Implications Of Fuel Wood Yield,Availability And Harvest In Tubah Mountain Forest,Cameroon

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***Abstract*-The paper focuses on the problems of wood fuel yield, availability and harvest. It investigates the underlying causes of the wood fuel crisis and establishes that the root causes are diverse and require a more comprehensive and objective view of the problem. The study demonstrates that focusing development efforts on wood fuels and the symptoms of their scarcity ignores the much broader and deeper strains in the environmental, social, economic and political fabric of which firewood scarcity is only one of the manifestations. It finally elaborates strategic guidelines for the sustainability of wood fuel resources based on the adoption of ecologically integrated land use systems and the appreciation of the complex, extremely dynamic, and multi-sectoral issues underlying the broader crisis of population pressure, food security, energy acquisition poverty and natural resource management.**

INTRODUCTION

Fuel wood and related energy problems are important and pressing concerns in their own right in developing countries. Since most Africans are poor and can afford or have access to little other than firewood, charcoal or crop animal residues to meet their basic energy needs, wood fuels dominate the energy economies of virtually all African countries. In sub – Saharan Africa they account for 60 to 95 percent of total national energy use, with the highest proportion in the poorest countries (FAO, 1983). It will take many years of rising incomes and infrastructure development before such countries can afford alternatives to this massive fuel wood dependence (Anderson et al., 1984). The shortage of fuel wood is very acute and it has been estimated that in Africa South of the Sahara close on two-thirds of the population were experiencing fuel shortages in 1980. It is expected that, by 2000, only nine million Africans will have adequate fuel wood supplies (Beets, 1989). The fuel wood situation is expected to have an increasing detrimental effect on the environment; shortages are threatening to disrupt the existing farming systems and the general social fabric (spears, 1986).The more obvious symptoms of this dependence are well known. In many places wood fuel resources are dwindling because of deforestation. As wood resources diminish and recede the cost of obtaining firewood whether in cash, or time for gathering them, are imposing severe and increasing strains on already marginal household survival and production strategies. These impacts are greatest for the poor and for women, who normally bear the responsibility of fuel provision and use (Williams, 1983). Over the past two or three decades the government of Cameroon adopted an energy policy, planning and donor aid structures to address the wood fuel crisis directly as a problem of energy supply and demand. The issues appeared quite simple and the solutions self-evident. Protected public forests were created. Foresters tried to increase firewood supplies with peri-urban plantations of eucalyptus and the promotion of rural people to create village energy woodlots. The Ministry of Mines and Energy tried to curb rising consumption of fuel wood by promoting more energy efficient cooking stoves in order to reduce pressure on the forest. These energy focused efforts have had little success and have failed to turn the tide of wood depletion. The misleading premise was that the use of wood fuels is the principal cause of deforestation. This provided a powerful economic rationale for all kinds of afforestation and conservation measures in peri-urban and semi-urban areas.

This study focuses on a survey of the Tubah cloud forest at the periphery of Bamenda city. The forest survey seeks to demonstrate that focusing development efforts on wood fuels and the symptoms of their scarcity is looking only at the tip of the proverbial iceberg, it ignores the much broader and deeper strains in the environmental, social, economic and political fabric of which firewood scarcity is only one of the manifestations. The study therefore, elaborates strategic guidelines for the sustainable development of the wood fuel sector.

I. Environmental Setting

Tubah Mountain range is part of the Cameroon Highlands. The range forms a ridge which divides Bambui village from Sabga Plateau, Bamessing and Babanki-Tungo in the Bamenda Highlands. This, ridge belongs to the geographical boundary between West and Central Africa, that is, the actual division of the large basins of the rivers Congo and Niger. The area has a very important diversity of plants and animals with numerous endemics particularly among the birds and vascular plants. The high and often very localized endemism is believed to have arisen during the Pleistocene age when climate changes caused the forest to retreat to the wetter mountainous areas, leaving tracts of forest or "refugia" cut off from one another. Within Cameroon, the most important refugia are thought to have existed in the areas surrounding Mount Cameroon, Mount Kupe and Bamenda Highlands (Stuart, 1986). Despite their scientific importance, these cloud forests of Cameroon have received little conservation attention. The Tubah montane forest is situated at an altitude of 1800 to 2200m and has a high conservation importance.

