Household Energy Demand and its Challenges for Forest Management in the Kakamega Area, Western Kenya

Research

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Abstract

The presented study investigated the energy demand of a sample of 201 households adjacent to Kakamega Forest. The aim of the study focused on the evaluation of possible threats to the forest under the scenario that the local population continues to heavily use Kakamega Forest, disregarding the restrictions posed by national law. The data collected serves as a base for an estimate of the potential demand on forest resources and as a resource for developing management strategies. Sooner or later the demand for energy and plant material by an ever increasing population needs to be satisfied, and the only easily available resource is Kakamega Forest, in particular in an environment without industrial and commercial benefits.

This study showed that the demand for energy is still very high, and that legal restrictions do not protect forests from over-use and destruction. The current restrictions prevent the population from understanding the need to protect the forest. This results in disinterest in protection efforts, even though there is high interest and efforts in protection of common goods. The early awareness of these conditions could protect natural forests from being destroyed, and help to sustainably manage them.

Introduction

Wood is the most important energy source for domestic use for Kenya, a country without oil resources. Woody species have a high economic importance as sources of fuel-wood and charcoal, as timber and veneer, as well as sources of traditional medicine. The bark of *Prunus africana* (Hook. f.) Kalkman for example yields a high potential cancer remedy (Ishani 2000, Santa 2003, Stewart 2003, Strong 2004), and is so over-exploited that the species is now listed on CITES Appendix II as endangered.

The trade in tree products is only allowed from plantation sources, and the use of forest trees is generally restricted. Extraction of forest products is only permitted for domestic use and only outside conservation areas. Logging, even in national parks, however, is still a common practice. The fact that logging occurs close to forest stations and settlements leads to the assumption that there is either little concern about the severity of these activities by the administration, or there is direct involvement by the officials in charge (Vanleeuwe *et al*. 2003).

Generally, most communities are very concerned about the destruction of forests, but poverty forces people to over-use the forest as a vital resource. The remaining areas with high forest cover are under high pressure, because in the surrounding areas the population density is often extremely high. Recent studies show a constantly increasing demand for wood products (KIFCON 1994c, Kigomo 2001). The Kenya Forestry Master Plan calls for an increase of 70% of wood fuel production in the next 15 years (KFMP 1994, Mbuga 2002). Taking into account that Kenya suffers from a continuous loss of forest cover, one of the major challenges to the government is the in-

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Ethnobotany Research & Applications 6:363-371 (2008)

Published November 15, 2008

www.ethnobotanyjournal.org/vol6/i1547-3465-06-363.pdf

troduction of powerful management concepts to prevent forests from disappearing (KIFCON 1994c, Nyang 1999). These concepts however must not keep people out of the forest. On the contrary, the population needs to be involved in the planning and decision making process. To develop useful strategies the potential demand for forest resources needs to be known.

Methods

Study area

Kakamega forest is situated in the western part of Kenya, about 50 km north of Lake Victoria between 0° 9' N, 0° 25' N and 34° 49' E, 34° 57' E at an altitude between 1500 to 1700 m (Figure 1). Kakamega forest lies on a mainly flat to slightly undulating terrain. Temperatures range from 18°C to 29°C with minima of 11°C to 12°C (Cords 1987). Rainfall shows high annual variation from 1325 mm to 3500 mm (Tsingalia 1988). Kakamega forest encompasses semi deciduous to evergreen forest communities, the latter forming the easternmost relict of the Guineo-Congolian rain forest. Kakamega occupies a very a special biogeographical position, forming the transition zone of the lowland Congo basin forest to the Afromontane forest, and presents a mixture of species of both forest types. The forest is mostly situated on nutrient poor ferralo-chromic/orthic acrisols, with deep, leached clays. In the south an area with nitosols provides more fertile conditions (KIFCON 1994b, Kokwaro 1988, Mutangah 1996). Kakamega forest was gazetted as a 19,792 ha Forest Reserve in 1933 (KIFCON 1994b). Current estimates of the extension of forested areas (mostly secondary forest and plantations of exotics) amount to about 13,900 ha (Mutangah 1996). Kakamega District has one of the highest population densities in Kenya, with an average of 369 people per km^2 (KIFCON 1994b) to a maximum of 870 people per km^2 in some areas (KIFCON 1994b). This population pressure causes Kakamega forest to be one of the heaviest utilized forests in Kenya (KIFCON 1994b).

