rinorea scheffleri	F		E (EU)
Rinorea ferruginea	F		N

[1] Species which do not appear in Iversen (1991). Summary information is based on Ruffo *et al.* (1989), Lovett (1993) or the *Flora of Tropical East Africa*.
[2] Information is based on Ruffo *et al.* (1989).

KEY TO ABBREVIATIONS FOR TABLE 3

Ecological type (based on Iversen, 1991):

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Habitat: (based on Hamilton, 1989)

- L - Lowland: Occurring at altitudes of <850 m;
- S - Submontane: Occurring at altitudes of >850 m.

In the case where species occur in both lowland and submontane habitats, the most common habitat will be listed first and only this habitat will be counted in the summary statistics. If a species is common in forest gaps, rather than in the forest proper, this will also be noted.

Endemic status: (based on Iversen, 1991):

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowlands between Somalia and Mozambique.
- W - Widespread distribution.

EU - Range limited to the East Usambaras ; WU - Range limited to the West Usambaras
? Insufficient data

Table 4 summarises information for species which were recorded in Magoroto outside the range described by Ruffo *et al.* (1989).

Table 4. Trees found outside their previously recorded range in the East Usambaras.

Species	Location as previously recorded[1]
Allophyllus melliodorus	Lutindi and Mtai forest reserves
Vincentella passargei	Mtai forest reserve
Hallea rubrostipulata	Near Amani

[1] Information is based on Ruffo *et al.* (1989).

Ecological type:

Table 5. Summary of ecological type for tree and shrub species (based on Table 3).

Ecological type	Number of species	% of total species
(F) Forest Dependent Species	48	44.0
(f) Forest Non- Dependent Species	38	34.9
(O) Non-Forest Species	7	6.4
Unknown	16	14.7
Total:	**109**	**100.0**

Habitat:

Table 6. Summary of the habitat for tree and shrub species (based on Table 3).

Habitat	Number of species	% of total species
(L) Lowland Forest Species	22	43.1
(S) Submontane Forest Species	29	56.9
Total:	**51**	**100.0**

Endemic status:

Table 7. Summary of endemic status for tree and shrub species (based on Table 3).

Endemic status	Number of species	% of total species
(E) Endemic	5 (2 - EU & 3 EU &WU)	4.6
(N) Near Endemic	30	27.5
(W) Widespread	59	54.1
Unknown	15	13.8
Total:	**109**	**100.0**

* EU - endemic to the East Usambaras; WU - endemic to the West Usambaras

No Map Currently Available in Digital Format

Figure 4. Vegetation of Magoroto forest.

5.3.2 Disturbance transects

Three disturbance transects were recorded for pole and timber extraction during the survey. The disturbance transects are described in Table 8 and the results summarised in Table 9 for poles and Table 10 for timber. The terms pole and timber are used in this section only as this method examines the forest in terms of its extractive value. Poles are defined as <10 cm dbh and timber as >= 10 cm dbh.

Table 8. Description of disturbance transects.

Plot number	Topography	Altitude (m)	Vegetation type
1	steep mid-slope	800	Disturbed forest
22	mid-slope	750	Disturbed forest
25	plateau	720	Disturbed forest

Table 9. Disturbance transect results for pole counts.*

Plot number	Length of transect (m)	Total poles sampled	Cut poles	Average per 100 metres	Naturally fallen poles	Average per 100 metres
1	540	274	247	**91.5**	27	**10.0**
22	630	291	281	**89.2**	10	**3.2**
25	700	604	501	**143.1**	103	**29.4**

* Due to differences in methods, the results under 'Average per 100 metres' are doubled to allow direct comparisons with other forest reserves in this survey series.

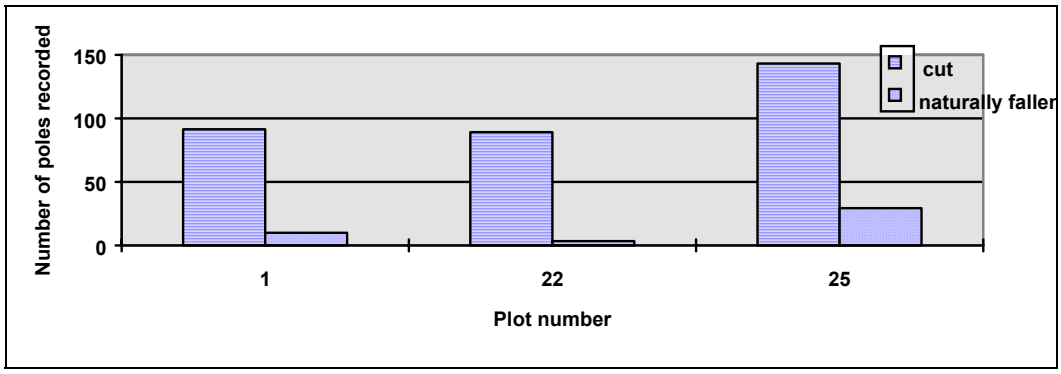

Figure 5. Cut and naturally fallen poles recorded per 100 metres by transect.

Table 10. Disturbance transect results for timber counts.*

Plot number	Length of transect (m)	Total timber sampled	Cut timber	Average per 100 metres	Naturally fallen timber	Average per 100 metres
1	540	92	65	**24.1**	27	**10.0**
22	630	90	76	**24.1**	14	**4.0**
25	700	50	36	**10.3**	14	**4.0**

* Due to differences in methods, the results under 'Average per 100 metres' are doubled to allow direct comparisons with other forest reserves in this survey series.

Figure 6. Cut and naturally fallen timber recorded per 100 metres by transect.

5.4 Summary

Magoroto forest covers an area of 215.5 ha within Magrotto estate. Altitudinal zonation ranges from 650 to 880 m. One hundred and nine trees and shrub species were identified from 33 families.

Ecological Type

Forest dependent species defined as limited to primary forest only, were recorded 48 times. This represents 44.0% of all species recorded. Twenty-four of the forest dependent species are also endemic or near-endemic to the Usambaras.

Seven non-forest species were recorded.

