Indigenous forests fragmentation and the significance of ethnic forests for conservation in the North Pare, the Eastern Arc Mountains, Tanzania

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This study evaluates the extent and effects of fragmentation of the forests in the Eastern Arc Mountains, and particularly in the North Pare Mountains (NPM). The data have been collected using participatory methods. The vegetation cover analysis is based on comparison of air photos, satellite images and maps. In the NPM, the forest fragmentation is more substantial than presented in previous studies. The loss of indigenous forests in the NPM during 1982–1997 was 31%, and the loss of all types of forest was about 37%. During the same period, the cultivated land area increased by 68%. In 1997, the total area of the closed forests was no more than 5% of the land area. They have, however, a high endemism and a rich biodiversity. Only about a fifth of the Government Forest Reserves (FRs) are closed forests at present. Outside the FRs traditionally protected forests (TPFs) and riverine forests are the last indigenous forest remnants, both of which have been protected by local Gweno ethnic communities "forever". The total area of the TPFs is considerable, about 1/3 of the size of closed forests inside the FRs. In that sense, the importance of the TPFs for biodiversity conservation becomes evident. These forests can act as corridors or stepping stones in connecting the FRs. Also, about 77% of the TPFs are located in the most fertile altitudes between 1200–1400 meters where no FRs exist. They are ideal for biodiversity conservation as their management is based on local caretakers and customs.

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Introduction

The North Pare Mountains (NPM) are part of the Eastern Arc Mountains (EAM) which stretch from south-eastern Kenya through central Tanzania. The Eastern Arc Mountains with the Coastal Forests of Tanzania and Kenya are the richest in endemic vascular plant and vertebrate species per unit area of the 17 globally most endangered tropical forest ecosystems (Myers et al. 2000). It also forms one of the world's 25 biodiversity hotspots. The EAM consist of 13 large mountains (Fig. 1). Taita Hills are in Kenya while the rest are located in Tanzania. Because of high altitude the mountains catch moisture. The vicinity of the Indian Ocean allows rainfall in some areas as high as 3000 mm per year. In some western rain shadow slopes, however, rainfall is as low as 600 mm. The EAM were formed 100 million years ago and the Eastern Arc forests may have persisted for up to 30 million years, representing one of the oldest and most stable terrestrial ecosystems on the continent. In comparison, Kilimanjaro is situated 40 km northeast of the North Pare Mountains (see Fig. 1) and does not belong to the EAM because it is volcanic and its lava deposits are only one million years old. The age of the EAM, their geologic origin as crystalline basement block mountains, thick series

of highly metamorphosed sediments, and proximity to the ocean are features, which separate them from other highland regions in East Africa. These same features have also contributed to their very diverse and unique biota which is quite distinct from the adjacent savannah and woodland habitats in East Africa (Kingdon 1989).

Rainforests existed all over central and eastern Africa before the latest glacial period. The time when the latest glacial period reached its maximum (ca. 20,000–12,000 BP) was also a period of maximum aridity in tropical and subtropical areas. Evergreen forest virtually disappeared, even from Uganda, and receded to the Kongo Basin, but the EAM stayed phytogeographically distinct and constituted a refuge for rainforest plants and animals like birds, nocturnal arboreal mammals, nocturnal forest amphibians and reptiles. The rainfall of the EAM is closely tied to the Indian Ocean, which is more important than the temperature for the continued existence of evergreen forests. The coastal forests of Tanzania and Kenya normally extend ca. 50 km inland from the coast of the Indian Ocean (Burgess et al. 1992). Only a few of them still exist, and some which are situated between Handeni, Mkata and Tanga are marked in Fig. 1. The smallest ones have not been marked as their size is sometimes even less than 1–2 ha. They are normally sacred sites (Mwihomeke et al. 1998; Mwihomeke et al. 2000). Evergreen lowland forests also exist near Dar es Salaam with a traditional sacred site e.g. in Pugu Hills. Also, near Mombasa there are evergreen forests with sacred sites (Spear 1978).

In 1999, the FAO reported that 10.5% of Africa's forests had been lost between 1980 and 1995, the highest rate in the developing world and in sharp contrast to the net afforestation seen in developed countries. Forest loss between 1990 and 2000 was over 50 million hectares, representing an average deforestation rate of nearly 0.8% per year over this period. As a consequence, availability of forest resources per capita declined from 1.22 ha/person in 1980 to 0.74 ha/person in 1995 (UNEP 2003). According to the report, the annual deforestation rate in Tanzania is about 1.2%, 50% higher that the average of Africa.

The average annual loss of forests in Tanzania does not explain the quality differences in the forest cover. Indigenous forests in the EAM are closed canopy mountain forests. This forest type covers only 0.2% of the area of Tanzania (Newmark 2002: 10–11). During this study in the NPM it was established that the loss of the closed canopy mountain forest between 1982–1997 was 31%, and the loss in the total forest area in the mountains was about 37%. Unfortunately, the situation in other parts of the EAM is not necessarily much better. Extremely serious illegal timber logging has recently been identified in the South Pare Mountains (Persha 2003). Charcoal burning also threatens to reduce by half the catchment forests by the year 2020 (Musendo 2002). This will cause many environmental problems, like problems in water supply in cities along the rivers and on the coast. For example, the Eastern Arc Mountains form a catchment area for rivers supplying hydropower that represents 61.5% of Tanzania's total electricity generation capacity (Iddi & Sjöholm 1997).

Objectives

In this study the aim is to assess the extent of fragmentation of the forests in the EAM and the NPM as part of it. Another aim is to identify the indigenous forest remnants. All remaining indigenous forests outside the forest reserves in the NPM have been traditionally protected. Traditionally protected forests, (TPFs) have been protected by local communities "forever"; many of them even before the Gweno and Pare ethnic groups arrived in the NPM. Present problems of the existence of the TPFs are explained and new methods such as by-laws are described. In addition to sacred sites, the possibility of using riverine forests as ecological corridors is being evaluated. Riverine forests and springs have been traditionally respected and protected. In a place like the NPM where the forest habitat degradation has developed far, the existence of small indigenous traditionally protected closed forest patches (TPF) may be the reason why so many species still exist.

Previous studies about the survival of species in fragmented forest habitats with different size, time, and edge effect are assessed. These will be used to assess how ecology and spatial theories and previous studies of fragmentation, connectivity, patch

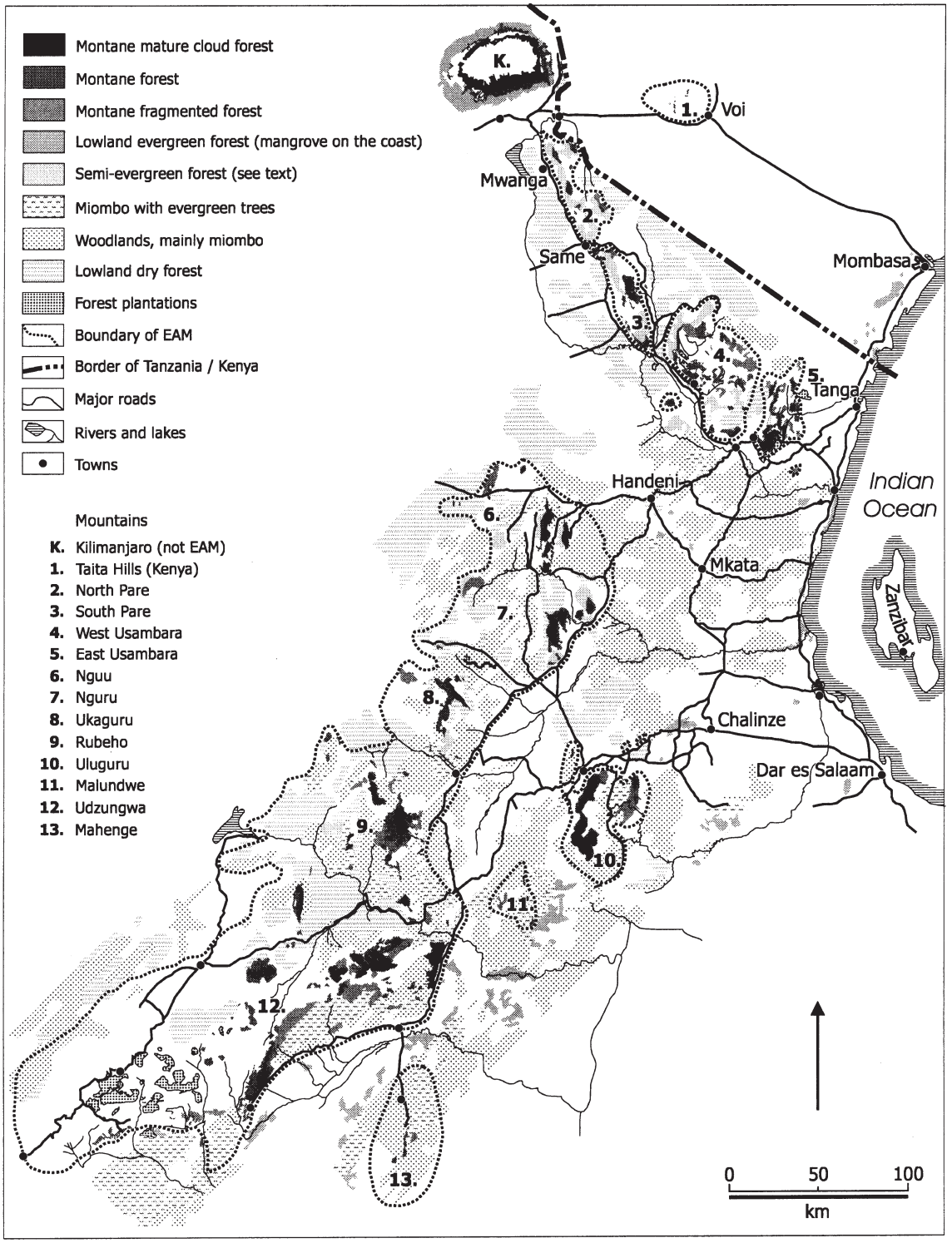

Fig. 1. Forests of the Eastern Arc Mountains (EAM) and surrounding lowland forests. Source: Burgess et al. 1992; TFCG 1998; Persha 2003.

size, and altitude can be used for conservation purposes. These theories are being used to make an assessment of whether traditionally protected forests can act as corridors or stepping stones to connect government forest reserves, where the biggest indigenous forest areas are situated. Also *in situ* and *ex situ* conservation possibilities are assessed.