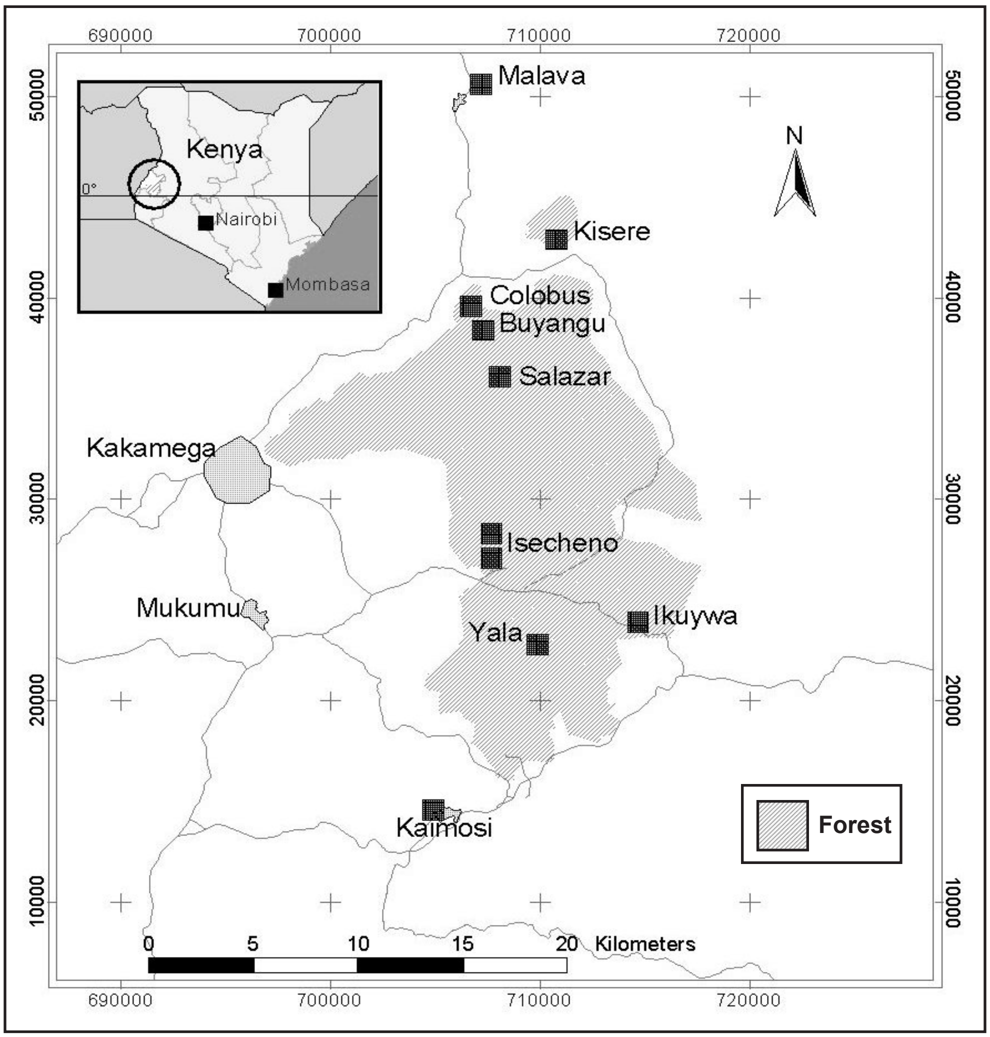

Figure 1. The study area of Kakamega Forest in Western Kenya.

In 1967, the northern parts of the forest were transformed into a National Reserve under the management of the Kenya Wildlife Service, while the remaining forest was converted into a Forest Reserve under the management of the Forest Department. The forest is surrounded by approximately 70 settlements on an area of 218 km^2. The dense population and intensive settlement activities lead to extreme pressure on the remaining forest, although heavy exploitation by sawmills and clear felling were banned in 1975. Large scale forest destruction in Kakamega was also caused by a short gold rush from 1930 to the late 1940's (KIFCON, 1994a, Mitchell 2004, Mutangah 1996).

Survey methodology

As part of a vegetation classification and forest use study, 201 households in the vicinity of Kakamega Forest were interviewed about their potential demand for forest resources. To obtain prior informed consent of the population meetings with village elders and authorities were organized to inform the community about the aims and benefits of our research. In addition, all participants received a small financial reward for their support. Most of the households consequently were willing to support our research, and only in few cases people refused cooperation.

