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Effects of selective logging and exploitation of non-timber forest products on Budongo Forest Reserve, Uganda

Paul Mugabi ,Joseph Obua,Gufu.O
Department of Forest Products Engineering, Faculty of Forestry and Nature Conservation,
Makerere University
P.O. Box 7062 Kampala, Uganda

Abstract

The effects of selective logging and exploitation of non-timber forest products (NTFP) was investigated in Budongo Forest Reserve, Uganda. Tree data were collected along transects in nested plots established in compartments N1 (buffer zone) and N2 (exploited zone) on the seedlings, saplings and mature trees and wood volume. Tree species diversity index and the percentages of valuable commercial timber and less preferred species exploited were computed. The tree species diversity was higher (Simpson's diversity index = 24.7) in N2 than N1 (22.4). Greater wood volume per tree was found in the N1 (3.04 ± 0.2m^3) than in N2 (2.29 ± 0.2m^3). Utilization of both valuable and less preferred species was greater in N2 than in N1. We recommend that the range of tree species exploited for timber should be increased as a conservation strategy to reduce the negative effects of selective logging of few popular tree species.
Key words: **Conservation, tree species, Budongo, timber, selective logging.**

Introduction

There are 4.9 million hectares of forests and woodlands in Uganda, which cover 24% of the land area (Ministry of Water, Lands and Environment, 2002). The majority (81%) of the forest area is woodland, 19% is tropical high forest and less than 1% is plantation (National Board of Forestry, 1997). In addition, there are substantial forest resources in the form of scattered trees and agroforestry crops within farming systems. The existing natural forests on private land and in government reserves are the major source of timber and non-timber forest products. The volume of timber used for construction, furniture making and manufacture of other products is estimated at 800,000 m^3 per year (NEMA, 2001). A further 875,000 m^3 per year is harvested in form of construction poles.

Budongo forest is one of the natural forest reserves where selective logging has been practiced since the 1930's after the colonial Forest Department identified and documented different species. The timber trees in the forest reserve were categorised as desirable species when the tree had diameter at breast height (DBH) exceeding 50 cm above buttresses and with good form. These included *Entandrophragma angolense* Welw., *E. cylindericum* Sprague, *E. utile* Dawe & Sprague, *Erythrophleum guineense* (Guill. & Perr.), *Khaya anthotheca* Welw., *Lovoa brownii*, *Milicia excelsa* (Welw.) C. Berg among others. Based on this categorisation, only few species that had marketable timber were logged. The rest were considered undesirable and regarded as weeds to be removed by poisoning with aboricides (2,4,5-T and 2,4-D in the ratio 1:2 mixed with diesel). From the 1930s to the 1980s, the mahogany cut per compartment in the Budongo forest per decade was greater than 61% of the total species harvested. Between 1950 and 1959, the mahogany cut per compartment was about 75% of the total trees exploited (Plumptre, 1996).

According to Plumptre (1996), the long-term effects of selective logging in the tropics are poorly known. There are very few places where sustainable management of tropical forests has been attempted for long enough to measure the impact of logging operations on the fauna and flora. This is particularly so where monocyclic or uniform harvesting systems are used, because of the long-term rotation periods between felling cycles which are of the order of 60-80 years. Around the 1950s, it was reported that selective logging at a rotation of 40 years caused damage to Budongo forest (Plumptre, 1996). Among the tree species deliberately killed was *Cynometra alexandri* C.H. Wright in order to open up the canopy and stimulate regeneration of *Khaya* and *Entandrophragma* (Mahogany) species. Later, the rotation was increased to 80 years (Paterson, 1991). By the 1970s use of arboricides was stopped mostly due to the cost of the chemicals as well as the realization of the growing markets for some of the species that were previously considered less valuable (Paterson, 1991).

Thus, as Kityo and Plumptre (1997) noted, high demands for the limited supplies of timber species resulted in overexploitation, while those species that were considered to be of poor timber quality were under-utilised. For instance, *Celtis* species that occurred in large quantities provided good timber, while *Cynometra alexandri*, which is five times more abundant than any other preferred species is under-utilised (Kityo & Plumptre, 1997).