Also, some management-plan ideas are given for site selection for indigenous species conservation strategies. Finally, conservation successes and failures are compared between the central government managed forest reserves and the community managed traditionally protected forests.

Materials and methods

The most detailed data presented in the study have been collected in the two most northern villages, Simbomu and Vuchama-Ngofi (Fig. 2). These two villages differ from other villages in the sense that there are more traditionally protected forests in them and they are in different condition in these two case-study villages. In Vuchama-Ngofi the traditional forests grow stately and intact and they are a dominant feature in the landscape. In Simbomu traditional forests have been badly degraded. These were the main reasons to select them as case study villages. For more information about the villages, see Ylhäisi (2000: 205–207).

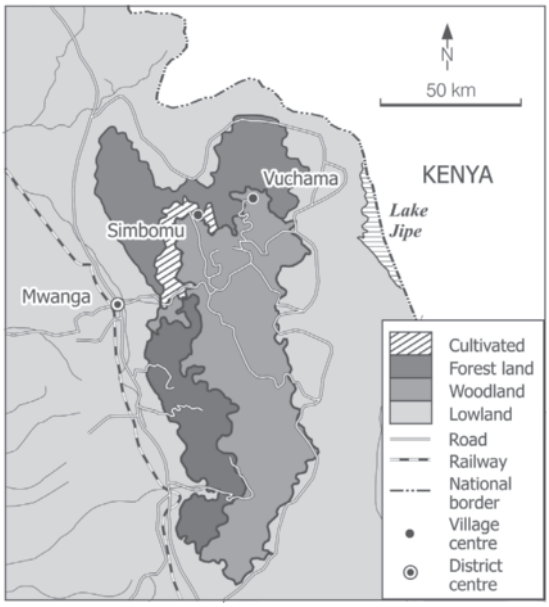

Fig. 2. Forests in the North Pare Mountains according to a 1:250 000 map. Notice the small cultivated area and the two case study village centres. Source: Hunting Technical Service 1996.

Data have been collected during the years 1997–2003. Data collection methods have been participatory, including village maps, transect walks, matrix valuation, village meetings, group discussions, as well personal open discussions (Chambers 1983, 1997; Laitinen et al. 1995; Ulvila 1995).

The vegetation cover analysis is based on air photos from 1982 (TN 4 172 and TN 032), a SPOT-PAN 141/357 satellite image from 1996, a Landsat-TM 167/63 image from 1997, field work in 1997–2003, maps GAF (1998a, 1998b, 1998c) made by a German company (GAF 1998d), and a biodiversity study generated using sampling plots. The biodiversity study was made during the 1997–2000 period in co-operation with the Tanzania Forest Research Institute (TAFORI). The assessment of the recent situation in January 2003 is based only on visual observations by the author. More details about the data collection of traditionally protected forests are presented in Mwihomeke et al. (1998) and Ylhäisi (2000).

The North Pare Mountains

The study area of the North Pare Mountains is situated in Mwanga District, Kilimanjaro Region, at an altitude of 800–2000 m a.s.l. with slope gradients often exceeding 40 degrees. Mwanga District covers about 2640 km^2 of which the mountain area covers about 365 km^2. On the surrounding dry savanna plains vegetation is very different as compared to mountain evergreen closed forests. Rock outcrops and cliffs are a common feature of the landscape of the mountain slopes, which start from 800 m and end as high as 1400 m a.s.l. in a highland plateau. The NPM have three high peaks: Kindoroko (2112 m), Ngofi in Minja FR (1810 m) and Mramba (1720 m).

The climate around the NPM is generally semi-arid. In the NPM the annual precipitation is about 700–1300 mm on the eastern slopes on the windward side. In contrast, the northern and western slopes and lowlands are on the leeward side and receive less precipitation, about 500–650 mm per year, with occurrences of droughts. There is a bimodal distribution of rainfall. There are signs that rains are becoming less, and more unreliable, due to the destruction of natural resources. This is also an opinion expressed by the locals.

Farms in the region are small with average size less than 1 ha. The main crops are maize mixed-cropped with beans and cassava or sweet potatoes for subsistence production. Coffee is normally intercropped with banana (*Musa paradisiaca*) or shade and fruit tree species such as *Grevillea robusta*, *Albizzia schimperiana*, *Cordia africana*, *Persea americana* and *Artocarpus heterophyllus* (Mvungi 1998). Sometimes food crops are intercropped with leguminous shrubs such as peas. The soils are generally well drained, mainly reddish and of medium texture, characterized by low to moderate fertility with pH values 4.5–6. Grazing is practiced by more than 95% of the households in the NPM (Mvungi 1998: 163). Currently, there is hardly any area left for grazing and already in 1994 Msangi and Mwihomeke wrote that farmers are forced to keep their animals in stalls and feed them by a cut-and-carry system.

The total population of the District is 115,600 people (URT 2003: 47) growing at an average of 1.6% per annum, which is much less than the growth of the previous census period (URT 1988: 48). According to Omar (1998), only about 20% of the district population live on the plain. This means that the population density in the mountains can exceed 400 inhabitants/km^2. When areas unsuitable for settlement and cultivation (slopes and forest reserves) are included, the density is about 210 inhabitants/km^2. In the lowlands of the district the population density is only about 11 inhabitants/km^2. The main ethnic groups are Pare and Gweno, and the average household size is about 5 persons in the mountain area. The lowlands were mainly unoccupied before 1940. The latest wave of migration came after the shortage of land in the mountains and low world market price of coffee.

Rivers and ravines, especially in slopes, are numerous in the NPM. Formerly, river and stream banks were given due respect and inhabitants were not allowed to cultivate up to the river and stream banks. There have been indigenous irrigation systems but in Ugweno in the most northern part of the NPM, the irrigation canals are no longer functioning according to Mshana (1992) and Mvungi (1998: 163), because water sources have dried up due to forest cover depletion or farming activities that have blocked the canals. At present, due to population pressure and insufficient law enforcement, the farmers are cultivating up to the river/stream banks and are also trying to recover old traditional irrigation systems.

Indigenous forest habitat fragmentation and degradation

It must be noted that the indigenous forests in mountains are highly heterogeneous. Reasons for differentiation can be due to variations in altitude, rainfall, geographical location, the amount of light, humidity, temperature, sun, evaporation, wind, clouds, shadow, soil depth, pH, etc. There are also some general rules: wetter forest types contain more endemic plant species than drier forests. Each forest type has a different species composition, and the endemic plants have their own narrow ecological ranges. The dry forest endemic species do not occur in wet forest and vice versa (Lovett 1998: 65). Floristic composition correlates highly with altitude. There are various reasons for this. The temperature decreases by six degrees per 1000 metres. There are clouds hanging around upper slopes, especially during rainy seasons. The temperature and humidity affect the topsoil down to 10 cm below the litter. Acidity is lower where the altitude is higher and where the humus layer is also deeper (Hamilton 1998: 86, 87). There are already marked changes in topsoil at an altitude of about 850 m, with a sharp fall in pH and the presence of a thick mor-humus layer at higher altitudes. According to Hamilton (1998), forest degradation has caused the upward movement of vegetation zones and a warmer and less misty climate over the last 25 years. Also, the humus layer has

suffered in forest clearings, and under exotic tree in the NPM the invasive tree *Maesopsis eminii*, the topsoil pH acidity seems to be over a pH point higher than normally.

Reduction of habitat size and duration of the decline in species diversity in forest fragments have been difficult to establish and are still very much unknown. This is one reason why fragments of tropical rainforest have a high priority as conservation areas since they could form the pool of origin for the regeneration of larger forest areas (UNEP 2003). There is a Species-area Relationship Model:

$$\log S = \log k + z \log A,$$

where S is the number of species, A is area, k and z are constants. The relationship is a linear equation, and therefore the constants are frequently estimated through simple linear regression. The constant z is an exponent that defines the slope of the species-area curve. The most common value for z is approximately 0.25 although values from 0.12–0.5 are reported. According to the model, a loss of 95% of habitat, for example, can mean a 53% loss in species number (Newmark 2002: 71–73). Another interesting theory relating to size, formation and fragmentation is presented Forman's (1995: 72–73) comprehensive study, which indicates that several patches have a higher avian species richness than one patch with a larger size than the smaller forests' total area.

