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Land Use Histories and Fuelwood Consumption in a Highly Populated and Degraded Area in Nkhata Bay District, Malawi

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Abstract The main objective of this study was to describe the land use histories as a major determining factor in landscape change in Chindozwa village in Nkhata Bay district, Malawi, Africa, based on interviews with the local people. Four land use patterns were recognized: cultivated area (namely slush and burn agriculture field), fallow area, grassland, and residential area. Six main vegetation types were also recognized: garden dominated by cassava, shrub vegetation, grassland, middle forest and tall forest are found in the village. *Miombo* woodland is found in the forest reserve near the village. The severity of human pressure, which is due to increasing population, was judged by a number of indicators. These included the amount of time women spend in collecting firewood and distance covered, size of firewood, the crop yield, the duration of the fallow period, the extent of forest cover in the area and the availability of other natural resources. There is a general increase in the area for slash and burn agriculture and a decrease in the fallow period in accordance with the increasing population. As a result the productivity of the land seem to be decreasing and forest resources also have declined in the past ten years, suggesting severe human pressure.

Key words: human pressure, land use, landscape ecology, disturbance, degradation, fuelwood, high population.

Malawi is endowed with vast amounts of natural resources including forestry resources covering almost 40% of the land area, water resources (dominated by lake Malawi) covering almost 20% of the total territorial area, mineral resources, energy resources and some of the most fertile soils for agricultural use in southern Africa. These resources, if properly utilized, can support sustainable development of the country. However, these resources are currently challenged by a complex interaction of several factors. Malawi's National Environmental Action Plan (NEAP) lists several factors, some of which are high dependency of the economy on agriculture, which encroaches on forested land, poverty, high population growth of 3.2% per annum and depletion of forestry resources due to wood extraction for fuel (Government of Malawi, 1994). Most of the Malawi's landscape has therefore been degraded due to high population growth exerting pressure on the natural resources in various ecosystems.

Forestry resources are vital to Malawi as a source of energy (accounting for 90% of the country's energy consumption) to a large percentage of the population (Ministry of Energy and Mining, 1997). They also maintain biodiversity in both terrestrial and aquatic environments, and stabilize catchments, which in turn minimize siltation of lakes and rivers. The increasing demand for land for crop production and growing demand for wood fuel makes sustainable management of forest resources an almost impossible task. In addition the increasing incidences of wildfires in forests has resulted

in serious environmental consequences.

With an intercensal population increase of 17% between 1987 and 1998 (National Statistial Office, 1998), it is expected that the land use pattern and history, vegetation cover and general landscape in the country and in particular Chindozwa which is the study area will also change from the edge of Lake Malawi to the top of the hill and beyond.

Located in the southernmost basin in the African Great Rift Lake systems, Lake Malawi contains the most diverse community of freshwater fishes in the world (Abbot, 1996). It has approximately a perimeter of 12,667 km (Desanker *et al.*, 1995) of which about half is in Malawi and the rest in Tanzania and Mozambique.

Lake Malawi is important to the country because it is the largest body of surface water, but it also provides up to 60% of fish, that accounts for up to 70% of annual animal protein intake by the population. Other uses include tourism, lake transport and is also the main reservoir of water used in hydropower generation along the Shire river. Hydropower is the main source of electricity in the country.

Because of the importance of the lake, there is need for proper management of its catchment area. A catchment approach to management of the lake may not be possible considering the vast area involved. Of immediate attention in terms of management, however, is the shore area (aquatic-terrestrial ecotone or land-water ecotone). An ecotone is defined as a zone of transition between adjacent ecological systems, having a set of characteristics uniquely defined by space and time scales and by the strength of the interactions between adjacent ecological systems (Holland, 1988; Petts, 1990). Land-water ecotones play a number of functions including reducing flood effects, natural filters of diffuse pollution from the floodplain, source or organic carbon for aquatic ecosystems, connection lines for special fluxes (Pinay *et al.*, 1990), indicators of hydroclimatic change (Petts, 1990), harbouring of rich assembly of species, and can be used to test new ecological ideas (Risser, 1990). Considering the importance of the ecotone in not only of satisfying life cycle needs of many organisms, but also as the immediate catchment area for lake Malawi, this study was initiated.

Apart from the work done by Abbot (1996), and two other vegetation studies undertaken within the Lake Malawi National Park documenting serious woodland degradation attributed to fuelwood harvesting by the local communities around the park (Abbot, 1996), no other detailed studies have been conducted to determine the consequences of human pressure on vegetation and landscape along the shore area of lake Malawi.

Landscape ecology focuses on the structure, function and changes in landscapes and on ecological consequences of landscape heterogeneity (Forman and Godron, 1986). The concept of landscape involves the interrelationship between nature and humans (Naveh and Lieberman, 1993). Heterogeneity in landscape can be caused by natural or anthropogenic disturbances. Anthropogenic disturbances include agricultural and forestry activities which in turn depend on socio-economical environments (Kamada *et al.*, 1991). In a human dominated region, anthropogenic factors are more prominent force altering landscape structure than natural disturbances (Kamada and Nakagoshi, 1996).

The study aimed at describing the land use histories as a major determining factor in landscape change of the lake Malawi ecotone in relation to human pressure in Chindozwa area in Nkhata Bay district. The long perspective is to predict the future land use pattern and consequently vegetation cover and possibility of putting up a conservation strategy for the area to ensure sustainable development.

