Survey of fuel wood and service wood production and consumption in the Sudano-Sahelian region of Central Africa : the case of Garoua, Cameroon and its rural environs

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Survey of fuel wood and service wood production and consumption in the Sudano-Sahelian region of Central Africa

The case of Garoua, Cameroon and its rural environs

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Abstract — The continuous dependence of Man on fuel and service wood results in serious degradation of the fragile savanna ecosystem. A **s**urvey of fuel wood and service wood production and consumption was carried out in Garoua, Cameroon, and its rural environs. Results show that all the rural population is 100% dependent on wood energy while 59% of the urban population depend entirely on fuel wood and another 28% of the urban households use wood in combination with alternative heat energy sources. A kg of wood sells for 33 FCFA in Garoua compared to an average price of 10 F/kg in the rural area. This price varies according to seasons ; wood being more expensive in the rainy season. The average wood consumption in the rural area is 1.2 kg/person/day compared to 0.80 kg/person/day in town. 23.9% of rural households use improved fireplaces. Their average consumption of 1.05 kg/person/day saves 11.2% on wood consumption. 68.9 % of the rural population harvests wood from the natural forest while only 3.6% gets its supply from tree plantations. Harvesting in the natural forest is indiscriminate and results in severe environmental degradation**.** Some **r**ecommendations for sustainable management and for reducing wood consumption are made.

Résumé — Suivi de la production et de la consommation de bois de feu et de service dans la zone soudano-sahélienne d'Afrique centrale : Le cas de Garoua, Cameroun et de ses environs. L'utilisation continue par l'homme de bois de feu et de service conduit à une forte dégradation des fragiles écosystèmes de savanes. Une enquête sur la production et la consommation de bois de feu et de bois de service a été conduite à Garoua, Cameroun, et dans les environs. Les résultats montrent que la population rurale est à 100 % dépendante du bois comme source d'énergie tandis qu'en ville 59 % de la population dépend complètement du bois pour la cuisine et 28 % utilisent le bois en plus d'autres sources d'énergie. Un kg de bois est vendu 33 F CFA à Garoua contre 10 F/kg en zone rurale. Ce prix varie selon les saisons : il est plus élevé en saison des pluies. La consommation moyenne de bois dans les zones rurales est de 1,2 kg/personne/jour contre 0,80 kg/personne/jour en ville. 23,9 % des ménages ruraux utilisent des foyers améliorés. Leur consommation des bois est de 1,05 kg/personne/jour, soit une économie de 11,2 %. 68,9 % de la population rurale exploite le bois des forêts naturelles ; seulement 3,6% exploitent des plantations. L'exploitation des forêts naturelles n'est pas raisonnée et il en résulte une dégradation sévère. Des recommandations sont faites pour une gestion durable des forêts et pour diminuer la consommation de bois.

Introduction

Wood use/consumption

Wood is one of the oldest sources of energy and commonest service material known to Man and has been used for over 500 000 years (Sharpe, 1976). Factors such as family size, cost of wood, season, type of cooking device, alternative energy sources and the type of wood determine the level of wood consumption (Hamed, 1990). According to FAO (1995), 2 out of 5 people worldwide depend on wood or charcoal as a source of domestic energy. Floor (1997) stated that wood represented 60 to 90% of the energy consumption of Africans.

In the dry savanna zone of Africa, wood is the major source of energy (Keita, 1987) and it is also used as service wood. In the Sudan and Sahel climatic zones, majority of the urban population and the totality of the rural people depend exclusively on wood for heat energy (Hamed, 1990).

A study conducted in the Sahel by CILSS - Comité inter-Etats de lutte contre la sécheresse au Sahel - (1978) evaluated the total wood energy consumption for this zone to be 16 million m^3/year. This corresponded to 0.6 m^3/person/year. Mali's consumption in the rural zones varied between 0.7 and 2.1 kg/person/day (ESMAP, 1992 In: Basile, 1997). Guinea Bissau's consumption was estimated at 0.4 kg/person/day and 0.5 kg of charcoal/person/day in the urban zones, while rural consumption was estimated at between 1.7 to 1.9 kg/person/day (Diombera, 1993). The consumption of Ouagadougou (Burkina Faso) stood at 1.3 kg/person/day (Ouedrago, 1974). That of Niamey was 0.8 kg/person/day (Delwaulle et Roederer, 1973). Approximately 70% of the population of Cameroon depend wholly on firewood for cooking and another 20% use wood or charcoal to supplement alternative energy sources (Njiti and Sharpe, 1994).

In Maroua (200 km north of Garoua), there has been inconsistent figures for wood consumption: A survey of 267 households led to an estimate of 1 kg/person/day and about 39 000 tons/year for the town (AFVP, 1989). During this same period, the same author gave another estimate of 0.7 kg/person/day and about 27 000 tons/year obtained by measuring the daily consumption of 55 families for a week. A third survey reported by the same source, based on the flow of wood into Maroua during 7 days, estimated an annual flow of 33 000 tons. Differences between the wood flow (traffic) survey and the household consumption survey could probably result from the fact that the household surveys dealt strictly with fuel wood while in the wood traffic survey, some of the wood transported might have been destined for other uses. Assan (1991), in a survey where households declared the quantity of wood used, estimated consumption for Maroua at 1.6 kg/person/day. A survey of wood consumption in Garoua estimated consumption to be 0.9 kg/person/day (Agostini *et al.* 1985). In rural areas where other sources of domestic energy are absent, fuel wood consumption is usually higher.

Problem

The continuous dependence of the rural population and a major portion of urban inhabitants entirely on fuel wood and service wood results in serious degradation of the fragile savanna ecosystem. At the same time, a switch to alternative heat energy sources is slow while knowledge of the mechanisms and the extent of production and consumption in the Central African Zone remains superficial.

