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MEETING THE NEEDS OF THE PEOPLE THROUGH SPECIES DOMESTICATION: A BASIS FOR EFFECTIVE CONSERVATION OF THE EASTERN ARC MOUNTAIN FOREST BIODIVERSITY

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ABSTRACT

Threats of biodiversity loss, caused by the overexploitation of natural resources are serious local and global concerns. Available information on the components of biodiversity, especially in the natural-resource-dependent third world, indicates a gloomy trend. The situation for the forest biodiversity of the Eastern Arc Mountains is serious. Many deliberations on the urgency and possible conservation measures needed to limit or curb the pending catastrophes have not yielded the desired results. Growing human populations, adjacent to the biodiversity centres and without alternatives, continue seeking their forest-based material needs from the forests. Some of the most sought-after products come from endemic species. Thus, effective future biodiversity conservation strategies will not lie in the routine *in situ*, but through radical *ex situ* conservation. The present paper discusses these issues, including future needs for the identification of the species people want, their location in the forest ecosystem and the development of appropriate technologies for their acquisition, propagation and domestication.

INTRODUCTION

The Eastern Arc Mountains of Tanzania, especially the associated forests, are extremely important both locally and internationally. Locally, they support the livelihood of millions of people in the mountains, agricultural valleys and urban centres served in various ways by the material supplies and services accruing from the mountains. They also contribute to the national economy. Over the years, the forests of the Eastern Arc Mountains have provided an effective and exceedingly important catchment area for many stable rivers and streams (Svendsen *et al.*, 1995) supplying water for household use, agriculture and industries (Temple, 1973; Lovett & Pócs, 1993; Svendsen *et al.*, 1995), fertile soils for agriculture (Svendsen & Hansen, 1995) and a diversity of products and services (Temple, 1973; Hamilton, 1989a, b; Hamilton & Mwasha, 1989a, b; McNeely, 1995). They have similarly been dependable sources of timber for various sawmills, supporting the construction and lumber industries, and contributing to regional timber trade.

Globally, besides offering some of the products, *e.g.* timber, that have come from these mountains and have variously contributed to world trade (Kowero & O'Kting'ati, 1990), their significance lies in the science and knowledge they harbour for present and future generations. The mountains are marked by a high species richness, endemism (Lovett, this

volume b; Newmark, this volume; Stanley *et al.*, this volume) and a large number of restricted-range species and genera (Fjeldså *et al.*, 1995; Newmark, this volume). For instance, it is known that 25–30 % of the approximately 2,000 Eastern Arc plants (Lovett, 1988; Lovett, this volume a), over 12 of the world's 1,111 globally threatened bird species (out of c.9,000 known bird species), and an equally large number of other forms of animals are endemic to the Eastern Arc Mountains. The Uluguru, Udzungwa and Usambara Mountains are particularly rich (Brenan, 1978; Collar & Stuart, 1988; Fjeldså *et al.*, 1995; Lovett, 1988; Lovett & Wasser, 1993). Because of the high biological diversity value, the Eastern Arc Mountains have been targeted as a high priority area for biodiversity conservation through local, regional and global initiatives (Bennun *et al.*, 1995; ICBP, 1992; IUCN, 1980, 1985; Lovett, 1988; UNEP, 1992). The Uluguru Mountain forests, for instance, are ranked 16th of all the forests on the African continent and fourth among all forests in East Africa in terms of conservation value for the protection of Threatened and Near-threatened bird species (Collar & Stuart, 1988; Fjeldså *et al.*, 1995). They also form an important part of C24, one of the 221 priority areas for global conservation of birds (ICBP, 1992). There is, therefore, an urgent need for evaluating the current successes and failures in our continuing collective conservation efforts in the Eastern Arc Mountain forests and to set in motion strategies for future dynamic biodiversity conservation management. Newmark (this volume) suggests a reconnection of large forest patches with wildlife corridors as a management strategy to bridge-up the gaps of taxa discontinuity. Lovett (this volume b) proposes an expanded geographic coverage of local biodiversity centres to include the Eastern Arc mountain forests, the coastal lowland forests and the Eastern Arc rain shadow as a World Heritage area.

