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Biodiversity, conservation and development in Mkomazi Game Reserve, Tanzania

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ABSTRACT

Savanna woodlands and their associated species diversity and endemism are widely seen as declining through human impacts. Alternative views suggest that savanna ecosystems vary with a large number of biophysical factors, among which human impacts may be of relatively minor importance. This paper examines the debate with respect to Mkomazi Game Reserve in Northern Tanzania, where biodiversity has been inventoried and local resource use studied. It sets out the history of land use in Mkomazi and examines the available data on the area's plant, bird and invertebrate diversity. Comparative analysis is complicated by the paucity of data for other savannas in the same biogeographic zone, and by differences in sampling effort and methodology. Conservation literature and Tanzanian government documents present Mkomazi as one of the richest savannas in Africa, as a centre of endemism, and as threatened by deleterious impacts of human land use. Available data do not substantiate such statements. The paper examines implications of those perceptions for management, particularly eviction of resident pastoralists from the Reserve in 1988, and subsequent exclusion of reserve-adjacent dwellers. Conservation relies increasingly on reserve-adjacent people, and on prioritizing the allocation of scarce resources. There is an urgent need for rigorous studies of the implications of human land use in savannas, for better data on biodiversity, and for rigorous standards in the way those data are applied.

Key words. Savanna, biodiversity, conservation, development, land use, environmental degradation, fire, grazing, woodland-grassland dynamics, Africa.

INTRODUCTION

Savanna woodlands make up most of Africa's tropical and subtropical forest cover, but are widely thought to be declining rapidly under human impacts (Grainger, 1999). In addition to concern over the loss of woodland area, there is concern over the potential associated reduction of biodiversity, defined here as species richness together with level of endemism. Biogeographic vegetation classification avoids the term savanna as not being sufficiently specific (White, 1983; Davis *et al*., 1994) and as misapplied to woodland. Such classifications focus on vegetation habit, largely defined by woody plant height and canopy cover, as well as species, dividing savanna areas into woodland, bushland, bush grassland, wooded grassland and grassland (White, 1983; Davis *et al*., 1994). However, these areas are not so much heavily disturbed yet potentially stable climax formations, as systems driven between multiple alternative states by the random interplay of biophysical factors (Dublin, 1995). Changes through time, as well as spatial gradations, make boundaries between the vegetation formations associated with savanna woodland hard to define. The term 'savanna' is therefore used throughout the present paper to encompass the dynamic mosaic of wooded grassland, bushland and woodland, and to acknowledge the spatial, temporal and ecological continuities between these vegetation formations.

Savanna woodlands are relatively poorly known (Grainger, 1999), both in terms of their species diversity, and in terms of ecosystem processes of woodland production, decline, regeneration and response to disturbance. However, long-term studies suggest that fluctuations between relatively dense canopy and open grassland are common in East African savanna woodlands (Dublin, 1995). Savanna species are generally widely distributed in contrast to their forest counterparts (Davis *et al.* 1994; Stattersfield *et al.*, 1998). Savanna vegetation appears resilient, with individual plant species, communities and vegetation formations re-establishing themselves despite major fluctuations (Belsky, 1987; Dublin, 1995). Factors driving such disturbance include rainfall, fire frequency and intensity (Malaisse, 1978; Huston, 1994; Braithwaite, 1996), ground water table/salinity (Amboseli: Western & van Praet, 1973), grazer and browser population density (Serengeti: Pellew, 1983; Dublin, 1995), elephant impacts (Tsavo: Leuthold, 1977; van Wijngaarden, 1985; Leuthold, 1996), or a combination of all these (Anon, 1997).

Local land-use impacts, hitherto assumed to be deleterious to woodland formations and biodiversity, may often be negligible compared to the impact of nonanthropogenic factors (Western & van Praet, 1973; van Wijngaarden, 1985; Dublin, 1995; Hoffman *et al.,* 1995; Leuthold, 1996; Sullivan, 1998, 1999). Indigenous use of savanna woodlands may be highly destructive in some cases (Ribot, 1998). However, it is often based on considerable local expertise (Shepherd, 1992), and maintained at sustainable levels despite assumptions of degradation (Abbot & Homewood, in press). Local land use may even underpin regeneration and foster more habitat-diverse, species-rich communities that maintain important levels of endemism (Fairhead & Leach, 1996; Nyerges, 1996).

There is thus a variety of perspectives. There is the widely held perception that savannas are undergoing degradation, that savanna biodiversity is being lost, and that strict protection is needed (Kramer *et al.,* 1997; Coe *et al.*, 1999). However, processes of change may be characteristic of savanna ecosystems rather than symptomatic of degradation (Hoffman *et al.*, 1997). Savanna biodiversity is in part created and fostered by the dynamic mosaic that perturbations create (Davis *et al.*, 1994).

