

Economic and social importance of fuelwood in Cameroon

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SUMMARY

The study presented in this article focuses on firewood and charcoal in Cameroon. The study analyses subnational secondary data combined in some cases with additional collected data on firewood and charcoal consumption as well as their market prices. The findings estimate a total consumption of 2.2 million metric tons for firewood and 356,530 metric tons for charcoal in urban areas of Cameroon. Firewood and charcoal contribute to the GDP for an estimated amount of US\$ 304 million representing 1.3% of the GDP of Cameroon. In addition, the sub-sector provides about 90,000 equivalent full time jobs while 80% of the people in Cameroon depend entirely on wood-energy for household energy supply. Unfortunately, there is no government policy to develop the wood-energy sub-sector.

Keywords: wood-energy, firewood, charcoal, consumption, benefits, national economy

Importance économique et sociale du bois-énergie au Cameroun

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L'étude présentée dans cet article s'est intéressée au bois de feu et au charbon de bois au Cameroun. L'étude s'est basée sur l'analyse des données secondaires issues d'études récentes conduites à des niveaux sous nationaux, complétée dans certains cas, par des collectes additionnelles de données tant sur la consommation du bois de feu et du charbon de bois que sur les prix de vente de ces produits sur le marché. Les résultats ont été que, les consommations totales en zone urbaines du Cameroun sont estimées à 2,2 millions tonnes et 356.530 tonnes pour le bois de feu et le charbon de bois respectivement. Le bois de feu et le charbon de bois contribuent au PIB pour un montant estimé à 304 millions de dollars US représentant 1,3% du PIB du Cameroun. De plus, le sous-secteur procure environ 90.000 emplois équivalents plein temps tandis que 80% de la population dépend entièrement du bois-énergie pour l'approvisionnement des ménages en énergie. Malheureusement, il n'existe pas de politique gouvernementale pour le développement du sous-secteur bois-énergie.

Importancia económica y social de la leña en Camerún

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El presente artículo describe un estudio llevado a cabo sobre la leña y el carbón en Camerún. El estudio se basa en el análisis de datos secundarios recientes a nivel subnacional, que han sido completados en ciertos casos con datos adicionales sobre el consumo de leña y carbón, así como sus precios de mercado. Los resultados indican que el consumo total en áreas urbanas de Camerún gira en torno a 2,2 millones de toneladas de leña y 356.530 toneladas de carbón. Se estima que la leña y el carbón contribuyen con 304 millones de US\$ al PIB de Camerún, lo que corresponde a un 1,3%. Además, el subsector genera un equivalente de 90.000 trabajos a tiempo completo, y el 80% de la población de Camerún depende completamente de la dendroenergía para el suministro de energía en el hogar. Desafortunadamente, no hay una política gubernamental para desarrollar el subsector de la dendroenergía.

INTRODUCTION

Mastering the economic and social impact of fuelwood is of paramount importance in the bid to mitigate forest degradation and fight against poverty. In fact, over 80% of the energy supply in African countries comes from wood. Fuelwood accounts for about 90% of the total wood consumption in Africa and 81% of African households use solid fuels while 70% depend on them as their primary energy source for cooking (AFREA 2011). Nearly 60% of urban dwellers also use woody biomass as an energy source for cooking (IEA 2010). Africa, especially Central Africa, is one of the southern continent where wood consumption will continue to grow as a household source of energy in the coming decades fuel (Ekouevi and Tuntivate 2011, Marien, 2009) although it will stay important for the other developing regions of the world.

Cameroon is no exception to this general situation because 83% of Cameroon's populations depend on woody biomass as a source of energy, and in rural areas it is often the only available source of energy (INS 2008). According to the Ministry of Energy and Water (MINEE 2010) fuelwood consumption increased from 1981/1982 to 2001/2002 at an annual rate of 2.67%. Generally, fuelwood is used as an energy source in two main forms: firewood and charcoal. MINEE (2010) estimates that the consumption of energy from biomass is distributed as follows: firewood (91.18%), charcoal (0.97%), bagasse and palm kernel shell (5.39 %) and other waste (2.45%). Existing studies show large discrepancies in the contribution of wood as a household source of energy between urban and rural areas on the one hand (Nkamleu *et al* 2002, Folefack and Abou 2009, Madi 2012.) and between major agro-ecological zones on the other hand. In general, the use of alternative sources of energy to wood increases as we move from rural to urban areas (Tchotsoua 2006, Madi 2012). Despite its importance, the fuelwood sector in Cameroon has not been a subject of intense scientific literature and scientific articles on the subject are rather scarce. Most information is contained in technical reports and grey literature. The current article intends to contribute to the so needed scientific basis to support wood energy policy making.

Against the backdrop that harvesting and processing of timber are characterized by (1) a 33% rate of wood return, (2) non negligible losses along the chain of production and (3) an unstructured wood market at national level, the Government of Cameroon signed in April 26, 2010 a joint decree No. 0878 / MINFOF / MINCOMMERCE to develop and organize an Internal Wood Market "MIB". Since 2013, Cameroon is also working to develop a Wood Energy Modernization Strategy for the Far Region of the country (MINFOF, 2014c). The goal is to optimize sustainable valorization of its forest, to promote and market legal timber and forest products in the country (MINFOF 2014a, MINFOF 2014b). Fuelwood, little known until now is the more vital element of the MIB for the the urban and the northern populations. Other components being

roundwood, sawn goods, peeling and slicing. An economic study of the importance of fuelwood is very essential to learn about the supply and demand of wood energy and constitutes a decisive step towards creating, organization and managing the MIB. In forested rural area, fuelwood is to a very great extent a self-consumption product. In fact, most households that use it fetch it directly. However, there are significant disparities between various socio-ecological regions. For example, 40% of households using fuelwood in urban areas of the three northern regions of Cameroon (Adamawa, North and Far North) buy from the market; this proportion drops to 19% for other regions of the country (MINEE 2010). These proportions do not take into consideration supplies in Yaoundé and Douala that are administratively under the Centre and Littoral regions respectively.