Objective

To determine the manner in which rural and urban duelers resolve the problem of wood production and consumption. More specifically, to identify the major wood supply axis to Garoua, determine the mode of production, transportation and commercialization, estimate consumption by households and industries, compare alternative heat energy and wood, and identify strategies for reducing consumption.

Justification

The major work of Agostini *et al.* (1985) on wood consumption in Garoua town needs to be updated given the evolution of events, especially the rise of the Garoua population from less than 142 000 in 1987 to an extrapolated (growth rate of 2.9/yr.) figure of 293 000 inhabitants in 2000. Some work was carried out on the flow of wood into Garoua in 1992 by the Forestry team of NEB (Nord–Est Bénoué)

project but according to Peltier *et al*. (1993) this was limited to the cost and weight of wood sold on the different roads converging into Garoua. Furthermore, Floor, in Basile (1997), stated that in 1991, the commerce of wood in Africa was worth a turn over of 5 billion U.S dollars but that the fuel wood sector remained poorly understood. To our knowledge, the aspects of rural production and consumption of wood have never been treated. Unlike previous studies in this zone, this study evaluates the commercial fuel wood, charcoal, and service wood consumption in addition to household consumption. World Bank (1985) estimated that in 1980, 90% of the countries in the Sudan and Sahel zones had populations exceeding the acceptable ecological carrying capacity. This study was aimed at providing basic data for the sustainable management and a better understanding of wood resources in the region.

Materials and Methods

The study was carried out in Garoua Town, Benoue Division, and the rural area within a radius of 50 km from the town's centre. This zone was retained because it is considered to be the zone that essentially supplies Garoua with wood. According to Peltier *et al* (1993), it is within this zone that reforestation or management for the production of wood can have the spontaneous interest of the population. This zone is characterized by the presence of plains and hills with altitudes varying between 150 and 600 m, an annual rainfall of 900-1000 mm and high temperatures with monthly averages attaining 35°c.

The 1987 population census revealed a population of 141 839 for Garoua. In 1998, this population was estimated at 230 000 (Ministère de l'administration territoriale, 1998). Presently, the Garoua urban council estimates the population to be 293 000 inhabitants, with an average household size of 5 persons. The rural population for the Bénoué Division according to the 1987 census stood at 126 720 inhabitants. With the national population growth rate of 2.9% (neglecting immigration), the present rural population for the Bénoué Division can be estimated as, 178 186 inhabitants.

Data was collected by survey. Appropriate questionnaires were addressed to rural producers, consumers and vendors and to urban vendors, urban household consumers and urban industrial or commercial wood consumers. The rural area of Garoua within a radius of 50 km was divided into four blocks (quadrants) for even representation (Table I). A number of localities or villages were selected for survey from each block depending on the size of the block. A total of 31 localities were selected based on map information, actual field experience, and access. A questionnaire on rural wood production and consumption was administered to a certain number of households (1 person/household). The questionnaire dealt with (among others), the mode of production (exploitation), species exploited, quantity, mode of transportation from the point of production to the house or market, quantity of wood consumed, alternative energy sources used, and precautions taken to economize energy consumption. The questionnaire was administered strictly to family heads in order to avoid duplication of information.

Table I. List of rural localities surveyed for wood production and consumption.

Block (Axe)	*Localities*	Distance range from Garoua (km)	*Number of people surveyed*
Block I	8	19-64	45
Block II	7	27-74	50
Block III	13	10-75	106
Block IV	3	55-100	21
General total	31		222

The quantity of wood exploited, consumed, or sold by every interviewed person was estimated by weighing a sample presented to us by the respondent. The number of poles and sticks used was estimated for each household and multiplied by the average weight of one pole obtained by weighing 37 carrying poles, 50 roofing poles and 50 fencing sticks.

The survey of urban wood vendors in Garoua was carried out based on the 21 residential quarters in the town. All commercial wood depots were visited and the vendors interviewed. The questionnaire among other things dealt with source of supply, the cost of wood, and other costs related to the wood activity. Vendors generally classify wood according to prize categories (2 000, 1 000, 500, 100, and 50 FCFA). Samples for each of these categories were weighed and the average prize per kilogram determined.

A questionnaire was designed for household consumption in the urban area and was administered to 586 households (1% of the number of households in Garoua) evenly distributed (27 households/quarter) among the 21 residential quarters except for larger quarters (Laindé and Djamboutou) which received 36 and 37 respectively. Households to be surveyed were randomly selected.

The questionnaire was administered to an adult member of each household irrespective of whether the household uses wood or not. The quantity of wood and alternative heat energy (gas, kerosene and electricity) consumed per given period were evaluated. Only bought charcoal (as opposed to charcoal obtained as a by-product of household wood use) was weighed. Pieces of service wood used per household were counted and multiplied by the average weight for each category of wood. 32 carrying poles were weighed in town as an addition to the 37 weighed in the rural zone to determine the average weight of a pole.

Urban commercial (industrial) wood consumers were grouped into four categories (local breweries, restaurants, roasted meat or "soya" vendors, and blacksmiths) and the sample size was determined by a pre-survey carried out during the household consumption survey (Table 2).

For each category, the sample was randomly chosen from each residential quarter and the questionnaire, administered to the proprietor, requested information on quantity of wood consumed per given period, cost/kg and source of supply.

Table II. Sample size for industrial wood consumers in Garoua.

Consumer Category	Population	Sample size (%)
Local breweries	415	10
Restaurants	33	51.5
Soya vendors	80	50.0
Blacksmiths	18	50.0

Results and discussion

Rural wood production

Wood exploitation is more intensive in the dry season because access to the sources of collection is easier and no farming activity is going on. There are essentially four sources. The relative importance of each of these sources is shown in Table 3. 68.9 % of the rural population harvests wood from the natural forest while only 3.6% gets its supply from tree plantations. These results are in harmony with those of Assan (1991) who reported that over 70% of the wood supply in Maroua was from the natural vegetation and that the targeted species, like many in the dry savanna, are multipurpose. Harvesting in the natural forest is indiscriminate. The choice of cutting shrubs, whole trees or branches, dead or live trees, depends on the harvester. The meagre contribution of plantations is a clear indication of man's continuous dependence on the free wood from Mother Nature.