Study Site

The study area that measures 3 km by 5 km, is located in Chindozwa village in Traditional Authority Mkumbira north of Nkhata Bay district center along Lake Malawi (Fig. 1). The area is highly degraded due to over reliance on firewood for cooking. According to the coarse scale (1 : 250000) Land Cover Map (Satellitbild, 1993) and the land use map from the Ministry of Agriculture (Ministry of

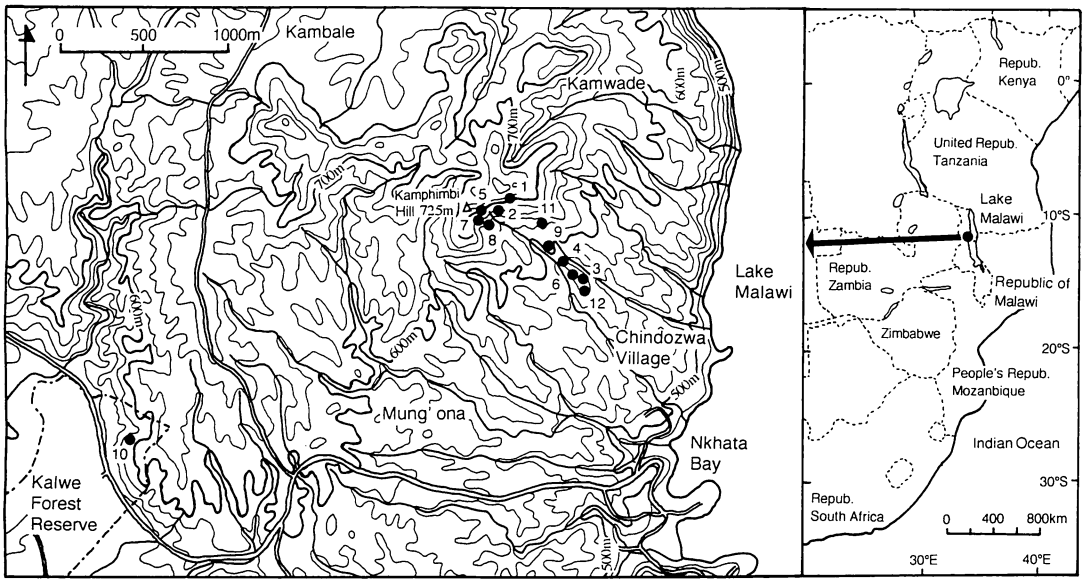

Fig. 1. Location of the study site. Number means plot number.

Agriculture, 1989), the study area is characterized by soil type X3r5/X4r5 (laterite soil) and Kamphimbi hill with semi-evergreen woodland dominated by *Brachystegia spiciformis* and *Erythrophloeum* species. The land below the hill to the lake edge is supposed to be utilized for cassava, maize, bananas, groundnuts, finger millet, sweet potatoes and mangos. At present, however, most of such natural vegetation and some crops are no longer there due to high human pressure.

Method

Literature search was carried out before going to the field to decide on the sampling area and number of samples. Land cover maps (1 : 250000) published by the Forestry Department of the Ministry of Forestry and Natural Resources (now called Natural Resources and Environmental Affairs) and the land use maps produced by the Ministry of Agriculture were used to identify the initial situation. Population data from the National statistical office was obtained to get population data of the study area for 1966, 1987 and 1998.

A preliminary field survey was carried out for three days in July 1999 to tentatively identify the vegetation types. Permission was also sought from the chief of the village to work in his area.

Main survey was carried out in August 1999. A total of twelve plots were set in gardens, fallows and forested areas (Fig. 1) in all the land use types for identifying vegetation structure. Plot number 10 was established in a protected area (Kalwe Forest Reserve), which is mainly *miombo* woodland. Miombo is a vernacular word that has been adopted by ecologists to describe those woodland ecosystems dominated by trees in the genera *Brachystegia, Julbernardia* and *Isobernia* of the family *Leguminosae* and subfamily *Caesalpiniaceae* (Wild and Fernandes, 1967; Campbell, 1996). Tree species composition was recorded and diameter of trunks at 1.3 meter height were measured for all trees present in each plot.

The owner of the area of interest was then identified and interviewed. For each area/plot, a number of parameters to determine the land use history were collected. The parameters included location, the vegetation type, human impact, former land use, fallow period if any at all, first cultivated year, number of people in a household depending on the particular area, crop yield ten years ago and present, common tree species, incidence of fire, and number of gardens per household/family.

Volume of different species collected as firewood was determined from measure-

ments of the length and diameters of all collected wood pieces in a headload. Days taken to utilize one headload and frequency per week of collecting wood were also determined for each household. Species names of trees used as firewood, their total volume in all twenty-two households were obtained and percentage accumulation of wood consumption worked out.

Interviews were also held with the local traditional doctor and local people to find out what plant species are used for medicinal purposes.

For each area, severity of human impact was determined by the evidence of fire, tree cutting, general vegetation cover, crop yield and presence of footpaths.

Results

1. Population growth

The population in Nkhata Bay district has increased from 83,911 in 1966 to 138,381 in 1987 and 171,134 in 1998 (Department of Census and Statistics, 1966; National Statistical Office, 1995, 1998; Fig. 2). The population in Traditional Authority (TA) Mkumbira where Chindozwa is located has increased from 6,784 in 1966 to 12,949 in 1987 and 17,014 in 1998. The average population density in the district is currently estimated at 21 in 1966, 34 in 1987 and 42 in 1998 persons per square kilometer. The density in TA Mkumbira has increased from 73 in 1966 to 139 in 1987 and 183 persons per square kilometer in 1998. Population density is extreamly high in TA Mkumbira, because this area is the center of Nkhata Bay district.

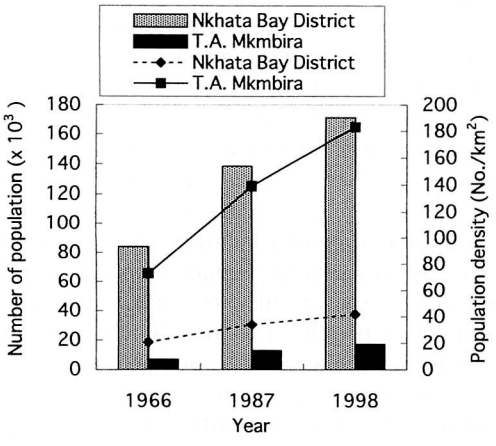

Fig. 2. Population growth (column) and density (line) in Nkhata Bay district and T.A. Mkumbira.