This study aims to determine the economic and social impact of fuelwood in the Republic of Cameroon. It gives special emphasis on consumption in urban areas because most financial transactions related to wood energy in Cameroon relate to the supply of urban areas while in rural areas, wood energy is a product for self-consumption gathered directly by household members to satisfy their needs. Nevertheless, the revenues generated by urban markets are believed to represent a major source of income for rural households in areas with access to urban markets (Zulu and Richardson, 2012).

STUDY METHODS

Information used in this study comes mainly from secondary sources and to a lesser extent, from primary sources, where studies had not yet been carried out (forested areas of the country). In fact, many socio-economic studies on fuelwood have been conducted in various socio-ecological zones of the country, mainly in the northern part of Cameroon and in major urban centres. While they revealed the various actors, available studies also helped to estimate fuelwood consumption and its contribution to the economy and social life in the regions concerned.

From the foregoing, it means that estimating the economic importance of fuelwood in Cameroon must take into consideration the following distinctive factors:

- Socio-ecological zone¹: the national territory can be divided into three major socio-ecological zones: (a) the dry savannah zone that groups the three northern regions (Adamawa, North and Far North) where fuelwood availability from natural vegetation is quite limited, (b) the highlands wet savannah zone of the West and Northwest Regions, where fuelwood availability is average, and (c) the forest zone (Centre, East, Littoral, South and South-West Regions) with the highest availability of fuelwood in the country,

¹ The notion of socio-ecological zone is introduced here to take into consideration not only differences due to ecosystem variety (forest, wet savannah, dry savannah) but also discriminating social order such as poverty level and access to alternative sources of energy.

- The differences between (a) urban areas where alternative sources of energy to wood are more accessible and where households have higher incomes and greater difficulties to have self-supply of fuelwood, and (b) rural areas where self-consumption of fuelwood collected by households is the rule,
- The two largest urban areas in Cameroon, Douala and Yaoundé.

Identification of actors of the fuelwood sector

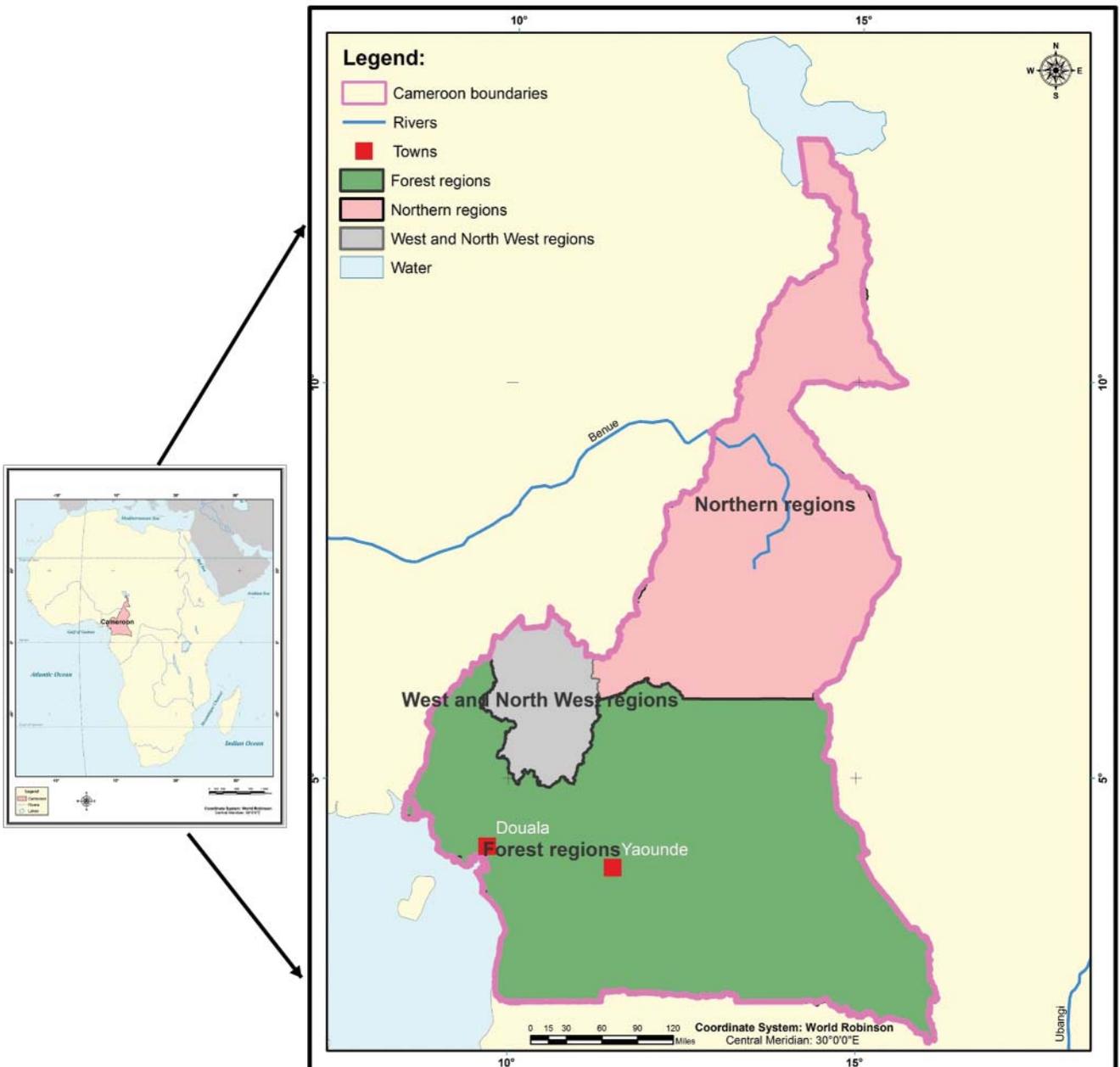
Surveys conducted in the field have identified key players of the fuelwood sub-sectors in the country (CEDC 1996, CODEV 2006, Tchotsoua 2006, Folefack and Abou Sale

2009, Simo Tamo and Schure 2010, Charpin and Richter 2012b, Madi 2012, Brainstore Consulting 2013a). A dozen of field trips made it possible to discuss with actors (sellers, producers and transporters – 52 in total) concerned about their activities to confirm, complement and update available information.