Non-timber forest products (NTFP) can be defined as all intangible and tangible forest products other than timber. However, definitions vary according to different forest resource stakeholders (Banana, 2003). NTFP include medicines, craft materials and food, whose value is significant to the communities neighbouring the forest.

This study examined the effects of selective logging on the Budongo forest reserve. Answers were sought to the following questions: what were the effects of selective logging on species abundance, wood volume and species diversity in compartments N1 and N2? How do the local communities view timber exploitation and harvesting of NTFP?

Methods

Study area

Budongo forest reserve is a medium altitude moist semi-deciduous forest located in Hoima and Masindi Districts (1°37'-2°00' N and 31° 22'-31° 46' E). It covers an area of 825 km² of undulating ridges alternating with valleys running in southeast to northwest, making it Uganda's biggest forest reserve (Hamilton, 1984). The soils are Ferralitic and are regarded as the final stage in tropical weathering process (Paterson, 1991). The mean annual precipitation usually exceeds 1400 mm year per year, while the surrounding savannas seldomly receive 850 mm per year.

Budongo is divided into five blocks: Biso, Nyakafunjo, Waibira, Kaniyo Pabidi and Siba. Each of these blocks is sub-divided into compartments, and the only compartments that had not been logged and kept as nature reserves were N15, W31 and W32. The present study was conducted in compartments N2 and N1 (Figure 1). N2 is a production compartment while N1 is a buffer compartment for the nature reserve (N15). Both N1 and N2 were officially logged between 1945 and 1947. Pitsawyers harvested timber trees illegally in these compartments.

Parameters

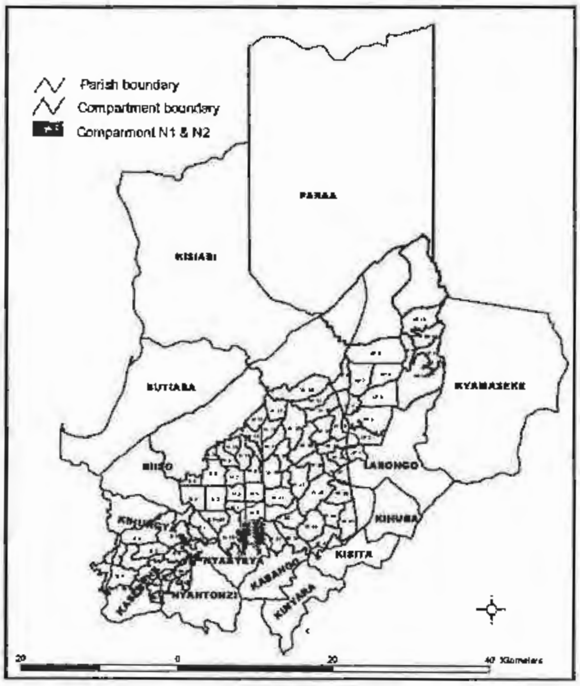
Species abundance

Transects (a total of 9 in N1 and 10 in N2) running east-west at 100 m intervals were laid in compartments N1 and N2. Nested (concentric) plots of 1 m, 3 m and 10 m radii were established (Howard, 1991; IFRI, 1993; Banana & Twecheyo, 2001) within 190 plots located at 100-metre intervals. In the plots, seedlings (<1 m high) were identified and counted in the 1 m-radius plots, saplings (1-3 m high) were counted in the 3 m-radius plots, and the mature trees (> 10 cm DBH) recorded in the 10 m-radius plots.

Forest utilization

Household lists from Nyabyeya and Nyakafunjo villages (neighbouring compartments N1 and N1) were obtained from Local Council chairpersons from which 50 households were randomly selected. Structured questionnaires were administered to gather information on the species exploited, products made from different species and reasons for choosing particular species. Responses were recorded by use of interpreters in cases where the respondents did not understand English language. Percentages of trees and saplings cut (stumps) in the 10 m-radius plots were recorded.