The slopes range from flat and gently sloping in the upland basins to very steep towards the ridges and downwards to

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streams. Rainfall varies from 1780 to 2290mm per year and most rain falls between July and September. Generally January and February have the lowest relative humidity (average 45 – 52%). The monthly average exceeds 80% in July and August. During the rainy season, mist and low cloud occur frequently. The rainy season lasts from mid – November to mid – March when the dry season sets in. Mean maximum temperature is 20 to 22oc and the mean minimum 13 to 14oc. November has the lowest mean minimum and December the highest mean maximum.

II. Socio-Economy and Land Use HistoryA

ccording to Nkwi and Warnier (1982) the Bamenda Highlands have experienced over 300 years of intensive cultivation and dramatic transformation of the montane forest landscape to a domesticated landscape characterized by a patchwork of farmlands, grasslands, fallows, woodlots, homegardens and montane forest refugia. The current population density of 100 persons per square kilometres is imposing serious biological stresses on montane forests. About 250 migrant farmers farm in the forest. Grazing takes place at the 2000 metre altitude and situated at the vicinity of Bamenda city and Bambui town fuel wood demands for both rural and urban needs increase this ecological stress. Slash – and – burn cultivation kills the trees. These are eventually harvested for fuel wood. An ethnobotanical study of the forest was undertaken in order to determine the livelihood activities provided by it. These are summarized in table 1.

Table 1: Ethnobotanical survey of Tubah mountain forest

.Scientific Name	Family Name	Local Uses
Acacia sp	*Mimosoideae*	Charcoal, Fencing, Firewood
Albizia coriara	*Mimosoideae*	Timber, Fencing, Charcoal, Firewood
Angaura salicifolia	*Ericaceae*	Highly medicinal
Bridelia Speciosa	*Euphorbiaceae*	Local tooth brush production
Canarium schwei	*Bursearaceae*	Fruits, shell, timber, medicinal
Cordia africana	*Boraginaceae*	Poles, carving, medicinal
Carapa grandifora	*Meliaceae*	Timber, poles
Croton macrost	*Euphorbiaceae*	Fencing, poles, timber, shade, medicinal
Entada abyssinica	*Mimosoideae*	Charcoal, poles, timber
Eucalyptus sp	*Wyrtaceae*	Timber, poles, fencing
Ficus sp	*Moraceae*	Shade, fencing, carving
Kigelia africana	*Bignoniaceae*	Carving, traditional
Cola allata	*Rubiaceae*	Medicinal, edible seeds
Lasiociphon glaucus	*Thymelaeceae*	Local production of papers and envelopes
Maespsis manii	/	Timber, shade, carving, medicinal
Newtonia buchananii	*Mosaceae*	Carving
Noubouldia laevis	*Bignoniaceae*	Timber, carving
Polyscia fulva	*Araliaceae*	Poles, timber, honey, charcoal
Schefflera abyssinica	*Araliaceae*	Timber, carving
Vitex diversifolia	*Verbenaceae*	Timber, carving
Vitex doniana	*Verbenaceae*	Edible fruits, carving
Voacanga sp	*Apocynaceae*	Seeds, medicinal, local and industrial poles, timber
Entandrophragma	*Meliaceae*	Timber (furniture)
Trema orientalis	*Ulmaceae*	Medicinal value for women
Xailobier sp	/	Fire wood
Pittosporum manii	*Pittosporaceae*	Furniture, medicinal
Prunus africana	*Rosaceae*	Highly medicinal bark
Nuxia congesta	*Loganiaceae*	Musical instruments
Faraga rubescens	*Rutaceae*	/
Khaya senegalensis	*Meliaceae*	Good timber
Raphia farinifera	*Palmae*	Fibre, handicraft, wine, construction bamboo, wood