Estimation of fuelwood consumption in urban areas of Cameroon

The consumption of fuelwood has been estimated mainly on the basis of available secondary data presented in study reports. However, most of the available studies gives estimates at sub-national or local levels not at the national level.

FIGURE 1 *The main socio-ecological zones of Cameroun*



The approach of the study was then to first extrapolate the available figures from a specific location to the entire urban population of the socio-ecological zone to which the location belongs. The estimated urban consumption includes not only the household consumption but also small size enterprises such as bakeries, restaurants, grillrooms and others. The estimates at the level of a socio-ecological zone were made taking into account the year at which the study was conducted. In a next step, projections were made for the year 2012 based on the results of the national census that provides demographic data for each location for 2005 (Government of Cameroon, 2005) and sets the annual population growth rate at 2.8% for the country in average. Finally, estimates from all socio-ecological zone were aggregated to obtain a national level estimate. The estimates of fuelwood consumption for each socio-ecological zone took into account the following specific characteristics:

Estimation of fuelwood consumption in northern Cameroon
Northern Cameroon is the zone where the highest number of studies on fuelwood has been conducted, some of which are recent (CEDC 1996, Folefack Sale and Abou 2009, Charpin and Richter 2012b, Madi 2012, Brainstore Consulting 2013a, Brainstore Consulting 2013b, Tchotsoua 2006). The most detailed study on firewood consumption in northern Cameroon was done by Madi (2012), it provides basic data on the estimates made. However, as these data relate only to the Far North Region, data collected by Brainstore Consulting (2013b) which includes the North are also used. Estimates on the Adamawa Region are extrapolations from these two studies and population estimates are based on the General Population and Housing Census (Government of Cameroon, 2005) report.

For urban areas, studies focused on Maroua (Far North Region) and Garoua (North Region) that are the largest urban centres in their respective administrative regions. An extrapolation of the data was made for smaller towns on the assumptions that the quantities of wood consumed per inhabitant or per household remain the same (conservative assumption), but that the selling price of a kilogram of wood or charcoal is equivalent to 75% of prices in large urban centres given the proximity of the resource and the low purchasing power of the inhabitants of those towns compared to those of the regional headquarters. Estimates for Ngaoundere (Adamawa Region) are based on the assumption that consumption per inhabitant is similar to that of Garoua, it is the same for secondary towns of the Adamawa where per inhabitant consumption is comparable to that of secondary towns of the North region. However, given that wood is more available in the Adamawa which nevertheless remains a savannah zone, it is considered that fuelwood is 10% cheaper in the Adamawa as compared to the North. A similar approach to the one explained above for firewood was used to estimate the consumption of charcoal in Ngaoundere and in secondary towns of the three regions.

Estimation of fuelwood consumption in the West and North West Regions

Recent surveys conducted in 204 households in Bafoussam (West Region) and its environs in the course of 2012

(Ngoungouré, 2013) helped provide updates on fuelwood consumption and economics of the sub-sector. The findings are extrapolated to the entire highlands socio-ecological zone (West and North-West).

Estimation of fuelwood consumption in Douala and Yaoundé

Douala and Yaoundé are the two biggest cities of the country. They have similar characteristics regarding access to fuelwood and alternative energy sources (electricity, gas, kerosene). Data considered here are those published by Nkamleu *et al.* (2002) and especially the more recent ones by Simo Tamo and Schure (2010) who surveyed 130 households in Yaoundé and Schure *et al.* (2011). All worked particularly in Yaoundé but their data could be extrapolated to Douala.

Estimated consumption of fuelwood in towns of the forest regions

We used data collected in the South-West Region (Anonymous 2010) and older ones of the South Region (Nkamleu *et al.* 2002), and a study conducted in Batouri in the East Region (Nkolo *et al.* 2011)

Estimation of fuelwood-related economic and financial benefits

Firewood

Most available studies have estimated the consumption of fuelwood in various parts of the country and sometimes described the sub-sector without going into detailed economic analysis that lead to net profits. To this end, this nation-wide analysis is based on the following studies: (i) Madi (2012) for the Far North Region, (ii) Ngoungouré (2013) for the West and Northwest Regions and (iii) Tamo and Schure (2010) and Schure (2011) for Yaoundé, (iv) Nkolo *et al.* (2011) for the forest regions additional observations were made in 2012 in Ebolowa (South Region) and Bertoua (East region). In each of these towns, we registered the selling prices of firewood from 20 market sellers (40 sellers in total) and also weighed the different quantities for which a selling price was given. In similarity with the approach taken to estimate fuelwood consumption, the estimation of benefits was first done for each zone and then the national figures were derived by aggregation of all regional estimates.

For each zone, the financial benefits were first estimated by category of actors, then the net benefits generated by the fuelwood business at the regional level was estimated by totalling figures obtained from all categories of actors. The net profits for each category of actors was obtained by subtracting all the charges met by the considered category from the total sales made by the given category.

Charcoal

The estimated net profits made on charcoal was made from the values of estimated sales, from which is deducted costs related to wood purchase, processing, transportation to cities and marketing. There is little data on the costs of production of charcoal, most existing works are limited to demand

estimates. However, raw data was collected by CIFOR on the process of making charcoal in the West Region (Ngoungouré, 2013) as part of this study and around Yaoundé (Schure, 2011). In the West Region, the study was conducted on production sites (Sanki, Mounié and Yolo) around Bafoussam (the main city of the Region) to characterize the charcoal production system. In total 17 production teams were surveyed. The data collected were on the wood species used, the time required for each production activity, the size of the team, the role of each team member and the related salary, the quantities of charcoal produced and the sale prices.