2. Land ownership system and vegetation cover

Three land tenure systems exist in Malawi, namely, private, public (controlled by the government) and customary. The land in the area is customary and therefore it is the responsibility of the village headman to divide it to the people. Currently all the land including the hill which is the main source of wood products has been divided amongst the families of three villages, Mung'ona, Kamwade, Kambale villages (Fig. 1). In 1986 Kamphimbi hill was divided by Traditional Authority Mkumbira (overall chief overseeing several villages) and shared amongst three village headmen (village headman Mung'ona on the eastern side, village headman Kamwade on the northern side of the hill and village headman Kambale on the western side). Mung'ona village where this study was focused has the biggest area of the hill.

Table 1 summarizes the general information about the land use. Children inherit land from parents. Shifting cultivation is still practiced in this area. The vegetation is cut and burnt to open up a new garden. After cultivating for about 5 years the land is left to fallow and a new area is cut and burnt for cultivation. Fallow period is usually 5 years. On average each household owns three gardens and there are on average ten people per household. Cassava is the main food crop of the area. In this area, patches of good forest were only found in the graveyards where people are not allowed to cut trees. All villagers respect the graveyards. Only dead wood is collected but is used by the grave diggers only when there is a funeral.

Interviews with the local elderly people indicated that up to the early 1980s the vegetation cover was very thick. With the division of the hill in 1986, control was difficult and people started cutting down the trees carelessly. When it was realized that many trees had been cut, it was agreed amongst the three village headmen through the Traditional Authority in consultation with the

Table 1. General information about land use around the surveyed plots. NA, no answer; *, owned by the same owner; **, shared with the owner; ***, measured by the number of cassava mounds to fill a bag of cassava or a basket full of flour.

Lacation	Village	Village	Village	Village	Bottom of hill	Bottom of hill	Hill	Hill	Hill	Hill	Hill	Kaluwe Forest Reserve
Plot No.	Plot 4	Plot 12	Plot 6	Plot 3	Plot 9	Plot 11	Plot 8	Plot 7	Plot 1	Plot 2	Plot 5	Plot 10
Owner	K. Mhone	M. Phiri	A. Nyirenda	Malipa	V. Manda	P. B. Munthali	A. Banda	Banda	S. Kondowe	M. Kondowe	Y. Phiri	Government
Year of first cultivation	1958	NA; inherited from parents	NA; inherited	1962	NA; inherited from parents	1964	1965; by parents	NA; inherited from uncle	1986	NA; inherited	NA; inherited	Not cultivated
Former land use	Fallow (1994–1998)	Cassava garden	Cassava garden	Cassava garden	Forest (last cultivation was in 1983)	Cassava garden	Fallow (from 1965 to 1996?)	Cassava garden	Cassava garden	Cassava garden	Cassava garden	Miombo forest (not cultivated)
Year of land use changed	1999	1993	1993	1994	1983	1996	1997	1997	1994	1987	NA	Not changed
Present land use	Cassava garden	Fallow (shrub)	Fallow (shrub)	Fallow (middle forest)	Grassland for 16 years	Fallow (shrub)	Cassava garden	Fallow (shrub)	Fallow (middle forest)	Fallow (middle forest)	Fallow (tall forest)	Miombo forest
Age of the current land use	0	6	6	5	16	3	2	2	5	12	>20	?
Burning at the garden	No	No	No	No	No	No	No	No	No	No	No	—
Burning at the fallow	Every year	Every year	Every year	Every year	Every year	Every year	Every year from 1992	Every year	Every year	Every year	Every year	—
Notes for land use history	—	Owner left 1997 and at that time not has cultivated.	—	—	Trees just cut to give room to grass.	1964–1966: garden 1966–1982: fallow 1982–1996: garden	—	—	—	—	Usually cultivated for 5 years and left 10 years fallows.	—
Additional number of gardens*	1	—	2	2	3	1	3; These were started to cultivate in 1995.	2	1	2	1; It is started to cutivate in 1998.	—
Number of fallow areas**	2	1	2	1	1/2 uncultivated	2	1	1	1	1	4	—
Number of people sharing meal**	22	5	5	7	7	12	14	Communal eating (sleep=6)	13	12	6	—
Crop yield (mounds/1 bag)***												
10 years ago	4	3–5	5–10	NA	6	NA	3	3	5	5	10	—
present	15	10–20	50	NA	15	NA	10	15–20	10–20	20		—

Forestry Department that some bluegum (*Eucalyptus* spp.) should be planted on the top of the hill. The agreement was that people could cut trees and pay their respective village headmen. The money would be used for development activities in the villages.

It was also pointed out that the coming of multiparty in 1994 worsened the situation because people thought they are free to do anything even just cutting trees anyhow. It was also found that the expansion of the hospital contributed to the increased deforestation. Many women who were guardians of patients access the forest or buy the wood from the forest for cooking and this has increased deforestation.

It was also learnt that another factor that led to massive cutting down of trees at Kamphimbi hill was the outbreak of cassava disease "*kodikodi*" (Cassava mealy bug) in 1984 in the lower parts of Chindozwa area. This forced many people to abandon their gardens and open up new ones on the hill.

The forest and fallows are burnt once every year in Chindozwa area. People have always burnt the bush ever since and the reason is that they want to clear the old vegetation and give room to new shoots to come up when the rains start. Gardens occasionally get fire accidentally but this is very rare because people make sure that the gardens are weeded to prevent fire from spreading. This is one of reason of degradation of the forest.

3. Natural resources and their usage

1) Species composition in different land use types

Four main land uses are found in the village area: garden, grassland, fallow and residential area. Five main vegetation types were recognized in these land uses: cassava garden, grassland, shrub, middle forest and tall forest. Miombo woodland is found in the forest reserve near the village.