Habitat

Magoroto forest is considered to be mainly submontane forest as defined by altitude. Consequently, over 50% of the known trees and shrubs are submontane species.

Endemic Status

Of the plant species recorded, 59 (54.1%) have widespread distributions. Near-endemics contribute 30 species (27.5%) from 15 families to the floristic composition of the reserve.

Five of the species surveyed are endemic to the Usambaras. These endemics are: *Dolichometra leucantha* and *Rinorea scheffleri*, found only in the East Usambaras and *Zimmermannia capillipes, Englerodendron usambarense,* and *Vitex ferruginea* found in the East and West Usambaras. All are forest dependent species (Iversen, 1991).

Range Extensions

Psychotria megistantha, a shrub typical of rain forest habitats known only from southern Tanzania (FTEA);

Zanthoxylum milbraedii, a tree recorded from rain forests of Uganda, Kenya, Zaire, and Rwanda (FTEA). This is a new record for Tanzania;

Cola stelacantha, a forest dependent tree limited to five locales in southern and east-central areas of Tanzania. The occurrence of this tree in Magoroto raises the number of locales where it exists, to six (FTEA).

Disturbance

The rate of pole cutting occurred between 89.2 and 143.1 per 100 m and for timber cutting, 10.3 to 24.1 per 100 m. All areas assessed recorded pole and timber cutting at much higher rates than naturally fallen saplings and trees. Pole cutting was higher in the vicinity of the estate house whereas timber cutting was low around the house and higher in the other forest areas where timber quality is better.

6.0 ZOOLOGY

6.1 Introduction

The faunal biodiversity of Magoroto forest was investigated using standard, repeatable, survey methods. Studies on small mammals, birds, bats, reptiles and amphibians. In line with the specific aims of the survey, an inventory of all fauna encountered was compiled. This data was analysed to assess the biodiversity value of the area.

6.2 Methods

All methods used during the expedition survey are outlined in detail in the FT FRP methodologies report (SEE, 1996). A brief description is presented below. The location of capture location plots are presented in Figure 7.

6.2.1 Mammals

Four different methods are used to sample the mammal community within Magoroto forest: (1) snap trap lines, (2) bucket pitfalls, (3) bat netting and (4) opportunistic observations.

6.2.1.1 Snap-trap lines

In order to sample the community of rodents, small and large break-back traps (snap-traps) were used. Typically the traps were set out in transect lines of approximately 50, with traps positioned at least 2 m apart. However, this was not always possible due to the nature of the habitat. The traps were set each evening and checked early the following morning. A bait of fried coconut and peanut butter was used. Previous forest surveys indicate that this bait is very successful in terms of catch numbers and species diversity (Stanley, *pers. comm.*). Each mammal caught was weighed and measured. Trapping and biometric data was recorded on standardised data sheets. Unless otherwise indicated, specimens were identified by Prof. K. Howell or by Dr. D. Kock (see Appendix 2).

6.2.1.2 Bucket pitfall trapping

The bucket pitfall traps consisted of five 20 litre plastic buckets sunk flush to ground level in a linear transect. These were positioned approximately 2.5 m apart. A continuous piece of plastic sheeting ran perpendicular to the ground across the centre of each bucket forming a "runner". A lip of plastic sheeting, a drift fence, was kept on the ground on to which soil and leaf litter was placed. An animal was, therefore, channeled along the plastic to one of the buckets. The bucket pitfalls, acting as live traps, were designed for sampling a community of shrews within the forest. Each mammal captured was weighed and measured. Trapping and biometric information was recorded on standardised data sheets. Unless otherwise indicated, taxonomic identification was made by Prof. K. Howell, Dr. D. Kock or Dr. W. Stanley (see Appendix 2).

6.2.1.3 Bat netting

Bat mist netting was used to collect and study a representative sample of the forest bat community, and also provide data on species' ranges. Mist nets were placed near potential roosts sites and across obvious flight "corridors", such as paths and rivers. Nets were set up at dusk, observed continuously throughout the night and closed shortly before dawn. Each bat caught was weighed and measured at the netting site. Trapping and biometric information was recorded on standardised data sheets. Unless otherwise indicated, taxonomic identification was made by Prof. K. Howell or Dr. D. Kock (see Appendix 2).

6.2.1.4 Mammal observations

Other vertebrate species were recorded on an opportunistic basis throughout the survey.

6.2.2 Birds

The aim of this study was to assess the avifaunal diversity of the study site. Diurnal bird censuses were randomly located, and conducted throughout the study site. Sampling was also carried out at night to identify nocturnal species. Identifications were based on visual observations using binoculars and where possible, confirmed with bird calls.

6.2.3 Reptiles

The aim of this study was to collect and identify a representative sample of the forest reptile community. The community of ground-dwelling reptiles was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted by hand, and a snake stick where necessary. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or Prof. D. Broadley (see Appendix 2).

6.2.4 Amphibians

The aim of this study was to collect and identify a representative sample of the forest amphibian community. The community of ground-dwelling amphibians was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted, especially in reference to tree frog collections since they were often beyond capture with the bucket pitfalls. After rain, typical amphibian habitats were targeted for sampling. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or by Prof. J. Poynton (see Appendix 2).

6.3 Trapping sites and sampling intensity

Eight trapping sites were conducted in various habitats. Table 11 describes the sites and Table 12 summarises the sampling intensity for each site and for each trapping method.

Table 11. Summary descriptions of trapping sites.

Plot number	Vegetation type	Altitude (metres)	Topography
1	disturbed secondary forest	850	ridge top
3	secondary forest	820	ridge top
4	secondary forest	780	upper slopes
13	oil palm	750	plateau
25	heavily degraded forest	700	plateau
UK*	oil palm plantation	750	plateau
UK*	secondary forest	800	mid-slope
UK*	forest edge/oil palm plantation	770	mid-slope

* UK - Unknown plot number

Table 12. Sampling intensity by trap night (number of nights x number of traps).