Forman (1995: 406–409) divides the degradation of a habitat into five steps: 1) perforation, 2) dissection, 3) fragmentation, 4) shrinkage and 5) attrition. Perforation (making holes) in a habitat or land type is a typical beginning of land transformation. Another common form is dissection, subdividing an area in two or more pieces. In perforation the connectivity is not a problem. Fragmentation means the breaking up of a habitat or land type into smaller parcels. Shrinkage is the decrease in size of parcels such as forest patches. Attrition is the disappearance of patches and corridors. Usually small patches disappear, although the occasional disappearance of large patches is especially significant ecologically (Forman 1995: 408).

Deforestation and forest fragmentation, i.e. the reduction of large continuous forests to small isolated remnants, affect the survival of natural populations in complex ways. The above model about fragmentation does not take into account quality changes in the remaining habitats. In the model, the quality of the habitat remains the same. This is normally not the case because edge effects increase during the fragmentation (Fimbel et al. 2001). Studies have also been made about the size effect for the existence of species (Forman 1995: 43–80; Newmark 2002: 69–127). All of these models still consider the habitat quality itself unchanged, although the latest step in the fragmentation model is attrition. Attrition could be understood also as the loss of the original quality of the habitat. Selective logging can also pose a great threat to the original site specific indigenous forest habitat. For example, diffusion of exotic species from plantations presents a threat to the biodiversity (Mshana 1992). These factors reduce and isolate indigenous populations in forest habitats.

Species vary as to their vulnerability to extinction. The rarity of a species, or its small population size, is an important predictor of extinction. Small populations are more adversely affected than large ones by demographic, genetic, and environmental random events and social dysfunction. Other reasons for vulnerability are temporal variations in population size and poor dispersal/colonization capacity (Newmark 2002: 112–114). Forests, for example, have distinct 'edge species' and 'interior species'. Edge species are those that are suited to conditions at the edge of the forest (where there is typically more exposure to light, wind, and predation), whereas interior species are more suited to conditions inside the forest. Forest fragmentation poses a substantial threat to many interior species, they are often very sensitive to forest degradation. Too much edge threatens interior species, natural forest dynamics can collapse and dramatic changes may take place in the species composition (Saunders et al. 1991; Murcia 1995; Fagan et al. 1999; Siitonen 2003: 10; UNEP 2003). The response of species to the edge-effect over time is unclear. On the basis of the few available studies, edge effect appears to be strongly dynamic over time (Murcia 1995; Siitonen 2003). There is evidence that forest interior species and island species are also more vulnerable because they have

often evolved in the absence of predators (Newmark 2002: 114).

Even species living in metapopulations may persist in fragmented landscapes over time by establishing themselves in new empty suitable habitat patches to replace local "extinctions" (Hanski 1999). Fragmentation of habitats decreases the size of distinct habitat patches and increases interpatch distances. If the site network is highly fragmented, this restricts opportunities for dispersal between sites leading to a poor capacity of forests to maintain species in the long term (Hanski & Ovaskainen 2002). It is necessary to keep the habitat network in good condition when poorly dispersing species with discrete habitat requirements are threatened by habitat fragmentation. Habitats should be located so close to each other that species can efficiently re-colonize locally extinct habitat patches to ensure persistence of a metapopulation (Hanski 1999; Hanski & Ovaskainen 2002; Siitonen 2003).

Indigenous forest fragmentation and degradation in the Eastern Arc Mountains and the North Pare Mountains

Habitat loss is identified as a main threat to 85% of all species described in the IUCN red lists. Over the last 2000 years, the EAM have lost over three-quarters of their original forest, which was estimated at around 23,300 km^2. In Newmark's (2002: 10, 11) comprehensive publication about the area and its conservation, the total forest cover of the natural forest is estimated to be about 5708 km^2. He also estimates that the total closed forest area, where the canopy is generally intact and continuous, is more than 1452 km^2. The rest 4256 km^2 of the natural forest is open forest, the canopy of which is broken and non-continuous mainly due to human disturbance and fire events. Much of this loss has taken place during the past 200 years due to a dramatic increase in human pressure and technological change.

Among the EAM forests suffering the highest proportional losses of original forest cover are the Taita Hills (98.1%), Ukaguru (90%), Mahenge (89.3%), West Usambara (84%) and Nguru Mountains (82%), Uzungwa (76%), South Pare (73%), Uluguru (65%), East Usambara (57%), North Pare (56.2%), and Rubeho (37%) (Newmark 1998: 32; 2002: 10). Even the remaining indigenous forests have suffered, and only a part of them are closed forests and undisturbed. They are also highly fragmented, as according to Newmark (1998, 2002), the median and mean patch sizes are 10.2 km^2 and 58.0 km^2, respectively.

According to the situation described above the total loss of the forest cover in the NPM is 56.2%. The remaining forests and woodland as well cultivated land areas are presented in Fig. 2. In actual fact the situation is even worse because the resolution used for is very rough in Fig. 2. Estimation of the other mountains' forest sizes, as given above, were derived utilising the same methods. In the NPM, when comparing Fig. 2 with the reality, those areas which have been marked as forest areas are mainly woodland in reality. The area marked as woodland is mainly cultivated. In the more detailed presentation (Fig. 3) it is not possible to find continuous large forests. The remaining closed forests and riverine forests together covered no more than 5% of the land area in 1997 (see Fig. 3). According to the Species-area Relationship Model, a 53% loss in species numbers can be presumed.

In the NPM, there are only about 15 km^2 of indigenous forests left. The largest ones are Kindoroko (5.9 km^2), Mramba (1.9 km^2), Minja (1.3 km^2) and Minja North patch (0.1 km^2) (see Fig. 3). The distance between the two Minjas is about 100 metres. The forest between them burned in January–March 1997 during a long and severe dry season when the short rains failed. The same fire burned about half of the original vegetation (Fig. 3). Kilambeni forest is one of the big forests (0.75 km^2). This forest is locally protected and it includes a major traditional training forest. Also the riverine forests are traditionally protected indigenous forests.

The NPM map of 1982 indicates how almost all cultivation was located in valleys. Ridges in mountain plains were uncultivated but the lowest and most fertile lands beside rivers were mainly in cultivation. In the middle of the mountain plain there was a patch of about two times five kilometres in size, which was entirely cultivated. The biggest

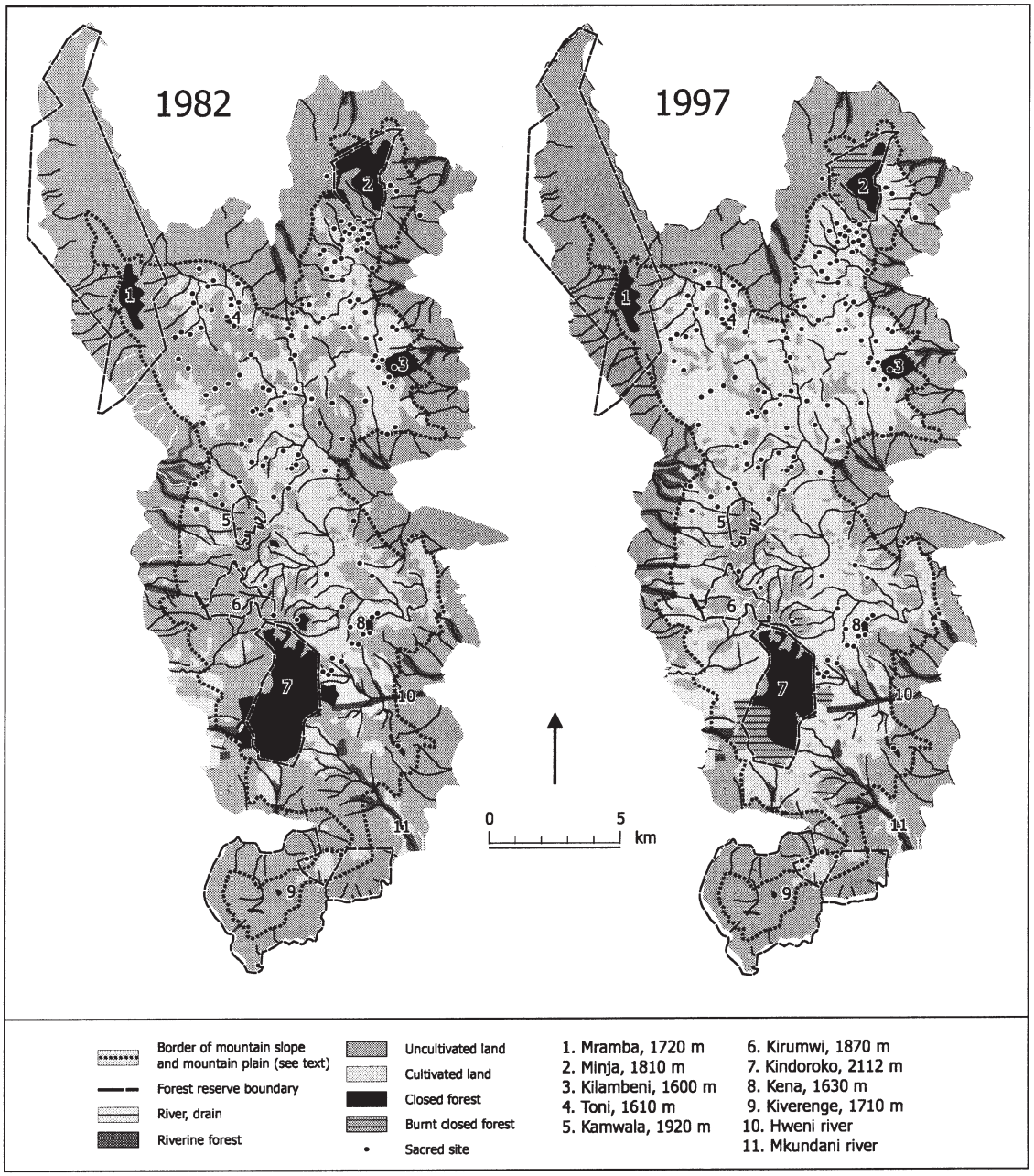

Fig. 3. Indigenous closed forests in 1982 and in 1997 in the North Pare Mountains, Tanzania. The Government forest reserves, riverine forests, burnt closed forests, cultivated lands, and the largest traditionally protected forests (named sacred site) are presented in the map. Also the highest altitudes a.s.l. of the peaks in the reserves are marked. Land use maps from years 1982 and 1997 have been compiled using air photo pictures from 1985, a SPOT satellite image from 1995, a Landsat image from 1997, and field work in 1997. Source: MGD 1982; SMD 1982; URT 1990a; URT 1990b; Kiwelu 1997; Swala 1997; GAF 1998a; GAF 1998b; GAF 1998c.