The debate is compounded by two further issues. First, with limited resources it is necessary to focus conservation efforts on priority areas (Leader-Williams & Albon, 1988). Second, conservation in Africa has been dominated by exclusion of people. Current political and economic realities, and awareness of the need and aspirations of rural African populations, make it necessary to enlist their support if conservation is to be sustainable (Kiss, 1990; IIED, 1994; Western & Wright, 1994). When evaluating conservation priorities, limited land use impacts must be weighed against the costs of exclusion to human welfare and livelihoods (Cernea, 1996; Ghimire & Pimbert, 1997; Brockington & Homewood, 1999; Brockington, 1998).

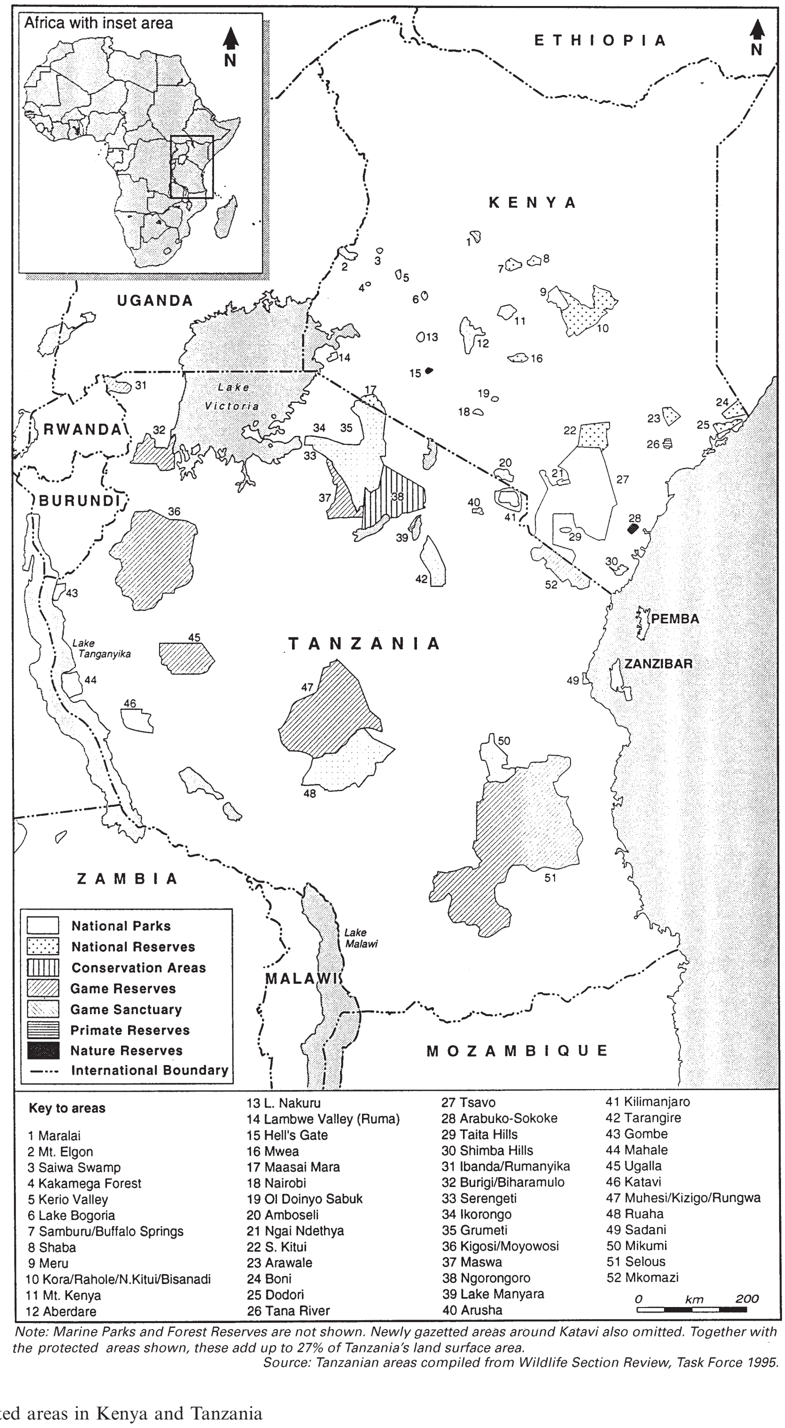
Savanna ecosystems are well represented in African protected area networks (Davis *et al.*, 1994). In Tanzania, very large tracts of savanna have been set aside for conservation, there are few resources to manage conservation areas effectively, and the rural populations are among the poorest in the world. Conflict and complementarity between conservation and development have become major issues in Ngorongoro (Homewood & Rodgers, 1991; Lane, 1996), Mkomazi (Rogers *et al.*, 1998), Selous (Neumann, 1997), and Tarangire (Igoe & Brockington, 1999; Fig. 1).

Mkomazi Game Reserve in Northern Tanzania was gazetted in 1951, but continued residence was allowed to some pastoralists (see below). In 1988, all residents were evicted after a history of increasing in-migration and growing conservation concern. Mkomazi has since been the site of a biodiversity inventory (Coe *et al.*, 1999). Past and present natural resource use by reserve-adjacent farmers (Kiwasila & Homewood, 1999) and herding groups (Brockington, 1998; Brockington & Homewood, 1999) was studied between 1994 and 1997.