More recently, tree planting on privately owned lands seem to be gaining grounds in the North Province. According to Maggi (1992), 66 private plantations of live fences and wood lots were realized in the NEB project zone in 1991. According to Peltier *et al.* (1993), tree planters in this zone prefer *Eucalyptus camaldulensis* for poles and firewood, *Azadirachta indica* for shade, and fruit trees (*Mangifera indica, Citrus aurantifolia, Psidium guajava* and *Anarcardium occidentale)*. Njiti (1987), stated that the establishment of plantations close to an urban dwelling can be a solution to fuel wood problems. However productivity of species in plantation is an important factor for the undertaking of a plantation project for urban wood supply. Harmand *et al. (*1997) gave the plantation productivity of some local and exotic dry zone trees in North Cameroon by rainfall and soil type. Species exploited from plantations are *Eucalyptus camaldulensis, Cassia siamea, Azadirachta indica,* and *Gmelina arborea*. These plantations are small in size, relatively young and too few to have any impact on zonal wood supply. The fact that they are few is due to ignorance and technical problems, cost of plantation establishment and also because in most cases the villagers cannot plant trees. Tree planting is considered as land appropriation contrary to the traditional land tenure system in practice in many localities. Curiously enough, 58.6% of the 222 persons interviewed proposed artificial regeneration as a solution to the wood problem. It was said that

poles are harvested from fresh wood and at a relatively young age. According to Salem and Nao (1981), different agro-forestry technologies could enable the cultivation of trees for firewood and other benefits on 2 to 5% of agricultural lands without any loss in production.

New farmlands are a characteristic of pioneer fronts. In the course of setting up a farm, the farmer cuts or kills the trees in the plot by burning to facilitate farm operations. He later collects and sells the wood which is generally of good quality and attracts a good market if access is no problem. A good market usually pushes the farmer to cut more trees than he may do in other circumstances.

Table III. Distribution of the 222 respondents among wood sources.

Wood source	*Number of users*	*Percentage (%)*
Natural forest	153	68.9
New farmlands	38	17.1
Plantations	8	3.6
Farm and forest	23	10.4
Total	222	100

Species exploited

Species which do not essentially serve as a food source, burn well and smoke less are exploited for fuel wood. Some species which are known to produce gradual and good flame are much more preferred. Being dense and resistant to rot and insect attack, these same species are exploited for service wood too. Table 4 shows the list of species exploited for these characteristics while Figures 1 and 2 indicate how many times the main species were cited for each use by respondents.

Table IV. List of species respondents cited as good for fuel wood and service wood.

Scientific name	*Fufuldé name (phonetic spelling)*
Acacia nilotica	*Gabdi*
Acacia senegal	*Pattulkelhi*
Acacia seyal	*Silluki-Bodehi*
Anogeissus leiocarpus	*Kodjolé*
Azadirachta indica	*Neem*
Balanites aegyptiaca	*Tanné*
Combretum glutinosum	*Houski*
Dalbergia melanoxylon	*Gelhelahi*
Diospyros mespiliformis	*Nelbi*
Entanda africana	*Fado wandu*
Eucalyptus camaldulensis	
Gardenia ternifolia	*Dingali*
Guierra senegalensis	*Geloki*
Khaya senegelensis	*Dalehi*
Mitragyna inermis	*Koli*
Piliostigma reticulatum	*Barkedjé*
Prosopis africana	*Kohé*
Tamarindus indica	*Jabbi*
Terminalia reticulata	*Kouladjé*
Ziziphus mucronata	*Djabbi-Gorki*