From the ethrobotanical survey the needs of the mountain people from the forest are mainly timber, poles, fuel wood and charcoal. Most of the forest was intact by the 1920s. Increasing monetarization of the rural economy, urbanization and market orientation of livelihood activities after independence in 1960 accelerated the forest degradation process. Moreover, graziers entered the mountain in the sabga plateau by 1920. Overgrazing has since established a moribund vegetation landscape. Forest invasion by both farmers and graziers in recent years is resulting in social tensions, conflicts, inter-personal and inter-community bloody scuffles. Without any conservation status the forest is an open access resources facing a “tragedy of the commons”. The construction of the

Bamenda – Ndop Highway through the Sabga Pass between 1920 and 1940 opened the forest to growing urban centres at the middle and low altitude areas (Ndop, Bambui, Bamenda). Enormous quantities of fuelwood are harvested and staked along the highway destined for urban household consumption. Charcoal burners cause accidental bush fires which destroy large portions of the forest. Similarly, migrant farmers now have easy access to the cloud forest.

III. METHODS

The survey of the cloud forest was based on species characteristics such as functions, condition of tree and the ecology of sampled plots. Two approaches were used, that is the sampled plot and the transect approach. Pre-knowledge of the classification of the forest area was obtained from 1987 aerial photographs. These aerial photographs and base maps of the study area permitted the survey team after ground reconnaissance surveys to select plots for study within the different patches of the cloud forest. The patches of these remaining indigenous forests were mapped and are presented in figure 1. The various land use types are presented in table 2.
The fieldwork was carried out with the assistance of forestry technician and two agricultural technicians working in the area. With the background knowledge about the forest, sample plots were then selected by visual observation, when a plot was selected a central point with 10m radius was established forming a circular plot. This was followed by:
Measuring of distance and compass angle of each tree with a tape.
Identification of species and the estimates of volume of stems and branches.
Description of forest type and importance of fuel wood on the stand.
Identification and measurements were carried out on all trees enumerated as found within the circular plot. The measurements taken were:
Distance of tree to plot centre.
Distance between tree and measuring point of angle and circumference with the use of tapes.
Total height of the tree and stem height measured indirectly using a "sunnto" clinometre.
The direction of the tree to plot centre was measured using a compass while slopes were measured using an altimeter.
All tree measurements were for stem height determination, for volume computation of each tree species and plot volume of timber.
For each plot detailed information was collected on the following aspects:
Situation of plot and accessibility.
-Land use/exploitation.
Species composition, height and density of the forest.
Evidence of recent forest fires and fuel wood collection or harvesting.
Measurements on trees respected the following rules:
Measuring the circumference(c) at the height of 1.3m.
Measuring both stems if the fork of a tree is below 1.3m height.
Counting only trees with circumference larger than 31cm or a 10cm diameter (d).

$$C = d \times \pi \text{ where } \pi = 3.14.$$

The height of trees was estimated by the use of a clinometers. The following formulae were used for height measurement with clinometers.

TOTAL HEIGHT	(B3 – B1) x d x cos a	Where B1 = angle to bottom B3 = angle to top crown a = slope angle of the ground d = distance between tree and person.
STEM HEIGHT	(B2 – B1) x d x cos a	Where: B1 = angle to bottom B3 = angle to top crown a = slope angle of the ground d = distance between tree and person

Final volume calculations were made by employing the following formula:

$$\frac{(\pi \, . \, D2 \, . \, H)}{4}$$

Where: V = volume

H =

Tree = 0.785398 stem height

D =

average diameter of tree of breast height i.e. 1.3m

$$\frac{\pi}{4}$$

The volume of wood (m3) per hectare of forest stand was established from the above calculations. Based on an average farm size of 8 persons and a monthly average fuel wood consumption of 3m3 the rate of deforestation was estimated in order to establish the final exhaustion time. Informal interviews of migrant farmers and farm family heads in Tubah community identified the root causes and the effects of deforestation. These assisted in the elaboration of strategies for the sustainable management of land resources, and a strategy that can turn the tide towards the sustainability of wood fuels.