Trapping method	Plot 1	Plot 3	Plot 4	Plot 13	Plot 25	OPP*	SF*	FE*
snap traps	310	270	270	212	325	100	134	60
bucket pitfall	11	11	11	11	11	0	0	0

* OPP - Oil palm plantation (plot unknown)
SF - Secondary forest (plot unknown)
FE - Forest edge (plot unknown)

No Map Currently Available in Digital Format

Figure 7. Location of capture location plots.

6.4 Results

6.4.1 Mammals

6.4.1.1 Mammals (non-bats)

A total of 73 specimens were retained for taxonomic purposes. These represent eight species from four families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Kingdon (1989).

Table 13. Summary of mammals (non-bats).

Species	Ecol. type	End. status	IUCN status	Capture location by plot/locale & number collected									
				1	3	4	13	25	SF	FE	OP	UK	Total
Cricetidae													
Beamys hindei	f	N	DD			8			1				**9**
Muridae													
Hylomyscus denniae	F	W		7									**7**
Rattus rattus	O	W			6	1	4	2		1	8		**23**
Lophuromys sikapusi	O	W		12	2	3		2	9	1			**29**
Mus minutoides	f	W										1	**1**
Grammomys dolichurus	O	W			1	1							**2**
Soricidae													
Crocidura occidentalis spp. *martiensseni*	?	W										1	**1**
Viverridae													
Genetta genetta	O	W										1	**1**

KEY TO ABBREVIATIONS FOR TABLE 13 (Definitions based on those described in the botanical section of this report).

Ecological (Ecol.) type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- DD - Data deficient

Capture Locale Codes:
- SF - Secondary forest
- FE - Forest edge
- OP - Oil palm plantation
- UK - Unknown

6.4.1.2 Opportunistic Observations

Ten species from eight families were observed but not retained for taxonomic purposes. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Kingdon (1989).

Table 14. Summary of mammal observations.

Species	Certainty	Ecol. type	End. status	IUCN status	Observation location by locale				
					F	OP	FL	FE	Total
Galagonidae									
Galago demidovi	possible	F	W					1	**1**
Cercopithecidae									
Cercopithecus mitis	definite	f	W		freq				**freq**
Cercopithecus aethiops	definite	f	W				2		**2**
Viverridae									
Nandinia binotata	probable	f	W		freq	2			**freq**
Civettictis civetta	definite	f	W		1				**1**
Herpestidea									
Atilax paludinosus	definite	f	W			2			**2**
Procaviidae									
Dendrohyrax validus	definite	f	N	E				1	**1**
Sciuridae									
Heliosciurus rufobrachium	probable	F	W		freq	1			**freq**
Hystricidae									
Hystrix sp.	definite	f	W			1			**1**
Macroscelididae									
Rhyncocyon petersi	definite	f	N	NT	1				**1**

KEY TO ABBREVIATIONS FOR TABLE 14 (Definitions based on those described in the botanical section of this report).

Ecological (Ecol.) type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- E - Endangered
- NT - Near-threatened

Capture Locale Codes:
- F - Secondary forest
- FL - Farmland
- OP - Oil palm plantation
- FE - Forest edge

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.
? - No data available
Certainty: Indicates the probability of the correctness of the identity of the species observed;
Definite: Can be regarded as occurring in the reserve.
Probable: Identification is likely but requires confirmation.before placing on the reserve's species list.

Table 15. Ranges for near-endemic mammal species recorded (National Biodiversity Database, UDSM, 1997).

Near-endemic species	Range
Beamys hindei	Usambara Mts; coastal forests, Tanzania; SE Kenya
Rhynchocyon petersi	NE and E Tanzania; Zanzibar; Mafia
Dendrohyrax validus	E Tanzania; Kilimanjaro, Meru, Usambara, Uluguru and Pare Mts; Zanzibar; Pemba

No Map Currently Available in Digital Format

Figure 8. Distribution of forest dependent mammal species.

No Map Currently Available in Digital Format

Figure 9. Distribution of near-endemic mammal species.

6.4.1.3 Bats

A total of 15 specimens were retained for taxonomic purposes. These represent nine species from five families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997); Howell (1993) and Kingdon (1989).

Table 16. Summary of bats.

Species	Ecological type	Endemic status	Capture location and number collected			
			F	FE/OP	OP	Total
MEGACHIROPTERA (fruit bats)						
Pteropodidae						
Lissonycteris angolensis	F	W		3	1	**4**
Epomophorus wahlbergi	F	W		3		**3**
MICROCHIROPTERA (insectivorous bats)						
Rhinolophidae						
Rhinolophus eloquens	?	W		1		**1**
Hipposideridae						
Triaenops persicus afer	f	W		2		**2**
Vespertilionidae						
Nycticeius Scotoceus hirundo	f	W	1			**1**
Mimetillus moloneyi	f	W		1		**1**
Molossidae						
Tadarida (Mops) brachyptera	F	W	1			**1**
Tadarida (Chaerephon) sp.	?	?	1			**1**
Tadarida (Chaerephon) pumila	f	W		1		**1**

KEY TO ABBREVIATIONS FOR TABLE 16 (Definitions based on those described in the botanical section of this report).

Ecological type:

1. F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

Capture Locale Codes:

- F - Secondary forest
- FE - Forest-edge
- OP - Oil palm plantation

6.4.2 Birds

A total of 82 species were observed or heard. These represent 33 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Zimmerman *et al.* (1996).

Table 17. Summary of birds.