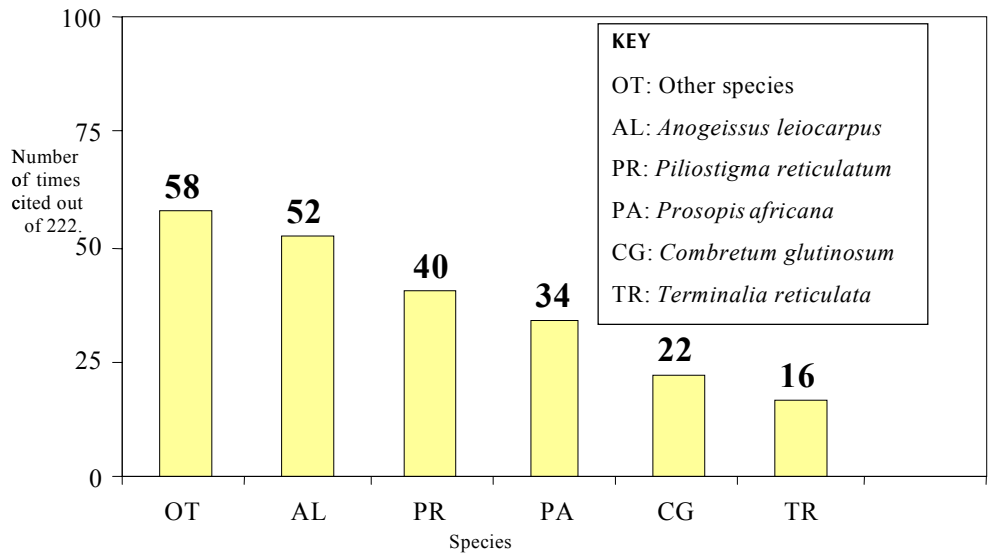

Figure 1: Main species exploited for fuel

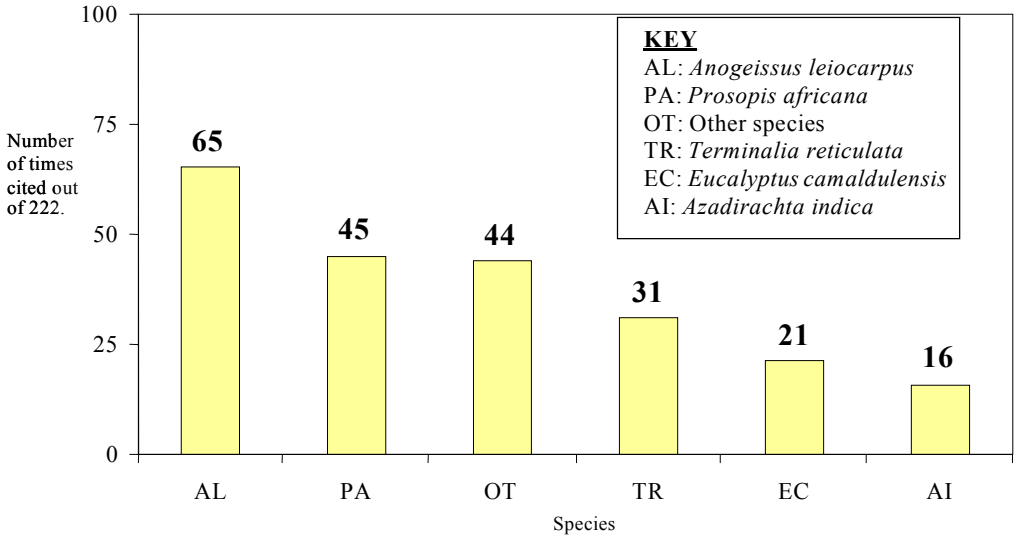

Figure 2: Main species exploited for service wood.

Wood production axis

Almost all the localities in the area are wood producers. However not all the zones supply wood to Garoua. As showed in Table 5, the most prominent wood supply axis are the Garoua–Nakong–Barnaké, Garoua–Demsa–Barnaké and Garoua–Ngaoundéré. The non-existence of supply in a particular locality indicates how much the locality has been deforested. The Garoua–Ngaoundéré and Garoua–Maroua axis along the tarred road remain powerful suppliers despite deforestation because the high level of demand from road users encourage the residents to continue to go further into the forest in search of wood.

Table V. Zones surveyed for wood production and their supply potentials to Garoua.

Road axis	Locality	Garoua (km)	Distance to point of collection (km)	Cost /kg at roadside (F CFA)	Relative supply status
Garoua – Nakong – Barnaké	Nakong	19	< 2	6.5	Very important
	Guibjol	25	< 1	6.5	Very important
	Tséraché	34	< 1	6.5	Very important
Garoua – Touroua	Boumédjé	55	< 3	7.6	Less important
	Horécardo	75	< 3	8.7	Less important
	Mayo Karlaye	100	< 4	6.5	Less important
Garoua – Demsa – Banarké	Bamanga	50	< 4	6.3	Nonexistent
	Fessango II	52	< 1	4.0	Very important
	Barnaké	64	< 4	5	Nonexistent
Garoua – Dembo	Nassarao	42	< 1	6.5	Very important
	Bachéo	44	< 3	6.8	Nonexistent
	Hama Koussou	46	< 4	7.5	Nonexistent
	Bachéo Dembo	64	< 4	4.5	Nonexistent
Garoua – Ngaoundéré	Bocklé	10	< 4	16.5	Important
	Mafakilda	20	< 3	16.5	Important
	Ouro Donkia	28	< 3	15.0	Important
	Karéwa	31	< 3	8.3	Less important
	Laindé Massa	33	< 4	8	Less important
	Ndjola	33	< 4	15.6	Less important
	Ngong	40	< 5	18.0	Less important
	Bame	44	< 4	15.0	Less important
	Tongo kaiwan	54	< 4	15.2	Less important
	Ouro Manda	65	< 4	8.0	Important
	Bocki	75	< 3	8.0	Important
Garoua – Ngong – Lagdo	Maidjardou	52	< 3	15.2	Less important
Garoua – Bibémi	Langui pionier	27	< 5	13.3	Nonexistent
	Badjouma	36	< 5	13.0	Nonexistent
	Ouro Mboki	48	< 5	10.0	Nonexistent
Garoua – Maroua	Badjouma	34	< 5	12.6	Less important
	Radié	54	< 4	7.1	Nonexistent
	Boula – Ibib Séboré	74	< 3	7.1	Less important

Key: Very important: 50–100% ; Important: 30–49%; Less important: 1–29%; Nonexistent: 0% of those surveyed supply wood to Garoua

Wood transportation, supply channels, and prices

Transportation

In the rural areas, wood is mostly transported by head from the bush to the village or road side (market) as reported by 69.4% of those surveyed. 8.1% use trucks; 9.5% use bicycles and only 1.7% use motorcycles. 11.3% harvest and sell in the bush. On the other hand, the villagers reported that all forms of transport are used in transporting wood to Garoua. These findings can be compared to those obtained by Assan (1991). He had the following frequency percentages of wood transportation in Maroua: bicycle 49.5%, head 30.2%, vehicle 12.1%, hand-pushed truck 2.8%, cart 2.2%, donkey 2% and motorcycle 1.2%. It should be noted that although transportation by head and bicycle is very common, the wood

volume transported is very little compared to transportation by vehicle though the latter is less frequent. The author also found that the 30.2% who transport wood by head are composed of 61.1% women, 26.5% children and 12.4% men.