The questionnaires were composed in the local language (Luya). Local villagers who were already trained in interviewing people conducted all interviews. After an additional introductory training about the aims of the study they worked unsupervised and were advised to interview people if possible, but to let them fill in the questionnaires themselves if they wished to do so. All cooperating households received a reward of 50 KSH. The household addresses and the name of the family were recorded separately from the questionnaires, and the questionnaires were only marked by a number in order to protect the participants from potential persecution for illegal use of forest products.

The survey tried to obtain demographic and economical data as well as data of the potential energy demand, using a questionnaire. The questionnaire asked about: the size of the house and construction materials used to build it; number, age and gender of people living in the household; source of income; amount and kind of energy sources, purpose of use of different energy sources; use of medicinal plants; responsibility for procurement of income and commodities and number and type of livestock.

All households who agreed to participate in the survey were interviewed. Individual households gave the amount and source of energy used. To calculate energy use the measurements units in responses to the questionnaires were standardized. Local measurement units were converted to liters or kg. More difficult was the estimation of numbers of pieces of firewood or volumes of charcoal. One tin of charcoal was standardized as 0.33 kg, and the length of logs and pieces of wood was recorded, and standardized to 1 m pieces. Wood pieces ranged to a diameter of 5 cm, while logs ranged from 5 to 15 cm diameter. To standardize these amounts we took 2.5 cm as the mean diameter for wood pieces and 10 cm for logs. A wood density range of 0.27 kg/dm^3 to 0.82 kg/dm^3 was found (Table 1). The mean density of 0.56 kg/dm^3 was applied for all calculations (Brown 1997, IPCC 2003, Labude *et al*. 2003, Niemz 1993).

In addition to the data gained from the questionnaires, head-loads collected in the forest were measured and weighed to obtain comparative data on fuel wood collections. This was particularly difficult because wood collection is officially prohibited in Kakamega Reserve. Due to the careful information provided prior to our study our presence was already known and accepted by the local population. Accompanied by a local interpreter, it was possible to weigh and measure the fagots in the less guarded parts of the forest. Participating villagers were granted a reward of 20 KSH (about 0.2 USD). The wood species encoun-

Table 1. Wood densities of common local species in the Kakamega Area, Western Kenya. Precision: *: density from other species of same genus; o: mean density of different species of same genus.

Species	Density [kg.dm^{-3}]	Source	Precision
Albizia sp.	0.63	Brown 1997	o
Antiaris toxicaria Lesch.	0.42	GDH 2008	
Bischofia javanica Blume	0.54	Brown 1997	
Blighia unijugata Baker	0.74	Brown 1997	*
Bridelia micrantha (Hochst.) Baill.	0.5	Brown 1997	*
Celtis sp.	0.65	GDH 2008	
Cordia africana Lam.	0.53	Brown 1997	
Croton sp.	0.57	IPCC 2003	
Diospyros abyssinica (Hiern) F. White	0.82	IPCC 2003	
Funtumia africana (Benth.) Stapf	0.45	IPCC 2003	
Harungana madagascariensis Lam. ex Poir.	0.45	IPCC 2003	
Maesopsis eminii Engl.	0.41	IPCC 2003	*
Markhamia lutea (Benth.) K. Schum.	0.45	IPCC 2003	*
Olea capensis L.	0.9	IPC-V 2008	
Prunus africana (Hook. f.) Kalkman	0.49	IPCC 2003	
Zanthoxylum gilletii (De Wild.) P.G. Waterman	0.33	Brown 1997	*

Table 2. Percentage of age groups in the Kakamega Area, Western Kenya.

	female	male	female	male	female	male
Village	**<15 years old**		**15-55 years old**		**>55 years old**	
Buyangu	8.0	22.4	36.0	24.8	2.4	6.4
Ikuywa	8.2	6.9	38.4	40.5	2.4	3.6
Isecheno	8.5	7.6	34.7	42.4	2.5	4.2
Kaimosi	5.5	6.1	41.1	41.1	1.8	4.3
Kisere	6.8	24.2	37.9	22.7	3.0	5.3
Lohro	13.9	8.3	55.6	19.4	0.0	2.8
Malava	14.1	9.4	32.4	36.5	2.9	4.7
Manganga	6.9	7.6	41.0	36.1	4.9	3.5
Mean	**8.4**	**10.5**	**38.4**	**35.6**	**2.9**	**4.3**

tered were compared to floristic samples already collected during the vegetation-classification part of the study. Vouchers of all species found during this study were collected, identified, mounted and stored at University of Nairobi herbarium (NAI).

