NATIONAL STAKEHOLDER'S WORKSHOP TO REVIEW THE SUSTAINABLE MANAGEMENT OF NON WOOD FOREST PRODUCTS IN UGANDA FOCUSSING ON BAMBOO AND RATTAN

Faculty of Forestry & Nature Conservation
MUK

Funded by:
FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS

May 28th, 2003

3.3.0 BAMBOO REGENERATION AND SUCCESSION IN ECHUYA

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3.3.1 Introduction

Echuya was gazetted in 1939 as a Forest Reserve. At that time, the forest vegetation consisted of dense evergreen stands of *Arundinaria alpina* (bamboo) (Howard 1991). Kingston (1968) report that in 1947 the bamboo stems in Echuya were big tall and dense, and hardwood trees and shrubs were scattered in a few places. Botanical field trips conducted by Eggeling (1934), Watt (1956). Kingston (1968) and Davenport. Howard & Mathews (1996) recorded *Arundinaria alpina* as the dominant grass. Other conspicuous plants in the vegetation included *Cassipourea malosana. Afircania volkenii, Dombeya spp. Hagenia abyssinia, Hypericum* species, *Nuxia* congesta. *Myrica salicifolia* and *Faurea salign.* However, the present concern by forest ecologists, environmentalists and the local community is that the bamboo shrubs are losing ground to other vegetation types (Banana et al. 1993).

No previous studies have documented this ecological change and the major question answered by this study was what are the factors leading to the current ecological changes in Echuya Forest Reserve?

An ecological inventory of Echuya Forest was carried out to ascertain the ecological changes in the forest. The objectives were:

a) To determine the current vegetation types by composition, distribution and abundance and compare it with the aerial photographs taken in 1954 and 1990.
b) To map forest gaps caused by both natural and human disturbances and characterize the species regenerating in them and
c) To determine the effect of the soil changes on ecological succession.

The hypotheses tested were that bamboo is a temporary vegetation cover that occupied the area because it was able to establish on soils formed after volcanic activity, and that bamboo is unable to regenerate in both natural and human-induced forest gaps.

3.3.2 Description of Echuya

Echuya forest reserve is located in Western Uganda in Bufumbira county, Kisoro district and Rubanda county, Kabale district. It lies between 1014-1021'S and 29047'-29052'E. Echuya is a natural forest reserve situated at high altitude (2270-2570m above sea level) running between lake Bunyonyi and Mgahinga Gorilla National Park. According to Howard (1997) and Davenport et al. (1996), the reserve covers an area of 34km2 and is surrounded by densely population parishes of over 230 people km2, Geologically. Langdale-Brown (1960) and Langdale-Brown, Osmaston & Wilson (1964) associated the area with volcanic activity and warping due to the formation of the western rift valley.

3.3.3 Materials and methods

Tree species composition and distribution

Eight transects were laid at 1000m intervals across the forest in an east-west direction and three transects were laid at the same interval but facing north-south direction. Circular plots with a radius of 10m were located at intervals of 200m along each transect. Five percent of the total area of the forest reserve was sampled. According to Howard (1991). White more & Sayer (1992) and Higgins et al. (1996). A 5% ratio is acceptable in surveys of tropical forests.

In each circular plot, three concentric circles were established at radial distances of 1,3 and 10m Kent & Coker (1992). Species of herbs and woody seedlings were identified in the 1m-radius plot, and tree saplings, shrubs and bamboo were identified in a 3m-radius plot, and stem diameter and height recorded. Plants were considered as saplings when their stem diameters were >2.5cm but <10cm at breast height. Trees with 10cm diameter at breast height (Dbh) were enumerated and the height measured in the 10m-radius plot.

Gaps and levels of disturbance

Along each transect, all gaps that were at least 10m2 were measured and categorized according to the cause of the gap and the tree species regenerating in them. Gaps were measured by connecting gap edge points and determining the enclosed area (Jans et al 1993). The diameter of the gap was measured by taking the average of the diagonal distances from a central position of the gap.

Arial photograph interpretation

Two sets of aerial photographs taken in 1954 and 1990 were analyzed and interpreted with the aid of a stereoscope and the resultant photographs were digitized. The area under each forest type was calculated and the photographs compared with the vegetation data obtained from the current.

Soils sampling and analysis

Soils were collected in areas occupied by pure bamboo, bamboo-hardwood mixture and pure stands of hardwood. Soils were analyzed for calcium, potassium, magnesium, and sodium, available phosphorous, clay, nitrogen, organic matter, silt and pH.

Data analysis

SPSS and SAS packages were used for data analysis. The area of Echuya occupied by pure bamboo, bamboo-hardwood mixed with broad-leaved trees and pure broad-leaved trees in

1954, 1990 and at present was estimated. The Chi-square test was used to test whether or not the observed differences in area occupied by the different vegetation types in 1954,1990 and 1999 were significantly different, and current biological diversity was established.