SOURCES OF THREATS TO FOREST BIODIVERSITY OF THE EASTRN ARC

We are certain that the Eastern Arc Mountain forest biodiversity is increasingly being subjected to tremendous resource use pressures, which seriously threaten its sustainability and even its existence. Fjeldså *et al.* (1995) observe that the Uluguru forests are among the most critically threatened in the Eastern Arc. Biodiversity loss is a major potential problem and the causes of this loss may be direct or indirect. Martens (1995) indicates that immediate causes include habitat loss and fragmentation, physical alteration, over-exploitation and introduction of alien species. Indirect losses are mainly brought about by the high rate of human population growth, unsustainable use of natural resources, economic policies that fail to value the environment and its resources, insufficient scientific knowledge, and weak legal and institutional systems.

It is, however, the increase in the human population and the resulting activities to meet the various needs that have placed an immense pressure on natural resources, and have, as Martens (1995) indicates, led to their misuse or abuse. Anthropogenic conversion of natural habitats into settlements and farmlands, resource exploitation, replacement of the natural forest vegetation with monocultures of exotic plant species, and relentless use of destructive dry-season fires are all human population dynamic dependent activities that have a very strong bearing on the scale of achievements in the efforts to conserve the forests and forest biodiversity of the Eastern Arc Mountains. Indeed, it is on this human element that more focused attention is required to suggest long-term, practical solutions to the problems.

Human population

The Eastern Arc Mountains consist of fragments of forests that are surrounded by an ever-growing human population. While nationally the Tanzanian population grows at an average of 2.8–3.2 % annually, the growth rates in the agriculturally high-potential and natural resource-rich areas of the Highlands, which include the Eastern Arc Mountains, are generally higher. Recent estimates of the human population in the Uluguru Mountains indicate annual growth rates of up to 6.5% (Bhatia & Ringia, 1996; Fjeldså *et al.*, 1995; Lyamuya *et al.*, 1994), although this can only be possible with substantial immigration into the area. Similarly, population growth rates in the Southern Highlands, Usambaras and Pare Mountains are reported to be higher than both the local district, regional and national averages. Kikula (1989) reports that the East Usambara population increased manifold since the 1900s. The IUCN (1985) and Mwasha (1989) further observe that the population of Amani Division, within East Usambaras, increased by 48 % between 1967 and 1978. Reports of escalating population growth rates around forest reserves are common countrywide thus posing serious management problems to such forest estates.

Conversion of the natural vegetation into settlements and farmlands

Due to favourable rainfall and soils, the highlands of Tanzania have a higher potential for crop production than any biogeographical region in the country (Lundgren, 1980). Moreover, growth in the population results in more pressure for land resources both for settlements and farmland. Large areas of the Eastern Arc forests have been cleared in the past for agriculture, and these forests are very threatened from a rapidly growing human population demanding ever more land for agriculture (Fjeldså *et al.*, 1995). Kikula (1986) indicates that during the period 1958 to 1986, parts of the Usambara forest vegetation cover were reduced in area between 22 % and 100 % (*i.e.* total clearance), mainly due to conversion to subsistence agriculture, commercial tea, coffee and cardamom plantations, and for settlements (table 1). Forest loss proceeded rapidly in ungazetted forests but increased encroachment into the forest reserves by the border communities are being reported from many parts of the country (Nsolomo & Chamshama, 1990; Fjeldså *et al.*, 1995). Livestock has had very little influence on biodiversity loss in most of the Eastern Arc forests, except in parts of the Usambaras (Moshi, 1997).

