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MANAGEMENT OF CATCHMENT FORESTS WITH EMPHASIS TO THE
EASTERN ARC MOUNTAINS

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INTRODUCTION

Tanzania has set aside 1.6 mill. hectares of tropical rain forests for promotion of watershed protection (Appendix 1). Of this area the eastern arc catchment forests account for 37%.

The hydrological, timber and genetic potentials of the Tanzania's rain forests were formally recognized during the German period (in 1890's) when the first reserved protective forests were declared in the Usambara's, Kilimanjaro, Arusha and Morogoro. The reservation efforts were taken for the following reasons:-

- to ensure an adequate and continuous flow of clean water to district and provincial headquarters.
- to prevent soil erosion and to maintain good microclimate for cash crops (mainly tea, coffee and pyrethrum.
- to ensure an adequate future supply of hardwood logs for export.

To ensure strict protection; the forest reserves had their boundaries cleared and directional trenches constructed including numbering of beacons. At each

beacon a bottle with charcoal was buried. Boundaries were screefed annually before dry season to prevent fires from adjacent cultivated or public lands. There was also control of harvesting through coupe demarcation, tree numbering and allocation of felling rights to long-term licencees. Minimum felling diameters were determined for most fine hardwoods. Pit sawing was strictly a salvage operation directed at what the long term licencee left.

Outside reserved areas, local chiefs regulated land use activities - including forest use. Forests surrounding water points and in steep terrain were identified and given special protection status. Grazing areas also received recognition. By-laws were commonly used to discipline those who disregarded established routines and provided also a measure of control over the use of fire; any farmer intending to use fire was required to seek permission from local chiefs. The mechanism, in practice relied on agreement about the best time for burning. If control over a fire was lost its origin would be known.

The situation after and during independence drastically changed. Political, social as well as economic factors contributed to the general decline in the forest reservation and protection efforts. First some of the protective and control measures were seen as colonial

and Anti Ujamaa. Long term licences were for example abolished in accordance with the Ujamaa policy (unacceptability of a few people controlling public natural resources). Some areas were degazetted to give way to agriculture and to improve political image among peasants. Chiefdoms were formally abolished and certain social control mechanisms got ignored. Population swelled in and around major catchment areas thus increasing pressure on forest resources. Economic hardships increased leading to reduced morale among workers.

To day we are in a very bad situation. Enchroachment of forested areas has increased and in areas like Usambara, Pares and Uluguru, almost all forest reserves under local authorities have disappeared. Illegal pitsawing is mushrooming every where due to inadequate mobility by forest guards. Pressure on the remaining forests is on the increase and unless farmers are given alternatives they will have to enter the forests to cultivate. The country is currently losing 300,000 - 400,000 hectares annually through various forms of deforestation representing a potential ecological disaster in terms of soil erosion; disruption of water supplies, loss of ecosystems and genetic resources and consequently increased poverty to Tanzanias. Concerted conservation efforts are therefore needed urgently to reverse the situation.

This paper first attempts to describe the conservation values of the Eastern arc mountain forests, secondly the principal conservation problems are presented and at the end suggestions are given as to the most priority areas of action in the Eastern Arc.

2. THE EASTERN ARC FORESTS

2.1 Location

The eastern arc is a chain of isolated mountain ranges composed of old crystalline rocks. In Tanzania the ranges stretch from north Pare, West and East Usambara, Uluguru, Ukaguru and Rubeho in Morogoro Region, then to Udzungwa in Iringa Region (Fig. 1)

2.2 Forest Resources

The eastern arc forests cover approximately 37% of the total area designated as catchment forests in TANZANIA. Distribution of the forest areas in each mountain range is shown in Table 2. Names of forest reserves are seen in appendix 2.