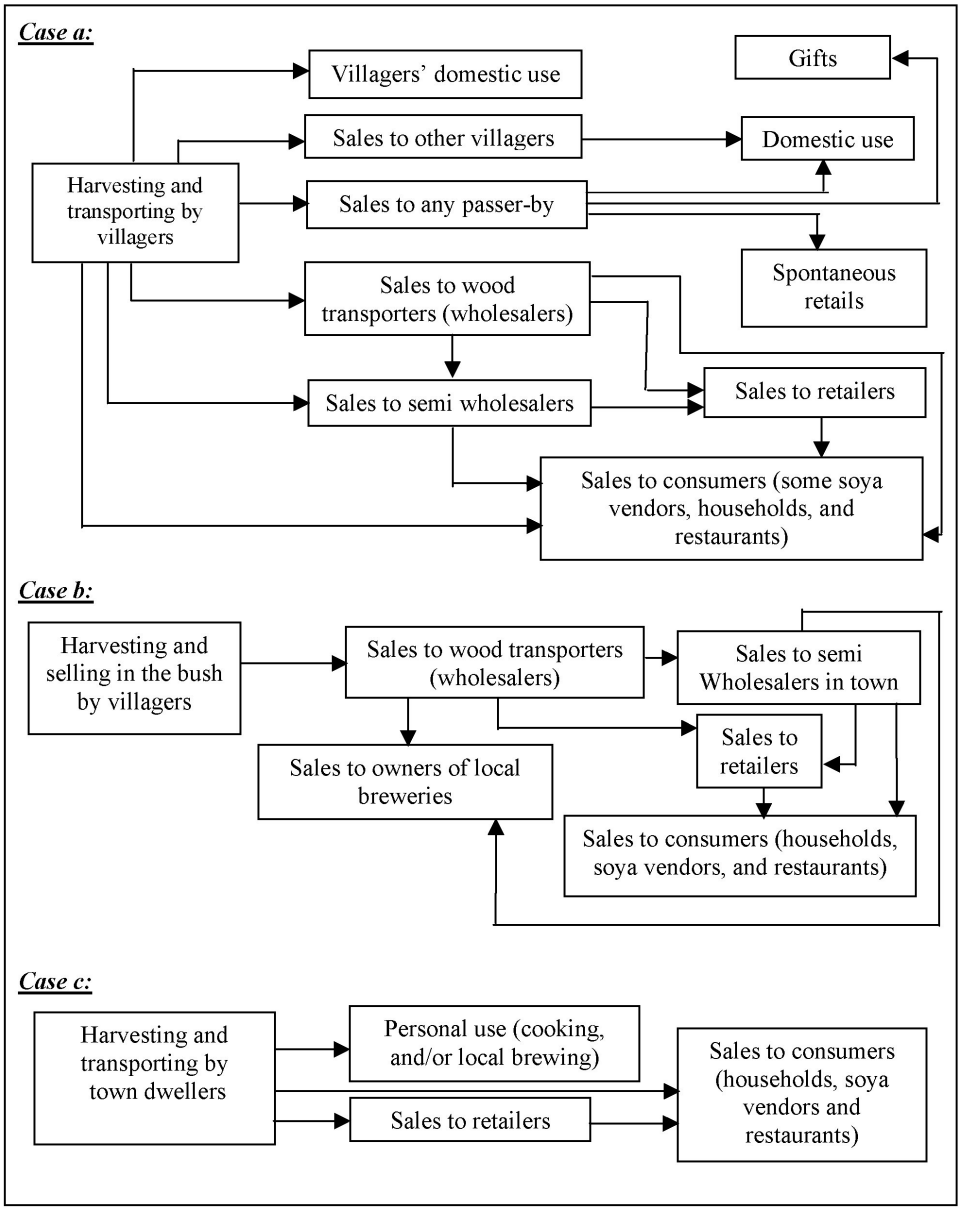

Figure 3. Wood supply channels identified in the Garoua region.

Supply channels

Three different supply channels for wood to Garoua and its environs are identified as illustrated in cases a, b, and c in Figure 3. In cases b and c, the transporter is actually the wholesaler and plays a key role in the wood market at the level of rural sellers and township buyers. In cases a and c, the wood is generally tired in bundles made up of either round branches, or split logs mixed with branches. The smallest bundles have an average weight of 6 kg, the medium 11 kg, and the largest bundles 19 kg. The above channels could be compared to the five channels reported in the Sahel by Hamed (1990): the self-supply channel, an irregular supply channel, a channel of non-motorized professionals, a channel of motorized professionals and an institutional channel. These numerous channels and their inter-dependence give an idea of the socio-economic importance of the fuel wood sector the zone. According to Dianka and Laura (1996), the fuel wood sector of Senegal is worth a turnover of more than 20 billion FCFA/yr. which

represents more than a quarter of the turnover of their national electricity organization and provides revenue for close to 20 000 persons. Many rural and urban families earn a living by exploiting, transporting and/or commercializing wood and charcoal. In 1992, the wood market in Garoua was worth 1.5 billion FCFA (Maggi, 1992).

Sow (1987) noted that in the Sahel, wholesalers play a central role in the wood market. They control supply by sending woodcutters to harvest and by buying in bulk. They control transportation by the fact that often they are vehicle owners. Lastly, they partially control distribution.

Prices

The unit price of wood sold in bundles in the rural areas varies from one locality to the other as shown in Table 5. However the average price is 9.8 FCFA/kg. The variation is mainly as a function of distance from Garoua, confirming the findings of Peltier *et al*. (1993). The authors reported that wood costing about 15 FCFA/kg in Garoua costs only about 6 FCFA/kg 40 km away. After 40 km it strangely rises to 10 FCFA/kg up to 60 km and later decreases progressively with distance. These authors attributed the following explanation to these variations in cost: In Garoua (0 km), wood has transportation cost added. 40 km away, there is no transport cost and wood is also of poorer quality due to an over exploitation of the resource. 60 km away, although distance has increased from town, price has increased by 4 FCFA compared to 40 km from town. This is due to the fact that we are in the pioneer front. The wood resource is still relatively in good shape and the peasants are exploiting better quality wood. Above 60 km, we are still in the pioneer front with better wood but the distance from the major consumption center is very great, hence transportation cost is high and wood prices are forced to drop. A similar situation was noticed in Niamey (Bertrand *et al*,, 1991).