Subsistence farming through the highly destructive practice of shifting cultivation is a characteristic feature of land-use systems among the poor, forest-dependent communities throughout the Eastern Arc Mountains. In the Ulugurus, shifting cultivation has converted most of the mountain slopes, below the gazetted forest reserves zone, into treeless grasslands (Temple, 1973; Fjeldså *et al.*, 1995; Newmark, this volume). Newmark reports that 77 % of the original Eastern Arc forest has been lost through human disturbance and fire over the last 2,000 years. It is also suspected that reduction in the forest cover in the Eastern Arc Mountains has played a part in the reduction in the amounts and the predictability of rainfall, thereby lowering the land's carrying capacity for people. Temple (1973), Kikula (1986), Nsolomo & Chamshama (1990), Lyamuya *et al.* (1994), Fjeldså *et al.* (1995) and Bhatia & Ringia (1996) report that both the Uluguru and Usambara Mountains have been cultivated even on very steep slopes, while the fallow periods are becoming shorter and shorter thus exposing the soil to severe erosion and leaving behind infertile and unproductive soils. Outside the forests soil erosion is a big problem, and on most slopes no measures are taken to prevent it (Fjeldså *et al.*, 1995). In 1993, for instance, hundreds of tonnes of mud from eroded soil in the Uluguru Mountain slopes flooded Morogoro Municipality, forcing a

several-months closure to the main market and requiring several days of costly heavy machinery work to clean the area and repair the damage!

Table 1: Changes in the area (km^2) of forests in the East Usambara Mountains. Source: Kikula, 1986 (NC indicates cells not covered by air photos)

Grid cell No. (5 x 5 km)	1958	1976	1982	1986
7	0.4	NC	NC	0
13	14.7	NC	NC	0
14	4.9	NC	0.4	0.1
15	NC	NC	5.5	4.0
20	1.3	NC	NC	0.9
25	1.3	NC	NC	0.9
27	18.8	NC	14.4	15.6
33	17.0	NC	11.1	15.7
38	9.0	NC	NC	2.1
39	17.0	NC	12.9	11.6
40	NC	NC	14.3	11.1
43	2.9	NC	NC	2.9
44	23.0	NC	13.6	14.9
45	11.0	NC	NC	11.0
46	NC	NC	11.7	9.4
49	2.2	NC	2.2	1.4
50	23.7	21.0	20.0	20.0
51	9.3	NC	NC	6.3
52	NC	1.8	NC	1.1
56	5.8	5.4	5.3	5.0

Similarly, conversion of parts of the forest vegetation into farmland results in habitat fragmentation and loss in the forest biodiversity (McNeely, 1995). Forest fragmentation affects indigenous floral and faunal populations by reducing the total habitat area, which reduces the population size and increases local extinction rates, and the remaining fragmented area limits dissemination and immigration (Wilcove *et al.*, 1986; McNeely, 1995; Lyaruu & Mwasumbi, 1997). Already over 30 % of the Eastern Arc Mountain forest species have become extinct or are in jeopardy of future extinction due to cultivation (Newmark, this volume). These forests are, indeed, highly encroached and fragmented but the implications of this on the trends of species vitality and biodiversity richness need to be established.

Resource exploitation

The livelihood of the local communities bordering the centres of forest biodiversity worldwide and, to varying extents national economies, are variously dependent on the diverse products accruing from them. Wood (mainly fuelwood, building poles and tool handles), medicines, food (*i.e.* fruits, vegetables, edible stems and roots), and wildlife/honey, are the important necessities sought from the forest biodiversity almost on a daily basis by the local communities. Other minor products include rope, barks or leaves for making various items (*i.e.* baskets, mats and brooms), roofing materials like grass, and a multitude of other utilities. Seekers of commercial products such as sawn timber, carvings and commercial plant parts such as young stems and leaves of some tree species (*e.g. Catha edulis,* which has suddenly become a very popular export stimulant), often come from

outside the local communities but they increasingly intensify their exploitation often using very crude and highly wasteful technologies, *e.g.* pit-sawing and machine logging. Table 2 presents some of the human activities in the reserved catchment forests in Morogoro Region (Nsolomo & Chamshama, 1990).

Table 2. Human interference in catchment forests in Morogoro Region, Tanzania. Source: Nsolomo & Chamshama (1990).