Results

Demographic survey:

In the surveyed households 19% of the household members were under 15 years old, 74% were between 15 and 55 years, and 7% were older than 55 years (Table 2). An overview of the average number of members per age-group in the households is given in Table 3. People were often reluctant to state their age, and thus only very broad ranges were used.

The type of construction of the main house was taken as one factor of the economic situation of a household. For the Kakamega area two major construction types were identified: clay and wood construction for the walls or bricks. In general brick-buildings were roofed with corrugated iron sheets. Clay-buildings were mainly thatched with grass. Wealthier households could afford iron sheet roofing. This indicates that families with brick-houses had higher incomes than families living in clay houses. Families living in clay-houses with iron sheet roofing were wealthier than families with grass roofed clay-houses. 168 (84%) of households lived in clay and wood buildings, 20 (10%) of households owned a brick building, and 13 (6%) of households did not answer this question.

Almost every household depended in some part on subsistence farm production, with 92 (45.8%) of the households stating that farm work was the main source of income. 36 (17.5%) got their main income from daily contract labor, 32 (15.9%) from salaries earned as employees, 22 (10.9%) earned their income with their own business, 9 (4.5%) as free-lancers, 3 (1.5%) relied on charitable donations, and 2 (1.0%) were teachers. Five (2.5%) refused to answer this question.

A further parameter for the economic situation was the degree of education. Because of high school fees, only a few people can afford to send their children to secondary or high school. 119 (8.5%) of 1406 household members had attended school for more than 4 years, and 55 (27%)

Table 3. Mean number of household members per age group in the Kahamega Area, Western Kenya.

	Mean number of household members					
	female	**male**	**female**	**male**	**female**	**male**
Village	**<15 years old**		**15-55 years old**		**>55 years old**	
Buyangu	0.56	1.56	2.50	1.72	0.17	0.44
Ikuywa	0.60	0.51	2.82	2.98	0.18	0.27
Isecheno	0.59	0.53	2.41	2.94	0.18	0.29
Kaimosi	0.43	0.48	3.19	3.19	0.14	0.33
Kisere	0.60	2.13	3.33	2.00	0.27	0.47
Lohro	1.25	0.75	5.00	1.75	0.00	0.25
Malava	1.00	0.67	2.29	2.58	0.21	0.33
Manganga	0.40	0.44	2.36	2.08	0.28	0.20
Mean	**0.59**	**0.74**	**2.70**	**2.50**	**0.21**	**0.3**

of the 201 households had access to middle or higher education.

Energy survey:

Of the 201 interviewed households, 198 (98.5%) relied directly on wood as a major energy source for cooking purposes. Another 16 (8.0%) used charcoal, 7 (3.5%) used kerosene and only one (0.5%) household used gas. Multiple answers were possible.

For lighting purposes most of the households (198, 98.5%), used kerosene. Eleven (5.5%) used wood, two (1.0%) used gas and one (0.5%) household used solar energy. One household (0.5%) indicated that they used charcoal for lighting.

From this information about the regular demand for energy a mean weekly demand of 19.2 kg of charcoal, 2.9 L kerosene, and 196 one-meter branches per household was interpolated. This wood demand resulted in 431 kg per household per week after standardization.

Head-load survey:

A total of 66 head-loads were measured and weighed in the southern part of the forest. Wood collection for subsistence use was tolerated in public forests in Kenya before the elections in December 2003. For this reason head-loads in the unprotected part of Kakamega Forest were much bigger than head-loads from restricted parts of the forests, in particular the Nature Reserve in the North. Because of the illegal character of wood collection in nature reserves it was not possible to measure head-loads when trying to compare wood collection in protected areas. It was estimated, however, that the head-loads of the South were about two to three times heavier than the ones of the North. Mainly groups of women or girls were observed collecting firewood. Boys accompanied a few groups of girls. Only one group of boys, and occasionally single women, were encountered collecting firewood. Only one man with his son was found collecting wood. This man carried log pieces on a bicycle, while wood was normally bundled to fagots and carried on the head. Therefore fagots are referred to as head-loads.