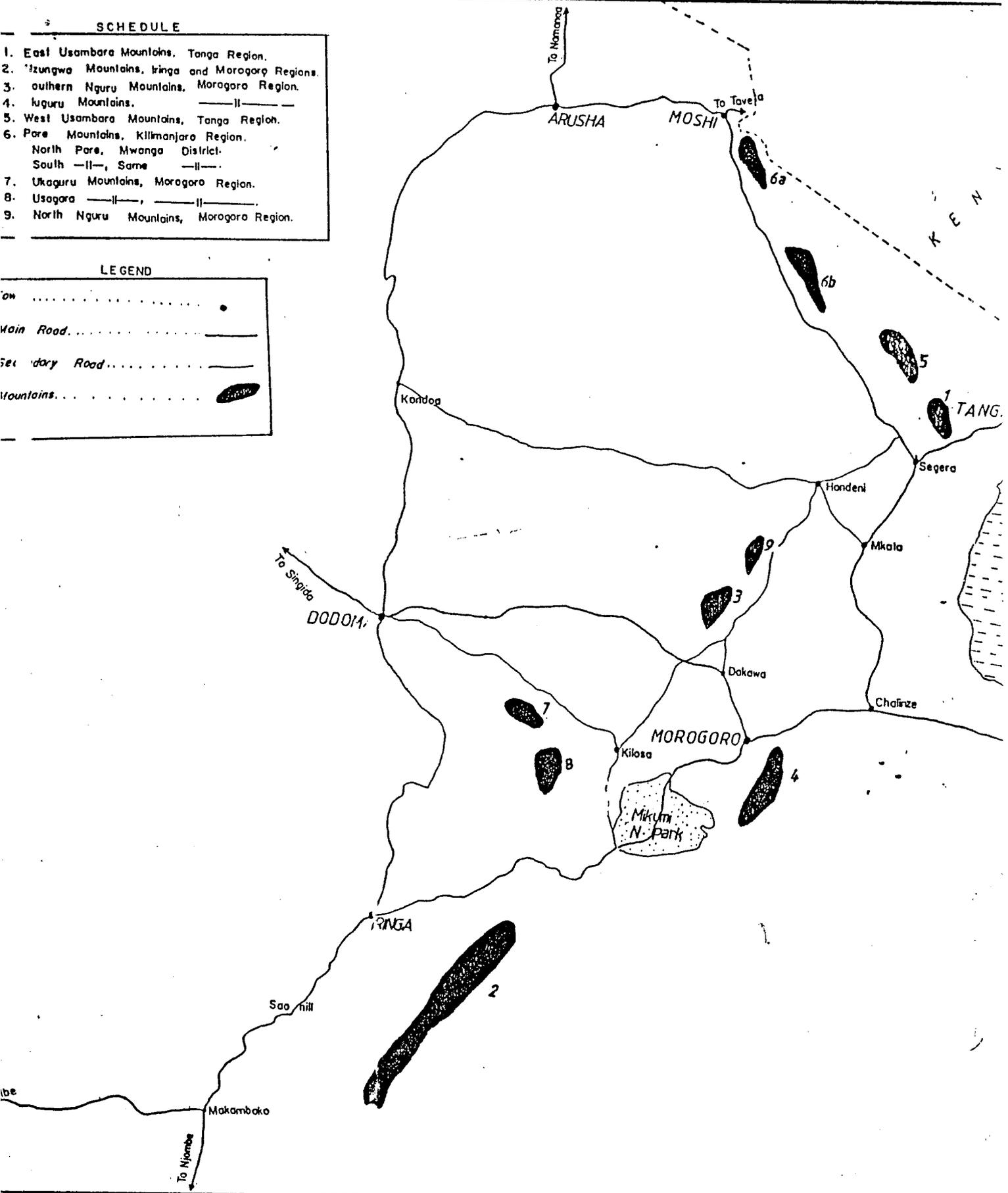
LOCATION MAP OF THE EASTERN ARCH MOUNTAINS

SCHEDULE

1. East Usambara Mountains, Tanga Region.
2. Uzungwa Mountains, Iringa and Morogoro Regions.
3. Southern Nguru Mountains, Morogoro Region.
4. Uguru Mountains, ————||———
5. West Usambara Mountains, Tanga Region.
6. Pare Mountains, Kilimanjaro Region.
North Pare, Mwanza District.
South —||—, Same —||—.
7. Ukaguru Mountains, Morogoro Region.
8. Usagora —||—, —||—
9. North Nguru Mountains, Morogoro Region.