Species	Ecological type	Endemic status	IUCN status	Obs./ heard in forest*	Obs/ heard outside forest*
Accipitridae					
Polyboroides radiatus	f	W		OC	OC
Circaetus fasciolatus	F	W		FQ	FQ?
Accipiter tachiro	F	W		CM	CM
Hieraaetus dubius	F	W		OC	
Gypohierax angolensis	O	W			
Terathopius ecaudatus	O	W			
Buteo augur	O	W			
Lophaetus occipitalis	O	W			
Columbidae					
Turtur tympanistri	f	W		CM	CM
Columba delegorguei	F	W		OC	
Treron australis	O	W		OC	OC
Streptopelia semitorquata	O	W			
Musophagidae					
Tauraco fischeri	f	W		CM	OC
Cuculidae					
Centropus superciliosus	O	W			
Chrysococcyx klaas	f	W		OC	
Strigidae					
Bubo africanus	O	W		CM	CM
Ciccaba woodfordi	f	W		CM	CM
Apodidae					
Apus affinis	O	W			
Cypsiurus parvus	O	W			
Telacanthura ussheri	f	W		OC	
Trogonidae					
Apaloderma narina	f	W		OC	
Apaloderma vittatum	F	W		OC	
Hirundinidae					
Hirundo fuligula	O	W			
Psalidoprocne pristoptera	O	N?			
Meropidae					
Merops sp. (prov.)	O	W			
Alcedinidae					
Halcyon albiventris	O	W			
Phoeniculidae					
Phoeniculus purpureus	f	W		OC	OC
Bucerotidae					
Bycanistes brivis	F	W		OC	
Bycanistes bucinator	f	W		CM	CM
Tockus alboterminatus	f	W		CM	CM

Table 17 *cont.*

Species	Ecological type	Endemic status	IUCN status	Obs./ heard in forest*	Obs/ heard outside forest*
Capitonidae					
Gymnobucco leucotis	F	W		CM	CM
Buccanodon olivaceum	F	W		CM	CM
Corvidae					
Corvus albicollis	O	W			
Fringillidae					
Serinus citrinelloides	O	W			
Serinus mozambicus.	O	W			
Picidae					
Campethera abingoni	f	W		OC	
Campethera cailliautii	f	W		OC	
Dendropicos fuscescens	f	W		FQ	FQ
Eurylaimidae					
Smithornis capensis	f	W		FQ	
Dicruridae					
Dicrurus ludwigii	f	W		CM	OC
Oriolidae					
Oriolus chlorocephalus	F	N		CM	
Oriolus auratus	O	W			
Turdoididae					
Trichastoma rufipennis	F	W		CM	OC
Campephagidae					
Campephaga flava	O	W			
Coracina caesia	F	W		FQ	
Pycnonotidae					
Andropadus milanjensis	F	W		OC	
Andropadus virens	F	W		CM	
Phyllastrephus flavostriatus	F	W		CM	
Pycnonotus caffer	O	W			
Turdidae					
Turdus gurneyi	F	W		OC	OC
Cossypha caffra	f	W		OC	
Neocossyphus rufus	f	W		OC	
Sylviidae					
Apalis melanocephala	F	W		CM	
Camaroptera brachyura	f	N?		OC	OC
Cisticola sp. (prov.)	O	W			
Prinia subflava	O	W			
Muscicapidae					
Muscicapa adusta	f	W		OC	
Trochocercus cyanomelas	f	W		CM	
Terpsiphone viridis	f	W		OC	FQ
Batis molitor	O	W			
Laniidae					
Dryoscopus cubla	f	W		OC	FQ
Laniarius ferrugineus	O	W			
Sturnidae					
Cinnyricinclus leucogaster	O	W			
Onychognatus morio	O	W			
Lamprotornis corruscus	f	W		CM	CM
Onychognathus walleri	F	W		CM	CM
Stilbopsar kenricki	F	W		OC	OC

Table 17 *cont.*

Species	Ecological type	Endemic status	IUCN status	Obs./ heard in forest*	Obs/ heard outside forest*
Nectariniidae					
Anthreptes collaris	f	W		CM	CM
Anthreptes neglectus	F	N		OC	
Anthreptes pallidigaster	F	N	NT	OC	OC
Nectarinia olivacea	f	W		OC	OC
Anthreptes rubritorques	F	N	V	OC	
Nectarinia sp. (prov.)	O	W			
Ploceidae					
Ploceus bicolor	f	W		CM	OC
Ploceus ocularis	O	W			
Estrildidae					
Spermophaga ruficapilla	F	W		OC	
Estrilda astrild	O	W		OC	
Lonchura bicolor	O	W			
Lonchura fringilloides	O	W			
Mandingoa nitidula	f	W		CM	FQ?
Motacillidae					
Motacilla clara	O	W			
Emberizidae					
Emberiza cabanisi	O	W			

KEY TO ABBREVIATIONS FOR TABLE 17 (Definitions based on those described in the botanical section of this report).

Ecological (Ecol.) type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- V - Vulnerable
- NT - Near-threatened

Obs/heard - Observed or heard in or outside of forest:
- CM - Common, recorded daily
- FQ - Frequent, recorded on more than half the survey days
- OC - Occasional, few records, recorded on less than half of the survey days

* non-forest species were not recorded for abundance.
Allowances were made for the lower detectability of secretive and/or non-vocal species and the naturally low density of large raptors by assigning them a higher abundance than these definitions indicate.
Abundances were not recorded for non-forest birds.
Prov: Provisional identification

6.4.3 Reptiles

A total of 48 specimens were retained for taxonomic purposes. These represent 29 species from 13 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997); Broadley and Howell (unpubl.); Howell (1993); and Branch (1994).

Table 18. Summary of reptiles.

Species	Ecol. type	End. status	IUCN status	Capture plot/locale and number collected									
				1	3	4	7	25	OP	FE	L	OR	Total
Testudinidae													
unidentified	?	?										1	**1**
Typhlopidae													
Typhlops gierrai	F	N	V				1						**1**
Typhlops schlegeli spp. *mucrosa*	O	W						1					**1**
Leptotyphlops													
Leptotyphlops longicaudus	O	W									1		**1**
unidentified specimen	?	?									1		**1**
Colubridae													
Mehelya capensis spp. *capensis*	f	W					1						**1**
Dispholidus typus	O	W			G		1						**2**
Duberria sp.	?	?					1						**1**
Elapidae													
Naja melanoleuca	F	W							3				**3**
Elapsoidea sp.	?	?							1				**1**
Viperidae													
Bitis gabonica spp. *gabonica*	F	W						2	*				**3**
Scincidae													
Leptosiaphos kilimensis	F	N	V	2		3	1						**6**
Lygosoma afrum	f	W					1			1			**2**
Panaspis sp.	?	?					1						**1**
unidentified	?	?				2							**2**
Lacertidae													
unidentified	?	?						1					**1**
Agamidae													
Agama montana	F	N	V			1		1				1	**3**
Chamaeleonidae													
Rhampholeon brevicaudatus	F	N	V				1	2					**3**
Rhampholeon temporalis	F	N	E			1	1						**2**
Rhampholeon sp.	?	?				3							**3**
Bradypodion tenue	F	N	V (CITES II)				1		1		1		**3**
Bradypodion fischeri	F	N	V (CITES II)								1		**1**
Chamaeleo dilepis	f	W				1					1		**2**