Table 2 shows the species composition in the plots; total basal area (cm^2) is given for each species. Fifty-nine woody plant species are found in the plots. Some species are common and found in most of the vegetation types while as others were found only in certain vegetation types. Common species include *Dalbergia nitidula, Diplorynchus condyrocarpon, Julbernardia globiflora, Brachystegia bussei* and *Strynchnos madagascariensis.* While as *Vitex domiana* and *Brachystegia microphyla* were only found in the garden, *Ficus sycononis* and *Ochna macrocalyx* in the grassland; *Memechylon flavoviscens, Cassia abbreviata* and *Crossopteryx febrifuga* in the middle forest; *Faure saligna, Securidaca longipedunculata* and *Hetromopha trifoliate* in the tall forest; *Crytosopalum maraviense, Ochna leptoclada, Pleurostylia capensis, Mangifera indica* and *Ficus sur* in the shrub vegetation. Kalwe forest reserve contained the highest number of species that were found only there. These were *Artabotrys monteiroae, Bridal micrantha, Catunarega spinosa, Erythroxylon emarginatum, Euclea shimperi, Garania buchananii, Hoslundia opposita, Ixora schefferi, Keeta gueinzii, Psychotria kirki, Rhus longipes, Uapaca sansibarica* and *Ximenia caffra.*

2) Fuelwood

Wood is the main source of energy in the area. It is used for domestic purposes on open fires in a three stone hearths as well as used in fish smoking. Almost all firewood is collected by women and girls from the fallow areas or the forest on the hill. Very occasionally one finds a man carrying a log on his shoulder. Girls as young as ten years (Fig. 3a), assist in wood collection. Women have therefore less time for other activities. Girls too have less time at school. Interviews with local people indicated that very few girls ever go to secondary school. They usually marry at an early stage (around 19 years).

In terms of the distance traveled by women, this has generally increased because the initial source, which was the nearby forest, has now been converted into gardens. Some wood is collected from fallow area but the sizes are very small as compared to those obtained from the tall forest (Fig. 3b). People prefer to pile wood at their homes than collecting it when needed (Fig. 4). The piled wood is also used during certain seasons like rainy season when it is not easy to walk in the forest. Normally this is fresh wood and they leave it to dry in the sun.

Table 3 shows the amount of collected fuelwood and its consumption pattern in Chi-

Table 2. Tree species composition and basal area (cm^2) in various vegetation types.

	Plot 4	Plot 12	Plot 6	Plot 3	Plot 9	Plot 11	Plot 8	Plot 7	Plot 1	Plot 2	Plot 5	Plot 10
Location	Village	Village	Village	Village	Bottom of hill	Bottom of hill	Hill	Hill	Hill	Hill	Hill	Forest reserve
Vegetation type	Garden	Shrub	Shrub	Mid. forest	Grass-land	Shrub	Garden	Shrub	Mid. forest	Mid. forest	Tall forest	Miombo forest
Quadrat size (m^2)	10×10	10×10	10×10	10×10	10×10	10×10	10×10	10×10	10×10	10×10	10×10	20×20
Species name												
Dalbergia nitidula	+	5.96	6.51	2.91		4.09	+	2.60	17.24	0.20	6.60	74.98
Diplorynchus condyrocarpon	+		26.64	12.93	+	24.02	+	+	143.22	117.52	98.65	790.37
Julbernardia globiflora	+	13.42	24.25	26.66	4.61	18.97			13.91	0.13	1.52	2193.43
Brachystegia bussei		7.78		23.96		9.62	+	177.80	408.24	435.12	879.11	
Brachystegia manga	+	8.88	199.66	185.05					51.89	0.95	0.28	
Brachystegia boehmii	+	11.90	56.00	45.24						0.64	63.38	
Strychnos madagascariensis	+	0.28	33.93	9.93	+		+	6.77				
Rothmannia englerana			+		+	+	+	+				10.17
Combretum molle	+				3.46		+		5.72			
Multidentia crassa	+			4.80		1.77		+				+
Ochna schweinfurthiana	+			4.46	+	8.04	+					
Pericopsis angolensis	+	4.42		+		46.61		2.54			+	
Lannea discolor		2.27			+	+						3.46
Brackenridgea zanquebarica		0.07		1.25	0.38	+						+
Psorospermum febrifugum	+	0.07	+				+					22.03
Brachystegia spiciformis	+	1.77		+								5136.20
Annona senegalensis	+		0.95									4.93
Bridelia cathartica				+			+	+	38.20	+		6.60
Diospyros kirkii		7.26	+	+				+				51.57
Margaritaria discoidea		+				+	+		7.45			53.59
Eriosema ellipticum			1.84	35.64							4.68	1.05
Psychotria eminiana				+			+	0.38				+
Brachystegia glaucescens									50.74			4500.50
Ozoroa insignis					+						0.64	2.01
Pseudolachnostylis maprouneifolia						95.25					62.75	+
Uapaca nitida						+						14.23
Vernonia colorata	+											6.60
Vitex doniana	+											
Brachystegia microphyla	+											
Antidesma venosum		+										
Cryptosepalum maraviense		+										
Ochna leptoclada		+										
Droogmansia pteropus			0.50									
Adenodolichos punctatus			0.20									
Crossopteryx febrifuga				67.94								
Ficus sycomorus					0.48							
Ochna macrocalyx					0.70							
Ficus sur						+						
Mangifera indica						+						
Parinari curatellifolia						383.75						+
Pleurostylia capemsis						3.46						
Cassia abbreviata									22.87			
Memechylon flavovirens										0.28		
Securidaca longipedunculata											166.97	
Faurea saligna											463.62	
Heteromorpha trifoliata											0.20	
Artabotrys monteiroae												2.98
Bridelia micrantha												0.76
Catunaregam spinosa												+
Erythroxylum emarginatum												17.87
Euclea schimperi												16.60
Garcinia buchananii												+
Hoslundia opposita												+
Ixora scheffleri												1.50
Keetia gueinzii												7.69
Psychotria kirkii												+
Rhus longipes												63.59
Uapaca sansibarica												1.13
Ximenia caffra												4.91
Total basal area (cm^2)	+	64.08	350.48	420.77	9.62	595.58	+	190.10	759.49	554.83	1748.40	12988.75

+, occurred but less than 1.3 m in height.