This paper examines the way prevailing assumptions about degradation processes and concepts of biodiversity have been used at Mkomazi. Failure to test those assumptions may have undermined both conservation and local people's needs. The paper looks first at the biogeography and environmental history of Mkomazi. It outlines the development of human use of the area since it was gazetted, and of conservationists' concern. It uses current knowledge of species inventories to offer an assessment of Mkomazi's conservation importance relative to other savanna protected areas. These data are then used to consider the implications of past land use in Mkomazi. The paper asks whether conservation management by exclusion is justified on the basis of Mkomazi's biodiversity on the one hand, and the scale and importance of local land-use impacts on the other.

MKOMAZI: BIOGEOGRAPHY, ENVIRONMENTAL HISTORY AND BIODIVERSITY

Mkomazi is a 3200 km^2 savanna area stretching from the Kenya/Tanzania border to the north-eastern slopes of the Pare and Usambara mountains, between



Note: Marine Parks and Forest Reserves are not shown. Newly gazetted areas around Katavi also omitted. Together with the protected areas shown, these add up to 27% of Tanzania's land surface area.
Source: Tanzanian areas compiled from Wildlife Section Review, Task Force 1995.

Fig. 1. Protected areas in Kenya and Tanzania

latitudes 3°45′–4°30′ south and longitude 37°45′–38°45′ east (Figs 1 and 2). Mkomazi lies within the Somali-Maasai regional centre of endemism (RCE: White, 1983), where the dominant vegetation is Acacia-Commiphora bush, woodland and wooded grassland. There is scrub forest, both lowland and montane forest on the hills that rise within the Mkomazi Game Reserve to 1400 m a.s.l.. Mkomazi borders the Afromontane RCE, with the lowland and montane forests of the Usambaras recognized as an outstanding centre of plant diversity (Davis *et al*., 1994), an endemic bird area (Stattersfield *et al*., 1998) and a centre of endemism for many other taxa (Rodgers & Homewood, 1982). This 'dry border' ecotone position means that Mkomazi species richness may be enhanced not only by the presence of species primarily associated with the adjacent ecosystems, but also by divergent selection driving the evolution of new forms (cf. Smith *et al*., 1997).

Environmental history

Mkomazi forms a wet season dispersal area for the much larger Tsavo ecosystem (Figs 1 and 2). This area has low rainfall (Same: 566 mm/yr; Voi: 556 mm/yr) although rainfall can be locally higher close to hills (Kisiwani: 734 mm/yr; Mnazi: 782 mm/yr; see also Harris, 1972). There are few natural permanent sources of water in Mkomazi. It has long been used by a variety of people, ranging from Pare and Sambaa agropastoralists, Kamba hunters, to Il Parakuyo and Maasai pastoralists and agropastoralists (Brockington, 1998). The area has little land suitable for cultivation. There has been some settlement and farming on hills within Mkomazi, but the main uses have long been hunting and cattle grazing (Anderson, 1967; Brockington, 1998).

Some Il Parakuyo pastoralists resident within the Reserve in 1951 were allowed to stay and continue using Reserve resources after it was gazetted. Over the ensuing decades, Maasai, Pare, Sambaa and Kamba herders established close links with the Parakuyo and negotiated access to Mkomazi resources. In the 1950s and 1960s a number of dams were built in the western part of the Reserve by the Division of Wildlife to improve water availability for wildlife. Pastoralists and agropastoralists resident within and around the Reserve eventually negotiated access to both these water points and to the grazing in the west (Brockington, 1998).

There are important contrasts between livestock population trends in the eastern and western parts of Mkomazi before and after 1970. Until 1970 there was a sizeable and increasing cattle population around the eastern half of the Reserve, but numbers were low in the west (Brockington, 1998). In 1970 there was a rapid influx of livestock into the west of Mkomazi. The first formal ground count, in 1978, reveals its extent. Cattle numbers in the west rose rapidly to nearly 40,000 by 1978 (Table 1).

The large numbers of livestock in the Reserve caused concern for conservationists for much of the Reserve's existence because domestic animals were perceived to be deleterious to Mkomazi's vegetation and large mammal populations. In the 1960s, there were a number of calls for the eviction of local users from the east of the Reserve, and for environmental rehabilitation (Anderson, 1967). These were not heeded. In the 1980s, following the use of the west of the Reserve by herders, there was mounting pressure from the Wildlife Division to remove all livestock keepers. This resulted in the final exclusion of pastoralists in 1988 (Brockington, 1998; Rogers *et al*., 1998).

Mkomazi has been widely presented as undergoing ecological degradation prior to the 1988 evictions, and recovery since them (e.g. Sembony, 1988; Mangubuli, 1991; Watson, 1991). Data to confirm or refute that claim are as yet unavailable. Currently, intensive work on remotely sensed images dating back to the 1970s is in progress to assess the actual trends in vegetation formations and species diversity before and since evictions took place (Packer *et al*., 1999). Preliminary analyses have been reported elsewhere (Cox, 1994, cited in Brockington & Homewood, 1999), but there are serious problems with the reliability of this analysis. The work was carried out by hand on a single pair of images from 1975 and 1987, with limited opportunity for ground-truthing. The 1975 image is of poor quality. Nonetheless, the results are of heuristic interest, if only in generating hypotheses that current, more detailed work should test.