Wood is more expensive in the rainy season than in the dry season. The seller reduces the size of the bundles for the same price he sells the unreduced bundle in the dry season making the wood more expensive even though the price has not changed. The seasonal variation in price is due to the poor state of roads to most rural areas in the rainy season coupled with the fact that the rural people are busy farming at this time and fetch less wood. This reduces the quantity of wood entering the urban market and accounts for the increase in price.

Rural wood consumption

Fuel wood

For the 1 753 persons belonging to the 222 households surveyed, total fuel wood consumption was 2 073 kg/day. This gave an average consumption per individual of 1.2 kg/day. All households surveyed attributed their adherence to wood for cooking to the fact that it is the only source of energy at their disposal and "free". However, 65.8% of those interviewed were of the opinion that if nothing was done, there was an eventual risk of a severe wood crises. A decrease in the abundance of targeted wood species is signaled by 41% of those surveyed. Just 17.6% of the households do not supplement wood with stems of crops like cotton, sorghum and maize. 23.9% of the 222 households make an effort to control wood consumption by using improved firesides. This is essentially a clay-closed built up fireside with one inlet for wood. Their total wood consumption was 469.6 kg/day making an average consumption of 1.1 kg/person/day. Compared to the general consumption of 1.2 kg/person/day, those using improved stoves save 11.2% on wood consumption. In 93.7% households, fire is put off after cooking. 53.4% of the 93.7% go further to collect charcoal for cooking, warming up the room, ironing. Charcoal collection economizes wood.

Service wood

In the rural area a very significant number of poles is used. Every household uses poles mainly for fencing, roofing shades and houses and as carrying poles for shades. The average weight of a dry carrying pole was determined to be 7.3 kg while that of fencing and roofing sticks is 4.1 kg. Table 6 gives a summary of the quantity of service wood used by the rural and urban sample populations.

In the rural area, the highest quantity of service wood was used in roofing and the least in construction of shades. Averagely, households were using about 13 (94 kg) shade construction (carrying) poles; 45

(185 kg) fencing poles and 67 (276 kg) roofing poles. This gives a total of 555 kg of service wood per household. The average replacement time for poles as obtained from respondents is 4 years. This means a rural household uses 138.8 kg of service wood annually.

Table VI. Quantity of service wood used by 222 rural and 166 urban households .

Type of service wood	Number in use		Total weight (tons)	
	Rural	Urban	Rural	Urban
Shade carrying poles	2 854	1 115	20.7	8.1
Fencing poles	9 950	1 900	41	7.8
Roofing poles	14 927	1 064	61.5	4.4
Total		4 079	123.2	20.3

Urban wood commercialization

Fuel wood

The wood vendors survey revealed that 59.4% of the 64 persons interviewed are females and 37.5% are literate. 76.6% of the vendors obtain their supply in town and the others get theirs from the rural area or from both rural and township. Vendors either use their personal means of transport or pay public transport. The survey equally revealed that 78.1% vendors are retailers selling to households, restaurants and soya vendors. Some vendors (9.4%) obtain loans (essentially from ethnic meeting groups) for the wood sales operation. Those identified selling wood as a main activity are 75.0%; the others do this alongside other activities.

In Garoua, the cost of different categories of vehicle loads of wood varies as shown in Table 7. In the rainy season, 1 kg of dry wood sells for 33.3 FCFA (for wood sold in bundles for 50 and 100 FCFA). During this same season, the average weight of a 500 FCFA pack of dry wood is 22 kg, a 1 000 FCFA pack is 50 kg, while that for 2 000 FCFA is 110 kg. Other costs incurred by vendors include the cost of off loading and splitting. It takes 500 FCFA to off load a pick-up and 1 000 FCFA to off load a lorry of wood. It costs 4000 and 10 000 FCFA for the splitting of a full pick-up and lorry load respectively.

Table VII. Cost variation of a vehicle load of air dry wood as a function of season and market location (FCFA).

	Rural market		Urban market (Garoua)	
Category of vehicle	Dry season	Rainy season	Dry season	Rainy season
Pick-up (4 tons)	5 000	8 000	17 000	22 000
Lorry (8 to 10 tons)	12 000	18 000	30 000	40 000

Charcoal supply from the rural zone follows a supply channel similar to that of case b in Figure 3. Some of the supply is equally obtained in town from traditional brewers. Cases of pot makers in town who make their own charcoal in the forest were identified. A bag of charcoal (33 kg on the average) is sold at 1 500 FCFA in the rainy season in town while the average weight of 0.4 kg is retailed at 50 FCFA. A bag properly retailed will therefore sell for 4 125 FCFA compared to the 1 500 F/bag at whole sale.

Service wood:

The sale of service wood in town is not as rampant as that of fuel wood. Only one sales unit was identified in Garoua by the right of the Bénoué bridge. Here a pole of about 5cm diameter and 700 cm long sells for 250 FCFA. Vendors made us understand that they supply poles essentially on order. These vendors say selling service wood is very difficult because MINEF agents are seriously against it.

Household urban wood consumption

Demographic synthesis

A total of 586 households (sample size of 1.72%) with a population of 5060 persons were surveyed for wood consumption in Garoua. The average household size for this population was 8.6 persons as compared to 7.9% in the rural zone. 2.1% of the households were unmarried people; 78..2% were families were monogamous and 11.3% had 2 wives.