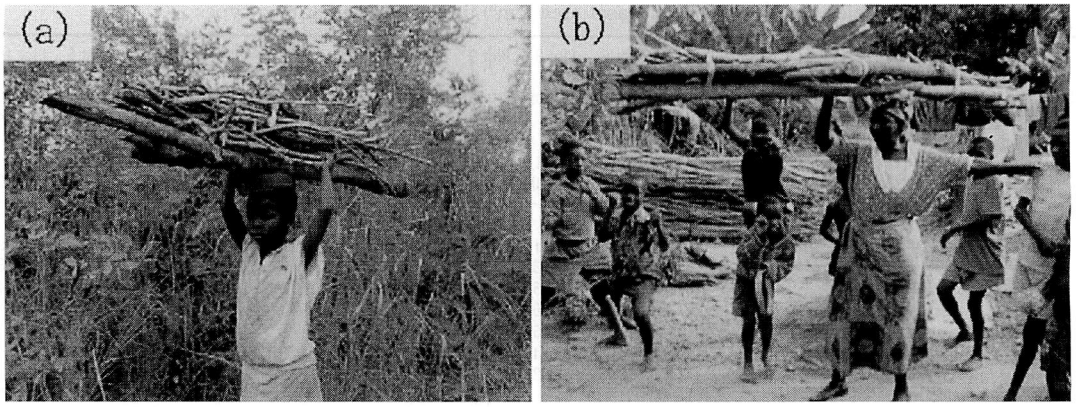

Fig. 3. Collected fuelwood. a, girl carrying twigs collected for fuelwood; b, woman carrying a headload collected from Kamphimbi Hill.

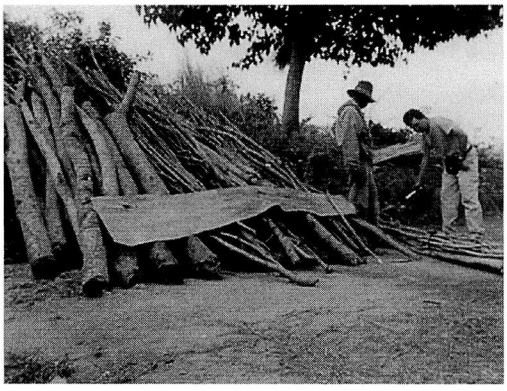

Fig. 4. Firewood piled and left to sun dry for future use.

ndozwa. In general for an average headload, it takes 4 to 5 days to finish. Frequency of collecting firewood is on average twice per week. An average household consumes 11.9 $\times 10^3$ cm^3 of wood per day in Chindozwa. Although the relationship between household size and fuel consumption was weak, the amount of wood used for cooking increased in accordance with the increase of household size (Fig. 5-a). However, the amount of wood per person per day is in inverse propoprtion to decreased in accordance with the increase of the household size (Fig. 5-b).

A headload consists of wood pieces from several tree species. It was found that women prefer the indigenous tree species for cooking than the exotic species such as *Pinus* sp. or *Eucalyptus* spp. because the former take long to finish. Table 4 shows the species that collected for firewood in the 10 households, and the percentage accumulation of wood consumed. It was discovered that common species preferred as firewood are *Brachystegia bussei, Julbernardiaa globiflora* and *Brachystegia manga.* Other species are least preferred for fuelwood.

The forest resources in Chindozwa area not only provide firewood to the residents of the village but also to the guardians of patients at Nkhata Bay district hospital (Fig. 6). Although the wood from the hospital was not quantified, observation at the hospital's cooking area clearly shows that the hospital contributes a sizeable impact on the forest.

Other products extracted from the forest include ropes, fruits, mushrooms and very few people get medicine.

3) Traditional medicine

A few plant species are used for medicinal purposes although the scope of this survey did not allow documentation of many different plant species. Plants used range from those treating barrenness in both men and women, snake bite, ringworm and other skin diseases, headache and kidney disease. Species for charms like luck and love portions are also found. For simple illness people collect their own plants for self treatment and for more complex ones they consult traditional doctors. It was pointed out that people come from as far as Likoma Island on Lake Malawi and ask for permission from the

Table 3. Patterns of fuelwood consumption by 19 households in Chindizwa area.

Household No.	Volume ($\times 10^3$ cm^3)	Persons in a household (No.)	Days for consumption (Days)	Amount of consumption	
				/person/day ($\times 10^3$ cm^3)	/household/day ($\times 10^3$ cm^3)
2	39.9	11	5	0.7	8
3	38.8	5	3	2.6	12.9
4	45.7	5	4	2.3	11.4
5	20.8	7	4	0.7	5.2
6	26	4	4	1.6	6.5
7	32.6	*	4	*	8.2
8	17.6	*	4	*	4.4
9	29.6	*	4	*	7.4
10	21.1	*	4	*	5.3
13	45.5	7	3	2.2	15.2
14	58.6	27	3	0.7	19.5
15	52.6	12	4	1.1	13.1
16	40.6	7	2	2.9	20.3
17	38.9	*	3.5	*	11.1
18	40.8	*	7	*	5.8
19	52.7	*	7	*	7.5
20	113.4	22	3.5	1.5	32.4
21	61.6	6	4	2.6	15.4
22	51	4	3	4.2	17
Mean	43.6	9.8	4	1.9	11.9
S.D.	21.2	7.4	1.2	1.1	7

* Data is not available.

village headman to collect medicinal plants.

The people were not willing to disclose which tree species were used for specific diseases. Medicinal plant species used include Msolo (*Pseudolachnostylis maprouneifolia*), Mkaku (*Schrebera alata*), Chitimbe (*Bauhinia thonningii*), Mkuyu (*Ficus sycomorus*), Msimbiti (*Ozoroa* sp.), Nthula (*Solanum panduriforme*), Mazaye (*Strychnos spinosa*), Kachekenji for acute stomachache, Chimbuyafwi, Ntchefu, Mzakaka, and Ntcheti-Thundu. It was pointed out by some people that some medicinal trees are not found in the area like Zobala wa Chingoni and Muwawani (*Cassia* sp.) but are needed and if possible ways must be found of bringing them to the area.

Four medicinal tree species (*Pseudolachnostylis maprouneifolia, Ficus sycomorus, Ozora* sp. and *Cassia* sp.) were recorded in the plots we studied. It is likely that other medicinal plants species are found in the non-sampled areas. Although a few medicinal plants are found in the area, most people indicated that they prefer going to the hospital rather than using these medicinal plants these days because the hospital is nearby.