In addition, GIZ studies (Nkolo *et al.*, 2011) give average yields of various processing processes and related costs. Data from these studies were used to estimate the net profit of charcoal in Cameroon. The assumption made is that currently almost all charcoal produced using traditional technologies of which a ton of wood produces about 200 kg of charcoal (Nkolo *et al.*, 2011).

Estimation of economic benefits related to self-consumption

Estimates of fuelwood consumption per inhabitant in rural Cameroon are highly variable depending on the source and regions. In fact, studies on this energy source have usually focused on urban areas. Charpin and Richter (2012) estimated that in rural areas in the Far North Region, firewood consumption is 221 kg/person/year, equivalent to 0.6 kg/person/day. According to the same source and for the same region, charcoal consumption is 26 kg/person/year or 0.07 kg/person/day in rural areas. FAO (ForeStat) estimates that in Cameroon fuelwood consumption is 0.936 m³/person/year and gives the equivalence of 0,725 tons to a cubic meter of firewood, thus the consumption corresponds to 680 kg/person/year. In this study, it is considered that the average consumption of firewood in rural areas is 1 kg/inhabitant/day, and the consumption of charcoal remains negligible in rural areas. To estimate the monetary value of the consumption, the price used was that at which firewood is sold in rural areas in each region. This may appear to be a bit high because firewood sold in rural areas is destined for urban markets after it has been conveyed there. As such, some compensation has been made because of the belief that charcoal consumption in the rural area is neglected.

Estimation of social benefits

Employment

The fuelwood sub-sector is predominantly informal and as such it is very difficult to estimate the number of jobs it generates, especially as many of these jobs are part-time. Using the quantity of wood consumed nationally and using both the literature and observations made in the field by CIFOR researchers, it was possible to estimate the number of full-time equivalent jobs generated by the sub-sector. It is considered that a full-time job is 8 hours per day and 250 days a year (we consider that actors do not work on Sundays and only half day on Saturdays, additionally they take 37 days for social events, sicknesses and others), or 2,000 hours of work. Indeed, considering a total of 365 days during a year, the

producers would rest one day a week (they usually rest only on Sundays) but they would additionally suspend their activities for the holiday season at the end and the beginning of the year and for family events and sicknesses, which is about 60–63 more days of suspension. A study in Malawi (Openshaw, 2010) indicates that the collection, processing and transportation of a ton of firewood up to the city market take 48 hours of work (six days of work). Given that the exact working conditions in Malawi where this study was conducted are unknown, it was considered with precaution that 40 hours (5 days) are used for the marketing of a ton of wood.

To complement the secondary data analysed for the current study, we used a data set organized by CIFOR in 2010 on the process of making charcoal (see Simo Tamo and Schure, 2010). To estimate the costs related to the making of charcoal, 30 charcoal producing teams were followed up and interviewed in 11 villages of the Centre Region that supply charcoal to consumers in Yaoundé. The data collected focused on: access to the wood resources, the tools used, the type of site, the time and size of the team needed for each production activity and the type of producer (permanent or temporary). An analysis of these data allowed us to estimate that a furnace that produces 40 bags with an average weight of 44 kg/bag (1.76 tons) requires 54.37 man/day labour, or 31 man/day to produce a ton of coal and transport it to the marketing place.

FINDINGS AND DISCUSSION

Actors of the wood energy sub-sector

Fuelwood is in large part traded to the final consumer located in urban areas. Studies conducted in the various socio-ecological zones (Brainstore Consulting 2013b, Madi 2012, SimoTamo and Ngoungoure Manjeli 2012) show that despite regional differences, the sub-sector involves four main categories of actors: collectors, transporters, traders and consumers. To these four main categories of actors can be added processors who intervene particularly in the case of charcoal.

Collectors

Collectors sometimes called producers ensure the availability of fuelwood from various places where the resource is available. This category includes casual wood-cutters and local pickers, and more or less professional wood-cutters often mandated from urban centres. Wood-cutters and local pickers are mostly made up of farmers who collect most of the wood for their own consumption, but also sell them along the road near their homes.

Transporters

Transporters ensure that fuelwood is transferred from villages to cities. They are grouped according to means of transport that can be motorized or not. Non-motorized machines used for transportation are the bicycle, cart and hand-trucks. Wood is also carried on the head. Motorized vehicles used by these actors are lorries, vans, pick-up trucks or motorcycles.

Traders

Traders are distinguished into wholesalers, semi-wholesalers, retailers and sometimes micro-retailers. Wholesalers, semi-wholesalers and retailers are usually found in markets where there are large stocks of wood that thus constitute deposits. Micro-retailers are closer to the end consumer of neighbourhoods' households.

Consumers

Fuelwood consumers are a category of actors made up of several sub-categories, each with its needs, its logic and its preferences. Generally, they are households, artisans and promoters of small and micro-enterprises. They include grill-rooms, local beer breweries, bakeries and traditional pastries, make-shift restaurants, street tea vendors, clothes ironers, etc.

Consumption and fuelwood turnover in Cameroon*Fuelwood consumption and turnover in cities of the northern regions*

The quantities of firewood and charcoal consumed and traded in the northern regions of Cameroon are to the tune of 837 343 and 27 127 tons, respectively (Table 1). These figures are quite close to those of ECAM3 (INS 2008) which estimated charcoal consumption in the northern parts of the country at about 24 000 tons. Table 1 also provides information on the consumption of fuelwood in the main cities of the northern regions (Maroua, Garoua and Ngaoundéré) as well as secondary towns.