Household fuel wood consumption

Two of the households use electric energy while 4 use sawdust. The rest use different types and combinations of energy as shown in Table 8. 58.5% of the households depend exclusively on fuel wood and another 28.0% complement wood with other forms of energy. This gives 86.5% depending on wood energy. These figures are are compared to the national figures of a 70% exclusive dependence on wood and 20% partial dependence given by Njiti and Sharpe (1994). The 86.5% use a total of, 3 469 kg of air dry wood and 120 kg of charcoal per day, implying a household consumption of 1 266.2 tons of wood/yr. 4 332 persons belonged to households using wood. This gives an average consumption per person of 0.80 kg /day, indicating a 0.11 kg drop from the consumption reported 15 years ago by Agostini et al (1985). Households using exclusively wood use an average of 0.85 kg/person/day.

Table VIII. Urban household use of different types of heat energy.

Types of domestic energy.	Number of households using it.	*(%)*
Firewood exclusively	255	43.5
Charcoal exclusively	19	3.2
Charcoal and firewood	65	11.1
Sawdust	4	0.7
Total users of wood energy exclusively	343	58.5
Firewood and kerosene	100	17.1
Firewood and gas	29	4.9
Firewood, kerosene and gas	35	6.0
Total users of wood and alternative energy	164	28
Gas exclusively	23	3.9
Kerosene exclusively	40	6.8
Kerosene and gas	14	2.4
Electricity	2	0.3
Total users of gas, kerosene and electricity	79	13.4

The population belonging to households who buy charcoal was 727, giving an average charcoal consumption of 0.17 kg/person/day. The 120 kg of charcoal used a day implies that 1 200 kg are used a day for the whole of Garoua, and gives an annual consumption of 438 000 kg for households.

For the 2 427 persons belonging to families using exclusively firewood, the cost per person for wood energy is 843 FCFA/month. For those using only gas (209 persons) the average cost of energy stands at 697 FCFA/person/month and those using exclusively kerosene spend 1 146 FCFA/person/month. It should however be noted that using wood is more expensive than gas only in the rainy season due to an increase of 31% in wood prices. In the dry season wood costs 578 FCFA/person/month. This represents a 119 FCFA/person/month gain over gas in the dry season. Figure 4 shows the costs/individual/month for the use of firewood, gas and kerosene by season.

44% of households using wood gave various cost related reasons: Wood is cheaper; wood is retailed for as low as 50 FCFA whereas other forms of energy like gas need a heavy initial investment for cooker, bottle and gas. Other households, 38%, use wood for different socio-cultural reasons. They said wood is practical for the cooking of their staple meals or that they were brought up cooking with firewood and

will stick to it. The other 80 households were indifferent as to why they use wood. Charcoal users attribute their dependence on it to the fact that it is relatively clean compared to wood and more efficient. They all use improved metallic charcoal stoves. In 87% cases using wood, supply is obtained from vendors in town. The others buy or collect from the rural zone.

Only 34 households economize wood by using improved stoves. Twenty three of the 34 use traditional clay-built improved firesides and the others use improved metallic stoves. Those using gas and kerosene complain of the cost as a discouraging factor. Of all the households interviewed, 21% cook once a day, 48% twice and 31% thrice.

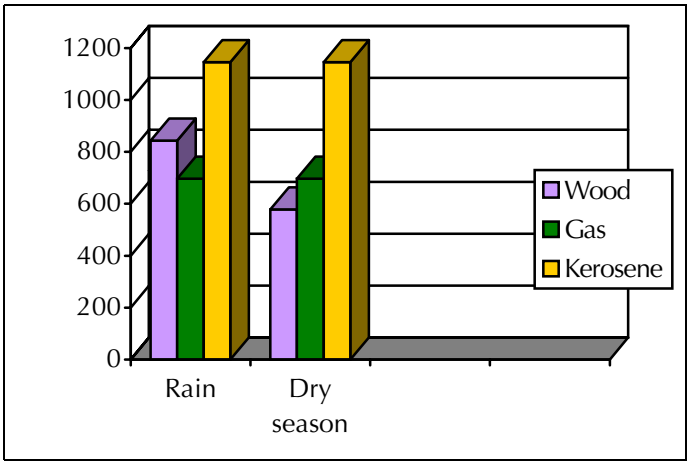

Figure 4. Cost comparison of wood and other energy sources by season - Cost/individual/month (FCFA)

Households in town use less wood compared to those in the rural area because rural households have unlimited access to wood which is relatively abundant and most often obtained without a financial cost; secondly some town duelers supplement wood with other types of energy.

Household consumption of service wood

28% of the households in Garoua use a total of 4 079 poles with a total weight of 20 296 kg as shown in Table 6. Given the average life span of 4 years for a pole, the annual service wood consumption is 5 074 poles.

Urban commercial fuel wood consumption

Consumption by traditional breweries

Traditional breweries produce an alcoholic drink locally called "bili-bili" obtained from the fermentation of sorghum and requires intensive cooking. These breweries operate as "bili-bili" bars by women (98%). Each bar has a number of women ensuring supply such that each day, the bar operates. The 42 bars use a total of 3 474 kg of wood/day making an average daily consumption of 83 kg/bar. For the estimated 415 bars in Garoua, this gives a total consumption of 34 320 kg/day (an annual consumption of 12 530 tons). Wood used here is essentially big logs of the best quality. They use the traditional three stone fireside. The ground between the stones is dug to accommodate a number of huge logs. All the respondents in this survey admitted that there was no substitute for wood within their reach in the processing of this drink.

Consumption by restaurants

Eight of the 17 restaurants surveyed are run by men. Only 6 of the 17 restaurants use wood. Another 6 use exclusively charcoal and the other 5 use gas in association with kerosene. Restaurants using only wood use a total of 268 kg/day. Those using only charcoal use a total of 158 kg/day. This gives an average daily consumption of 45 kg of wood and 26 kg of charcoal/restaurant. Considering a sample size of about 52%, daily consumption for restaurants can be estimated at 88 kg of firewood, and 51 kg of charcoal. This implies an annual consumption of 32 tons of wood and 19 tons of charcoal.