4) Wild animals

From the interviews, the only wild animal species now found in the area are monkeys, birds and very rarely wild pigs. Twenty years ago wild pigs, leopards and bushbucks were plentiful. The number of species and individuals of wild animals are considered to decrease due to the degradation of the forest.

4. Crop Yield

The main crop grown in the area like other lakeshore areas is cassava. Very little maize (which is the main staple food for the rest of the country) is grown. In 1998/99 growing season, maize production slightly increased because people received free maize seed and fertilizer from the government. Other crops include vegetables along the streams and riverbanks, sugarcane, bananas, sweet potatoes and some fruit trees grown around the

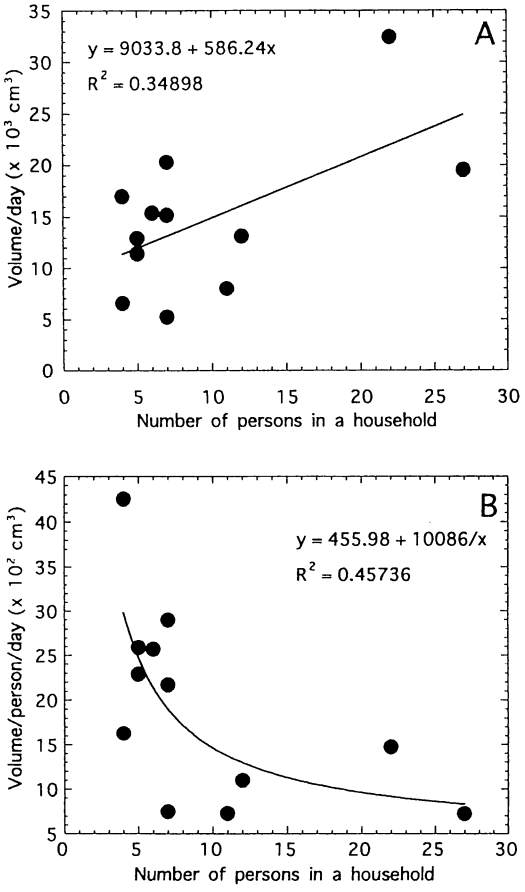

Fig. 5. Relationship between the number of person in a household and the amount of wood consumed in a day (A) and the amount of wood consumed per person in a day (B).

homesteads. Millet and sorghum were grown in the area but are no longer grown now.

Cassava is grown on soil mounds that are approximately half a meter high and round shaped with an average diameter of one meter. On each mound about 5 stems are planted. It takes one year for the cassava root to be ready for harvesting. The young leaves are prepared into a delicious vegetable dish. Once the cassava has been harvested, the gardens are immediately replanted.

The harvested cassava root is peeled and soaked in clay pots (Fig. 7) and 5 days later when it becomes soft it is washed and dried on mats. Later when dry, the cassava is ground into flour by the women (Fig. 8). The flour is cooked into '*nsima*' and eaten with fish, meat, vegetables, peas, beans or any other relish as necessary.

People used to harvest a lot of cassava from a small piece of land in the early days. It would take 3 to 5 average cassava mounds to fill a bag of cassava or a basket full of flour. Now it takes about 10 to 20 mounds as shown in Table 1. For an average family of 5 this flour takes about 5 days. So harvesting is done at least once every week. Most of the times therefore, women in Chindozwa spend time either in the garden or preparing the cassava flour apart from collecting firewood.

Table 4. Composition of woody species collected for firewood. Original data set is the same as Table 3.

Species	Volume ($\times 10^3$ cm^3)	Relative abandance (%)	Percentage accumulation (%)
Brachystegia bussei	546.7	39.8	39.8
Julbernardia globiflora	331.1	24.1	63.9
Brachystegia manga	246.4	17.9	81.8
Diplorhynchus condylocarpon	59.3	4.3	86.2
Brachystegia boehmii	57.8	4.2	90.4
Pericopsis angolensis	54.4	4.0	94.3
Combretum molle	35.3	2.6	96.9
Tremor orientalis	17.2	1.2	98.1
Dalbergia nitidula	12.6	0.9	99.1
Parinari curatelifolia	11.1	0.8	99.9
Strychnos madagascalensis	1.1	0.1	100.0
Annona senegalensis	0.6	0.0	100.0
Total	1373.7	100.0	100.0

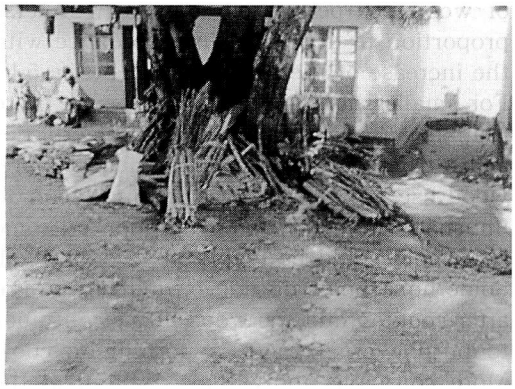

Fig. 6. Firewood used for cooking by guardians of patients at Nkhata Bay district hospital.

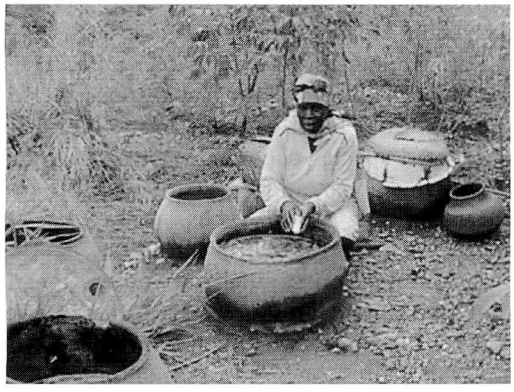

Fig. 7. Clay pots for soaking cassava.

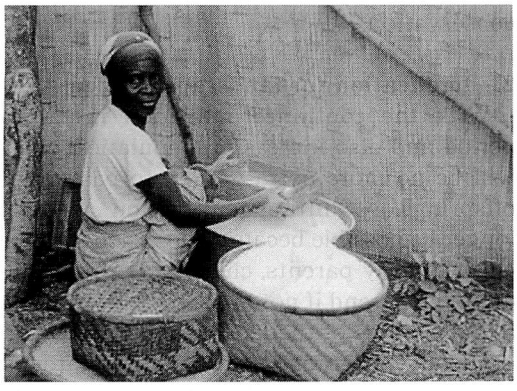

Fig. 8. An average basketful of cassava flour enough for 5 days for a household of 5 people.