LEGEND

Town ●
 Main Road ————
 Secondary Road ————
 Mountains ■■■■■



SKETCH MAP. SCALE 1:2000000

Table 1

DISTRIBUTION OF FOREST AREAS IN THE EASTERN ARC
MOUNTAIN RANGES

MOUNTAIN RANGE	REGION	APPROXIMATE AREA (HA.)	%
1. North Pare	Kilimanjaro	4,610	0.8
2. South Pare	Kilimanjaro	20,390	3.5
3. East Usambara	Tanga	20,930	3.7
4. West Usambara	Tanga	20,804	3.6
5. North Nguru	Tanga	28,240	4.8
6. Southern Nguru	Morogoro	33,000	5.6
7. Uluguru	Morogoro	26,417	4.5
8. Uzungwa*	Morogoro & Iringa	350,000	5.9
9. Ukaguru	Morogoro	19,154	3.3
10. Usagara	Morogoro	65,244	11.2
Total		583,819	100

Source - Catchment Project FBD.

*Udzungwa scarp and West Kilombero forest reserves are in Iringa Region.

From the above table, Morogoro and Iringa Regions cover 83.6% of the eastern arc forest areas, with the Udzungwa being the biggest range; followed by Tanga (12.1%) and then Kilimanjaro with 4.3%.

3. CONSERVATION VALUES OF THE EASTERN ARC FORESTS

The forests of the eastern arc area serve the following purposes: -

- watershed protection
- gene pool reserve
- timber production & forest products (minor)

3.1 Watershed Protection

Two important factors make the eastern arc area a potential water resource area comparable to an oasis in a desert. The factors include high precipitation and presence of forest cover.

Except for north Pare, the rest of the eastern arc area experiences high annual precipitation normally above 1,200 mm. Occult precipitation is also known to persist in these areas although quantitative figures are not available. The high precipitation is a reflection of the mountains proximity to the Indian Ocean as well as the effect of orography.

The surplus rain (after satisfying the evaporative demand of the atmosphere) flows overland into drainage channels or is transferred under ground appearing again on land as springs, streams and rivers. The arc is

therefore an important catchment for rivers including Pangani, Uмба, Sigi, Mkulumuzi, Ruvu, Wami and Rufiji. The water generated from the catchment forests sustains agriculture and industries in the predominantly dry low lands. The flood plain caused by the river systems is of immense agriculture potential. The Rufiji for example has 622,400 hectares of irrigable land and fisheries potential of 14,700 tonnes per annum.

The need for protective forests in water catchment areas is appreciated by many communities. Forests are known to be the most practical cover in steep terrain and in watercatchment areas although they are not necessarily the best in terms of maximum water production. Most forest policies in tropical countries are in favour of maintaining an adequate forest cover in mountainous areas water source areas and in areas susceptible to landslides. In a land capability classification for mountainous regions of Tanzania utilizing 24 hour rain with 10 year return period, slope and acceptable soil loss, areas with more than 24% slope should not be under agriculture.

A forest cover offers the following protective mechanism:

- the crown of trees (canopy) act as a barrier between the falling precipitation and the soil. The force

of rain is reduced by this barrier and the rain water reaching the ground surface by stem flow and through flow takes much longer time.