IV. RESULTS

The original vegetation of montane and sub-montane forest is fast disappearing. Among the tree species, which dominate, are Croton, Albizzia, Trama, Ficus, Newtonia, Polysias, fulva, and Cimbretum. Apart from these, Vocanga, Maissa, Phonix, reclinata and a large variety of plants which form a thick undergrowth in undisturbed forest areas. The undergrowth is slashed and set on fire. Trees scorch at their base and quickly dry up and die. The biodiversity of the forest is being lost due to this destructive practice.

Table 2: Vegetation and Land use on different sites (figure 1).

Location Name	Area (ha)	Indigenous forest	Subsistence farming	Grazing land	Bush land and fallow
Bambili upland	750 ha	~200 ha 26%	~ 100 ha 13.3%	250 ha 33.3%	~ 200 ha 26%
Bafunge upland	1400 ha	240 ha 17.1%	> 200ha 14.2%	959 ha 68.5%	?? Seasonal grazing
Tchabal (Bamessing)	770 ha (+)	~ 60 ha 7.7%	10 ha 0.1%	600 ha 77.9%	??? Seasonal grazing
Bambili	600 ha	Totally degraded	Large area ~ 200	Mainly grazing 400	None
Tchabal (Kedjom K)	430 ha	None left	Less than 250 ha	Mainly grazing 300	??? Seasonal grazing
TOTAL	3950	500	760	2509	???

Grazing land, as elsewhere in Cameroon is burnt every year by the graziers, mainly to stimulate regrowth in the early rainy season. Generally the pastures are in a poor state, badly eroded and have a very low fodder potential and have a widespread growth of the fern between the dominating stubbles of Sporobolos grass. Table 2 presents some approximate data on the vegetation and land use based on a rough cartographic survey of the study area. The increase in population combined with improved market access (the area is located at the urban fringe) has meant that farmers are cropping more intensively than before and the traditional system of fallowing for 10 to 15 years is faltering. The slash and burn cultivation system has destroyed most of the cloud forest to the extent that remaining patches are mainly in upland riparian areas. Cattle grazing and associated annual bush fires accelerated the degradation and fragmentation of the natural forest. The following is a description of the sampled plots.

PLOT 1:

Altitude: 2010m and 2030m above sea level.

Floristic composition: Lasiocephon glaucas, croton macrostachyus, Bridelian sp. And Nuxia sp. With Nuxia being the dominant species. Generally an open wood with an open canopy. The undergrowth is composed of Bracken fern. Sporobolus Africnas, Cedar circulata, and Aframumun sp. Sporobolus is the dominant grass.

Land use: site is partially used by graziers and was partially burnt to stimulate new growth for cattle. Signs of timber and fuel wood extraction were visible.

PLOT 2

Altitude: 1910m and 1930m above sea level.

Floristic composition: Trees include Carapa grandifolia, Ficus oreodryadum, Canarium schwei, Schefflera

Floristic composition: Trees included Albizia, Carapa, and Voacanga, with Carapa being the dominant species. Trees were very tall forming a one layer close canopy. The undergrowth was composed of Aframumum, Bracken fern and Sporobolus africanus.

Land use: Evidence of bush fires was visible on tree trunks and the undergrowth. Cattle tracks at the forest fringe were

abyssinica, Newtonia buchananii with Carapa and Canarium being dominants. This was a dense forest area with a close canopy, with shrubs, climbers, twigs and grasses interwoven, and forming a thicket. The forest floor was covered with dense litter, dead tree logs and branches, fresh and dry leaves. Aframumum and Bracken fern were dominant undergrowth.

Land use: Some timber and fuelwood extraction and signs of dry season bush fires on trees trunks.

PLOT 3

Altitude: 1800m above sea level.

Floristic composition: Similar to plot 2. The dominant species was Carapa grandifolia.

Land use: Some timber and fuelwood extraction and signs of dry season bush fires on tree trunks.

PLOT 4

Altitude: 1840m to 1858 above sea level.

Floristic composition: Hill slope completely burnt by slash-and-burn cultivation. Signs of burning were concentrated on tree stumps. Few trees included Croton, Albizia and Bridelia, with Bridelia being the dominant species.