Discussion

1. Fuelwood consumption

Wood is the main source of energy for cooking in Chindozwa like many parts of the country because many rural people are poor and can only afford to use firewood that is cheaply obtained from the forests. Other sources of energy are expensive for the rural majority to afford. People prefer to use indigenous tree species to exotic species like *Eucalyptus* spp. Because wood from indigenous tree species is believed by the local people to produce bright and long-lasting flames. The three preferred species as shown in Table 4 are also amongst the common species found in the area. These species are also the dominant miombo woodland species. Even looking at the next preferred species again the miombo species are preferred. Abbot and Lowore (1999) indicate that in Chimaliro forest in Mzimba district, people prefer to use *Julbernardia paniculata, Combretum apiculatum, Acacia amythethophylla, Combretum molle* and *Pericopsis angolensis* for fuelwood. In Zimbabwe, *Julbernadia globiflora, Colophospermum mopane* and *Brachystegia boehmii* were said to be the most frequently used species for fuelwood (Grundy *et al.*, 1992). All of them are common species in miombo forest.

It is widely recognized that in most African societies women are the main collectors of firewood for domestic use (FRIM, 1995; Abbot and Lowore, 1999) and in Chindozwa area this is no exception. Abbot and Mace (1999) found that women of Chembe village in Mangochi district, which is also a lakeshore village collect wood every 4 days. Similarly, women and girls collect wood every 5 days in Chindozwa area.

Traditionally women have collected dead wood that is easier to pick and also lighter to carry. In Chindozwa area, because of intensive collection, the dead wood from naturally falling branches or dead trees is no longer available. Consequently people resort to cutting live trees or branches for firewood. Where dry wood is collected, normally this would be from trees that had been cut previously for other purposes. In addition, both young and old trees are cut for firewood in Chindozwa area. Elsewhere, however, like in Chimaliro forest in Mzimba district, Abbot and Lowore (1999) showed that people were more selective in choosing sizes and type of

firewood. With a population density of 183 persons per square kilometer in Chindozwa, competition for firewood is high. People have very little chance to choose. Where the population density is low, it is possible to be more selective in firewood collection because there is adequate wood.

Continued extraction of these trees in Chindozwa in a non-selective manner means that eventually all miombo species will be wiped out if no proper management plan is put in place. This will then transform the whole landscape from one of miombo woodland to a shrub or grassland. Consequently the whole landscape will be affected. Some species will be lost in the process. Indeed, the 1989 Land use map of the Ministry of Agriculture classifies this area as dominated by *Brachystegia spiciformis* and *Erythrophloeum* species. The local people did not mention the latter to be in the area and the former only found in the village part of the study area and the forest reserve. This means that it is almost eliminated in the fallow and forested land on the hill and bottom of the hill. It was also pointed out that initially the land was covered with thick forest cover. People would collect firewoods which belong to preferred species for fuel in the climax forest. It would be expected that species that are now not preferred for firewood will remain and dominant even in the protected area. Climax vegetation would change to disturbed forest. However, with continued deforestation and no reforestation of the cut trees, even those species that are not currently preferred, will be used as firewood in the near future if nothing is done to manage them.

An average household consumes 11.9×10^3 cm^3 (Table 3) of wood per day. Abbot (1996) reported that the household size is independent of the amount of wood consumed. However, the amount of firewood consumed may be expected to increase with the increase in household size. In Chindozwa, the amount of wood used for cooking slightly increased in accordance with the increase of household size (Fig. 5-a). The number of person in two households was high; 22 and 27 persons were using the same fuelwood. These were the cases in that the parents, children and their families decided to eat together. The amount of wood per person per day is in inverse proportion to decreased in accordance with the increase of the household size (Fig. 5-b). For smaller households that consume more than the expected average, other activities apart from domestic cooking demand firewood use. The other contributing factor to unusually high wood consumption by some household could be inefficient use of wood. Some households do not extinguish the fire after cooking and the wood hence continues to burn even if there is nothing to cook. More conscious individuals extinguish the fire and reuse the wood for future use. From the interviews with the local people these include brick burning, fish smoking, selling wood for cash and demand from the hospital. Both small and big trees were cut and both live and dead trees were collected.

Forest and fallow burning does not pause a serious problem to the forest resources. It is the slash and burn that is destructive. Fire intolerant species such as *Brachystegia spiciformis* disappear and only fire tolerant species such as *Diplorhynchus condylocarpon* remain (Abbot, 1996; Frost, 1996).

A combination of all these factors means that the human pressure on the forestry resources in Chindozwa area is very high. This study indicates the importance of forest products to the area and immediate surrounding (e.g. hospital). Future management should therefore aim at reconciling local needs and conservation.

2. Implication for landscape change

With the continued reduction in fallow period and also increasing population, there will be no more extra garden to pass on to offsprings. Shifting cultivation will no longer be possible because all gardens will be cultivated by parents, children or grandchildren. This trend if not managed will result in a total change of the landscape from a heterogeneous one to one dominated by gardens. It can be predicted that with the current pattern of deforestation and population increase the vegetation cover of Chindozwa area will be lost in the coming years if no conservation measures area employed. The landscape is expected to change from that with four classes (garden, residential, fallow

and forest) to that which is dominated by residential and garden only. Most tree species will therefore be lost except for a few mango trees and other domesticated fruits dotted around the landscape.

The continued reduction in fallow period affects crop yield. Cassava is currently the main food crop. The average number of cassava mounds, which were required to fill a basket full of flour, increased 3 to 5 in 10 years ago to 10 to 20 in the present. This means larger area should be used to get crop yield than before. In addition woman would have to spend almost all their time cultivating, harvesting, processing cassava and cooking.