The preliminary satellite data analyses cover the western half of the Reserve, which was the focus of heavy influx, and bracket the period of rapid increase in people and cattle and the time of heaviest anthropogenic impact. Most categories of vegetation show small decreases, arguably within the range of measurement error. However, these are balanced by a measurable (20%) increase in savanna woodland (defined as > 40% woody canopy cover), particularly at the expense of less dense woodland (20–40% canopy cover). This runs counter to changes expected on the basis of human impacts of cutting and clearing

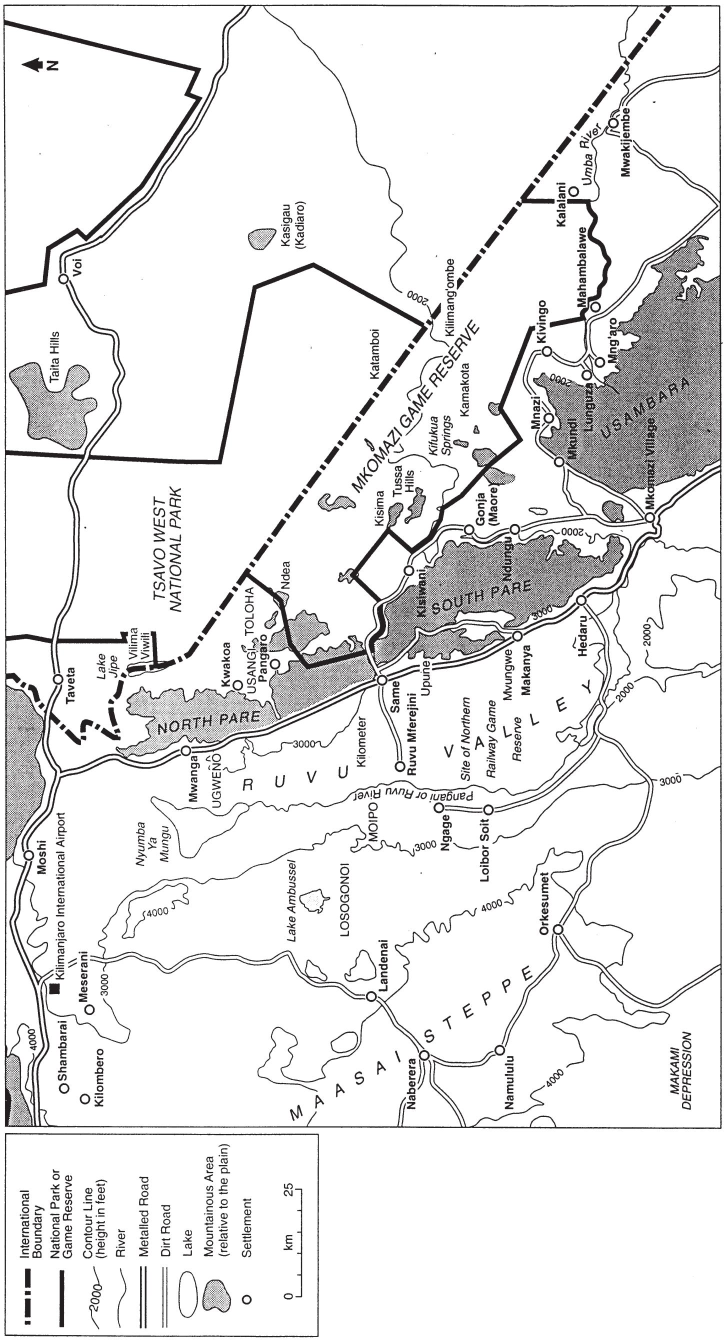


Fig. 2. The location of Mkomazi Game Reserve

Table 1. Cattle numbers around Mkomazi

Year	East (Lushoto District)	West (Same District)	Total
1960	21,984	No data, probably not more than 15,000*	21,984 + ?*
1967	45,245	no data, probably not more than 15,000*	45,245 + ?*
1978	28,218	39,539	67,758
1984	48,233	39,977	88,210

Data are taken from District level livestock census data compiled from official ground censuses referring to livestock based in Reserve-adjacent villages as well as in homesteads within the Reserve itself. Reserve-adjacent villages are defined as all those in immediately Reserve-adjacent wards. It is not possible to be precise about the proportions of these herds using the Reserve at any one time, nor the proportion of their time spent within it. The figures, therefore, give a relative estimate of livestock numbers using pastures within and adjacent to the Reserve. These are total counts, not samples and therefore there are no confidence limits that can be set around them. For further detail on methodology see Brockington (1998), Brockington & Homewood (1998).
*Harris (1972) carried out intensive ground observations during 1970 and recorded negligible numbers in the Same part of Mkomazi. Circumstantial evidence from other sources supports this. Parker & Archer (1970) give a map of livestock distribution showing them as absent from most of the Same part of Mkomazi and environs. There was no official record of or concern over pastoralism in the Same part of Mkomazi and environs during this period. By contrast it was an active issue in and around east Mkomazi.

woodland. It is not consistent with changes as a result of heavy grazing and burning, which would be expected to stimulate the spread of low bush and shrub at the expense of grassland.