1

PLOT 5

Altitude: 1920 above sea level

Floristic composition: Tall trees with a one canopy layer: Albizia, Carapa, and Voacanga, with Voacanga being the dominant species. The forest floor was clean (probably swept by bush fires).

Land use: Plot accessible by cattle track close to a stream. Plot undergrowth probably degraded by grazing and bush fires during the dry season. Visible signs of fuelwood extraction and logging were present.

PLOT 6

Altitude: 1020m above sea level.

also indicative of some grazing. Fuelwood extraction and logging were also visible.

The volume of wood (cubic metres per sampled plot) was then determined. Wood is extracted for various purposes: charcoal, fencing, fuelwood, construction timber, poles, carving, tooth brush production, production of packaging bags, fabrication of musical instruments and bridges. The volume of wood in the remaining forest expressed in cubic metres per hectare is presented in table 3. Table 4 is derived from table 3.

Table 4: Fuel wood indicators for Tubah communities

PLOT 1

Lasiociphon	1.49	47.422
Nuxia	1.78	56.652
Croton	0.5	15.913
Bridelia	1.43	45.512
Total	5.2	165.499

PLOT 2

Capara	3.42	108.848
Ficus	0.22	7.001
Canarium	3.35	106.62
Total	6.99	222.469

PLOT 3

Wink	13.7	436.028
Capara	3.7	117.759
Khaya	0.5	15.913
Unident	3.5	111.394
Total	21.4	681.094

PLOT 4

Croton	3.12	99.300
Bridelia	4.19	133.355
Albizia	6.33	210.464
Total	13.64	434.119

PLOT 5

Carapa	1.130	35.964
Unident	0.84	35.964
Newtonia	10.9	346.913
Birdelia	2.36	75.111
Total	15.230	484.723

PLOT 6

Albizia	4.52	143.857
Unident	.18	5.729
Capara	3.6	114.577
Voacanga	.03	.955
Total	8.330	265.120

	2.253.024 m^3
Average volume per hectare	375.504 m^3
Standing volume for Tubah forest (500 ha)	187.752.000 m^3
No. of farm families in Tubah (1998)	2.362 families
Average fuel wood requirements/month/family	3.0 m^3
Annual fuel wood requirement/family	36.0 m^3
Annual fuel wood requirement for communities	58.860 m^3
Annual fuel wood requirement as a percentage of standing wood per hectare	22.8%
No. of years required to totally degrade a hectare by fuel wood harvesting alone	53 months or 4.4 years

Assuming an average farm size of 8 persons table 4 presents an analysis of the wood demands of the Tubah community. In 1998 the population dependent on the Tubah forest for their livelihood was estimated to be 18.891 inhabitants or 2362 farm families, with an estimated annual growth rate of 3.8%. This population will be 24.527 and 35.613 inhabitants in 2005 and 2015 respectively. Deforestation is attributed to slash-and-burn shifting cultivation, harvesting of construction wood and medicinal plants, fuel wood and inadequacies in the supply of forest products to the masses. The forest originally covered 3950 hectares. Today only 500 hectares of indigenous forest are left. Slash and burn shifting cultivation has degraded about 850 hectares and grazing by pastoral tribes on an estimated

2509 hectares. The remaining indigenous forest is refuged in narrow upland riparian areas (figure 1). The following were identified as the possible causes of the alarming threat to the forest; ignorance of the value of forest protection, lack of water and grazing resources, lack of integration of forest protection into local economy, poor communication between local rural development workers and local people resulting to misconceptions, lack of funding for forest management, top-down approaches and political interference by administrative and technical officers. The pressure on fuelwood extraction is increasing as it becomes more profitable to sell wood. Growing urban populations are becoming reliant on wood from rural areas accessible by motorable roads.