closed mountain forests were located apart from each other but they still had connections which were not cut by cultivated lands. The connection from Kindoroko F.R. via Kamwala F.R. to Mramba F.R. and Toni (number 21 in Fig. 5) was very important. Similarly important were connections from Kindoroko F.R. to Hweni and Mukundani rives and to Kiverenge. There were very few cultivated gaps wider than 1 km in the year 1982.

The map describing the situation of forests in 1997 gives alarming information about the forest degradation and fragmentation (Fig. 3). The total area of cultivated land from 1982 to 1997 has increased from 73 km^2 to 123 km^2 giving a 68% increase in only 15 years. This means that the deforestation rate in the future will decrease simply because there is no more uncultivated land left except in forest reserves and on slopes, which are impossible to use without massive terrace construction. However, labour intensive terracing exercises are very unlikely to start. The border of the mountain slope and mountain plane is marked in Figs. 3 and 7. The slope gradient is very steep between the marked line and the lowland. The slopes are also very often rocky. Inside the borderline there are very few uncultivated larger areas except government forest reserves. About 70% of land inside the borderline in the highland was cultivated.

During the drought in 1996–1997, just before the severe El Niño event, a total of 7.5 km^2 of forest burned in the NPM. The losses were dramatic, especially in Minja where almost half of the indigenous evergreen forests burned. A smaller percentage, but larger area, burned around Kindoroko. For the biodiversity such a big loss of forests in these fires must have been extremely dramatic, and it happened in a very short time. This was also a warning about the risks which will be more common when the total size of closed forest area becomes smaller and climate and vegetation becomes drier. Also, in Kirumwi and in some adjacent areas, almost half of the area of the forest burned. These forests were secondary or planted forests, but not intact. These burnt areas are not marked on Fig. 3, instead the burned indigenous closed forests are marked. There have been tree-planting projects and woodlots. Their total size is around 2 km^2 in the NPM, but on the slopes many of them have unfortunately been unsuccessful mainly because of fires (Anspach 1999).

Kamwala, Kirumwi and even Kindoroko Forest Reserves are now like uncultivated islands in the middle of cultivations, in spite of still being connected to each other. It is important to maintain this connection. There are no vertical (east–west) connections between the forests any more except via the Hweni and Mkundani rivers to Kindoroko and to the west from there. However, even here some slopes are being taken for cultivation. This is a reaction to the shortage of land and raises fears that in the future even the last riverbanks will be taken for cultivation.

Forman's (1995: 406–409) model of habitat degradation can be used to describe the situation in NPM. In 1982, there were 16 bigger "perforations" with smaller ones plus some "dissections" (see Fig. 3). The overall situation in 1982 was a mixture of the stage of perforation and fragmentation. Fifteen years later in 1997 there were only 5 "perforations" left plus some very small ones and no "dissections" (Fig. 3). The 1997 situation could be described by using Forman's categorization as somewhere between shrinkage and attrition.

In the NPM, there is a high number of forest patches with natural and indigenous vegetation. The reason seems to be the local culture and religion, which are retarding the process of diminishing and eliminating of these small forest patches. In the NPM, the traditionally protected forests are small closed forest areas outside forest reserves, but as Lovett (1998: 67) and Mwihomeke et al. (2000: 191) mention they can also be rich in endemic species and important even globally. Even relatively small patches of forest can contain many regionally highly specialized endemic species, especially when the quality of the forest patch is high, as mentioned before. In 1997 inside the borderline in the highland, the closed forest covered 8% of the area, but without the TPF the coverage was only 6%.

Protection of indigenous forests in the Eastern Arc Mountains

Conservation areas cover large parts of Tanzania. According to Newmark (2002: 11, 13), approxi-

mately 7000 km² of land in the EAMs is protected in national parks, nature reserves, forest reserves, or local authority forest reserves, and about 80–90% of the remaining natural forests are officially protected. Unfortunately there are some problems with the protection of government forest reserves and parks. Already in 1952, during the British colonial period, much of the forest reserves were secondary forests (Lind & Morrison 1974: 209). According to the fairly recent report of the Vice President's Office (1998: 50), only 9% of the protected 'low rain forests' and 33% 'Afro-montane/Alpine shrub' areas are covered by natural vegetation at present.

According to Newmark (2002: 11), most of the borders of reserves are poorly defined. In the field beacons have disappeared, and even border tree lines have been illegally cut down (Persha 2003). Vegetation growth has obscured marked boundaries, and demarcation is often incomplete. Large non-forested areas inside the reserves bring about even more confusion. The most common reasons for the destruction of these areas are human encroachment and fires. There are many reasons for peoples' behaviour which originate from the history of forest reserves since their establishment during the colonial period (see Mshana 1992; Conte 1994; Koponen 1994: 530–536; Ylhäisi 2003). Also, the forest plantations of exotic tree species – about 115 km² in the EAM – are in the former natural forest areas and threaten the survival of indigenous species. This organized invasion into government reserves is very serious. In Chome FR, in the South Pare Mountains, this is very well documented by Persha (2003). In one day of aerial survey it was possible to identify 310 pitsaw sites and cutting down of over 1000 endangered indigenous trees, mainly endemic *Ocotea usambarensis*.

The traditional forest protection by ethnic groups is very poorly studied in the EAM. However, there is some information on the existence of sacred forests and sites in at least 11 out of 13 Eastern Arc Mountains. The sacred sites' size, location, and ways of ritual performances vary by ethnic groups and there are differences even between clans. Amani national park in East Usambara, which is the flagship of rainforest conservation in the EAM, seems to have been created around sacred sites. In the Taita Hills all remaining indigenous forests have been traditionally protected.

Protection of indigenous forests in the North Pare Mountains

Areas protected by the government are essential for the conservation of biodiversity in the EAM and the NPM. The government protected forests in the NPM cover 75 km², 20% of the total mountain area. The problems in the protection of FRs are the same in the NPM as elsewhere in the EAM. The effects of fire have increased partly because of the relatively small size of the forests. In the NPM, fire has damaged over a fourth of the closed forests just in recent years, mainly inside the forests reserves (see Fig. 3). Only about 12% (9.2 km²) of the government forests are still closed forests (see Fig. 3).

The Mwanga District Council has enacted by-laws dividing the land into prohibited, reserved and restricted areas. Restricted areas refer to any area which forms part of a hill, slope or valley. No one can graze, cultivate or cut trees in these areas without the permission of the District Council. Any area around rivers, gullies and springs (a radius of 15 metres) is considered a prohibited area. Preserved areas are determined by the discretion of the District Council. There are very strict laws in district as well in government forest reserves prohibiting any use of the forest for locals. Officially, the protection is well organized, but the reality is different (Mvungi 1998: 164, 165).

In the NPM, the local authority forests are under the jurisdiction of village and district governments. The forest cover of local authority forest reserves is only 3.7 km² (Mwihomeke et al. 1998; Newmark 2002: 12). The local authority forests are mostly traditionally protected forests and therefore without legal rights until an agreement (TFAP 1997) made between traditionalists and village governments in the North Pare Mountains.

The main altitude of the TPFs location is different compared to the altitudes of government forest reserves. TPFs are in areas where people have been living the longest and the human activities are the most intensive (an exception are the sacred sites on mountain tops which are unoccupied). Although the sizes of the TPFs are small, the forest

coverage in TPFs is high. The total size of the TPFs is about 1/3 of the size of closed forests inside government forest reserves.

Traditional protection, village by-laws and conservation in the North Pare Mountains

There are 276 identified sacred TPFs in the NPM (Mwihomeke et al. 1998). In Fig. 7, only the 136 largest TPFs are marked (sacred sites). There are, in total, more than 100 indigenous forest patches, the size of which is about one hectare. The biggest of them are Kena 10 ha (it is smaller than originally), Toni about 6 ha (plus about 30 ha badly disturbed forest land), Kilambeni 20 ha (in good condition), Mbachi 6 ha (partly disturbed) and Chela 8 ha. Furthermore, there are 32 other traditionally protected forests of almost one hectare in size. These do not, however, give the grand total number of traditionally protected forests. There are three divisions in the NPM and the most southernmost and smallest Division of Lembeni was left out of the survey, although there are some well known TPFs there which have been marked in Figs. 3 and 7. At present, with the exception of a few national forest reserves, the TPFs are the only natural forests where one can find remnants of important indigenous tree species. Common tree species found in sacred forests in the North Pare Mountains are *Syzygium cordaturm*, *Albizia schimperiana*, *Croton microstachys*, *Bridelia micrantha*, and *Ficus* spp.