The study of Brainstore Consulting (2013b) estimates that the average price of firewood in Maroua is CFAF 145² per kg and that the price in Garoua is half that of Maroua. The value used in the calculations is CFAF 72.5 per kg. The average selling prices of charcoal are in turn estimated at CFAF 200 per kg in Maroua and CFAF 160 per kg in Garoua.

Fuelwood represents an annual turnover of about CFAF 81.63 billion solely in urban areas of the three northern regions of Cameroon

Fuelwood consumption and turnover in cities of the West and North-West

According to latest estimates, the average consumption of firewood is 0.25 kg per person per day and 0.18 kg for charcoal. The quantities of firewood consumed in the West and North-West regions are 81 101 tons and 71 027 tons, respectively (Table 2).

The 2012 survey (Ngougouré, 2014) shows that the selling price of firewood varies between 40 and CFAF 50 per kg for Eucalyptus wood and other yellow woods, and about CFAF 70 per kg for kolanut trees and other wild fruit trees. For calculations and using a conservative approach, CFAF 50 per kg was used. Similarly, charcoal prices per bag of 40 kg range from CFAF 5,600 to CFAF 7,200 depending on the quality of the charcoal, which itself depends on the manufacturing process. For this study, a conservative value of CFAF 5,600 per bag, being CFAF 140 per kg of charcoal was used.

TABLE 1 *Quantity and sales value of firewood and charcoal used in urban areas of the northern regions of Cameroon*

Locality	Firewood		Charcoal	
	Quantity of wood (t)	Sales value (billion CFA F)	Quantity of charcoal (t)	Sales value (million CFA F)
Maroua	128 000	18.56	2 320.6	464.12
Secondary towns Far North	332 551	36.16	7 356.5	1 103.47
Garoua	92 359	6.70	3 822.3	611.57
Secondary towns in North	136 729	7.43	5 658.6	679.03
Ngaoundéré	59 760	3.72	2 473	356.14
Secondary towns Adamawa	111 047	5.18	4 595.7	661.80
Total	837 343	77.75	27 126.7	3 876.13

TABLE 2 *Quantities and values of wood-energy sales in urban areas of the West and North-West Regions of Cameroon*

Region	Consumption of firewood (t)	Value of firewood sales (Billions of CFA F)	Consumption of charcoal (t)	Value of charcoal sales (Billions of CFA F)
West	81 101	4.05	58 393	8.18
North-West	71 027	3.55	51 139	7.16
Total	152 128	7.60	109 532	15.24

² €1= CFAF 655.957

Firewood in the West and North West regions generate sales of CFAF 4.05 billion and CFAF 3.55 billion respectively. As for charcoal, the values of total sales in these regions are estimated at CFAF 15.24 billion. Thus, the turnover of fuelwood sales in urban areas of the West and North-West Regions of Cameroon is estimated at CFAF 22.84 billion.

Fuelwood consumption and turnover in the cities of Douala and Yaoundé

According to the sources mentioned in section 2, average household firewood consumption in Yaoundé is 77.89 kg per month while that of charcoal is 25.42 kg per month. The average household size is estimated at 7 persons, there is a consumption rate of 0.37 kg/person/day for firewood, and 0.12 kg/person/day for charcoal. Urban areas of Yaoundé and Douala consume quantities of firewood estimated at 297,802 metric tons and 312,540 metric tons respectively, quantities of charcoal consumed in these two cities are 96 584 metric tons and 101 365 metric tons, respectively.

The average selling prices for firewood and charcoal are CFAF 53 per kg and CFAF 162 per kg respectively. The annual sales value of firewood in Douala and Yaoundé is estimated at CFAF 32.35 billion and that of charcoal sales is CFAF 32.07 billion, for a total turnover of approximately CFAF 64.42 billion.

Fuelwood consumption and turnover in urban areas of forest regions

Cameroon forest regions of the Centre, East, Littoral, South and South-West have attracted very little attention from experts and researchers regarding fuelwood, possibly because of the perception that there is wood in abundance in these regions. Recent data collected in the South-West Region (Anonymous 2010) and older ones of the South Region (Nkamleu *et al.*, 2002) show that in towns of forest regions, firewood consumption is about 0.72 kg/person/day as against about 0.05 kg/person/day for charcoal. The annual firewood consumption in urban areas of forest regions is estimated at 603 683 tons per annum, while that of charcoal is 41 922 tons (Table 3).

Observations in markets of towns in the East, South and South-West were used to estimate the selling price of a kilogram of firewood at CFAF 25. Similarly, the prices of

a kilogram of charcoal vary between CFAF 75 in Batouri (Nkolo *et al.* 2011) in the East Region, and CFAF 145 per kg in Nkongsamba in the Littoral Region. The average value of 125 CFAF/kg was used in the calculations, as regions with higher population density (Littoral, South-West and Centre) are those where prices are above CFAF 100 per kg. The annual sales value of firewood in urban areas of forest regions is estimated at CFAF 14.20 billion, while the annual charcoal sales is estimated at CFAF 5.24 billion (Table 3). Thus, the turnover of fuelwood sales in urban areas of forest regions is about CFAF 19.44 billion per annum.

Estimates of fuelwood consumption and turnover at the national level in Cameroon

In total, the annual fuelwood consumption of urban areas of Cameroon is estimated at 2 203 496 tons for firewood, and 356 530 tons for charcoal. All, for a turnover estimated at CFAF 188.33 billion (€ 287.1 million) per annum.

Financial benefits generated by firewood in Cameroon

Net profits of firewood actors of the northern regions of Cameroon

Financial costs incurred by collectors are considered negligible because these actors use rudimentary tools that are used for other activities, especially farming. Thus, net profit is almost identical to the value of firewood sales (gross profit) in rural areas aimed at supplying the city.

Various selling prices for firewood bundles (about 10 kg) in the supply area of Maroua range from CFAF 200 to CFAF 500 depending on the distance from the market. However, the average is close to CFAF 300 per bundle that is CFAF 30/kg or CFAF 30 000/ton. Similarly, we can estimate net profit recorded by wood collectors in the North and Adamawa Regions for supply in urban zones. However, it is assumed that given the higher availability of the resource, a ton of wood collected in rural areas and destined for sale in the city sells for CFAF 20 000 in the North and CFAF 18 000 in the Adamawa.