Table 18 *cont.*

Species	Ecol. type	End. status	IUCN status	Capture plot/locale and number collected								
				1	4	7	25	OP	FE	L	OR	Total
Gekkonidae												
Hemidactylus mabouia	f	W					1					**1**
Hemidactylus platycephalus	f	W					2					**2**
Cnemaspis africana	F	N	NT		1	1						**3**
Lygodactylus sp.	?	?					1					**1**

Table 19. Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	Observation locations by plot
Testudinidae				
Kinixys belliana spp. *zombensis*	definite	f	W	25
Varanidae				
Varanus niloticus	definite	f	W (CITES II)	unknown

KEY TO ABBREVIATIONS FOR TABLE 18 & 19 (Definitions based on those described in the botanical section of this report).

Ecological (Ecol.) type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- E - Endangered
- V - Vulnerable
- NT - Near-threatened

G - Grass area in plot.
OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.
? - Insufficient data
* Numerous, encountered almost daily.
Certainty: Indicates the probability of the correctness of the identity of the species observed;
Definite: Can be regarded as occurring in the reserve.

Table 20. Ranges for near-endemic reptile species recorded (Howell, 1993).

Near-endemic species	Range
Agama montana	East Usambaras; West Usambaras; Ulugurus; Ngurus
Philothamnus macrops	East Usambara; Zanzibar; Rondo Plateau
Leptosiaphos kilimensis	Kenya, northern Tanzania (montane forest)
Rhampholeon brevicaudatus	East Usambara; Uluguru; Uzungwa; Coastal forest
Bradypodion tenue	East Usambaras; West Usambaras; Shimba Hills, Kenya
Bradypodion fischeri fischeri	East Usambaras; Ngurus

No Map Currently Available in Digital Format

Figure 10. Distribution of forest dependent reptile species.

No Map Currently Available in Digital Format

Figure 11. Distribution of near-endemic reptile species.

6.4.4 Amphibians

A total of 109 specimens were retained for taxonomic purposes. These represent 29 species from seven families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997); Howell (1993); Poynton and Broadley (1991); and Poynton (unpubl.).

Table 21. Summary of amphibians.

Species	Ecol. type	End. status	IUCN status	Capture site and number collected					
				F	FE	WC	OP	L	Total
Arthroleptidae									
Arthroleptis stenodactylus	f	W		4			3		**7**
Arthroleptis xenodactyloides	f	W		2			3		**5**
Bufonidae									
Bufo brauni	F	N	V	1	1				**2**
Bufo gutturalis	f	W				1	1		**2**
Nectophrynoides tornieri	F	N	V (CITES I)	7		1	1		**9**
Hyperoliidae									
Leptopelis barbouri	F	N	V	2		1			**3**
Leptopelis flavomaculatus	F	W		2	1				**3**
Leptopelis uluguruensis	F	N	V	2					**2**
Leptopelis vermiculatus	F	N	NT	1	2				**3**
Leptopelis parkeri	F	N	V	3		1			**4**
Hyperolius argus	f	W		1		4			**5**
Hyperolius mitchelli	F	W		1		3			**4**
Hyperolius puncticulatus	F	W		2	5	5		1	**13**
Hyperolius spinigularis	F	N				5			**5**
Hyperolius viridiflavus spp. *mariae*	f	W				2			**2**
Hyperolius parkeri	f	W				6			**6**
Hyperolius marmoratus	f	W		1		1			**2**
Afrixalus uluguruensis	F	N	V		3				**3**
Afrixalus fornasini	f	W				5			**5**
Afrixalus sp.	?	?			1				**1**
Kassina maculata	f	W				3			**3**
Microhylidae									
Callulina kreffti	F	N	V	1	1	1			**3**
Probeviceps macrodactylus	F	N	NT	3					**3**
Ranidae									
Arthroleptides martiensseni	F	N	V		1				**1**
Rana angolensis	f	W			1	1			**2**
Phrynobatrachus krefftii	F	N	V	2					**2**
Phrynobatrachus acridoides	f	W			4	1			**5**
Pipidae									
Xenopus muelleri	f	W				3			**3**
Scolecomorphidae									
Scolecomorphus sp.	?	?					1		**1**

KEY TO ABBREVIATIONS FOR TABLE 21 (Definitions based on those described in the botanical section of this report).

Ecological (Ecol.) type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- V - Vulnerable
- NT - Near-threatened

Capture locale codes:
F - Forest
FE - Forest edge
WC - Water course (stream, marsh, lake)
OP - Oil palm plantation
L - Brought in by local person, capture locale unknown

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it. In all these cases, these specimens were collected by a stream beside camp.
U - Unknown capture location.

Table 22. Ranges for endemic and near-endemic amphibians recorded (Howell 1993).

Near-endemic Species	Range
Bufo brauni	East Usambara; West Usambara; Uluguru; Uzungwa
Mertensophryne micranotis	East Usambara; Coastal forest
Leptopelis barbouri	East Usambara; Uzungwa mountains
Leptopelis uluguruensis	East Usambara; West Usambara; Uluguru; Uzungwa
Leptopelis vermiculatus	East Usambara; West Usambara; Southern Highlands
Arthroleptides martiensseni	East Usambara; West Usambara; Uluguru; Uzungwas

No Map Currently Available in Digital Format

Figure 12. Distribution of forest dependent amphibian species.

No Map Currently Available in Digital Format

Figure 13. Distribution of near-endemic amphibian species.

6.5 Summary

Species Richness

In this section, species which have been captured or observed three or more times during the survey are considered locally common. Although unproven this figure is based on extensive sampling of populations in the region and seems a reasonable basis for assessing abundance.