In the NPM, the 136 largest traditionally protected sacred forests, in Fig. 4, are especially important because of their altitudinal distribution. These forests are mainly in the elevations where the deforestation has been the most profound. The reason for the destruction is that the most fertile lands are in altitudes between 1200–1400 meters. This is where most of the traditionally protected forests are also located (77%). It can even be presumed that they are central for the existence of some species because closed forests do not exist in government forest reserves at these elevations.

There are only two TFPs on the outer side of the borderline of the slope marked in Fig. 7. However,

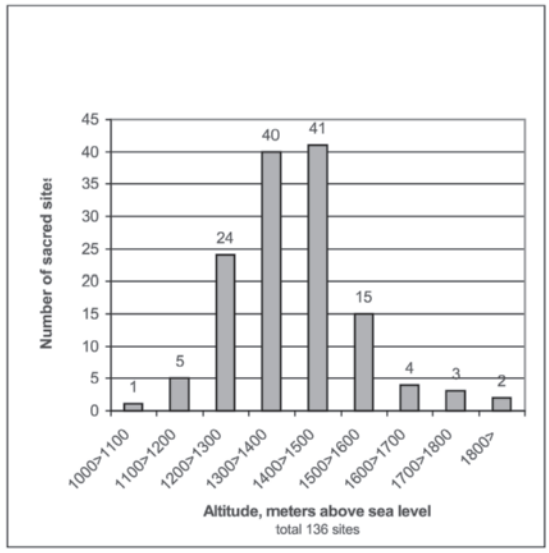

Fig. 4. The number of the traditionally protected forests (sacred sites) in different altitudes above the sea level in the North Pare Mountains (in Fig. 7) (MGD 1982; URT 1990a, 1990b; GAF 1998a, 1998b, 1998c).

slopes are the main location for TFPs, almost 40% of them are located on slopes, and in addition 7% on gentle slopes. All of these are inside the borderline. A second common location is on small hills (18%) and a third most common location is on mountain ridges (14%). There are still 6 TPFs on plains and 12 in valleys. Together they form 13% all forests. In the valleys beside the rivers there are still 11 forests (8%).

In 1982, only 18% of the TPFs were surrounded by cultivation, but in 1997 already 69% of them were surrounded by cultivation and only nine were without a contact to cultivated lands. In 1982, there were still 38 such forests. This shows the special character of the forests – they have remained untouched, although forests around them have changed to cultivation.

Traditionally there have been prohibitions in the NPM to enter the sacred sites without sacrifice. The general prohibition which concerns, for example, the use of fallen trees and twigs for firewood, is ecologically very important. The fact that the volume of dead fallen trees and snags appears to reflect the

richness of polypores, liverworts and epiphytic lichens is documented by several studies (Khiewtam & Ramakrishnan 1993; Siitonen 2003: 17). Also the prohibition of hunting animals in these forests is significant. There are information about animal populations in different countries which have survived because their habitat is sacred (e.g. Schaaf 1999; Trakarnsuphakorn 2003).

Unfortunately for the TPFs, customs are changing. Elders told in many places that their traditions have ceased and sanction mechanisms are not functional any more. Also performing rituals and initiation training have stopped. Christianity and Islam are the main reasons for the situation. Furthermore, some clans do not have enough land for agriculture because of population growth and they have started to clear their traditional forests (Mvungi 1998: 165). The average farm size has dropped from 2 ha in 1960 (Kimambo 1969) to less than 1 ha in 1995 (TFAP 1995) due to a continuous subdividing of the plots under clans. The land tenure system in the North Pare Mountains is customary and clans own the land. Possible expansion areas have been *mpungi* (family forest) and *mishitu* (training forests). Some of the owners of the forests have received traditional compensation, *mbuta*, to allow people to clear their *mpungi* for buildings and farms. "Traditionalists" categorized even themselves in history, but actually there are activities, values, respect, prohibitions, organization and interests to manage these forests. In the NPM, there are in total seven different types of TPF (see Mwihomeke et al. 1998; Ylhäisi 2000).

Mbungi and Mishitu by-law agreement in the North Pare Mountains

It seems that colonial foresters did not realize the local forest and environment management and its ecological importance, and the mistake continued until recent times. TPFs were not as evident and visible as today because they were earlier surrounded by other forests, as mentioned above. There have been court cases where the locals' rights have been nullified and caretakers have been told to cease appealing to the court (Ylhäisi 2000).

In the NPM, the Department of National Resources in Mwanga District, Tanzania Forestry Action Plan the NPM (TFAP the NPM) and Mpungi and Mishitu Divisions of Usangi and Ugweno have made a local agreement consisting of a new by-laws (see Appendix 1) to continue and support traditional protection of these forests. It allows for caretakers of the TPFs to protect their forests. In the agreement, a solution is also given for sacred sites which have lost caretakers due to various reasons. The most common reason is that the caretaker has adopted Christianity or Islam. In such a case the village government will take the responsibility for protecting the forest. A positive feature in the agreement is also a mechanism where the caretaker can leave an unsettled case to be dealt with by the village government. There are several reasons why this helps protection. Caretakers are normally elders and for them, because of their age and poor health, it is difficult to wait outside the courtroom for their case to be handled. The case can be complicated also, when near relatives have made the disturbance.

The agreement creates a mechanism to replant disturbed TPFs with the aid of foresters. Furthermore, it gives a recommendation to use indigenous tree species when replanting (see Appendix 1). Although it is stated in the agreement that replanted trees should not be for timber, one of the mentioned tree species is *mvinje* (*Casuarina*), which is firewood and even exotic in Africa. Other recommended tree species include respected trees even outside the NPM. *Mkuyu* (*Ficus sycomorus*) is a common ceremonial tree in Tanzania (Mbuya et al. 1994), in Zimbabwe (Mandondo 1997: 359) and a rainmaking tree in Kangata village in Handeni District. *Mvumo* (*Boraccus aethiopum*) is a traditionally protected tree in Nguru Mountains (Oppen 1992: 38). *Mzambarau mwitu* (*Syzygium guineense*) is a home of the Lion spirit in Zimbabwe (Mandondo 1997: 361). *Mwira* (*Bridelia micrantha*) is an over-exploited tree in Tanzania. It is not planted near homesteads because it attracts caterpillars and birds. It is, however, termite resistant and its fruits are used as medicine. *Mringaringa* (*Cordia africana*) is commonly used as a boundary demarcation tree in moist and warm areas at 1200–2000 m a.s.l. (Mbuya et al. 1994).

The agreement also sees traditions as a rational way of life and explains the history of the forests,

which is very important for the communities. It also serves as a good example for other regions of Tanzania.

Traditionally protected forests in the case study villages Simbomu and Vuchama-Ngofi

Simbomu is a village with about 2200 inhabitants and six traditional clans. Simbomu is located in the northwestern part of NPM and east of Mramba F.R (see Fig. 2). A majority of the inhabitants are Muslims and Christians. The sacred forests of Simbomu were not in a good condition in 1997 and 1999, but in January 2003 these forests were seemingly healthier and recovering. According to the village leader the reason for this was the comprehension of the uniqueness of the forests during the survey made between 1998–2000 and the legal instrument given to the village council by the TFAP agreement in 1997. Also precipitation at that time was good for vegetation recovery. According to the study, the share of people of Simbomu who valued "sacred" forests was the smallest in comparison with the other villages in the study. Still, a little less than 50% of the participants in Simbomu valued these forests, but rituals were valued by less than 25% only (see Ylhäisi 2000).

In Simbomu there are 27 traditionally protected forests (Fig. 5). Simbomu meeting forest (number 22 in Fig. 5) is in original condition except for the edge of the cultivation which seems to migrate slowly inward into the forest. The size of the meeting forest is 0.8 ha. The biggest forest, Toni (about 6 ha), is the ritual part of the former bigger TPF between three clans. In Toni forest (number 21 in Fig. 5) there is now a large deforested area which is planned to be reforested. There are already two small reforestation patches as well as in the neighbouring Mruma village connected to the Toni forest. The Toni ridge is now surrounded by cultivation. In 1982, there was still a connection to Mramba forest reserve and to Kindoroko forest reserve. The gap is now about 500–700 metres from the nearest secondary forest to Mramba forest. In Simbomu, cultivated areas are in the valleys as usual. Slopes on the northern and northeastern side decline steeply to the lowland plain about 400 metres in one kilometre, and rise up on the west side 500 metres in one kilometre to the peak in Mramba Forest Reserve, which is still covered by closed forest.

Fig. 5 demonstrates how the sacred sites have been surrounded by cultivation. Forests 27 and 23 are important as "stepping stones" (more about "stepping stones" below) between Mramba F.R. and sacred sites 21 (Toni), 22 (Simbomu) and 12, and furthermore to riverine forest between Mangio and Simbomu all the way to the next riverine forest in the north. After this, stepping stones will continue to forests 42, 40, 16, 14, 21, 20, 19, on the way to Minja F.R. in Vuchama-Ngofi village (Fig. 6).