Figure 2 presents an analysis of the core problem, that is, poor or unsustainable harvesting of products from the montane forest and their effects. Apart from the fuel wood crisis, rural people sense the following effects of deforestation; loss of biodiversity, water contamination, soil erosion, dry season potable water shortages, farmer grazier conflicts, land disputes and poor crop yields under slash-and-burn cultivation. These are the consequences of poor forest resources management whose root cases are: annual bush fires, grazing encroachment into forests, population pressure resulting in invasion of upland forests by landless farmers, institutional weakness and inefficient extension service, poor farming methods, poor grazing methods, and gender/land ownership problems related to adoption of agroforestry practices and the establishment of woodlots. Limited access to credit and training also hamper the adoption of agroforesty practices. The prices of staple foods are low hence obliging farmers to migrate to afro-alpine zones where market gardening is more profitable. Figure 2 identifies the strategies that can resolve the fuel wood scarcity problem using ecologically integrated land use systems.

V. Discussion and Conclusion

An ethnobotanical survey of Tubah cloud forest reveals that it supports several livelihood activities. Some 23 tree species out of 30 species (76.7%) provide wood for diverse purposes. These range from fuel wood, fencing poles, charcoal, construction timber, carving wood, furniture, and other handicrafts. Non-timber forest products account for 23.3% of the uses. Fuel wood demands and An ethnobotanical survey of Tubah cloud forest reveals that it supports several livelihood activities. Some 23 tree species out of 30 species (76.7%) provide wood for diverse purposes. These range from fuel wood, fencing poles, charcoal, construction timber, carving wood, furniture, and other handicrafts. Non-timber forest products account for 23.3% of the uses. Fuel wood demands and construction wood (timber) requirements are imposing a severe strain on tree species such as Lasiociphon glaucus, Nuxia congesta, croton macrostachyus, Bridelia micrantha, carapa grandiflora, ficus spp. Canarium sp,. Khaya, Albizia gummifera, Newtonia and voacanga.

Annual fuel wood requirements per farm family for the Tubah community are 36m3/year. The annual fuel wood requirements for this community of 2,362 farm families stands at 58,860 m3 or 22.85% of the standing wood per hectare. At the current population growth rate of 3.8% it will take 4.4 years for the community to totally destroy a hectare of the remaining forest. 4.4 years of degradation by wood fuel demand does not reflect the underlying causes of deforestation and can mislead rural development policy to heal symptoms rather that root causes. The study established that fuel wood and timber extraction were not major activities causing forest degradation. These are secondary processes intensifying degradation. After areas have been cleared for farming then the resulting dead timber is removed for fuel wood and timber. Similarly timber from fire damaged forest is utilized for fuel. Grazing also causes shrinking forest borders.

These findings show that a more comprehensive and objective view of wood fuels is needed and that there are no single, simple answers and that the problems surrounding them are inseparably linked to the complex, diverse, extremely dynamic and multi-sectoral issues underlying the broader crisis of population pressure, food security, poverty, land and natural resource management. These are summarized in figure 2. Successful remedies for the fuel wood crisis must therefore be firmly rooted in this broader context. Most farming systems in sub – Saharan Africa are subsistence systems where the use of land is directed towards satisfying the basic needs of food, fuel, fibre, medicine and shelter. It is therefore apparent that they constitute a prime area for the adoption of ecologically integrated land use systems and agroforestry must form an element of such systems. If interventions are to create lasting successes they must recognise at least three basic factors:

- The need for local assessment and actions and the unhelpful nature of large scale averages. The "landscapes" and "peoplescapes" of rural areas are extremely diverse. Problems and opportunities for solving them are therefore specific to place and to social groups in each place. The aim therefore should be to reach underlying causes rather than heal the symptoms;
- The need for indirect approaches to wood fuel issues and greater participation by local people at every stage to help them to prioritise and solve their own problems. This follows from the first point, and also from the fact that success normally depends on starting and strengthening processes rather than delivering technical packages on "how" rather than "what" things are done; and
- The need for decentralized and multi-disciplinary approaches, including the use of competent and

trusted “grassroots” agencies, to facilitate the two first points. However, this does not exclude the need for economic, legal and political initiatives at the macro-level to improve the broad contexts for local, positive change.

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