Forest reserve	Pit-sawing	Encroachment	Pole, fuel-wood & other products	Fire	Extent
Uluguru North	-	v	v	v	minor
Uluguru South	-	v	v	v	minor
Ruvu	-	v	v	v	severe (encroachment)
Dandili	-	-	v	v	minor
Mkungwe	v	-	v	v	minor
Kimboza	-	-	v	v	minor
Nguru South	v	v	v	v	severe (encroachment)
Kanga	v	v	v	v	minor
Mindu	v	-	v	v	severe
Mamiwa Kisara North	-	-	v	v	severe
Uponela	-	-	v	v	severe
Ikwamba	-	-	v	v	severe
Mamboya	v	-	v	v	severe (fire)
Mwanihana	v	-	v	v	minor
Mahenge scarp	v	v	v	v	minor
Kwiro/Mawenge	v	v	v	v	severe (encroachment)
Mselezi	v	v	v	v	minor (illegal pitsawing)
Sali	v	-	v	v	minor (illegal pitsawing)

Depletive losses to biodiversity in the Eastern Arc forests are likely to escalate as the natural-resource-dependent human populations continue to grow around centres of biodiversity. Illegal and dubiously licensed pit-sawing is escalating in both the reserved and public forest lands of all the Eastern Arc forests. Destructive methods of harvesting some forest products are also posing conservation challenges, especially when unorthodox techniques like removal of all the leaves, such as when harvesting *Catha edulis,* have recently been found during a biodiversity inventory of the West Usambara forests (Msuya & Madoffe, this volume). Other forms of excessive harvesting of the leaves, roots, bark, seeds, flowers and uprooting of whole plants, *e.g. Deinbollia borbonica,* for medicinal purposes are also known. Destructive harvesting of truly endemic fauna and flora with little or no known propagation methods and efforts is a frustrating challenge conservationists have to try and solve urgently.

Replacement of the natural forest vegetation with alien plant species

Another very serious threat to the conservation of biodiversity in the Eastern Arc Mountains is the emergence of strong inclinations/preferences for a single or a few, and most often exotic, plant species that are being established, almost in monocultural plantations, following the clearance of the genetically and species-rich natural vegetation. Currently, for instance, the Australian *Grevillea robusta* tree species has become very popular in the whole of the

East African region and is almost singly being widely incorporated in farming systems, planted in woodlots, plantations, in soil and environmental conservation schemes and even being used for enrichment/gap planting in the reserved forests. The tree has already become a dominant feature in the community forestry schemes in the Eastern Arc Mountains. This is not only unhealthy from the point of biodiversity loss but also from the risks this management poses. The catastrophic *Heteropsylla cubana*, *Cinara cupressi* and *Dothistroma pini* infestations of what used to be our miracle *Leucaena leucocephalla*, *Cupressus lusitanica* and *Pinus radiata* tree species, respectively, are still vividly painful in our minds.

Maesopsis eminii is another tree species which was introduced in the East Usambara forest reserves in the early 1960s for filling up gaps following heavy logging in order to avoid the invasion of the clear-felled areas by the local farmers, and with a hope that it would also nurse and promote the regeneration of the more valuable shade-demanding hardwood tree species. The species, however, turned out to be highly competitive, spreading into and transforming the surrounding natural vegetation into an almost *Maesopsis* monoculture (Mwasha, 1989). The allelopathic effects of several other species *e.g. Eucalyptus grandis* to the immediate biodiversity are similarly well known. Thus, while introductions of new genetic materials in a biological system may be desirable (McNeely, 1995), such measures need to be handled with extreme care especially when the genetic materials are of foreign origin.

Relentless use of destructive dry-season fires

Most forest fires in the Eastern Arc Mountains are started by people for reasons which include farming, hunting, protection, warming, rituals and fanaticism. Although in other countries like Zimbabwe where dry-season thunderstorms are reported to cause wildfires (Phillips, 1965; Komarek, 1971; Kielland-Lund, 1990) and potential of other causes like sparks of rolling stones and self-ignition of decaying organic materials exist, their roles in causing fires in the Eastern Arc Mountains is not ascertained.