Mammals:

Of the mammals recorded, *Lophuromys sikapusi*, was the most common with the invasive species, *Rattus rattus* as second most common. The occurrence of *Rattus rattus* is probably due to the heavily disturbed forests and the oil palm plantation. Only *Rattus rattus* was captured in the oil palm plantation apparently excluding other species including *Lophuromys sikapusi* which is known to live in these plantations (Bellier, 1965; Delaney, 1972).

Of the bats, *Lissonycteris angolensis* was recorded most frequently. This is a forest dependent bat which was recorded in lowland secondary forest near human habitation, at the forest/plantation interface, and in submontane ridgetop forest.

Birds:

Numerous species were commonly observed inside and outside the forest however the data provides only broad estimates of abundance.

Reptiles:

The most common reptile species is *Bitis gabonica* spp. *gabonica* observed almost everyday in the oil palm plantation. The abundance of this species may reflect the abundance of its potential prey species *Rattus rattus* in the plantation. Other common reptiles recorded are *Leptosiaphos kilimensis, Cnemaspis africana, Bradypodion tenue, Rhampholeon brevicaudatus, Agama montana* and *Naja melanoleuca.* These species are considered common as they were captured more than three times during the survey.

Amphibians:

The most commonly caught species of tree frog was *Hyperolius puncticulatus*. Other amphibians that appear locally common are *Arthroleptis stenodactylus, Arthroleptis xenodactyloides, Phrynobatrachus acridoides, Phrynobatrachus krefftii, Rana angolensis, Probeviceps macrodactylus, Callulina kreffti* and *Nectophrynoides tornieri.*

Endemics and near-endemics:

Of the 29 endemics and near-endemics recorded, 16 (55.2%) appear to be locally common as they were recorded at least three times during the survey.

Forest dependent species:

Of the 54 forest dependent mammal, bird, reptile and amphibian species, 34 (63.0%) appear to be locally common.

High risk species:

Assuming that the number captured reflects relative population size, those species that are locally uncommon, forest dependent and either near-endemic or endemic species are considered to be at high risk. These species are: *Anthreptes neglectus, Anthreptes pallidigaster, Typhlops gierrai, Rhampholeon temporalis, Bradypodion fischeri fischeri, Bufo brauni, Leptopelis parkeri* and *Arthroleptides martiensseni*

Table 23. Summary of faunal families and species (identified to date).

Taxon	Number of families	Number of species
mammals	16	27
birds	33	82
reptiles	13	29
amphibians	7	29

Table 24. Summary of capture locations of faunal species.

Taxon	forest	oil palm planta-tion	forest edge/ planta-tion	farm-land	outside forest	lake/ marsh/ stream in planta-tion	grass land	un-known
mammals	14	6	8	1				3
birds	52				31			
reptiles	16	8	6	1	1	3	1	5
amphibians	14	4	14			14		

Ecological type

Table 25. Summary of ecological type of faunal species.

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	53	31.7
(f) Forest dwelling but not forest dependent	62	37.1
(O) Non-forest species	38	22.8
Unknown	14	8.4
Total	**167**	**100.0**

Endemic Status

Table 26. Summary of endemic status of faunal species.

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	0	0
(N) Near-Endemic: ranges in restricted locations	29	17.4
(W) Widespread	126	75.4
Unknown	12	7.2
Total	**167**	**100.0**

Range Extensions

Mammals:

The Mops Free-tailed bat, *Tadarida brachyptera,* is a third record for Tanzania and the first for the East Usambaras (Kock, *pers. comm.*). This specimen was captured in the forested area of the estate.

Reptiles:
The paratype of a new species of blind snake, *Leptotyphlops macrops*, was collected (Broadley, *pers. comm.*). This represents a range extension.

CITES

Nectophrynoides tornieri is listed as a CITES I amphibian species.

Varanus niloticus, Bradypodion fischeri and *Bradypodion tenue* are CITES II reptile species.

IUCN Status (National Biodiversity Database, 1997)

Dendrohyrax validus and *Rhampholeon temporalis* are listed as 'Endangered'.

Anthreptes rubritorques, Typhlops gierrai, Leptosiaphos kilimensis, Agama montana, Rhampholeon brevicaudatus, Bradypodion tenue, Bradypodion fischeri, Bufo brauni, Nectophrynoides tornieri, Leptopelis barbouri, Leptopelis uluguruensis, Afrixalus uluguruensis, Callulina kreffti, Arthroleptides martiensseni and *Phrynobatrachus krefftii* are listed as 'Vulnerable'.

Rhyncocyon petersi, Anthreptes pallidigaster, Cnemaspis africana, Leptopelis vermiculatus and *Probeviceps macrodactylus* are listed as 'Near-threatened'.

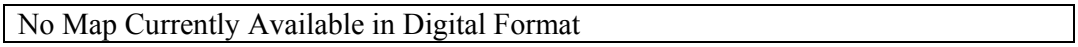

Figure 14. Areas of disturbance in relation to the distribution of animal species that are both forest dependent and near-endemic.

7.0 SOCIO-ECONOMICS

By Kerry Woodcock

7.1 Introduction

On Magoroto Hill, two villages, Mgambo and Mwembeni were studied in depth, with Magula and Gare villages visited once.

7.2 Methods

Each village around the study site was identified and sampled using a range of Participatory Rural Appraisal (PRA) tools (WRI, 1990).

These tools were variously combined in each survey and include: semi-structured interviews with a representative cross-section of the community; key-informant interviews, formal and informal group meetings, participatory social mapping, transect walks and seasonal calendars. These methods are outlined in detail in the FT FRP methodologies report (SEE, 1996).

7.3 Results

7.3.1 The villages and the population

Magoroto Hill has four settlements; Mgambo, Mwembeni, Magula and Gare. The current population of all these four villages combined is approximately 4,239. Almost all families interviewed have lived on Magoroto Hill for many generations and are engaged in subsistence agriculture. Immigrants to the area settled for economic purposes, such as tailoring and pitsawing. The majority of local people are Wasambaa tribe, with a minority being Wabondei and Wapare.