Net profits made by wood collectors for supply in urban areas of the northern regions of Cameroon stand at CFAF 21.13 billion (Table 4).

TABLE 3 Annual quantities and value of wood-energy sales in rural areas of forest regions

Region	Annual firewood consumption (t)	Firewood sales value (Billions of CFA F)	Annual consumption of charcoal (t)	Charcoal sales value (Billion CFA F)
Centre (1)	130 411	3.26	9 056	1.13
East	89 773	2.24	6 234	0.78
Littoral (2)	133 013	3.33	9 237	1.15
South	72 354	1.81	5 025	0.63
South-West	178 132	3.56	12 370	1.55
Total	603 683	14.20	41 922	5.24

TABLE 4 *Net profit of wood collectors in the northern regions of Cameroon to supply firewood in urban areas*

Locality	Quantity of wood (t)	Net profit (Billion CFA Francs)
Maroua	128 000	3.84
Secondary towns of the Far North	332 551	9.98
Garoua	92 359	1.85
Secondary towns of the North	136 729	2.73
Ngaoundéré	59 760	1.08
Secondary towns of the Adamawa	111 047	2.00
Total	837 343	21.13

For transportation actors, the volume of transactions and income from the activity vary depending on expenses (financial costs) incurred by various transporters. These expenses include: purchase of wood, fuel and lubricants, primary processing related to resizing the wood, handling, taxes, staff costs and other incidental taxes (feeding). These expenses are different depending on the modes of transportation. Bicycles, carts and pedestrians for example do not buy fuel and lubricants. Prices also vary on delivery. If they are the same for all motorized vehicles, they are lower for carts and almost close to the average selling price to the final consumer (CFAF 145 per kg) for pedestrians (CFAF 140 per kg) who as it can be imagined, deliver directly to known households. Transporters and traders make net profits of CFAF 24.43 billion and CFAF 6.04 billion, respectively (Table 5).

Excluding export to neighbouring countries, net profits from firewood is estimated at CFAF 51.6 billion in urban areas of the northern regions of Cameroon.

Net profit of actors of the West and North-West Regions

The net profits of actors (tree owners, wholesalers-transporters and retailers) involved in supply to urban areas of the West and North-West Regions of Cameroon are presented in Table 6.

The first link in the value chain is the tree owner whose property rights are linked to land ownership, followed by transporters who are closely related to wholesalers, then retailers and finally consumers at household level or at the level of small industry.

Coppiced eucalyptuses are the main trees sold for firewood. They generally have a large diameter, for the exploitation of smaller trees with good conformation rather supplies poles and posts to the market. Considering that most of the felled trees have an average of 25 years, the total cost of maintenance is then estimated at CFAF 881 per tree (5% symbolic discount rate) corresponding to CFAF 1.26 per kg. Net profit from the sale of a standing tree is CFAF 4,119 or CFAF

TABLE 5 *Estimated net financial profits of transporters and traders of firewood in urban areas of the northern regions of Cameroon*

Locality	Costs (CFA F)	Sales (CFA F)	Net profit margin (CFA F)
Net financial profits of transport actors			
Maroua	4 979 608 077	12 871 073 326	7 891 465 250
Secondary towns Far North	12 937 294 105	24953795663	12 016 501 557
Garoua	2 694 794 662	4 620 258 975	1 925 464 313
Secondary towns North	3 989 395 504	5 129 901 169	1 140 505 665
Ngaoundéré	1 743 640 891	2 690 544 600	946 903 709
Secondary towns Adamawa	3 240 061 747	3 749 710 168	509 648 422
Total	29 584 794 985	54 015 283 901	24 430 488 916
Net financial profits of firewood traders			
Maroua	17 137 768 331	18 560 000 000	1 422 231 668
Secondary towns Far North	33 362 139 854	36 164 921 250	2 802 781 397
Garoua	6 177 085 369	6 696 027 500	518 942 131
Secondary towns North	6 858 454 824	7 434 639 375	576 184 552
Ngaoundéré	3 597 141 150	3 899 340 000	302 198 850
Secondary towns Adamawa	5 013 199 464	5 434 362 563	421 163 099
Total	72 145 788 992	78 189 290 688	6 043 501 697

TABLE 6 Net profits of tree owners, wholesalers-transporters and retailers involved in supplying urban areas of the West and North-West Regions of Cameroon

Region	Consumption (kg/year)	Gross profit (CFAF/year)	Net profit (CFAF/year)
West	81 101 422	-	486 608 533
North-West	71 026 530	-	426 159 183
Sub-total	152 127 953	-	912 767 716
Profit of wholesalers-transporter			
West	81 101 422	1 970 764 558	462 278 106
North-West	71 026 530	1 725 944 690	404 851 224
Sub-total	152 127 953	3 696 709 248	867 129 330
Profit of retailers			
West	81 101 422	4 055 071 107	1 565 257 447
North-West	71 026 530	3 551 326 523	1 370 812 038
Sub-total	152 127 953	7 606 397 630	2 936 069 485
TOTAL			4 715 966 531

6 per kg. They make a net profit of about CFAF 912.77 million per annum.

In many cases, the roles of wholesalers and transporters are the same and they use paid sawyers. The costs they have to incur include: purchase of trees, felling tax, operation of the chain saw, salary of the sawyer, transportation to the roadside, loading the truck, truck fare, regeneration tax, council tax and special levies.

For the delivery of a 3.5 ton lorry, all these charges amount to about CFAF 65,000 (CFAF 18.6 per kg) (Ngoungoure, 2012). Such a load is delivered at CFAF 85,000, which represents CFAF 24.3 per kg and a margin of CFAF 5.7 per kg. The profit margin for wholesalers-transporters was estimated at 5.7 per kg hence their net profit of about CFAF 867 million per annum.