- the total amount of water reaching the ground is reduced due to interception/evaporation and transpiration the total of which is referred to as evapotranspiration. Forests are capable of returning over 50% of the rain to meet the evaporative demand of the atmosphere and interception loss estimated at 30% for forests contributes greatly to this process.
- under undisturbed forest the ground is normally covered with forest litter including dead leaves, twigs and branches. Further the soil under a dense forest is binded by a mat of fine roots. The quantities of these roots are large. A plantation of Cupressus lusitanica can have as much as 6.1 tonnes of roots per hectare mostly in the top 10 cm of soil and these are continuously renewed. This living net work of roots provides mechanical support on steep slopes and contributes greatly to slope strength and prevention of landslides.

One can therefore conclude that the protective role of forests in watershed areas and land slide prone areas including the eastern arc is through the

evapotranspiration loss; the water flow delay mechanism and the binding and protection of the soil which is the major storage for rain water. A combination of the protective role and the delay mechanism helps to maintain reliable perennial water flow. The Ruvu river depends on the protection offered by the tiny Uluguru forest reserve. Also 96% of the water on Kilimanjaro mountain originates from the small band of forest encircling the mountain of 1,800 m - 2,700 m above sea level (Folley 1989). Where possible about 60% of a catchment should be under forest cover.

3.2 Biological and Gene pool Conservation

Tanzania has an unusually rich variety of ecosystems of economic, scientific and aesthetic value (Smith et al 1989). The eastern arc forests are however regarded as the richest in terms of species diversity and endemic fauna and flora. For example east Usambara forests contain more than 200 tree species and a high proportion of endemic species in all taxa (except mammals). Of the 2,000 plant species available in East Usambara 500 are endemic. Table 2 is a list of species Diversity and Endemism in the East and West Usambara mountains. There are also studies for Mwanihana, Luhombero massiff in Udzungwa mountains which also indicate high degrees of diversify and endemism.

Table 2

SPECIES DIVERSITY AND ENDEMISM IN THE USAMBARA MOUNTAINS

Group	Area	Species Number	Endemic Species	No. of Forest Species	Forest Endemic Species
Tree (>10m tall)	EW	?	?	276	50**(18%)
Diplopoda	E	41	35 (85%)	37	35 (95%)
Sphecidae	E	131	27 (21%)	74	27 (37%)
Gastropoda	EW	122*	55 (45%)	-	-
Forest Amphibia	EW	-	-	15**	4 (27%)
Lizards	EW	37	14 (38%)	24	14 (58%)
Snakes	EW	28	3**(11%)	18	3**(23%)
Birds	E	219	5**(2.2%)	100*	5** (5%)
Mammals	EW	55	1? (2%)	-	-

Source - W.A. Rodgers and K.M. Homewood 1978.

E East Usambaras

W West Usambaras

* Figure includes subspecies

** Figure includes near endemics

*** All 15 species are near endemics, restricted to Tanganyika-Nyasa montane islands.

? Information not known

- Data not available for this paper.

3.3 Timber Values

In principle catchment areas are supposed to be partially or completely exempted from any harvesting. However in Tanzania, harvesting by pitsawers as well as sawmill has been going on in some catchment areas.

There have been inventories to determine the timber potential of the catchment areas. One of these recent inventory is the Amani Forest Inventory financed by FINNIDA. There have also been some inventories carried out in parts of West Usambara and Udzungwa mountains. Two inventories have been carried out in parts of Udzungwa i.e. 1973 and 1976. The area contained 23.5 mill m³ of merchantable wood in 1973, Assessment in 1976 gave 3.4 mill m³ of merchantable wood. In table 3 below, allowable cut figures for five species in E. Usambara are given.

E. Usambara

Table 3

ALLOWABLE CUT FIGURES FOR FIVE SPECIES IN EAST USAMBARA

	Newtonia buchanii	Cephalos- phaera usambaransis	Chlorophora excelsa	Beilsch- meidia kweo	Maesopsis emini
Total volume (m ³)	336,000	320,000	58,000	61,000	154,000
Allowable cut m ³ /year	5,100	2,530	830	360	1,420

Source - Amani Forest Inventory and management plan project 1988.