3.3.4 Result and discussion

Tree species composition and distribution

A total of 2651 plants were recorded. Of these, 26.9% were trees and 53.2% was bamboo. Although there were few stems per ha, trees occupied a significantly larger area than bamboo. Forty-seven trees species were observed in Echuya forest and 11 trees species accounted for about 99% of all trees enumerated. Simpson's diversity index was low (1.73). The most dominant tree species were *Macaranga kilmandscharia (*8.2%), *Xymolas monspora* (5.5%) *Nuxia congesta* (4.6%*), Brillantaisia species* (4.2%), *macrocalyx* (3.6%), *Dombeya rotundifolia Hoschst*. (2.8%), *Psychotria species (*2.6%), *Measa lanceolata Foressk.* (2.1%) and *Arundinaria alpina* (53.1%). Tree species were observed in all transects, suggesting that hardwoods are colonizing the entire forest reserve and are not restricted to particular microhabitats.

Except for *Macaranga kilimandscharia*, most of the broad-leaved trees were represented in the seedling, pole and tree size classes. According to Runkles (1982), this is a characteristic of shade tolerance, because suppressed seedlings tend to persist under shade until a gap is created. This observation also shows that *Macaranga kilimandscharia*, a light demander, is the major colonizing tree species in Echuya forest. The presence of shade- tolerant tree species in the seedling and pole stages suggests that these species are in the process of establishing in the entire forest. Echuya is dominated by trees with Dbh. <20 cm dominate Echuya. The mean Dbh. was found to be 14.8cm. Large trees with Dbh. >20cm represented 2% of the trees in the forest. Trees with Dbh. > 20cm were colonizing species such as *Nuxia congesta*, *Polyscious fulva. Dombeya goetzenii*, *Spraque* and *Macaranga kilimandscharia*, with mean Dbh. of 32, 28, 26 and 26cm, respectively. Although there were no indicators suggesting past human activities such as logging, shade-tolerant mixed tree species were present in seedling and pole stages only. As no evidence of previous harvesting of hardwoods was observed in Echuya and large trees of the same species are known to exist in nearby Bwindi impenetrable forest, it can be said that Echuya is a young hard wood forest in the making.

Gaps and level of disturbance

Twenty-eight gaps with a mean area of 0.24ha were found. The majority of the gaps (76%) had *Mimulopsis* climbers, which suppressed bamboo growth. Felled trees formed 10% of the gaps. The rest were natural gaps created by natural tree fall. *Macaranga kilimascharia*, *Neobutania macrocalyx*, Hagenia species, *Galiniara* species, *Dombeya goetzenii*, *Xymolas monospora*, *Measa lanceolata*. *Allophyllus macrobotrys Beauv*, *Chrysophyllum* species, *Trichillia* species, *Draceana afromontanar*. *Lobelia* species and Nuxia *congesta* were dominant in the gaps. Bamboo was observed in all the plots, although there was a marked absence of young bamboo shoots in the plots with a heavy mass of climbers. This indicates

Minulopsis climbers affect the regeneration of bamboo. The area affected by climber entanglements was extended. Heavy entanglements also created large gaps. Climbers also suffocated short bamboo, leading to suppression and death of entire clusters. In such a forest the gaps are filled by shade-tolerant hardwood tree species. Aerial photographs taken in 1954 and 1990 show those broad-leaved trees were dominant at the edge of forest. This shows that the gaps were created at the forest edges through encroachment or harvesting of bamboo by local people and then colonized by hardwood species.

Aerial photograph interpretation

The aerial photographs taken in 1954 and 1990 and survey results of 1999 show Echuya forest has changed in size and composition. The area under forest cover has reduced from 133,320.3ha in 1954 to 3730.7 ha in 1990. The decrease in forest area is due to clearing of bamboo clusters that were located outside the forest reserve boundary at the time of reservation, settlement and cultivation, and encroachment on the forest reserve.

Aerial photographs taken in 1954 and 1990 also show changes in area under the different vegetation types in Echuya forest. The area occupied by pure bamboo decreased from 20.5% to 12.5%(Table 1). The area occupied by bamboo-hardwood mixture also decreased from 48.2% to 26.2% in the same period, whereas the area under hardwood trees increased from 16% to 51%. A Chi-square test showed that the changes in area under the different vegetation types were significant ($P>0.01$). This study confirms observations by local people that bamboo is being replaced by other vegetation types (Banana et al., 1993). The decrease in area occupied by pure bamboo is attributed to the increase in area occupied by hardwoods and bamboo-broad-leaved mixture. Reduction in total forested area is due to cultivation and establishment of settlements up to the forest reserve boundary.

Soils and ecological succession

Due to numerous volcanic activities in and around Echuya, there was continuous disturbance to soils and vegetation during the Pleistocene and recent periods (Kingston, 1968). Most of the volcanoes came from the neighboring and active Muhabura ranges. Soil formations on these fields is very slow and, were it not for the volcanic ash emitted during the eruptions, which weathers down rapidly, the soils in the area would be shallow and stony (Harrop, 1960). Much of the ash appears to have been emitted during the later stage of the eruption and this covered the lava rubble.