Retailers buy wood from wholesalers and in addition pay to unload lorry, to rent the market space, to split wood, and settle council taxes. Total expenses are estimated at CFAF 107,600 for the same 3.5 tons lorry (CFAF 30.7 per kg) and sale to consumers is at an average of CFAF 50 per kg representing a margin of CFAF 19.3 per kg.

After deducting expenses, the net profit earned by firewood retailers in the West and North-West is estimated at nearly CFAF 3 billion per annum. Thus, the net profit of all firewood actors in these regions for supply to urban areas is estimated at CFAF 4.7 billion per annum.

Net profits of actors in Yaoundé and Douala

Net profits of firewood actors (collectors, transporters and retailers) for supplies to Yaoundé and Douala are presented in Table 7.

In many cases, the collectors of firewood to supply Yaoundé and Douala are the resource owners who collect and cut out deadwood in their farms. But given the size of

markets, paid labour is sometimes used to quickly collect large quantities of wood. Considering this paid labour makes it possible to estimate the cost of collecting firewood. Surveys conducted by CIFOR in 26 villages that supply wood in Yaoundé show that:

Collection and manual splitting of a calculated average quantity of 9 754 kg of wood costs about CFAF 15 269 being CFAF 1.57 per kg. Firewood thus collected is sold averagely for 70 kg at CFAF 2400 being at a price of CFAF 34.3 per kg. A net profit made by wood collectors from supplies to Yaoundé and Douala is estimated at about CFAF 20 billion.

Wholesalers/transporters deliver bundles of wood in various markets in Yaoundé and Douala at an average price of CFAF 2,500 per bundle. Weight measurements indicate that the average weight of a bundle is 52 kg and it sells at CFAF 48.1 per kg. Apart from buying wood from collectors in villages (CFAF 34,3 per kg), transporters/wholesalers have to pay transportation and incidental taxes estimated at CFAF 8.3 per kg. Firewood transporters/wholesalers make a net profit of CFAF 3.36 billion per annum. This is calculated after deducting the costs of purchase, costs of transportation and special levies.

Retailers sell wood averagely at CFAF 53 per kg. They incur many expenses including transportation, taxes, splitting of wood, special levies, the right of place in the market, security and labour related to handling and splitting of wood. A retailer who delivers 12 tons of wood per month spends about CFAF 34 000 (CFAF 12.8/kg) in addition to the purchase of wood at CFAF 48.1 per kg.

Retailers who buy wood for CFAF 48.1 per kg and spend CFAF 12.8 per kg for other costs, sell averagely at CFAF 53 per kg. Their net profit is CFAF 1.28 billion.

Overall, the net profit made by those involved in the sale of firewood in Yaoundé and Douala is estimated at CFAF 24.6 billion per annum.

TABLE 7 *Net profits made by firewood collectors, transporters and retailers for supplies to Yaoundé and Douala*

City	Consumption (tons)	Total cost (CFAF)	Total sale (FCFA)	Net profit (CFAF)
Profits of collectors				
Yaoundé	297 801 270	466 172 258	10 214 583 560	9 748 411 302
Douala	312 540 395	489 244 595	10 720 135 544	10 230 890 949
Sub-total	610 341 665	955 416 853	20 934 719 104	19 979 302 251
Profits of transporters-wholesalers				
Yaoundé	297 801 270	12 686 334 101	14 324 241 086	1 637 906 985
Douala	312 540 395	13 314 220 822	15 033 192 993	1 718 972 172
Sub-total	610 341 665	26 000 554 922	29 357 434 079	3 356 879 157
Profits of retailers				
Yaoundé	297 801 270	15 158 084 642	15 783 467 309	625 382 667
Douala	312 540 395	15 908 306 099	16 564 640 928	656 334 829
Sub-total	610 341 665	31 066 390 741	32 348 108 237	1 281 717 496
TOTAL	610 341 665			24 617 898 904

Net profits of actors in cities of forest regions

The activity of firewood collection is closely linked to agricultural activity and as such it is very difficult to assign a cost to it. Thus the value of wood sales in surrounding villages of towns in forest regions is considered net profits of wood collectors. On average a bundle of 35 kg of wood is sold in villages that supply forest cities at CFAF 500, which corresponds to CFAF 14.3 per kg.

For a total consumption of urban areas estimated at 603 683 tons/year, the net profit of these firewood collectors is estimated at CFAF 8.63 billion per annum.

On average, firewood is sold in the cities of forest regions at CFAF 25 per kg as discussed above. But in addition to wood purchase, sellers have to pay for transportation, council taxes and special levies. These expenses are about CFAF 150 for a bundle of 35 kg or CFAF 4.3 per kg. If wood purchase is included (CFAF 14.3 per kg), total expenses amount averagely to CFAF 18.6 per kg of firewood.

After deducting expenses of transporters/sellers (CFAF 18.6 per kg of firewood on average), the net profit of transporters/sellers from supplying urban areas of forest regions is estimated at CFAF 3.86 billion per annum. Generally, net profit for the supply of firewood in urban areas of forest regions is estimated at CFAF 12.49 billion per annum.

Net profit at the national level

In summarizing the findings obtained in the various socio-ecological zones, the net profit made by the actors involved in the sale of firewood across Cameroon is estimated at CFAF 93.45 billion (€ 142.5 million).

Economic benefits related to self-consumption

The total value of self-consumption of firewood by the rural population of Cameroon is estimated at CFAF 77.8 billion (€ 117.4 million) per annum (Table 8). As might be expected,

firewood is of special importance for the Far North Region, not only because of the population size, but also because of the value of wood per measurement unit (price per kg) which could entail resource scarcity.