Despite the fact that quantified information on the losses of Eastern Arc forest biodiversity caused by wildfires is not available, their contribution is, no doubt, significant. Fires on the Uluguru Mountains are burnt each year destroying extensive areas of vegetation. Nsolomo & Chamshama (1990) indicate that in the Mamboya Forest Reserve (455 ha) fire is scorching or killing four hectares of closed forest every fire-season and that only fire-resistant species remain. Due to the extended dry season in 1996/97, many hectares of closed montane forest in West Usambara Mountains, *e.g.* Shume Forest Reserve, were devastated by wildfires (personal observation). Nsolomo & Chamshama (1990) observe that fire damage to vegetation is of a higher magnitude than damage caused by pit-sawing or fuelwood and pole cutting. The problem of fires is a recurrent one and a permanent solution is still to be found. It remains a living challenge to effective biodiversity conservation.

SUGGESTED FUTURE MANAGEMENT STRATEGIES

An important point is that some of the material needs of the local people are strongly characterised by preferences for specific genetic characteristics or species, *e.g.* medicines, fruits, vegetables, and even fuelwood and building poles. These specific requirements cannot be met by general programmes like tree planting unless these specific needs are appropriately taken into account when selecting the plant species for the programme. It is a common observation, even in the highly wood-deficient zones in many parts of the country, that

although many trees were planted during afforestation campaigns and are growing around households, farms and woodlots and some of them are over-maturing, most people still walk long distances to seek more preferred fuelwood and building pole species from the woodlands and forests. Similarly, it is worth noting that many of the formal species preference survey techniques currently being used are too superficial and do not adequately provide for in-depth analysis of real life situations in the villages and households. We overplayed when selling to the people the miracle exotic tree technologies in our earlier afforestation campaigns and are now reaping the fruits of the people's imagination that we want to confirm their memory and knowledge about the miracle trees which we had earlier taught them!

Many ideas and concepts for enabling effective biodiversity conservation where the human environment is involved have been advanced, and some of them tried with varying degrees of success (Fairhead & Leach, 1995; IUCN, 1980; McNeely & Miller, 1984; Wilson, 1992). Wells (1995), however, observes that successful and convincing examples where local people's development needs have been effectively resolved with biodiversity conservation remains difficult to find.

The critical issue at hand is, obviously, not the dependency of the local communities on the local biodiversity they surround. It is, rather, whether supplying natural forest resources to an ever-growing local population can continue to be effectively reconciled with sustainable conservation of the already fragmented, highly depleted and degraded Eastern Arc forest biodiversity. Should our future conservation strategies directly focus on managing these remnants of forests (*in situ* conservation), or should we concentrate our collective efforts and resources on working with the people in the development of their farmlands into the main or the exclusive sources of the products sought from the forests, while the natural forests are left untouched or with limited human impact (*ex situ* conservation)? Surely under the conditions of the present and foreseen future pressures on the already engulfed, variously encroached and highly threatened remnant centres of biodiversity in the Eastern Arc Mountains, *in situ* conservation as a strategy alone seems to be too weak. It is being suggested in this paper that in the future efforts, the two strategies should go hand in hand but with the *ex situ* programmes taking the upper hand while paying special attention to:

- Precise determination of the various natural forest biodiversity based needs of the local communities that are sought from the centres of forest biodiversity.
- Identification of the preferred species for the various forest biodiversity-based community needs.
- Thorough ethno-botanical surveys of the biodiversity centres with a view to establish the availability and location of the species sought by communities.
- Programmes on germplasm retrieval of preferred species from the forest systems to develop appropriate propagation and management technologies for their domestication. Special and most urgent attention should be paid to the threatened endemics, particularly those being harvested destructively, *e.g.* uprooting or total removal of the aerial biomass.
- Develop and promote integrated and sustainable agro-forestry systems based on the identified forest biodiversity species that are needed by the communities.

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