Apart from timber values, the forests of the eastern arc yield other important products such as fruit and medicine. For the east usambara twenty species are known to be useful as seed fat, fruits and medicine. These include species like Allamblackia stuhlmannii used for cooking fat; soap and candles. Newtonia paucijuga used as medicine for stomach.

4. MAJOR CONSERVATION PROBLEMS

There are two major conservation problems in the eastern arc namely population explosion and frequent introduction of cash crops.

4.1 Population

The favorable climatic conditions both for human beings (less malaria) and plant growth (rain) has favoured increased human population in the eastern arc range mountains. Example from West Usambara show that in 1900 the population density was 7 - 8 person/km². In 1967 the density more than doubled to 136 per/km² and in 1978 the figure was 185 pers/km². (Ingvar 1982). The steep increase in population density can be seen from

recent census figures for four Regions in the eastern arc.

Table 4

TRENDS IN HUMAN POPULATION IN THE EASTERN ARC
1967, 1978 AND 1988

Region	Area/Km ²	1967	1978	1988
Kilimanjaro	13,309	49	68	83
Tanga	26,308	29	39	48
Morogoro	70,799	10	13	17
Iringa	56,861	12	16	21

Source : 1988 Population Census Bureau of statistics.

Table 3 indicate high density figures from Kilimanjaro and Tanga when compared to a national average of 25.5 persons/km² in 1988. The figures are also on the higher side when compared to an average for East Africa which is 19 persons/km². When looked at district level i.e. Lushoto, one would expect even higher figures than those based on Regional areas.

The high population density figures translates into increased demand for agricultural land; settlement areas and forest resources at the expense of forest land use. In some cases peasants have invaded extremely steep

areas for cultivation. In West Usambara one third of indigenous forest area was cleared and taken into cultivation between 1954 to 1980 (Ingvar 1982). A study in the East Usambara based on a sample of 27.5 km² showed an overall decline in forest cover (scrub and forest the two most effective types of ground cover combined) from 19.8 km² (1954) to 6.5 km² (1986) a drop of 67% (Mbwana 1988). The Morogoro river catchment covering 19.2 km² has 60% of its vegetative cover lost.

4.2 Cash Crops

As pointed above the relatively favourable climate obtained in the arc has attracted new cash crops including tea, coffee, pyrethrum and recently cardamom. Cardamom cultivation has indicated to be a major threat in the arc. It is planted in Pare, West and East Usambara. East Usambara produces over 90% of the Cardamom being produced in Tanzania. The growth requirements of cardamom are not in conformity with the required watershed conditions i.e. the presence of an adequate ground cover. Cardamom is planted under dense shade (forest canopy) or under bananas. Production falls after the fourth year and within ten years the plant is exhausted and the area is completely devoid of nutrients. The area is then cleared of all remaining trees followed by sugarcane and some times maize. The

area further gets exhausted and the farmer has to look for another forest area for shade. The loss of vegetation caused by the two conservation problems above have gross hydrological consequences in the arc. In the Morogoro river catchment for example land slides following deforestation had produced 1,300 t/km² compared to an annual sediment yield of 390 t/km². i.e. 3 times. The time lag - the time taken by water to flow from the Morning site after an intense rain was 60 - 90 minutes compared to a lag of 3 hours with intact forest. In East Usambara, a comparison of peak discharges for Sigi river between 1954 - 1976 and 1977 - 1983 testify that the river has been very flashy recently mainly due to loss of forest cover.

5. CURRENT ON GOING CATCHMENT FOREST ACTIVITIES
IN THE EASTERN ARC MOUNTAINS

Catchment forest management activities currently taking place in the arc can be grouped into two. Direct management activities and indirect management practices.