The 66 collectors were classified by gender into five age-groups. This resulted in ten potential categories (five male and five female, with one of each age group). However, as can be noted in Figures 2 and 3, males were not represented in the two older age groups. Most female collectors fell into the three middle age-groups. Only one adult man (1.5%) was found collecting firewood, while six boys (9.1%) from 10 to 18 years and four boys (6.1%) under 10 (Figure 2).

The female collectors carried mean head-load weights of 17.3 kg in the group of less than 10 years and 23.7 kg - between 10 and 18 years. For women between 18 and 40 years the mean head-load weight was 43.8 kg, and 30.6 kg at ages between 40 and 65 years. Women above 65 years reached a mean head-load weight of 34.0 kg. The heaviest head-load weight in the women group of 18 to 40 years, was 60 kg. The boys under 10 years reached a mean head-load weight of 8.0 kg, 15.0 kg for boys between 10 and 18 years, and one man of 34 years carried 21.0 kg of log pieces on his bicycle (Figure 3).

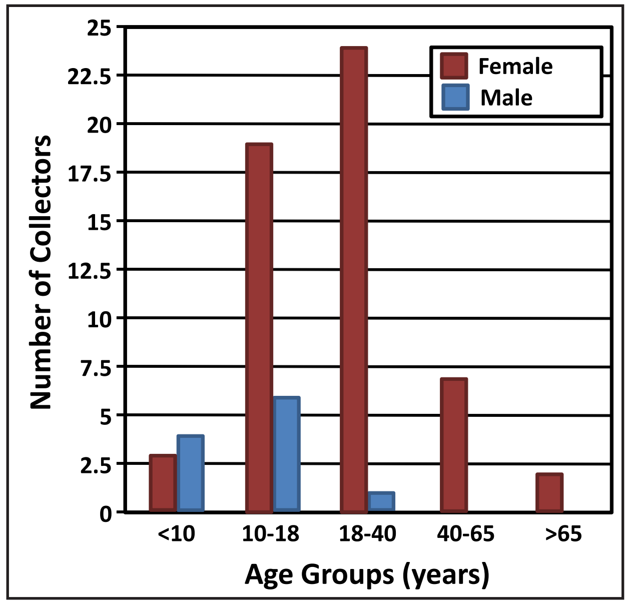

Figure 2. Number of collectors surveyed per age group in Kakamega Forest in Western Kenya.

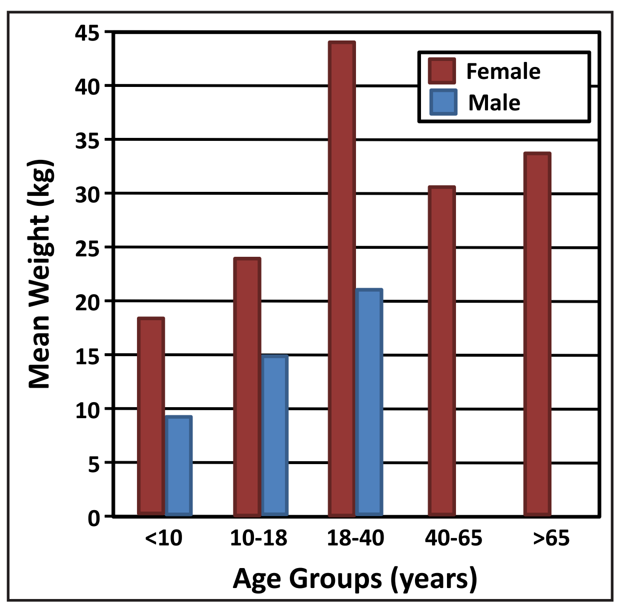

Figure 3. Mean head-load weight per age group in Kakamega Forest in Western Kenya.