Figure 1. Locatin of the study



Data analysis

Minitab computer statistical package was used to perform the analysis of variance (ANOVA) and apply a general linear model (GLM) to the data to compare variations in tree volume, utilization (response variables) grouped by valuable and under-utilised tree species according to forest sections (categorical variables). Differences between the forest compartments were compared by paired *t*-tests. Simpson's diversity index (Magurran, 1988) expressed as D = å (n*i*(n*i*-1)/ N(N-1) (where n*i* is the number of individuals in the i^{th} species and N is the total number of species) was used to determine the effects of selective logging on forest tree species diversity in N1 and N2. Pearson's correlation coefficient was used to show the relationships between seedlings, saplings and mature tree numbers. Responses by the local communities were not statistically analysed due to limited sample sizes and only computed as percentages of responses to the questions on forest exploitation. All tests were done at 5% level of significance.

Results

Tree species abundance

A total of 125 species were identified from both compartments: N2 had more tree species (112) than N1 (103). The twenty most abundant tree species are given in Table 1. With the exception of *Khaya anthotheca*, the rest of the tree species were under-utilised (less preferred) (Table 1). Nearly 63% of *Khaya anthotheca* trees were found in compartment N1 where timber harvesting was restricted while 37% was found in N2. There were more mature trees (48.9%) than seedlings (35.3%) in both compartments. Saplings (15.8%) were also less than the seedlings.

Pearson's correlation coefficient showed that there was a negative but significant relationship between the number of saplings and trees ($r = -0.115$, $P < 0.000$). The negative correlation between the number of seedlings and mature trees ($r = -0.211$, $P = 0.001$) and saplings and mature trees ($r = -0.202$, $P = 0.002$) was stronger for the valuable species.

ANOVA showed that there was a significant difference in wood volume of valuable and less valuable (under-utilized) species ($F = 31.11$; $P = 0.000$). The difference in wood volume between the compartments was highly significant ($t = 3.13$, $P = 0.002$). The average wood volume per tree in compartment N1 was greater ($3.04 \pm 0.2m^3$) than in N2 ($2.29 \pm 0.2m^3$).

Forest diversity

Simpson's diversity index was greater in N2 (24.7) than in N1 (22.4), although the difference was not statistically significant ($t = -0.71$; $P = 0.477$).

Forest utilization

GLM showed that the utilisation of valuable timber species differed significantly ($F = 127.62$; $P = 0.000$) from the less valuable ones. In addition, timber utilization differed significantly between the two forest compartments ($F = 13.20$; $P < 0.001$). Non-timber utilization also differed significantly between the tree species ($F = 7.61$; $P = 0.006$) but there was no significant difference between the two compartments ($F = 1.26$; $P = 0.261$). Timber was produced mainly from the valuable/desirable species and non-timber from the less valuable (Figure 2). The proportion of the valuable timber species utilised was much greater than the proportion for the less valuable ones (Figure 2). Of the 125 species recorded in both compartments only 12 were considered as valuable and utilised while the rest were under-utilised.

Table1. Percentage composition of tree species in compartments N1 and N2

	Seedlings		Saplings		Trees		Commercial Status
	Seedlings		Saplings		Trees		
Species	N1	N2	N1	N2	N1	N2	
Alstonia boonei De wild.	0	0	4	4	96	96	NP
Antiaris toxicaria Leschen.	37	30	6	7	57	63	NP
Bosquea phoberus Baill.	12	5	6	15	82	80	NP
Celtis gomphophyla Bak.	3	18	3	5	94	77	NP
Celtis mildbreadii Engl.	12	12	31	38	57	50	NP
Celtis zenkeri Engl.	49	62	5	5	46	33	NP
Chrysophyllum albidum G. Don.	68	71	0	7	32	22	NP
Croton sylvaticus Krauss	16	62	0	2	84	36	NP
Cynometra elexandri Wright	61	70	18	10	21	20	NP
Ficus exasperata Vahl.	0	0	0	0	100	100	NP
Funtumia elastica (Preuss) Stapf	10	19	15	10	75	71	NP
Khaya anthotheca Welw.	25	13	5	7	70	80	P
Lasiodiscus mildbreadii Engl.	45	51	33	35	22	14	NP
Lychnodiscus cerospermus Radlk	23	14	23	23	54	63	NP
Myrianthus holstii Engl.	23	20	5	10	72	70	NP
Phyllanthus inflatus Hutch.	3	65	0	0	97	35	NP
Rinorea ardisiaeflora Sensu ITUP	63	76	32	23	5	1	NP
Tabernaemontana holstii K. Schum	33	25	23	12	44	63	NP
Trichilia prieuriana A. Juss	26	10	9	12	65	78	NP
Trichilia rubescens Oliv.	13	4	27	10	60	86	NP