Consumption by soya vendors

All 40 vendors surveyed were males and 21 of them use metallic drums as heating units, 16 use clay built mounts and 3 use metal drums around which a clay mount is built. The 40 vendors consume a total of 1 593 kg of wood a day, making an average of 40 kg/vendor/day. For the 80 vendors in Garoua, it gives 3 190 kg of wood/day (annual consumption of 1 160 tons).

Charcoal consumption by blacksmiths

There are different categories of blacksmiths in Garoua. Those melting aluminum to make pots are 14 and those heating various metals to shape in to different objects are 4. These units were all surveyed and those making pots use an average of 100 kg each of charcoal daily making a total of 1 400 kg/day. Those units heating metals in to various objects use an average of 66 kg of charcoal daily (average of 264 kg/day). Therefore 1 664 kg of charcoal are used daily by blacksmiths giving an annual consumption of 607 360 kg. Pot makers reported that whenever they were short of charcoal, they go to the forest themselves and produce it. The species they target is *Prosopis africana*.

Summary of wood energy consumption in Garoua Township

Although the amount of wood used per person in Garoua is significantly less than the consumption per person in the rural area, the consumption for households in town is by far higher than for the rural area. These figures are those for the rainy season. It is probably less than the quantities used in the dry season when the resource is more accessible in the rural areas and more abundant in the urban market.

Table IX. Summary of urban fuel wood and charcoal consumption.

	Wood energy consumption (tons) *in Garoua*	
Type of consumer	Wood	Charcoal
Households	126 655	438
Local breweries	12 528	-
Restaurants	32	19
Soya vendors	1 163	-
Blacksmiths	-	607
Total	140 368	1 064

Conclusion

The results of this study lead us to the following conclusions.

- Wood is still the only energy source in the rural area and for the majority of urban duellers.
- Wood is essentially obtained from the natural forest using indiscriminate harvesting and non sustainable practices which are a threat to targeted species like *Anogeissus leiocarpus and Prosopis africana among others*. The practice on pioneer fronts is more dangerous, exposing large land surfaces to erosion, favoring soil degradation and negatively influencing agricultural production.
- The current output from wood plantations is too low to influence the present pressure on the natural wood savanna. On the other hand, for reasons related to cost, traditional administration and land tenure systems, private initiatives for the creation of plantations are not quite succeeding. It is necessary for extension services, NGOs and development agencies to double efforts in working with the rural world in setting up plantations for the production of targeted species for energy and service wood.
- The wood supply system is significantly diversified involving different categories of actors.

However, the transporters, who most of the time are wholesalers, constitute an important group of actors who should be implicated in initiatives for a more sustainable mode of wood exploitation in the region.

- The unit cost of wood varies from one production site to the other in relation to distance from Garoua the quality of wood and season.
- Wood selling is a flourishing business. However, it is profitable to all except the wood exploiter (peasant) who should otherwise be an important beneficiary so as to be motivated towards sustainable resource management.

- Commercial users of wood energy in Garoua consume a significant amount of wood . The consumption of local breweries is especially alarming with the estimated 415 bars consuming close to 10% of the annual urban household consumption compared to that of soya vendors whose annual consumption is closed to 1% of that of urban households.

- Charcoal users, especially pot makers and blacksmiths constitute a threat to charcoal-making species *(Prosopis africana)*.

- The scale and nature of businesses using wood energy, Bilibili, etc., does not give them the aptitude to easily adopt the use of possible alternative forms of energy like electricity. Besides electrical heat energy is very expensive in Cameroon.

Recommendations for sustainable management of the savanna forest resources and for Reducing wood consumption

The level of wood energy consumption can be reduced through the following approaches :

- Ameliorating the energy yield of firesides by using improved wood stoves which take into account the economic and socio-cultural acceptability of the population concerned. In 1988, a pilot program on a diffusion of improved stoves was carried out in Maroua and Mora. Two months after this program, Jambes (1989) reported a 25% economy of wood realized by households using the improved stoves. An opinion survey for the case of Maroua alone revealed that despite the energy gain, the population did not wholly adopt the innovation. Those refusing the technology complained of its cost, slowness in cooking and lack of protection.

- Substitution of wood energy with other forms of environmentally friendly forms of energy available in the zone which include solar energy, electrical energy, and gas. Meanwhile the extension service must prepare the minds of the people on the importance of alternative energy. Ki-Zerbo (1981) reported that women in the Sahel avoided the use of gas and electric cookers because of their cost and other inconveniences linked to their practical use. Her report further revealed that the women had a distinct preference for firewood cooking compared to charcoal, plant residues and cow dung in some cases.

- Using an appropriate cooking recipient (pot) depending on the duration of cooking. Aluminum recipients heat up faster, hence adapted for fast cooking ; clay recipients conserve heat, hence adapted for slow, long cooking.

- Soaking of grains in a volume of water twice that of the grains six hours before cooking, then cooking in the same water in order to conserve the nutritive elements of the grains.

- Splitting and drying wood for optimum combustion. This reduces moisture which reduces the efficiency of fuel wood (Njiti, 1984). The same author reported that, the use of wood with a higher specific gravity reduces the amount of wood used because such woods have a higher calorific value. Green fuel wood with about 50% moisture content has 65% available heat energy while air dry fuel wood with about 20% moisture content, has 80% available heat energy (Seybold, 1978 In: Njiti, 1984).

- The current wood exploitation practices are tantamount to mining and non sustainable. There is a need to encourage the set up of community forests under the provisions of the current forestry law in Cameroon. This is the only way the rural people can learn to manage and take the destiny of their natural resources into their hands.

- Appropriate agroforestry techniques should be incorporated into the farming system in order to diversify products and increase wood production on the farm. For this to take place, positive land tenure measures have to be taken to enable farmers feel secure on the lands they occupy.

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