The preferred tree species for wood-fuel were *Prunus africana* (14.0%), *Maesopsis eminii* Engl. ssp. *eminii* (12.2%), *Olea capensis* L. ssp. *welwitschii* (Knobl.) Friis & P.S. Green (11.6%) and *Bischofia javanica* (11.0%). *Funtumia africana* (5.2%) and *Harungana madagascariensis* (5.2%) were also collected frequently, while *Bridelia micrantha*, (4.7%) *Cordia africana* (4.7%), *Zanthoxylum gilletii* (4.7%), *Antiarias toxicaria* (3.5%), and *Celtis* sp. (3.5%) received less use. *Croton* sp. (1.7%), *Albizia* sp., *Blighia unijugata*, *Diospyros abyssinica*, *Dovyalis macrocalyx* (Oliv.) Warb., *Markhamia lutea* (1.2% each), *Acacia* sp., *Casaeria* sp., *Chaetacme aristata* Planch., *Erythrina abyssinica* Lam. ex DC. ssp *abyssinica*, *Ficus* sp., *Psidium guajava* L., *Sapium ellipticum* (Hochst.) Pax and *Trilepisium madagascariense* Thouars ex DC. (0.6% each) were only collected infrequently.

Additional use potential of the forest:

Of the 201 interviewed households, 173 (86%) indicated that they seek medical assistance only from the local hospital and use only medicine from the pharmacy/dispensary. Twenty (10%) of the households used both medicine from the pharmacy as well as medicinal plants, and eight (4%) households relied only on medicinal plants.

Discussion

Two major issues in interviewing people were the willingness of people to participate in the survey, and their ability to understand what was being asked. Even though the rate of collaboration was very high, people reacted sometimes with suspicion to our questions. The most important strategy was to hold regular meetings with local authorities to discuss the project and possible benefits for the community, to introduce members of the survey group and to gain their prior informed consent for our work. In remote places, where people were initially unaware of our presence, we sometimes experienced mistrust because people expected to be spied on by the authorities. This was particular in areas where people used the forest illegally. We always avoided interfering with any illegal activity.

A further issue was the ability of the participants to understand the survey questions and to estimate wood quantities they used. Most amounts where given in practical measurement units like ‘a tin of’, ‘X sticks of 1m’ or ‘X logs’ and so on. A conversion from the English system for measurements still widely used in Kenya to the metric system was unproblematic. After the survey all measurements were standardized. This proved easy for measurable amounts like a tin of charcoal or a bottle of kerosene, since only a few different containers were available. The rather difficult factor was measurement of wood. Due to the wide variety of twig diameters and logs collected and due to the difference in the density of wood of different tree species some simplifications were made. From the observed head-loads the mean diameter of used sticks and logs was estimated. The mean density of wood was estimated as between normal hardwood and very dense hardwood, which is preferentially collected. The density of wood was derived from Brown (1997), IPCC (2003) and internet sources (respectively GDH 2008, IPC-V 2008) for most local species (Table 1). If the density of a local species was unknown, the values from other species of the same genus were used for the calculation. In addition to getting a good estimate of the extracted biomass the individual impact of firewood collection on each tree species could also be derived from the interviews and the head-load survey.

While observed fuel demands for charcoal and kerosene were very comparable to other studies, the estimated amounts for wood used were five times higher than in other studies (KIFCON 1994a, Nyang 1999). This can only partly be attributed to overestimation by the households themselves, and the assumptions in the process of standardization. Even if the amount of fuel-wood used were set as one third of the estimated amount, the actual demand is still 30% higher than found by Nyang (1999) and KIFCON (1994a).

The results of the head-load survey and the information received from most of the questioned women indicate that women gather firewood almost every day. This indicates that the estimated firewood demand is very close to the real firewood amount extracted. Most of the informants however lived close to the forest, and Nyang (1999) found that the closer people live to the forest the more they rely on forest products. Due to high population pressure and low income many farmers start to use the adjacent forest as an additional source of income (Nyang 1999).

Use of forest products as medicine was rarely mentioned. Households using traditional medicines reported in most cases to also consult Western doctors. The results of the survey are in complete contrast to personal observations, which indicate a very pronounced use of traditional medicine by the Kakamega population. Two assumptions could explain this discrepancy. First, of the all survey questions were designed in such a way that people never had to indicate use of the forest directly, in order to avoid a direct reference to illegal activities. The question for traditional medicine, however, related to a direct (and thus illegal) use of the forest as a resource, and this might have prevented people from answering this question. In most cases interviewees who planted trees in their own compound had also some species with medicinal value and could answer this question without any reservations.

Conclusions

The rural population around Kakamega Forest lives in conditions of poverty. Materials for house construction come mostly from the adjacent forest or fields. Only 10% of households owned a house made of bricks. Just one third of the households (8.5% of the registered people) had access to secondary education. Most of the households were working in the farming sector, and almost half of the households relied on farming as a main source of income.