7.3.2 Economic activities and development

Cash crops are the main source of income and are sold in the markets in Tanga and Muheza. Women rank crop sales as the largest source of family income. Most households have members working away from home in the towns, who contribute to household income.

All communities stress that the poor condition of roads to markets is the major barrier to their economic development and improvement of quality of life.

7.3.3 Forest and land tenure

Village households own an average of between 2-4 hectares of land. The majority of households acquired land through family inheritance, with land inheritance being patriarchal. Women do not own land but were given land by their fathers, husbands or brothers on which to farm.

The traditional farming method is rotational shifting cultivation, whereby land is cleared and cultivated for 2-3 years and then left fallow for 3-5 years. Cleared forest land is preferred as 'fresh' farmland. Only those with small areas of land, mostly

immigrants, did not leave land fallow. Over half of the farmers interviewed use inter-cropping techniques, largely maize or cassava with beans, and crop rotation. In general, farmland is perceived to be fertile. Mgambo and Magula residents are experiencing higher soil erosion on the steeper slopes, especially in the rainy seasons. To combat this, few trees are removed on the steeper slopes. All farming techniques are learned through knowledge passed down through generations. All members of the household help with farm work and only wealthier farmers employ labourers during busy periods.

The majority of trees found on farmland are fruit trees. Very few farmers plant or retain non-fruit trees. Of those who do, the reasons for doing so are to produce timber and building poles. On Magoroto Hill, trees are retained as support for black pepper and shade for cardamom. A small number of farmers have planted teak on their farms for timber. Villagers however are having little success in growing them, as they have no information on the care of seedlings.

Men are almost wholly responsible for making decisions on tree planting, retention and use. The planting of trees is a land ownership issue, as the area around planted trees is considered to belong to the person who planted them.

7.3.4 Use of and dependence on the forest

Forest products were utilised by all households in all communities in their daily subsistence, however there is very little income generated directly from forest products except for the production of cardamom which is the main cash crop of the area and pitsawing before its ban in January 1993.

Other forest products that are used include wild plants. All households surveyed said that they regularly use wild plants in their diet. There use is seasonal, being higher in the dry season when there is reduced availability of cultivated vegetables.

Edible mushrooms are collected from forest, bushland and farmland by the majority of households. Collection is based on seasonal availability, with abundance being higher during the rains.

The forest is not a significant source of fruit for most members of the household. For most people it is more convenient to obtain fruit from trees on their own farmland.

Honey is mostly collected from natural hives for domestic consumption however it is not widely collected. These hives are most commonly encountered in the forest.

Hunting in the forest continues. Each village have at least two groups of men who hunt once or twice a week, and other groups who meet less regularly and hunt as a social event. Bushmeat was mainly utilised for domestic consumption. Trapping in the forest is also common. Techniques include using snares and pits.

The fronds of the wild date palm, *Phoenix reclinata,* are used for weaving baskets and mats for household use, sale and for wedding gifts. Villagers say that the palm is now difficult to obtain and can only be found in the more inaccessible parts of the forest.

Bamboo, found on Magoroto Hill in submontane forest, is used to make baskets which are used in the home or sold to generate income.

Collection of medicinal plants occurs only on a very limited basis.

Firewood is the main source of fuel. Kerosene is used by only a small number of wealthier families. Charcoal is not used. Firewood is exclusively collected by women and is collected on average 2-3 times per week. The time taken to collect firewood from the forest ranges from ten minutes in Mgambo to one hour in Kwemnazi. Villagers in Mwembeni said that it is becoming increasingly difficult to find good quality firewood and they are required to travel further into the forest.

Poles are collected from the forest for the construction and repair of houses. Poles are collected exclusively by men. Almost all twine and rope for building comes from the forest in the form of climbers or tree bark.

In all communities, areas of traditional spiritual value are known. These have a number of characteristics in common, such as they were all found on hills and under the cover of forest. Probably the most well known area is Mlinga Peak. Several species of trees are believed to have supernatural or sacred properties, such as baobab and strangling fig, and thus are protected by the culture from being cut.

7.3.5 Peoples attitudes to conservation

In general, the communities of Magoroto Hill saw the forest as a resource for day to day use: for building poles, timber, firewood, food, weaving materials and medicine. The water catchment properties of the forest were well known, however villagers complained that the government cared more about forests than the people living adjacent to them. Although many hunters attributed the reduction in animals to their own hunting efforts and the decrease in forested areas, they felt no remorse and thought it was an advantage to have less wild animals in the forest to reduce occurrences of crop attacks.

7.4 Discussion

The communities surrounding the remnant forest on Magoroto Hill generally lead a subsistence lifestyle. Economic development within the area is very limited, agricultural techniques are basic, and the overall standard of living is low. Perceptions of the forest focus on its' use value. The forest is seen as a resource to supplement agricultural production, and forest products were used by all households surveyed. The forest also has a cultural significance, in terms of traditional group hunting practices and spiritual beliefs. However, these appear to be declining in importance among younger generations.

Prior to the 1993 ban on pitsawing, timber extraction and processing provided a number of local people with livelihoods. At present, illegal timber extraction still continues though it appears few local people are involved or benefit in any way from this activity. The forest is also a source of construction materials, in the form of building poles, timber and rope fibres. At present there are few alternative sources of these materials which have not been traditionally collected from the forest.

Fuelwood is also collected from the forest, though it is becoming increasingly difficult to find. This situation is unlikely to improve without some kind of intervention. As noted above, the planting of fast-growing, multi-purpose tree species by local people would, in the medium- to long-term, reduce pressure on the remaining forest areas.

A number of non-wood forest products are also collected such as edible plants; medicinal plants; and fibers for weaving. These products seems to be collected on an *ad. hoc*. basis, however information suggests that collection levels may be unsustainable since the availability of some of these products is becoming scarce.

Conservation generally only applies if it has immediate practical benefits. Attitudes such as a reduction in wild animals means that there are fewer crop pests, still prevail. Preserving trees is only done if they serve a purpose, such as providing shade for cardamom or conserving soil on slopes. Thus, promoting forest conservation among local communities must be considered a priority. At present, the local communities are restricted in their access to the forest and these restrictions are likely to increase if the forest is gazetted. Human disturbance still presents a major threat to the continued existence of forest on Magoroto Hill.