With the exception of soil pH, clay content and silt, physical and chemical properties of soil collected from pure bamboo, bamboo-hardwood mixture and pure hardwood areas did not differ significantly ($P>0.05$). However, soils from pure bamboo and pure hardwood sites had significantly higher clay content ($P>0.05$) and less silt content than from the bamboo-hardwood sites (Table2).

Table 1: Change in vegetation composition between 1954 and 1990 in Echuya forest

Vegetation type	1954 (Ha)	% Of each type	19901 ha	% Of ha
Pure bamboo	2730.5	21.5	474.4	12.7
Bamboo dominant-broadleaved	6424.6	50.5	976.11	26.2
Broad-leaved tree mixture				
Fields under fallow)	2138.2	16.8	1902.69	51.0
Swamps	399.8	3.0	36.61	1.0
Grass pasture	961.9	7.6	306.48	8.2
	73.5	0.6	34.43	0.9
Total	**12728.5**	**100**	**3730.72**	**100**

The change in vegetation area between 1954 and 1990 indicates the extent of clearance of bamboo stands that were located outside the forest reserve for cultivation and settlement.

There was no significant difference in the available phosphorous, potassium and sodium in the soils collected from three different locations (P> 0.05). This suggests that vegetation types alone are not responsible for the available phosphorous, potassium and sodium. However the minerals significantly decreased (P> 0.05) from A to C-horizon in all the sites (Table3). Thus, the null hypothesis that the physical and chemical characteristics of the soil were the same in different sites and hórizons was accepted, except for clays, silt and pH.

Table 2: Nutrient status in the main vegetation types in Echuya (meq/100g)

Nutrients	Bamboo	Bamboo-hardwood	Hardwood	F	LSD	P
Sand	67.4b	45.0a	48.5a	0.002	9.46	0.9714
Silt	19.4a	32.0b	21.5a	0.53	10.44	0.9714
Clay	13.1b	23.5a	30.0a	0.029	11.37	0.0800
OM	5.58a	4.54a	5.44a	0.002	9.46	0.8836
PH	4.625a	4.225b	4.575a	0.026	0.2885	0.0301
N	0.378a	0.305a	0.368a	0.180	0.0883	0.4884
Na	0.293a	0.268a	0.0.363a	0.014	0.4521	0.6807
K	0.390a	0.325a	0.340a	0.525	0.1352	0.8957
P	0.378a	0.305a	0.368a	0.180	0.0883	0.9431
Ca	3.3088a	3.60a	4.43b	0.008	0.697	0.12
Mg	1.020b	1.597a	1.757a	0.014	04521	0.107

Values in the same row followed by similar letter are not significantly different at P>0.005 according to Fisher's LDS test significantly at P>0.05

Table 3: Base values within vegetation types and among soil horizons in (meq/100)

	Sodium			Potassium			Calcium			Magnesium		
Soil horizon	PB	BM	PH	PB	BM	PH	PB	BM	PH	PB	BM	PH
Top	0.6	0.3	0.6	0.6	0.5	0.7	4.2	4.3	5.2	1.2.	2.0	2.2
A	0.2	0.2	0.3	0.3	0.3	0.3	3.1	4.1	5.0	1.3	2.1	2.0
B	0.2	0.2	0.3	0.2	0.2	0.2	3.0	3.1	4.2	1.0	1.3	1.8
C	0.2	0.3	0.3	0.4	0.3	0.2	2.0	2.9	3.3	0.6.	1.0	1.1

PB= pure bamboo, BM=bamboo-hardwood mix, PH=pure hardwood

This implies that the increase in regeneration of hardwood tree species in Echuya forest cannot be attributed to changes in soil characteristic alone.

3.3.5 Conclusions and recommendations

There is little evidence to suggest that the observed vegetation changes from bamboo forest to mixed hardwood forest over four decades in Echuya is due to changes in soil conditions. Field surveys showed that the changes are due to colonization of gaps by hardwoods. in Echuya, falling trees and bamboo due to heavy load of climbers is the major cause of gap creation.

The most probable cause of heavy loads of climbers is the absence of fire and herbivorous wild animals in the forest. According to oral history, Echuya forest had large herds of buffalos, elephants, antelopes and duikers (Banana et al. 1993). By 1960, most of wild game had become extinct due to widespread hunting by the local people.

It is also however likely that the exclusion of human activities from the forest after reservation may be affecting the ecological succession of Echuya. Before reservation, grazing of cattle and extensive use of fire in the process of grazing was practiced widely by the local communities. According to the Forest Department records, the last major fire outbreak in the forest occurred in 1960.

The impact of formal regulations after reservation, such as exclusion of fire from the forest and exclusion of livestock, appears to have gradually led to the conversion of grassland-bamboo ecosystem into hardwood forest ecosystem. Bamboo traditionally provides building poles, firewood and crafts materials to local forest users-groups. The local communities around Echuya forest are permitted to harvest forest produce for subsistence and commercial use. The continued displacement of bamboo from Echuya forest by hardwoods would no doubt impoverish local communities in the long run. It can therefore be recommended that local communities be encouraged to plant bamboo on their own farmlands for personal use.

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