No inorganic fertilizer is applied to cassava. With the decrease in rotation years, and continued decline in crop yield, it may no longer be feasible to grow cassava in the area. People may have to resort to growing other crops that will require inputs like fertilizer and pesticides to have a good harvest. Application of inorganic fertilizer in turn would increase chemical pollution in the lake and affect fish production, which is the main source of protein for people in the area. This would mean a complete change in the eating life style of the people who have for generations relied on cassava. Many people indicated that they are poor and if such crops are introduced and the fish production goes down, it could mean serious nutritional problems in the area.

In terms of the decline in crop yield organic fertilizer should be encouraged. These can be made from the cassava peeling, and leaves and other organic material. Technologies such as vermiculture could also be a way of increasing the productivity of the land. Vermiculture is a technology that uses earthworms, organic material and ecobacterial to produce organic manure or fertilizer (Bhawalkar, 1998 pers. comm.). This can be done by anyone in the area. People would just need to have the initial vermiculture.

Currently people still get other products like medicine, fruits, and wood for domestic implements from the forest. If all trees are cut these will have to be bought or collected from Kalwe forest reserve and all ailments will have to be referred to the hospital even simple ones. Encroachment for these products and also firewood on Kalwe forest reserve will therefore be inevitable.

The implication of deforestation in the area is that there is a lot of run off into the streams and eventually Lake Malawi. Erosion of soil into the water bodies causes siltation and may affect the ecology of the lake especially in fish breeding areas. Fish production which is already declining may further be affected and thus affect the main source of income for people in the area. For fishermen, fish catch was plentiful long time ago but now the catch has also declined drastically. Twenty years ago the village headman would catch fish and share for free to all villagers. This is no longer the case.

3. Efforts for conservation of the landscape

The government, non-governmental organizations, private sector and some individuals have initiated considerable effort in order to minimize degradation of the forestry resources. Forestry research has been conducted mainly by the Forestry Research Institute of Malawi in the various areas. Other studies include the land cover survey (Satellitbild, 1993) and a land use map in 1989 (Ministry of Agriculture, 1989).

The landscape structure is greatly influenced by anthropogenic factors in Chindozwa area. These are agriculture expansion and firewood extraction caused by an increase in human population. The study has shown that human pressure is severe near the village and less in the hill. Since land is fixed, there is need to manage both human and natural resources in this area so that crop yield does not continue to decline, energy is available for domestic cooking and also the ecosystem balance is maintained.

Population growth can be controlled through public education in collaboration with the Ministry of Health or other related organizations. Appropriate and affordable alternative sources of energy like electricity, biogass, solar should be explored and encouraged. But since most people are poor, firewood will remain the main source of energy. It is therefore important that a continuous supply of wood energy is maintained

in Chindozwa area. This can be achieved through a number of ways.

Most people do not favor growing of exotic fast growing trees like *Eucalyptus* spp. if the main purpose is firewood. People are prepared to invest their time in growing species for other purposes and not firewood. Multipurpose indigenous trees should therefore be planted in the area. Planting of indigenous agroforestry trees in line with cassava crop needs to be explored. The department of Forestry, the University of Malawi and the International Centre for Research in Agroforestry (ICRAF) in collaboration with the community should be involved in this exercise. These trees would add nutrients to the soil and also provide firewood and/or fruits to the community. People should be encouraged to grow other fast growing tree species around their homesteads for building materials, firewood and other purposes like fruit. Research should be encouraged into those indigenous multipurpose trees that are fast growing.

Other energy saving technologies of cooking should be explored and made known to the people. This would greatly reduce pressure on the forest but also the time women spend collecting wood. Hence they would have more time for engaging in other activities like income generating and girls would spend more time at school.

Because of high population in the area, spare land may not be available for woodlots or buffer zones. Although it would be difficult to reserve part of the forest for conservation purposes, since the whole area has been already divided to the people, it is very important that the ecologically important parts of the catchment like banks of the stream, top of the hills be conserved. One way of achieving this would be through consultations with the chief and local communities to find out which pieces of land need to be preserved. Once this is achieved, all people whose gardens or fallow lands are within these areas should be compensated in kind by re-allocation of land. It was discovered during the survey that some owners of the land, like plot 12 had permanently left the area (left in 1997). People get old and die and may not have any descendants to pass on land to. In such cases, land is under the control of the village headman and he can use such land for compensation.

In conclusion this study has shown how important the forest products are to the people of the area. The study also indicates how land use histories can influence the landscape. Management should therefore aim at reconciling local needs and conservation.

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カタベイ地方（マラウイ共和国）の人口密集地域における土地利用変化と燃料木消費様式

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カタベイ地方（アフリカ，マラウイ共和国）のチンドズワ村における土地利用の変化を，住民への聞き取りをもとに記載し，景観変化の方向性について考察した．カタベイ地方は，マラウィ国の中でも人口が密集し，かつ人口増加率も高い農・漁村であり，森林からの木材資源の収奪量や森林から畑地への転換率が特に

大きいと思われる地域である．当村における土地利用型は，耕作地（主に焼畑），休耕地，草地，居住地の4型にまとめられた．それらを構成する植生型としてはキャッサバ畑，イネ科草本が優占する草地，退行したミオンボ林としての低木林，中木林，高木林が認められた．よく保存されたミオンボ林は村内にはなく，村近くの森林保護区で確認された．燃料木採取に費やす時間，採取場所，その他の自然資源の利用，キャッサバの収量の年変化，焼畑耕作後の休閑期間の変化，森林面積の変化等に関する聞き取り結果や，集められた燃料木の種やサイズ，人口増加に関する統計資料等を指標とした土地への人為圧強度との関係から，これら土地利用型や植生型の分布や土地利用システムの変化を次のようにまとめた．すなわち，人口増加に伴い焼畑面積が増加し，あわせて休閑期間が減少した．結果として，森林面積が減少するとともに，過去10年間で耕作地の生産性は低下した．なお，村人が燃料として採取していたのは，主にミオンボ林を特徴付ける *Brachystegea bussei, B. manga* および *Julbernardia globiflora* の3種であり，これらは休閑地に成立する群落の構成種であった．したがって，人口が増加する中で現状のまま木材資源の利用が続けば，当地のミオンボ林の劣化や，森林面積のますますの減少は避けられないと思われる．