8.0 CONCLUSION

This report presents the raw data of the survey with preliminary descriptions in terms of ecological type and endemic status. These two factors provide an indication of three main aspects of biodiversity and conservation:

1. the relationship between forest dependency and endemism;
2. the extent to which non-forest species are established in the reserve; and
3. the relationship between disturbance and areas of biological value.

Magrotto estate covers an area of 591.0 ha on the eastern edge of the main East Usambara range. With altitudes between 650 m and 880 m, it consists of approximately 51.3% oil palm, 0.1% cloves, 12.1% cardamom and 36.5% disturbed forest.

Disturbance

High rates of pole and timber cutting were recorded in all areas assessed for disturbance. The results suggest that all forest blocks in Magoroto are under a high degree of pressure and the integrity of the forest is under immediate threat.

Species Richness

The forest reserve was found to contain a minimum of 109 species of trees and shrubs; 27 mammal, 82 bird, 29 reptile and 30 species of amphibian.

Flora

Five tree species were recorded which are endemic to the Usambara mountains and 30 have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Forty-eight species are dependent only on primary forest, and of these species, 24 are also endemic or near endemic to the Usambara mountains. Seven non-forest tree and shrub species are established within the forest.

Fauna

One species endemic to the Usambara Mountains was recorded and twenty-nine species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. Fifty-four species are dependent on primary forest only, and of these species, twenty-five are also endemic or near endemic to the Usambara mountains. Forty non-forest species are established on the Estate of which four occur in the forested areas.

Table 27. Summary of biodiversity of taxa surveyed.

Taxon:	Total no. of species	% forest dependent	No. of non-forest species	No. of endemics	No. of near-endemics	No. of forest dependent endemics and near-endemics
trees and shrubs	109	44.0	7	5	30	**24**
mammals	27	22.2	4	0	3	**0**
birds	82	26.8	33	0	6	**4**
reptiles	29	34.5	3	0	8	**8**
amphibians	30	53.3	0	1	12	**14**
Total	**277**	**--**	**47**	**6**	**59**	**50**

Conservation

The East Usambara mountains are important due to their floral and faunal diversity, their high levels of species endemism and their water catchment value. The forests are also an important source of fuelwood, poles, timber, food and medicinal plants for the local people. Differences in the perceived value of the forests have caused and still cause a conflict of interest between the villagers and the Catchment authorities. The remaining forests of the East Usambara mountains are now only small refuges of what was present just one hundred years ago (Hamilton, 1989). The area continues to be vulnerable because of growing pressure for agricultural land associated with a growing population.

As has been documented many times before, forests are fragile ecosystems sensitive to overexploitation. Forest soils are highly susceptible to soil erosion and loss of fertility once the land has been cleared. Due to the tight nutrient cycling in the forest, once the land has been cleared the soil quickly loses fertility (Hamilton, 1989). Similarly, soil erosion increases dramatically with the removal of the canopy cover, causing increased siltation of the rivers and a corresponding decline in water quality (Bruen, 1989). Damage to the catchment capacity of the East Usambaras is of particular concern given that they supply water to communities along the Sigi river as well as to the coastal town of Tanga. In addition, the possible long-term effect of deforestation is the apparent decrease in rainfall and the greater unpredictability of the rainy seasons (Hamilton, 1989).

Within the East Usambaras, Magoroto forest and the nearby Mlinga Peak constitute a subset of forest containing endemics to these two forests only. One single catastrophic event could virtually destroy this area and its biological uniqueness.

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Appendix 1:

General Plot Information

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
1	SL	190	30	M	>30
2	M	300	25	M	20-30
3	M	320	25	M	20-30
4	SG	350	30	M	>30
5	GU	520	15	M	10-20
6	M	650	25	M	10-20
7	M	400	25	M	10-20
8	FV	220	5	M	20-30
9	SU	330	30	P	10-20
10	GL	250	10	EC	20-30
11	SU	400	5	M	<10
12	SU	500	25	M	20-30
13	SU	700	45	EC	20-30
14	missed plot				
15	M	380	15	M	20-30
16	FV	250	10	M	10-20
17	SL	330	15	M	20-30
18	SU	600	25	B	<10
19	SL	410	25	M	20-30
20	GL	320	15	M	20-30
21	SU	440	20	W	<10
22	SU	390	25	MC	<10
23	M	320	25	EC	10-20
24	SL	280	30	EC	10-20
25	SU	650	20	M	10-20
26	M	650	25	M	20-30
27	M	650	30	M	10-20
28	SU	640	20	B	10-20
29	M	510	25	M	10-20
30	M	410	30	P	<10
31	R	700	20	M	20-30
32	SU	700	30	M	>30
33	GU	550	20	M	10-20
34	SU	565	25	G	<10
35	SU	700	25	M	10-20
36	M	540	20	M	10-20
37	M	390	25	M	10-20
38	GL	360	?	M	20-30
39	M	400	20	B	<10
40	M	400	20	M	10-20
41	GL	260	25	M	20-30
42	GL	320	15	P	10-20
43	GU	600	20	M	10-20
44	GU	330	15	EC	10-20
45	M	400	30	B	<10
46	R	400	40	P	10-20
47	M	330	30	M	20-30

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
48	FV	200	5	EC	>30
49	GL	275	20	M	20-30
50	SU	350	25	M	10-20
51	M	430	30	M	10-20
52*	M	595	?	M	10-20

KEY TO ABBREVIATIONS

Topography

GL - gentle lower slope
SL - steep lower slope
M - mid-slope
GU - gentle upper slope
SU - steep upper slope
FV - flat valley floor
RT - ridge top
F - mature mixed forest
SG - steep gully

Vegetation Condition

M - mature mixed forest/more or less natural forest
P - disturbed primary forest or secondary forest
G - grassland
B - bushland and/or thicket
W - woodland
FC - forest edge/colonising
EC - former encroachment/colonising

* No 50m x 20m plot was surveyed in this area. This is a trapping site only.

Appendix 2:

Taxonomic Verification

BOTANY

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All other invertebrates:

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