P species preferred for timber production
NP species not preferred for timber production

.Figure 3 shows that among the valuable species *Maesopsis eminii* and *Mildbreadiodendron excelsum* were the most utilised (from the cut stumps observed in the two compartments). This was because the Forest Department has since the late 1990's banned the exploitation of mahogany (*E. utile*, *E. Cylindricum*, *E. angolense* and *Khaya anthotheca*) species which shifted the pressure onto the two species. The few mahoganies harvested (Fig. 3), were those cut illegally while concessions to cut valuable species such as *Maesopsis eminii* and *Mildbreadiodendron excelsum* were given by the Forest Department.

Figure 4 gives a comparison of timber and non-timber utilization in the two compartments. Since N2 is a production compartment, it experienced both legal and illegal harvesting activities than N1.

Figure 3. Utilization of valuable and less valuable species.

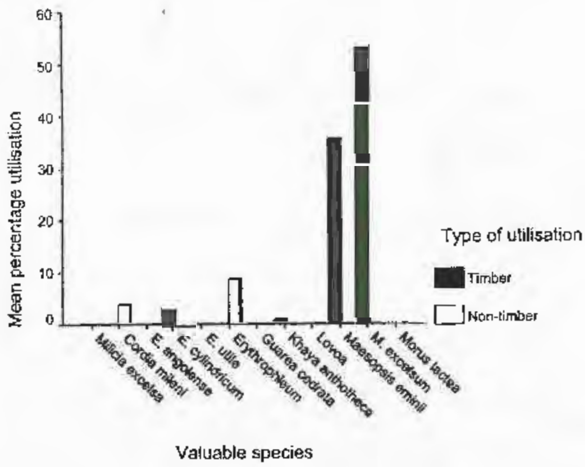


Figure 2. Utilization of valuable and less valuable species.

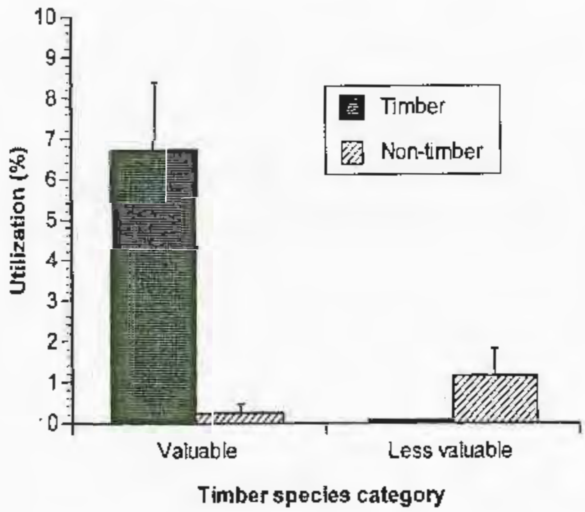
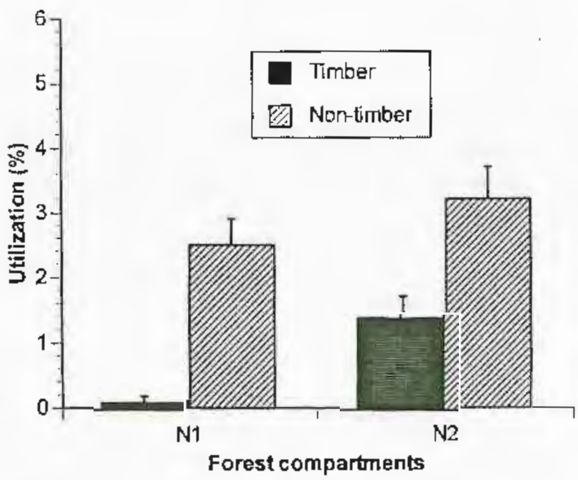


Figure 4. Comparison of utilization in compartments N1 and N2.