The change suggested by the preliminary analysis is consistent with parallel changes observed in the Tsavo East and West National Parks, continuous with Mkomazi and constituting most of the Tsavo ecosystem of which Mkomazi is part. As for elsewhere in East Africa (Laws *et al*., 1975), high densities of elephants destroyed trees throughout Tsavo in the 1960s. In the 1970s, Tsavo elephant populations crashed under the twin impacts of severe drought and a continent-wide escalation of poaching. They have been slow to recover. Throughout the late 1970s and 1980s, woodlands regenerated across Tsavo in the absence of elephant impacts (van Wijngaarden, 1985; Leuthold, 1996). Mkomazi's elephant population showed the same pattern of collapse from *c.* 3000 to fewer than 100 in the 1980s (Watson *et al*., 1969; Huish *et al.* 1993). This is perhaps not surprising, as the Tsavo/Mkomazi elephant populations move freely across the border. Vegetation changes suggested by the preliminary analysis in Mkomazi for the period 1975–87 are more consistent with recovery of woodland in response to changing elephant density, than with impacts of local land use. Evaluation of vegetation change in Mkomazi and consequent management recommendations should consider these changes in the broader ecosystem as well as events specific to the Reserve.

It is possible that the rise in cattle numbers during the 1970s was associated with temporary denudation of heavily used areas, and with the regrowth of unpalatable woody species ('bush encroachment'). Pastoralists within the reserve, as well as reserve-adjacent populations, may have set early dry season fires and used woody vegetation for fuel and construction. However, pastoralist and agropastoralist populations typically show low levels of woody vegetation use for fuel and for construction (Barnes *et al.,* 1984; Chamshama *et al.,* 1997). Reliable quantitative evidence for trends in woodland extent in Mkomazi pre- and posteviction must await more detailed remote sensing studies, and even then attribution to specific driving factors will be speculative.

Biodiversity in Mkomazi

Species diversity has been recorded for a number of taxa in Mkomazi (Coe *et al*., 1999). Mkomazi was anticipated to be 'one of the richest savannas in Africa, and possibly the world' for plants, birds and insects (Coe & Stone, 1995:1). African savannas are indeed species rich, suggesting their long-continued presence through recent geological past (Davis *et al*., 1994).

To some extent, existing species lists (Coe *et al*., 1999) can be used to evaluate the diversity of Mkomazi in global, regional, national and local contexts. However, there are a number of limitations on the comparisons that can be made. Data are incomplete, and for most taxa are not available in a form which allows direct comparison of sampling effort with that of other savanna areas within the Somali-Maasai phytochorion. It is not possible reliably to estimate likely species richness for the majority of taxa investigated in Mkomazi, let alone make comparisons which require good species distribution and sampling effort data (cf. Prendergast *et al*., 1993). It is also difficult to derive meaningful species-area curves for species in savanna protected areas, because unlike forests, savanna protected area habitats merge seamlessly with surrounding rangelands. Species-area curves reflect the area of the ecosystem available to the species population, rather than the area demarcated by the administrative boundaries of the park or reserve (see Western & Ssemakula, 1981). This paper therefore limits discussion to putting Mkomazi species richness in biogeographic context, rather than developing analyses that available data cannot support.

On the basis of White's analysis of African phytochoria and regional centres of endemism (White, 1983; Davis *et al*., 1994), Mkomazi would be expected to have plant diversity consistent with the Somali-Maasai RCE, moderated by species-area relations, by topographic/habitat diversity, and by climate (O'Brien, 1998). The Somali-Maasai RCE is listed as having an overall extent of $1.9 \times 106\,km^2$, with 4500 vascular plant species, of which 1250 are endemic (31% endemism), including two endemic families and fifty endemic genera (Davis *et al*., 1994). This is on a par with the Zambezian RCE in terms of plant diversity ($3.7 \times 106\,km^2$, with 8500 vascular plant species, of which 54% are endemic). It is considerably less than the Karoo-Namib RCE ($0.7 \times 106\,km^2$, with > 7000 vascular plant species, of which 35–50% are endemic, including one endemic family and 160 endemic genera). It does not begin to approach the diversity of the Afromontane forests ($0.7 \times 106\,km^2$, with 4000 vascular plant species of which 75% are endemic, including two endemic families and 200 endemic genera: Davis *et al*., 1994).