The main energy source for this rural area was wood from the adjacent Forest Reserve. Even though some firewood vendors were encountered, it can be expected that most of the households collected firewood from their own land or from the nearby forest. The local firewood sellers also got their wood from the local forest. In addition most of the people living close to the forest tried to sell wood as an additional source of income.

Kakamega forest not only suffers from fuel-wood consumption. Construction also relies on locally available timber, as well as for wood to burn bricks (Nyang 1999). Traditional ceremonial practices and religious beliefs cause further strain on forest resources. Western Kenya suffers from a high HIV infection-rate. This leads to in a high mortality rate, and a high demand for coffins made from local wood.

An apparently minor, but worthy to note, threat is the collection of plant material, particularly for medicinal use, and also for construction purposes like the thatching of roofs or fence posts. Even if the whole individual grass plants are not removed, which affects direct regeneration, the harvesting of grass also affects tree species. Seedlings are cut during collection of grass and some are removed of them to keep the area open so that the grass can expand. Indirectly, removal of parts from an individual inhibit the growth of plants, and therefore competition success. Without proper control of these activities the species composition is affected promoting even less competitive, unused species. Thus, provision of people with seedlings of useful species and/or establishing special areas for collection of plant material would detain this threat to the regeneration of the forest.

The results from the survey indicate a bleak outlook for the limited resources of Kakamega forest. This challenges the authorities to make a special effort to create a sustainable and participative management strategy. Instead of trying to conserve the forest by excluding the local population, a strategy that involves people and incorporates their needs has to be developed. The population shows considerable interest in the sustainable use of the forest, but, need the support of authorities and decision makers to get involved in sustainable strategies in order to benefit from these efforts. At the very least this strategy should take into account the interests of the people who through social and cultural rules are expecting protection of common property for the benefit of all. This will be accepted by people however, only if they receive an advantage from the common property. As more studies like this one aim for the development of communities embracing conservation activities, it will allow decision makers to develop a higher awareness about the links between people and common property. Many tree planting and reforestation projects are under way. Unfortunately most of these do not have the necessary knowledge about the original ecological conditions and species composition of Kakamega Forest, nor of the long term economical influences (Roberts & Gilliam 1995, Russel & Franzel 2004, Swetnam *et al*. 1999). In addition, ecosystems need a certain degree of disturbance to keep them vital (Duncan & Chapman 1999, Kigomo 2001, Liu & Ashton 1999). A long-term sustainable forest management depends on an understanding of the ecology and regeneration processes of Kakamega Forest, the needs of the local population, and the incorporation of this data in the development of realistic use and conservation strategies.

Acknowledgements

Thanks are due to Benson Chituy for assistance during fieldwork, to Prof. Richard Mibey of the University of Nairobi for making it possible to use the university facilities and logistical support. The authors are grateful to the Kenya Wildlife Service and the National Museum of Kenya for support in the field and the possibility to use of their infrastructure. Many thanks also to the University of Maseno, particularly Prof. John Onyango for logistic and material support. We gratefully acknowledge the Federal Ministry of Education and Research of the Federal Republic of Germany and the BIOTA project for financial and logistic support.

Literature Cited

Brown, S. 1997. *Estimating Biomass and Biomass Change in Tropical Forests - A primer. FAO Forestry Paper 134*, Food and Agriculture Organization, Rome, Italy.

Cords, M. 1987. Mixed-species association of *Cercopithecus* monkeys in the Kakamega Forest, Kenya. *University of California Publications in Zoology* 117:1-109.

Duncan, R.S. & C.A. Champman. 1999. Seed dispersal and potential forest succession in abandoned agriculture in tropical Africa. *Ecological Applications* 9(3):998-1008.

GDH. 2008. *Gesamtverband Deutscher Holzhandel*. www.holzhandel.de

IPCC. 2003. Intergovernmental Panel on Climate Change. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Edited by J. Penman, M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, Leandro, N. Kyoko, T. Todd, K. Tanabe & F. Wagner. Hayama, Kanagawa, Japan.

IPC-V. 2008. *Internationales Parkett Centrum*. www.ipc-v.de

Ishani A., R. MacDonald, D. Nelson, I. Rutks & T.J. Wilt. 2000. *Pygeum africanum* for the treatment of patients with benign prostatic hyperplasia: A systematic review and quantitative meta-analysis. *American Journal of Medicine* 109(8):654-664.