Birds are the animals most probably using the stepping stones, totalling 13 in their number. The fragmented chain of stepping stones demonstrates, however, how desperate the situation of habitat degradation in the area is for indigenous animals. Instead of an animal migrating all the way between Mramba and Minja forests, it is more probable that populations migrate shorter distances to and from the surrounding forests. In this way there can still be a slow genetic flow between the separated main populations. The classification of vegetation used in the Figs. 5 and 6 is explained in Appendix 2.

Vuchama-Ngofi is a village with 7000 people and 11 traditional clans located in the northeastern part of NPM (see Fig. 2). The majority of the population are Muslims and Christians. There are 43 traditionally protected forests in the region (see Fig. 6) and their condition is in many cases excellent. There are, however, TPFs in some clans' areas, which have suffered or shrunk to only one sacred tree. TPFs are respected by most of the villagers. Almost 80% of participants in the village meetings valued TPFs somehow and even the involved rituals were valued by more than 50% of the participants in the survey (Ylhäisi 2000).

In 1982, most of the land was in mixed-use cultivation with scattered trees. The oldest open fields were located at about an altitude of 1400 m a.s.l. but now they have reached even 1700 m in the highest places, while also slopes as low as 1000 m are being cultivated. Village lands surrounding Minja F.R. are located mainly above 1500 m with the highest peak Ngofi at 1810 m. In the for-

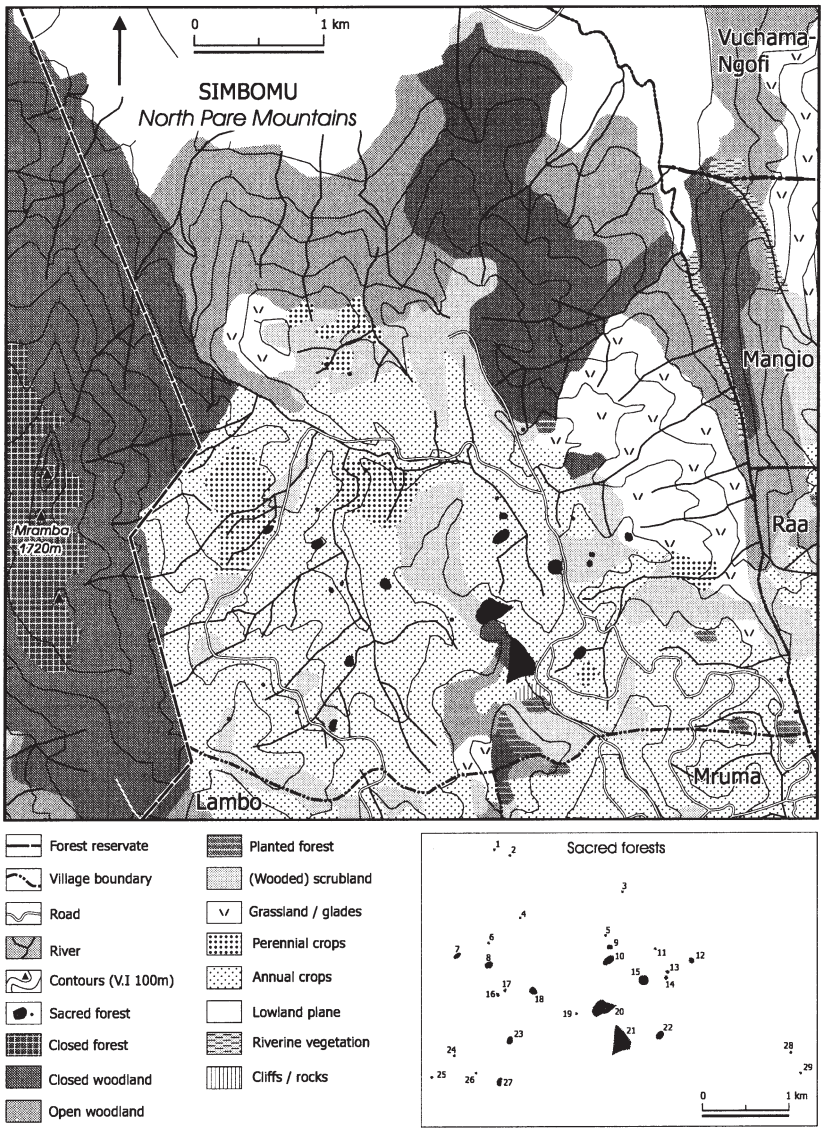

Fig. 5. Traditionally protected forests (named sacred sites) and the vegetation of Simbomu village in the North Pare Mountains in Tanzania. Source: MGD 1982; URT 1990b; Kiwelu 1997; GAF 1998a; GAF 1998b; GAF 1998c.

est there was a large fire before the El Niño rains in 1996 and the biggest part of the indigenous closed forest was burnt. The tree cover was very sparse and totally disappeared from many parts in 1997. Especially in the eastern parts of the village, there is a large area under cultivation, which is relatively green around the year because of perennial crops. The western side of the mountain slopes are too steep for trees to grow, or for economic land use.

Management alternatives for biodiversity conservation in the North Pare Mountains

It is of importance that the largest indigenous forest patches are not totally isolated from each other. Also dependency only on large forest reserves can have disadvantages; natural catastrophes like fire, storm, and diseases can cause local extinction by destroying entire populations. One large reserve

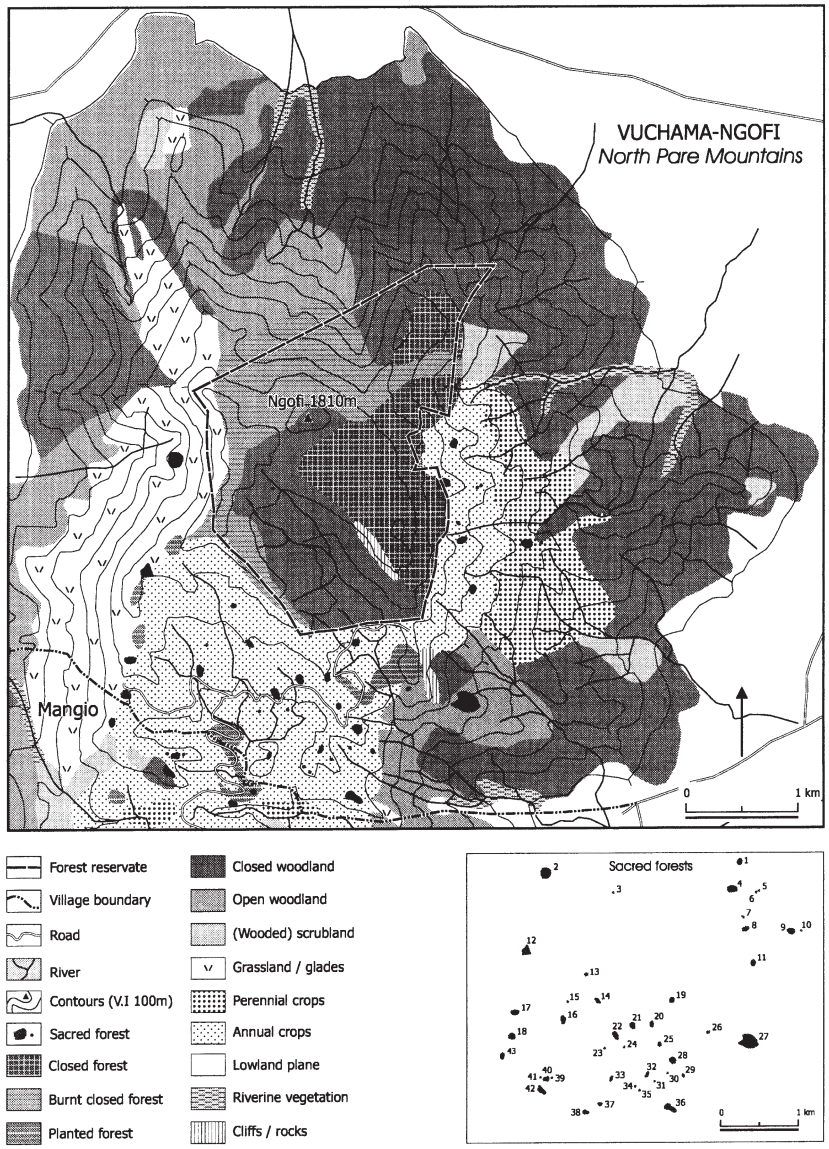

Fig. 6. Traditionally protected forests (named as sacred sites) and the vegetation of Vuchama Ngofi village in the North Pare Mountains in Tanzania. Source: MGD 1982; URT 1990b; Kiwelu 1997; GAF 1998a; GAF 1998b; GAF 1998c.

will probably not represent all of the habitats occurring in the region (Saunders et al. 1991; Forman 1995). For example, in 1996, the third largest closed forest (Minja F.R.) lost 50% of its vegetation cover. At the same time almost 50% of the biggest closed forest Kindoroko was lost due to fire. Therefore, it is less risky to have separate areas of target features, in this case indigenous closed forests, conserved (Siitonen 2003: 11, 15).