Although White (1983) lists the Serengeti as a detailed case of the Somali-Maasai RCE, exemplifying the Acacia-Commiphora vegetation formation, Davis *et al*. (1994) list only Somali sites as special centres of plant diversity. Centres of plant diversity are defined as first order sites of global importance, having in excess of 1000 vascular plant species of which $> 10\%$ are endemic either to the site or to the phytogeographical region, with at least some being strict site endemics. Mkomazi has in excess of 1000 vascular plant species, but the proportion of endemics (and particularly site endemics) appears low (Vollesen *et al*., 1999). Current data suggest that Mkomazi, while species-rich, has no globally or regionally special plant diversity status within the Somali-Maasai RCE, nor in the array of African savanna protected areas, whether in the Somali-Maasai phytogeographic region or in other RCEs (data in Coe *et al*., 1999). There is certainly good reason to believe that the Mkomazi flora is more diverse than the much drier Tsavo East (Table 2). Although the species known to date for Mkomazi, and the extrapolations made on the basis of those known species, suggest a greater species richness than for the small but rich Kora and Meru areas (Table 2), this does not allow for the differences in sampling intensity, in methodology, nor in completeness of coverage of different component habitat types for the different areas. Mkomazi's national importance needs to be assessed in terms of its complementarity with other Tanzanian savanna protected areas, particularly the Serengeti. Currently available data on species richness, endemism, and sampling effort are not enough to allow this.

Analogous to the identification of centres of plant diversity, there has been a concerted effort to identify areas of outstanding bird species richness and endemism (Stattersfield *et al*., 1998). Endemic bird areas (EBAs) are defined as areas which encompass the overlapping breeding ranges of restricted-range bird species, such that the complete ranges of two or more restricted range species are entirely included within the boundary of the EBA. Savannas are less likely to host site-endemic bird species than are forests. Only 8% of EBAs worldwide are savannas, and of the twenty-three African EBAs only the Juba-Shebelle valley is savanna (Stattersfield *et al*., 1998). The Usambara mountain forests adjacent to Mkomazi are listed as an extremely important EBA (Stattersfield *et al*., 1998), but Mkomazi itself has no site-endemic bird species. Mkomazi's 402 bird species are mostly widespread in East African savannas (75%), and include many birds of passage (Lack, 1999). Six species known from further north are not recorded from elsewhere in Tanzania.

Lack (1999) has carried out preliminary analyses of bird species richness in relation to sampling effort. As far as bird diversity is concerned, Mkomazi is potentially of importance in a Tanzanian context, but it is not of regional or global importance. Other protected savanna areas are equally rich. As for Mkomazi, their records include birds of passage as well as resident breeding populations. The $428\,km^2$ of arid savanna comprising the Samburu-Buffalo Springs-Shaba Reserve complex in Kenya has 369 bird species (Williams *et al.* 1981). The $3810\,km^2$ of the Amboseli National Park and reserve has 459 bird species

Table 2. Comparison of vascular plant species numbers for Mkomazi with other East African dryland areas

Site	Area (km^2)	Numbers of species observed	Reference
Mkomazi	3,400	1,148	K.Vollesen 31.5.98 working plant list and pers. com; Coe *et al*. (1999)
Tsavo East	13,000	937	Greenway (1969)
Kora	1,788	717*	Kabuye *et al*. (1986)
Meru	870	605	Ament & Gillett (1975), Gillett (1983)

*The main survey was carried out during two months, in July September 1983, with further sporadic collections up to 1986 (Coe & Collins, 1986). This represents a lesser sampling effort than that made in Mkomazi, but plant sampling effort is not quantifiable for any of the areas listed.

(Williams *et al*., 1981). Lake Baringo in the Rift Valley is an inland drainage area with wetlands extending over a few score km^2, surrounded by arid rangeland. At least 458 bird species are known from this small area, including wetland, dry rangeland and Acacia woodland species (Hartley, 1986). Like Mkomazi, these bird-diverse East African savannas owe their richness in part to their position on ecotones, to the proximity of other centres of habitat diversity and endemism, and to the fact that they are continuous with a much wider extent of savanna habitat than is enclosed by their administrative boundaries. The areas are not subjected to a more sophisticated analysis here, because they are not directly comparable in terms of habitat diversity, ecotones, or water availability, nor are the data available in a form that allows informative comparison of richness for sampling effort.

Problems of commensurability are perhaps best illustrated by the data collected on spiders and insects. Few savanna areas have been investigated with the intensity directed at Mkomazi, which limits the possibilities for legitimate comparison. The Mkomazi study of savanna tree canopy arthropods 'represents the biggest single study of savanna tree canopies ever undertaken' (Kruger & McGavin, 1997; Russell-Smith *et al*., 1997: 39). This study collected an estimated 0.5 million specimens from 266 trees, the runner-up being a 1980s study of Kora National Reserve, which collected 6742 specimens from forty-nine tree canopies. The huge difference in the relative numbers of specimens collected is not thought to be an indication of Mkomazi's special biodiversity so much as sampling effort (Russell-Smith *et al*., 1997:39). Part of this study is reported in Kruger & McGavin (1997), who analyse the results from 41,099 insect specimens from thirty-one tree canopies of six *Acacia* species. They identified fourteen orders, 133 families and 492 recognizable taxonomic units (RTUs), of which 121 were Hemiptera and 113 Coleoptera. RTUs are based on morphotyping rather than identification to species level: this gives a conservative estimate of richness and also the only one practicable given the numbers of specimens involved. Kruger & McGavin (1997) estimate that this sample represents 77% of the true richness averaged across orders, but that for Diptera the sample has only captured around 50% of true richness. Again, Mkomazi is clearly species-rich, but given the lack of comparable sampling elsewhere, it is premature to infer that Mkomazi's arthropod biodiversity outranks that of other (little studied) sub-Saharan savannas.