5.1 Current on Going Catchment Forest Activities In the Eastern Arc Mountains

So far the major direct intervention has been in the form of boundary opening and consolidation through planting of trees along the boundaries. This has been the major activity in the NORAD financed Catchment Project covering Arusha, Kilimanjaro, Tanga and Morogoro. Other activities include planting of open areas, patrol, control of harvesting and fire prevention. The availability of transport, field gear funds have contributed to an increased morale among the field personnel. The catchment project has also surveyed training needs for the catchment personnel.

5.2 Indirect Practices

5.2.1 Peoples' Participation

The involvement of the people in the conservation and management of forest resources outside the reserves has been an important effort in catchment forest management. This has the form of establishing woodlots, agroforestry; livestock keeping and soil erosion control in general. Examples of such initiatives are from the SECAP project - West Usambara; the IUCN East Usambara

project - Amani; Hifadhi Ardhi Iringa (HIMA) and the Concern Project Iringa district. These efforts will greatly reduce pressure on the remaining forests in the arc.

5.2.2 Research and Training

One of the limitations to successfully manage catchment forests is the lack of knowledge and scientific information. Currently the Sokoine University of Agriculture Faculty of Forest is carrying out research in Mazumbai forest in West Usambara. A new reference forest area is also being established in Nguu mountains by the same University.

6. PRIORITY AREAS FOR FUTURE CONSIDERATION IN THE EASTERN ARC MOUNTAINS

In order to direct the use of resources for planning and implementation of conservation activities in the eastern arc area, some basic management information is required. Below is a table of some areas where information is critically needed.

Table 5

LIST OF PRIORITY AREAS IN THE EASTERN ARC

Priority Area	Pare West Usamb- ra	East Usamb- ra	Nguru	Nguu North	Nguu South	Usagara	Udzu- ngwa	Ukaguri
Botanical Survey	@	0	0	0	@	@	@	@
Zoological survey	@	@	0	0	@	@	@	0
Timber potential survey	0	0	0	0	@	@	@	@
Hydrolog- ical potential	@	@	0	0	@	@	@	0
Boundary intergrity	@	0	0	0	@	@	@	@
Staff strength	@	0	0	@	@	@	@	@
Staff mobility	0	@	@	0	@	@	@	0
Staff housing	@	0	0	0	@	@	@	@
Socio economic survey	@	0	0	@	@	@	@	@
Research	@	0	0	0	@	0	@	@
Donor coverage	0	@	0	0	0	0	0	0
Population pressure	@	@	@	@	@	0	0	0

0 = Needed but not a critical issue

@ = very critical issue

in review

The above table gives a general picture of critical priority issues. A more informative picture could be produced if individual forest reserves were considered.

Based on the table above, West, East Usambara, Uluguru and Udzungwa seem to have enough basic management information to warrant operational planning and implementation. Other areas need further surveys to determine location and extent of conservation potentials.

APPENDIX 1

THE DISTRIBUTION OF CATCHMENT AREAS IN TANZANIA

Catchment Forest Projects	Area covered (ha)	Total (ha)
Arusha	145,000	
Kilimanjaro	135,000	
Tanga	89,000	
Morogoro	375,000	745,000
Other Catchment areas:		
West Lake	145,000	
Tabora	6,500	
Mbeya	134,000	
Lindi	4,500	
Ruvuma	130,000	
Shinyanga	1,000	
Coast	18,000	
Mwanza	3,600	
Mtwara	6,300	
Dodoma	51,000	
Iringa	333,000	832,900

Source: NORAD Report 1985

*The area should be slightly more than 1.6 mill hectares when considering forests ins Rukwa and Mara Regions.