Thinking about a maximum number of species protected in a minimum area, there are studies which underline the importance of sacred sites as indicators of high biodiversity areas (for example Gadgil & Vartak 1976; Gerdén & Mtallo 1990; Okafor & Ladipo 1992; Khiewtam & Ramakrishnan 1993; Aiah et al. 1995; Lebbie & Guries 1995; Sinha 1995; Bennet et al. 1997; Debal et al. 1997; Decher 1997; Tiwari et al. 1998; Mwihomeke et

al. 2000; Biggeli et al. 2003). In general, an assessment of the structural elements of a forest stand has proved to be a fast and relatively easy method to estimate the conservation value of forests (Lindenmayer et al. 2000; Siitonen 2003). Also, minor water bodies like riverine forests or moist depressions are areas of rich biodiversity, especially for vascular plants and mosses (Siitonen 2003: 17).

When the ancient forest habitats are located in "island type" mountains like the NPM (which is in the stage of attrition), there is a need for an active counterattack to protect the habitats of high biodiversity in the remaining forest remnants. For the counterattack, various instruments could be used such as corridors, stepping stone forests, *in situ* and *ex situ* conservation, education, information, mitigation and co-operation with local communities to protect, develop and help connectivity between indigenous habitat sites.

Corridors

A corridor is a strip of a particular type that differs from the adjacent land on both sides. Corridors have several important functions, including conduit, barrier and habitat. They are also used specifically in species-poor sites when one wants to help some species to return or survive (Forman 1995: 149–150; Williams et al. 1996; Burgess et al. 2003: 58–59). There is ample evidence worldwide showing that many animals use wooded strips as conduits in crossing portions of a landscape (Forman 1995: 149–151). Animals that are known to use the conduits include small birds, large game birds, nocturnal arboreal mammals, many other mammals, amphibians and reptiles.

Newmark (1991) has made the longest continuous study of a tropical bird community in a fragmented landscape, in the forests of the East Usambara Mountains (EUM) in the EAM (see Fig. 1). He discovered that most understory bird species will not cross gaps in the forest wider than one kilometre. This finding has led to the creation of wildlife corridors to link the Amani nature park in the EUM to the remaining large blocks of forest.

In the NPM, the distances between the biggest indigenous closed forests in the FRs are much longer (see Fig. 7): the distance between Mramba and Minja forests is about 9 km, between Mramba and Kindoroko about 12.5 km, between Kindoroko and Kilambeni 10.5 km, between Kilambeni and Minja 5.5 km, and between Kilambeni and Mramba 9.5 km. In other words, the closed forests are too far from each other to support migration of understory bird species, according to Newmark (2002).

In Fig. 7, "ecological corridors" in the NPM for two time windows, 1982 and 1997, are presented. The corridors present a simple model of possible paths for animals, based on an idea that species need not cross cultivated areas. The vegetation in the corridors can be woodland, grassland, burned forest or planted forest. This means that they are not necessarily ideal corridors for example for closed forest species. Corridors consist mainly of hill and ridge tops and riverine forests. In the NPM, there have been projects to create continuous catchment forests using TPFs partly as starting points for the schemes. It seems, according to Msangi and Mwihomeke (1994: 27–28), that in gentle terrain farmers are not willing to withdraw from their land because these areas are suitable for agriculture and settlement, and in some of them there are also old irrigation canals. Due to these reasons, it is more realistic to concentrate on existing resources in uncultivated areas (marked in Fig. 7) for corridor construction.

In the NPM, there are natural corridors such as riverine forests, which are indigenous strips of woody vegetation enclosing river or stream courses. Unfortunately, these riverine forests are also disappearing due to human activities. Those forests still existing are shown in Fig. 7. Traditionally, rivers and stream banks were given due respect, and inhabitants were not allowed to cultivate up to rivers/stream banks. Traditionally, strips of about 5 metres were left uncultivated on both sides. According to the National Forest ordinance, a strip of 15 metres on both sides of the riverbank should be left untouched. Unfortunately, river banks are currently being narrowed by farmers due to the problem of land scarcity.

A special feature of the riverine forests in the NPM is that the remaining forests are on the outer slopes. They rise from the surrounding plains at about 900 m to the highland plateau at an altitude

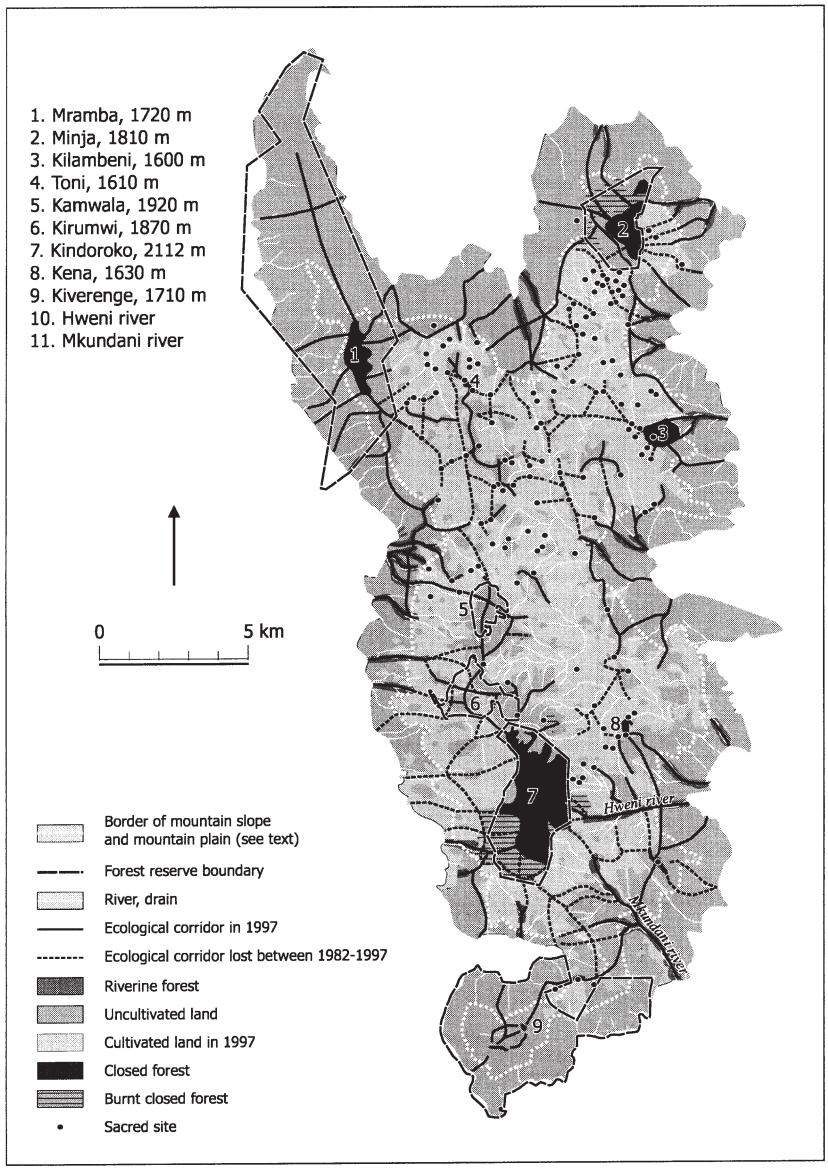

Fig. 7. The map of corridors and disappeared corridors between indigenous closed forests, riverine forests, rivers without forests, and sacred sites in 1982 and 1997 in NPM. Source: MGD 1982; URT 1990a; URT 1990b; GAF 1998a; GAF 1998b; GAF 1998c.

of 1200–1400 metres, and create a closed wood cover between different ecological areas which have differences in e.g. temperature and precipitation. They form gateways for many animals; some birds, for example, may survive by moving up and down the slope as climate warms or cools. There are still some riverine forests like those mentioned above, one of which is the Hweni river about 5 km in length and located east of Kindoroko Forest Reserve. Another one is Mukundani riverine forest south-east of Kindoroko, although it has lost its natural forests from a stretch of about 2 km near Kindoroko.

Stepping stones, *in situ* and *ex situ* conservation

A stepping stone is an ecologically suitable patch where an organism, such as an animal, lives or temporarily stops while moving along a heteroge-

neous route. A stepping stone can also be a habitat for a plant population which can receive seeds from outside or send them outside. They are important elements in corridors and enhance a network of habitat patches.

Traditionally protected forests are good examples of stepping stones for forest species because they exist where the evergreen vegetation has disappeared either recently or a long time ago. As mentioned before, Newmark (1991; 1998: 34) has found that understory birds do not cross gaps wider than one kilometre. This is one reason for protecting closed forest sacred sites to enhance connectivity of the type of forests. Most TPFs are located within 1 km distance from a nearest neighbour.

According to the IUCN, *in situ* conservation – the conservation of species in their natural habitats – is the most appropriate way of conserving biodiversity. A protected area is a geographically defined area that is designated or regulated and managed to achieve specific conservation objectives.

Ex situ conservation measures can be complementary to *in situ* methods as they provide an "insurance policy" against extinction, which is a real threat in the EAM (Lulandala 1998). *Ex situ* conservation is the preservation of components of biological diversity outside their natural habitats: in zoos, aquaria, botanical gardens and gene banks. These measures also have a valuable role to play in recovery programmes for endangered species.

Buffer zones and the edge effect

The term buffer zone means, in the case of the NPM, planted indigenous trees around closed indigenous forest and riverine forests. With buffers it is possible to defend indigenous forest habitat from future attrition, and also diminish the edge effect. TPFs are relatively well equipped against edge effects. The reasons for this are the fertile and moist soils in the sacred sites which keep them evergreen and less susceptible to fire during the dry seasons (also Mwihomeke et al. 2000: 191).