As well as the insect diversity in tree canopies, a series of workers in Mkomazi have evaluated species richness for sampling effort for arachnids, ants, cicadas, lacewings, beetles, butterflies, fig wasps, hanging flies, robber flies, and ants. The results are set out in detail elsewhere (Coe *et al*., 1999). As with tree canopy invertebrates, it is difficult to make valid comparisons when assessing spider diversity. Mkomazi has greater spider diversity than the Etosha National Park in Namibia, which has a different rainfall regime:

> 'it is not possible . . . to say to what extent [the greater spider species diversity in Mkomazi is] . . . to be attributed to climatic differences between the two areas or to historical or biogeographical factors'

(Russell-Smith *et al*., 1997:19)

Spider species numbers at Mkomazi remain uncertain, as does the degree of endemism:

> 'If the average proportion of undescribed species . . . [for two of the larger families of spider species in Mkomazi] . . . (38%) were applied to all the families from Mkomazi, the fauna would include 168 new species. However, given the high level of synonymy known to exist in African spiders, a more conservative proportion of 25% is probably more

realistic, giving a total of 110 undescribed species.' 'Relatively few spider families in Africa are sufficiently well known that the distribution of their species can be mapped with any reliability . . . for two of the larger families from Mkomazi . . . a relatively high proportion (43–63%) of all species have a poorly known distribution as they have been either recorded only from the type locality or from very few sites.'

(Russell-Smith *et al*., 1997:20)

As far as insect taxa are concerned, detailed results are as yet available only for the fig wasps. Over and above background levels of fig wasp and host fig tree species richness typical for savanna, there is one rare host fig tree species present in Mkomazi. This has an exceptionally high associated fig wasp species richness. Butterflies, cicadas, lacewings and hangingflies were only surveyed on an opportunistic basis, but further surveys of all these insect groups are expected to show species richness comparable to, or greater than, various South African and Zambian savannas (Van Noort & Compton, 1999). However, the possibility for legitimate comparison in relation to sampling effort with savannas from the same biogeographic zone remains limited (data in Coe *et al*., 1999).

ROLE OF BIODIVERSITY IN CONSERVATION PLANNING

The assertions about the wealth of Mkomazi's biodiversity have centred on plant, bird and insect species, and this paper focuses on those taxa. Mkomazi is not outstanding for the richness or endemism of its mammal, amphibian or reptile taxa, but no special status has been claimed for the area on the basis of these groups and they are not considered here.

Mkomazi emerges as species-rich for plants and birds, but not outstanding in global or regional terms. It is difficult to assess relative conservation value in terms of invertebrate diversity because even the more rigorous analyses available can make only limited comparisons with other African savannas, particularly within the same biogeographic zone (Coe *et al*., 1999). There is often poor congruence in species richness for plants, birds and insects between different sites (e.g. Howard *et al*., 1998). Rigorous evaluation of Mkomazi's national conservation value to Tanzania awaits more data, and more detailed analysis of any complementarity between Mkomazi and better-protected, larger, biogeographically-related savanna conservation areas such as the Serengeti (cf. Howard *et al*., 1998).

A consideration of the Reserve's natural conservation value must also consider it in terms of the extent of Protected Areas in Tanzania. Currently, 27% of the country lies within Game Reserves, National Parks and Forest Reserves (Wildlife Sector Review Task Force, 1995), in all of which human habitation is forbidden. This is a large area of land (Fig. 2), considerably more than the 10% recommendation made by the IUCN (IUCN, 1992). Where resources to fund conservation are limited it may be necessary to be selective about the level of protection that can be afforded for all these areas. However, considerations of the absolute amounts of land involved will contribute little to site-specific disputes between the different interest groups who may disagree as to what constitutes important variation, and as to what therefore merits conservation. For example, fund-raising for conservation (and revenue from wildlife tourism) often centres on large mammals, birds and vascular plants: invertebrate taxa generally stimulate less popular interest. Local people may place less value on spider or beetle biodiversity than on, say, the retention of a rare bird species of symbolic importance (Kandeh & Richards, 1996). Usambara communities value plant biodiversity highly, but recognize primarily the wide range of plant species which they use, rather than those species for which they have no use (Kessey, 1998).

Conservation in Africa has been dominated by exclusion of people from resource use and decision making in protected areas. Current political and economic realities, and awareness of the needs and aspirations of rural African populations, make it clear this may not be optimal management policy, however, attractive to hardline conservationists (e.g. Kramer *et al*., 1997; Struhsaker, 1998). It is necessary to plan the allocation of finite conservation resources, and to enlist the support of local communities if conservation is to be ecologically, economically and socially sustainable (Leader-Williams & Albon, 1988; Kiss, 1990; Davis *et al*., 1994; IIED, 1994; Western & Wright, 1994). Where exclusion causes impoverishment, its desirability, from both a practical and an ethical perspective, needs to be questioned (Brockington, 1998; Brockington & Homewood, 1999).