KFMP. 1994. *Kenya Forestry Master Plan*. Ministry of Environment and Natural Resources. Nairobi, Kenya.

KIFCON. 1994a. Kenya Indigenous Forest Conservation Programme. *Kakamega Forest Domestic Energy Survey*. Nairobi, Kenya.

KIFCON. 1994b. Kenya Indigenous Forest Conservation Programme. *Forest Inventory Report No. 3 Kakamega*. Nairobi, Kenya.

KIFCON. 1994c. Kenya Indigenous Forest Conservation Programme. *Literature Review on the use of Indigenous Forest in Kenya*. Nairobi, Kenya.

Kigomo, B.N. 2001. *State of Forest Genetic Resources in Kenya*. Sub-Regional Workshop FAO/IPGRI/ICRAF on the conservation, management, sustainable utilisation and enhancement of forest genetic resources in Sahelian and North-Sudanian Africa (Ouagadougou, Burkina Faso, 22-24 September 1998). Forest Genetic Resources Working Papers, Working Paper FGR/18E. Forestry Department, FAO, Rome, Italy.

Kokwaro, J.O. 1988. Conservation status of the Kakamega Forest in Kenya - the easternmost relic of the equatorial rainforest of Africa. *Monographs in Systematic Botany of the Missouri Biotanical Garden* 25:471-489.

Labude, M., P. Lohse, M. Scheurmann, H. Seidel, A. Soder, & H.J. Wiedemann. 2003. *Friedrich Tabellenbuch - Holztechnik*. Bildungsverlag EINS, Troisdorf, Germany.

Liu, J. & P.S. Ashton. 1999. Simulating effects of landscape context and timber harvest on tree species diversity. *Ecological Applications* 9(1):186-201

Mbuga, D. 2002. *Forest Outlook Studies in Africa (FOSA): Country Report Kenya*. FAO, Rome, Italy.

Mitchell, N. 2004. *The Exploitation and Disturbance History of Kakamega Forest, Western Kenya. Bielefelder Ökologische Beiträge 20*. University of Bielefeld, Faculty of Biology, Department of Ecology, Bielefeld, Germany.

Mutangah, J.G. 1996. *An Investigation of Vegetation Status and Processes in Relation to Human Disturbance in Kakamega Forest, Western Kenya*. Ph.D. thesis, University of Wales Aberystwyth, United Kingdom.

Niemz, P. 1993. *Physik des Holzes und der Holzwerkstoffe*. DRW-Verlag, Stuttgart, Germany.

Nyang, F.O. 1999. *Household Energy Demand and Environmental Management in Kenya*. PhD thesis, University of Amsterdam, Amsterdam, Netherlands.

Roberts, M.R. & F.S. Gilliam. 1995. Patterns and mechanism of plant diversity in forest ecosystems: Implications for forest management. *Ecological Applications* 5(4):969-977.

Russel, D. & S. Franzel. 2004. Trees of prosperity: Agroforestry, markets and the African smallholder. *Agroforestry Systems* 61:345-355.

Santa Maria Margalef, A., R. Paciucci Barzanti, J. Reventos Puigjaner, J. Morote Robles & T.M. Thomson Okatsu. 2003. Antimitogenic effect of *Pygeum africanum* extracts on human prostatic cancer cell lines and explants from benign prostatic hyperplasia. *Archivos Españoles de Urología* 56(4):369-78.

Stewart, K.M. 2003. The African cherry (*Prunus africana*): Can lessons be learned from an over-exploited medicinal tree? *Journal of Ethnopharmacology* 89(1):3-13.

Strong, K.M. 2004. African plum and benign prostatic hypertrophy. *Journal of Herbal Pharmacotherapy* 4(1):41-46.

Swetnam, T.H., C.D. Allen & J.L. Betancourt. 1999. Applied Historical Ecology: Using the Past to Manage the Future. *Ecological Applications* 9(4):1189-1206.

Tsingalia, M.B. 1988. *Animals and the Regeneration of an African Rainforest Tree*. Ph.D. thesis, University of California.

Vanleeuwe, H., B. Woodley, C. Lambrechts & M. Gachanja. 2003. *Changes in the State of Conservation of Mt. Kenya Forests: 1999–2002*. UNEP, Nairobi, Kenya.