APPENDIX 2

LIST OF THE INDIVIDUAL CATCHMENT FOREST RESERVES
OF THE EASTERN ARC MOUNTAINS

1. EAST USAMBARA MOUNTAINS, Muheza District, Tanga

Region:

Mtai	1,767 ha.
Kilanga	379
Msimbazi	3,396
Bamba Ridge	1,109
Kwangumi	1,048
Manga	867
Kwarimba	803
Amani West and East	243
Amani Sigi	1,141
Longuza	1,541
Kwamkoro	2,209
Bwiti	3,886
Magogoni	2,541
TOTAL AREA	20,930 ha.

2. UZUNGWA MOUNTAINS, Iringa and Morogoro Regions:

Uzungwa Scarp	20,220 ha
Matundu	17,664

Iwondo	24,748
Nyanganje	18,988
Iyondo	27,975
Mwanihanga	18,130
Ihanga L.A.	3,469
Uzungwa Scarp	?
W/Kilimanjaro	195,260
TOTAL AREA	350,000 HA.

3. SOUTHERN NGURU MOUNTAINS, Morogoro Region and District:

Nguru South	18,793 ha
Kanga	6,664
Mkindo	7,541
5 small L.A.	?
TOTAL AREA	33,000

4. ULUGURU MOUNTAINS, Morogoro Region and District:

North Uluguru	8,793 ha
South Uluguru	17,292
Vigoza	26
Nyandiluma	46
Shikurufumi	260
TOTAL AREA	26,417 Ha.

5. WEST USAMBARA MOUNTAINS, Lushoto District, Tanga Region:

Balangai	987 ha.
Ndelemai	1,421
Baga I/II	3,059
Mkussu	3,674
Shume Magamba	2,276
Shagayo	7,830
Kisima Gonja	448
Kikongola L.A.	575
Kwekanda	52
Mtumbi L.A.	242
Bombo L.A.	240
TOTAL AREA	20,804 HA

6. PARE MOUNTAINS, Kilimanjaro Region:

6.a North Pare, Mwanza District:

Kindoroko	885 ha.
Mramba	3,355
Kileo L.A.	370

6.b South Pare, Same District:

Chambogo	5,466 ha
Chome	14,281
4 small L.A.	?
TOTAL AREA	25,000 HA.

7. UKAGURU MOUNTAINS, Kilosa District, Morogoro

Region:

Mamiwa Kisara South	6,266 ha.
Mamiwa Kisara North	7,896
Uponera	293
Ukwamba	889
Miliondo	3,878
Miliondo Ext.	575
Mamboto	148
TOTAL AREA	19,154 HA.

8. USAGARA MOUNTAINS, Kilosa District Morogoro Region:

Ukwiwa	54,634 ha.
Pala Mountains	10,610
TOTAL AREA	65,244 ha.

9. NORTH NGURU MOUNTAINS

Kwediboma	285 ha.
Mkongo	984
North Nguru	14,041
Kilindi	4,641
Nderema	3,928
Pumula	1,062
Mbegere	368
Mkuri	2,931
TOTAL AREA	28,240 HA

GRAND TOTAL 589,000 ha

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LIST OF REFERENCES

- Bureau of statistics (1988): 1980 population census Preliminary report.
Ministry of Finance,
economic Affairs and
Planning Dar es Salaam.
- Charles Foley (1989): The Kilimanjaro elephant study. An Oxford University research Project. University of Oxford.
- Ingvar Backeus (1982): Report on a study tour to the indigenous forests of the West Usambara mountains Tanzania with special reference to Regeneration.
Vaxtbiologiska
Institutionen Uppsala.
- Mbwana, S.B. (1988): Land use/cover changes and water yield in the Sigi catchment - East Usambara. A thesis : submitted in fulfilment

of the requirement for
the degree of magister
in Scieantia in the
University of Wales.
School of Agriculture and
Forest Sciences
University College of
Northwales Bangor.

Rodgers, W.A. and

Homewood, K.M. (1978):

The conservation of the
East Usambara mountains
Tanzania: A review of
biological values and
land use pressure.
Zoology Dept. University
of Dar es Salaam
Tanzania.