Community utilisation of the forest

Seventy per cent of the respondents said that they had rights to exploit forest products for domestic use while 28% said they had both domestic and commercial user rights. However, 56% admitted to be actually using the forest only to meet their domestic needs. Although 14% said they preferred to exploit the valuable timber species, more than 50% said they did not select the trees species harvested for timber and other products. Dead wood was gathered for domestic use. Selection of tree species for construction poles considered the strength and availability of the species. Seventy four per cent of the respondents knew that they were not permitted to harvest mahogany tree species. Most of the timber and non-timber forest products were sold in the local market, a practice that the local people claim resulted in less earnings.

Discussion

The difference in number of tree species in the compartments is due to mechanical logging in N2 which resulted in the growth of shade intolerant tree species. The lower percentage of seedlings (35.3%) than trees (48.9%) was due to poor forest regeneration following mechanical logging. The percentage of saplings (15.8% was less than that of seedlings because the former were mostly exploited as non-timber products and used for constroction, making traps for animals and walking sticks.

The negative but significant correlation coefficient between the number of saplings and mature trees was probably due to gap creation that allowed light to reach the forest floor and promote regeneration (Osborne, 2000). Usually where there are mature canopy trees there is less light penetration resulting in few seedlings and saplings (Babweteera *et al.*, 2000). The closed forest canopy influenced tree regeneration in the compartments and corroborates with observations by Trenaman (1956) and Synnott (1985) that opening up of the canopy usually aids the growth of seedlings and saplings of tree species in closed forests.

Timber exploitation was greater in N2 than in N1, which clearly explains the lower mean volume per tree in compartment N2. However, the higher species diversity index in N2 suggests that forest exploitation improved the tree species diversity. These findings would help to reinforce the understanding that forest exploitation should be in tandem with the conservation of biodiversity. Whereas conservation of tree species diversity is one of the principal objectives of Budongo forest management, the choice may be between saving rare species vis-a-vis maintaining greater diversity through increased disturbance. The problem in the past has been that the Forest Department managed the Budongo forest reserve primarily for timber production while ignoring the fact that the same forest is also a habitat for wildlife.

Although there is evidence that timber and NTFP were exploited, the latter was not so much regulated as the former. It therefore seems prudent to suggest that the Forest Department should regulate the exploitation of valuable timber trees in N1 and N2. Furthermore, the Forest Department should regulate the exploitation of NTFP by local communities as well as the species previously considered as undesirable for timber.

Conclusions

It is clear from this study that the local community living around the Budongo forest reserve is aware of the Forest Department controls on harvesting of valuable timber tree species. However, continued harvesting of high value timber species indicates that the control has not been effective. Furthermore, the local community claim certain rights to forest products. What is not clear is how these rights are integrated into the overall forest management plan.

Selective logging of valuable species is putting pressure on the more preferred species. *Khaya anthotheca*, is one of the species that dominated the forest in the past (Babweteera *et. al*, 2000; Mwima *et al.*, 2001) and today, it is found mostly in the nature reserve. The less valuable species, such as, *F. elastica* (Preuss) Stapf, *C. alexandri* and the *Celtis* species also dominate the forest. Therefore the future management of Budongo for timber production should consider two important factors. First, managing the forest ecosystem for highly priced timber species alone is ill conceived from conservation point of view. The way forward is to integrate the management of Budongo for timber production with biological conservation. Second, the Forest Department has not acknowledged the important role NTFP play in the livelihood of the local people living around the forest. Thus, there is a need to consider exploiting some of the "undesirable" species for timber.

This study has highlighted the constraints to forest conservation from the point of view of the local communities. There is a need to maintain the integrity of the Budongo forest reserve without compromising the biodiversity values because of short-term financial gains from logging. We suggest that timber exploitation be planned and regulated within the broader goal of sustainable forest management.

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