Furthermore, it should be recognized that there are problems with making statements about the effect of people on biodiversity, where there is no baseline against which to judge present levels of biodiversity in Mkomazi, and thus past trends. Eviction was justified on the grounds of land use threats to Mkomazi's biological value. Given the considerable costs to welfare and livelihoods of local communities (Brockington, 1998; Brockington & Homewood, 1999), it would be more desirable to find some compromise that was less damaging to the local economy. It is also, both for managers and researchers, important to understand more clearly the implications of prevailing forms of local land use for habitat and biodiversity. This is particularly the case for potentially conservation-compatible forms of land use such as the grazing and burning associated with pastoralism.

To date, no evidence has been put forward to substantiate pre-eviction anthropogenic degradation in Mkomazi, despite repeated assertions about such degradation and its uncritical acceptance as the basis of management policy (Sembony, 1988; Mangubuli, 1991; Coe & Stone, 1995; M.N.R.T., 1997). The role of anthropogenic impacts in savanna and other rangeland change remains poorly understood, but is increasingly thought to be less deleterious than has been assumed (e.g. South Africa: Hoffman *et al*., 1995; Namibia: Sullivan, 1998, 1999). Fairhead & Leach (1996) have suggested that forest patches in Guineen drylands are fostered by village land use. Harvesting coppicing species such as *Bridelia micrantha* (Hochst.) Baill. potentially creates and maintains a patchy habitat without threatening its survival (Nyerges, 1996). Studies of savanna woodland/grassland dynamics, and of the factors underpinning biodiversity, do not suggest that local land use threatens Mkomazi's biodiversity. Pasture management by grazing and burning, and moderate use of dry forest species for fuel and construction purposes, arguably have a role in creating and maintaining savanna species richness. Excluding grazing and controlled burning may allow the accumulation of dry matter triggering damaging, hot, late dry season fires. At the very least, the case of Mkomazi makes clear the urgent need for rigorous studies leading to a better understanding of land use impacts.

CONCLUSIONS

Biodiversity in Mkomazi appears altogether more modest, and more centred on invertebrates, than has been suggested in the conservation literature and in Tanzanian government documents (e.g. Coe & Stone, 1995; M.N.R.T., 1997). Mkomazi is species rich, but it cannot be said to be one of the richest savannas in Africa and possibly the world (Coe & Stone, 1995: 1). Yet this is the conclusion presented to, and taken up by government and other agencies responsible for the allocation of scarce resources in conservation planning for Tanzania in general, and for management in Mkomazi in particular. Tanzanian government planners have taken this conclusion to mean that Mkomazi is a 'centre of endemism', that it is the 'richest area in Tanzania in terms of rare and endemic fauna and flora', and to imply that Mkomazi has 'more European-African bird migrants than any other site in Tanzania' (M.N.R.T., 1997: 16–18). Together with 'crisis talk' about degradation resulting from human land use, these misstatements encourage management focusing on exclusion and enforcement.

Mkomazi holds a rich and diverse ecosystem. However, the Reserve's importance for conservation needs to be thought about carefully. There are a number of pitfalls in the way in which the assessment of species richness and endemism has been used in Mkomazi for making statements about conservation values and suspected degradation. Where data on environmental change and trends in biodiversity are absent, then prevailing assumptions and concerns are not reliable substitutes as the basis of management decisions.

The way in which biodiversity values have been interpreted and presented for Mkomazi in the past is not consistent with available data evaluated in comparative context. In some cases, where claims of outstanding species richness and endemism are based on comparisons between areas that have been investigated in detail with areas that have not been subject to similar research, neither comparisons nor conclusions as to relative value are legitimate. Prevailing assumptions about the deleterious effects of human land use in Mkomazi are not substantiated by evidence. The documentation of high biodiversity values within a few years of allegedly environmentally damaging levels of use by local people also begs questions as to the real impacts of indigenous communities on species richness and endemism. It is possible, though not demonstrable, that preuse biodiversity levels may have been even higher. Alternatively, recovery has been remarkably rapid, in which case levels of local resource use perceived by outsiders as deleterious do not in fact threaten the ecosystem in the long term. Finally, it is possible that indigenous land use in Mkomazi may actively maintain and foster high species richness and endemism. Savanna woodlands are inherently variable, factors other than human agency drive transitions between multiple alternative states, and transitions may foster and maintain, rather than degrade savanna structure and biodiversity.

Unsubstantiated claims over comparative biodiversity do not justify setting aside local user rights in a country like Tanzania, where over 25% of the land is conservation estate, where the rural population is poor and vulnerable, and where incompatibility of local land use with biodiversity conservation is assumed but not demonstrated. Current understanding of the importance of providing practical benefits from Protected Areas underlines the need for rigorous work on land use impacts, and for equally rigorous standards in the way biodiversity is catalogued, interpreted and used in savanna woodland cases such as Mkomazi.

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