The edge effect is more pronounced the smaller or more fragmented the habitat is. Edge effects are complicated and they change with time due to complex interactions between several factors (Murcia 1995) such as changes in microclimate – increased solar radiation, wind and decreased moisture – within forest margins, which affect species composition directly and indirectly (Murcia 1995; Burgess et al. 2003).

The site conservation planning and conclusions

It is important that the government and the international community concerned with the conservation issues start their efforts from the context of local peoples. The destruction of the environment and forests may soon reach a stage of no return, even with any reconstruction programs and plans, since the equilibrium balance of the ecosystem has changed and the succession leads not towards a forest ecosystem but towards poor scrub and grassland. Historical, cultural, environmental, and land scenery values will be lost, animal and plant species will become extinct, and biodiversity in general will suffer. This means that the process in Tanzania is not a problem of Tanzania only. Tanzania needs urgent assistance from the international community to implement its laws and development goals. But it is also time for the people of Pare to realise that the environment in which they live is a unique one, and that this uniqueness is in danger of being lost. The new village land and forest laws enacted recently in Tanzania give the local people extensive decision making rights. This does not mean that the government is a bystander in the process, especially since the new laws are not yet even known by local village representatives, and less by average villagers. This became apparent in discussions in January 2003 in Simbomu and Vuchama-Ngofi. All parties, traditionalists, Muslims, Christians, government foresters, farmers, landless young men, women etc. should be part of planning, decision making and implementation.

The remaining forests in the NPM are highly heterogeneous and make the conservation of biodiversity more complicated than in many other places. Even a small indigenous forest habitat TPF can be important, and they can fulfil all criteria to be added to the official protected network defined in the Vice President's Office (1998: 51).

TPFs could be a new type of conservation model where the actors could be local communities with the educational support of the central government about ecology, biodiversity, conservation and perhaps ecotourism, and other income-generating activities (Burgess et al. 2003: 56). TPFs can also be categorized as heritage sites, not only as hotspots for biodiversity and endemic species, but also as culturally important localities.

The still existing riverine forests should have a special management plan by the government and district officials and local villagers to ensure their existence and connectivity between different areas. Riverine forests east of Kilambeni should be saved from isolation. Also, recovering traditional protection practices such as a 4–5 metre wide buffer zone beside the river banks is important, not only for animals, but to prevent soil erosion from the fields and subsequent silting of rivers.

Introduction of exotic tree species should be avoided not only in the buffer zones, but also in catchment forests and corridors, when the aim is the recovery of indigenous habitats. Buffer areas could be used selectively by local communities for their needs of forest products. In the near future, forest products will have a higher value and demand due to increasing economic activities and simultaneously diminishing forest area. Nearly all investments made in the forests of the EAM until the 1970s had been to plantations using mainly exotic tree species. In the NPM, there are also plantation type forests which have not been established in order to increase biodiversity, although they will hopefully ease the pressure to use indigenous forests. There is a need to support the use of indigenous local tree seeds and seedlings more than what has been the practice so far.

In some cases the caretakers are actively supporting replanting of the degraded area or an area which has been taken for cultivation without their permission. In these types of reforestation activities possible conflicts with neighbours should be avoided. It is important to notice that locals are willing to do the replanting by themselves and hence, external support is needed only for making the plan, and purchasing plants.

Traditionally protected forests in the NPM are ideal for *in situ* conservation as culture, customs, by-laws, institutions, organizations of local communities and indigenous habitat sites for very specific plant and animal species support this idea. In the case of *ex situ* conservation, a TPF could be a refuge for plants and animals which have lost their habitat for some reason. Alternatively, they can be new habitat areas when species populations need to be increased in number or size. *Ex situ* conservation could also create new income for the local people. At the same time, transport costs of species could be saved, and it would not be necessary to create an artificial environment for conservation somewhere else.

The locals should be assured that the income from the FRs does not go to wrong hands. The maintenance needs in FRs could create work opportunities for locals. It is also important to restore the large burnt areas. This will take decades, however. There is a need to study the situation of the burned forests and make a plan for implementation. It is more than obvious that locals are collecting as many burned tree trunks as possible and the collection will soon have a significant ecological impact, unless done in a planned way. It is also necessary to make a plan with the locals on how to prevent fires. A fire as extensive as the one in 1996 would destroy the remaining closed evergreen forests from the government reserves in the NPM.

In the NPM, the conservation situation is easier than in areas without the TPFs. The stepping stones, *in situ* areas and part of corridors are already protected, but not because of their biodiversity. They are protected due to their cultural and religious values. In reserve design, there is a need for a cost-efficient network and synergy activities. The locally conserved TPFs are also ideal because of local caretakers and customs, which makes it possible to organise conservation with relatively low economic expenditures in numerous compact small indigenous areas.

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APPENDIX 1. *Mbungi* and *mishitu* by-law agreement.

The agreement to protect *Mishitu* and *Mpungi* forests between the caretakers of traditionally protected forests, the village governments in Usangi and Ugweno divisions, and the Department of National Resources in Mwanga District (TFAP 1997). Names of the trees are in Kiswahili.

The traditional rules for protection of the forests need to be taken back into use, and the caretakers of every forest must continue to protect their forests. The owners of the forests who will not protect their forests because of e.g. adopted new religious beliefs have to hand over the duty of forest protection to the village government. Serious destruction of the forests must be reported to the village office and even to the court, if necessary.

Forests which have been disturbed will be planted with *masale* (the boundary marking plant in the NPM). The caretakers of *mpungis* and *mishitus* in co-operation with village governments and the department of forests are responsible for the planting. All traditional forests must be visited by the village government and a forester to mark the boundaries by painted marks before planting *masales*. All destroyed traditional forests must be replanted with trees which are good for the environment and not for timber, like *mkuyu*, *mvumo*, *mzambarau mwitu*, *mvinje*, *mwira*, *mringaringa* etc. The forest department must provide seedling for the work. Foresters will co-operate with the planters.

Ritual performing must continue and there is a need to renovate the local culture. Some owners of the forests had stopped ritual performing due the fear that village government do not allow it (however this is not the case). To give land for cultivation which is a part of the traditional forests is not allowed, and according to the agreement strong action must be taken to avoid this.

The rules specified in the agreement are:

1) It is prohibited for everyone to enter the *mpungi* or *mishitu* without permission of the owner of the forest. 2) Women are not allowed inside these forests (*mpungi*/*mishitu*). 3) Cutting trees or grass, making fire, collecting medicine or grazing inside the forests is not allowed. 4) Burning the forests is not allowed. 5) It is prohibited to hang bee hives inside the forests and 6) hunting.

The meaning of *mpungi* and *mishitu* forests:

Mpungi is a small traditional forest for rituals. There are skulls of ancestors who have died after a long time ago and they have a place in the forests.

Anyone found in a *mpungi* will be prosecuted; one black goat or sheep and two *debe* (pots) and two tins (18 l) of *dengelua* (traditional beer), one tin is to be consumed outside and one tin inside the forest in the penalty ritual.

Mishitu is a forest which has traditionally been used as a training forest for the youth to learn the traditions and culture. The youth stayed in the forest between 2 and 6 months.

Anyone who wants to go inside a *mishitu* needs one cow and two tins of beer made out of honey. The cow will be sacrificed and eaten and the beer drunk inside the *mishitu*. This ritual offering is made to settle and please ancestors, not to make harm to the owner, caretaker or his family.

People who break against the rules and do not participate in penalty rituals must be reported to the village government which will take them to the court. The agreement will be distributed to all leaders of the Justice in primary courts in Usangi and Ugweno divisions and forest officers of the Mwanga District.

APPENDIX 2. The classification of vegetation used in the Figs. 5 and 6.

Closed forests consist mainly of moist evergreen and deciduous species: canopy closure is over 70%. Forests usually consist of several layers and tree height is normally more than 15 metres.

Forests which have been exploited or utilised and where the canopy closure is less than 70% are not closed forests. Burnt forests are natural forests which have been burnt before the year 1997. Other land cover types in the NPM are: 1) woodland: tree height with 5–15 meters with open stand of trees; 2) dense woodland: canopy closure over 50%; 3) open woodland: canopy closure under 50%; and 4) forest plantations: young and old planted forests. Only closed moist evergreen forests are marked on the map.

Uncultivated land in the maps includes woodlands, thickets, shrublands, grasslands and areas permanently without vegetation. Thickets are areas of densely interlaced trees and shrub species which often form an impenetrable vegetation community. Plants are multi-stemmed with no layers with interlocking canopies. Canopy closure is over 70%. Shrubland is composed of woody single and multi-stemmed plants (branching at or nearly at the ground). Canopy cover is over 20% and height between 1–5 m. Grasslands are areas with less than 2% trees and shrub canopy cover and dominated by grass-like, non-woody, herbaceous plants. They may also be promoted by the frequent crossing of fires in the dry season. Wooded-grassland is land with clumped or scattered trees or shrubs with a canopy cover between 2–20%.

Cultivated lands are ploughed for crops. These areas include areas currently under crop, fallow lands and land being prepared for plantation. There are perennial crops like banana, which can be intercropped with coffee or maize, and cassava. Annual crop lands are mainly maize and beans, both with scattered trees. (The source of the classification is from GAF (1998d).