Net profits made from charcoal

These studies estimate the cost of obtaining one kilogram of charcoal at CFAF 65 in forest regions, CFAF 88 around Yaoundé and CFAF 55 in the West region. The conversion cost includes access to the resource. Charcoal production costs in the West Region have been applied to the northern regions. The other assumption made is that the transportation costs of one kg of firewood are the same as those related to the same quantity of coal in the same region. The estimated of the profit made by zone is given in Table 9. The estimated net profit generated by Charcoal is CFAF 23.47 billion (€ 35.8 million).

Net profit of fuelwood at national level

In summarizing the estimates for the various socio-ecological zones defined in this study, we obtain a net profit of € 35.8 million per annum for charcoal used in Cameroon cities.

The summing up of the net profits of all actors marketing firewood and charcoal results in a total net profit of € 179 million for fuelwood in Cameroon. This estimate of net profits is limited to two products only: firewood and charcoal. In Yaoundé, Douala and some towns of forest regions where there are industrial sawmills, wood shavings and sawdust play a recognized role as household energy sources. However, the contribution of these two by-products in satisfying the energy needs of households is still considered as insignificant and deserves in future to be the subject of a specific study. Moreover, this estimate of net profits is based on national

TABLE 8 *Economic value of self-consumption of firewood in rural areas of Cameroon*

Region	Population 2012 (inhabitants)	Total consumption (Kg)	Unit value (CFAF/kg)	Total value (CFAF)
Adamawa	654 367	238 843 878	18	4 299 189 810
Centre	1 054 523	384 901 067	14,3	5 504 085 252
East	593 140	216 495 947	14,3	3 095 892 038
Far North	2 908 516	1 061 608 238	30	31 848 247 134
Littoral	224 589	81 975 098	14,3	1 172 243 904
North	1472 626	537 508 366	20	10 750 167 318
North-West	1 315 748	480 248 002	15	7 203 720 026
West	1 194 858	436 123 192	15	6 541 847 879
South	493 350	180 072 630	14,3	2 575 038 603
South-West	916 450	334 504 385	14,3	4 783 412 706
Total	10 828 167	3 952 280 802		77 773 844 669

TABLE 9 *Estimated net profits generated by charcoal in Cameroon*

Zone	Total costs (billion CFA)	Total sales (billion CFA)	Total net profit (billion CFA)
Northern regions	2.3	3.88	1.58
West and north West	8.69	15.24	6.55
Yaoundé and Douala	19.06	32.07	13.01
Forest regions	2.91	5.24	2.33
Total	32.96	56.43	23.47

consumption of fuelwood to the exclusion of charcoal and/or firewood export, although some studies (Madi 2012, CODEV 2006, Charpin and Richter 2012) mention it and identify it as an important factor in the soaring price of fuelwood in the Far North region of Cameroon. The sub-theme of export should be the subject of detailed data collection.

Various operators incur a total cost of € 108.1 million. For operators who were observed, labour costs represent on average 48% of the costs incurred. This is equivalent to € 51.9 million for personnel expenses (an average of CFAF 30,000 per worker per month). However, actors usually use rudimentary tools and the amount of invested capital is generally low, which justifies a negligible value of capital depreciation. The added value of the fuelwood sub-sector is about € 232 million.

Contribution to public revenues

Formal taxes and administrative costs

A comprehensive analysis of taxation of the fuelwood sub-sector in Cameroon has been made by Cabinet CLS Audit Conseil (2012). Law No. 94/01 of 20 January 1994 to lay down forestry, wildlife and fisheries regulations makes it possible to classify firewood and/or charcoal as special products (of which the final list is ultimately determined by the forestry administration). The contribution of the fuelwood sub-sector is expected to come from two main sources

(General Tax Code, Section 246): (i) the regeneration tax (CFAF 10 per kg) applied to special products including charcoal and (ii) tax on cubic meter of wood (CFAF 65 per cubic meter), which falls under the general taxes of the sub-sector. Administrative costs come from the issuance of authorizations to collect dead wood in the northern regions of Cameroon. These authorizations are issued to wood transporters.

The data collected during this study show that the State does not receive more than € 23 000 per annum as formal taxes on fuelwood in the whole country. Administrative costs related to authorizations to collect dead wood in the northern regions of Cameroon are rather marginal, given the small number of people who establish them. Most of the fuelwood is not declared and thus not recorded in the statistics of the competent services of MINFOF.

This is a real policy and institutional problem besides technical issues of managing forest resources. In fact, previous policy guidelines had been unfavourable to the fuelwood sub-sector as is the case in many African countries (Mwampamba *et al.*, 2013). Generally, past policies and strategies minimized or even ignored the economic potential of fuelwood and the forestry administration has not designed a system to monitor the fuelwood sub-sector, thereby failing to appropriate it. For example, the January 1994 law barely mentions fuelwood alongside special products (art. 56). For this sub-sector that rivals the timber industry economically, MINFOF has not instituted at central level even a sub-department in charge of fuelwood.

Special levies

State actors and traditional authorities personally capture a significant part of the added value of the sub-sector through special levies. The latter is by definition illegal, the sums involved are not declared and are difficult to determine. The amount of the special levies are four to five times higher than the “legal” fees paid for access to the resource and account for nearly 10% of total expenses of activities of various transporters (Madi, 2012).

Special levies for supplying firewood to Maroua captures an estimated € 177 000 per annum. The one related to transportation of firewood for supply to Yaoundé and Douala is estimated at over € 561 000 per annum. These two examples show that actors of the fuelwood sub-sector are willing to pay large sums to be in compliance with government and carry out their activities legally. Probably because of poor and unsuitable laws and regulations, special levies capture much of the added value of the sub-sector at the detriment of the State. If the whole of Cameroon is taken into account, it is certain that the special levies could annually capture nearly € 1.5 million.

Social benefits

Contribution of the sub-sector to employment

In order to deliver 2,203,496 tons of firewood consumed in Cameroon, 88,139,840 hours of work is need, representing approximately 44,070 full time jobs. Upstream (from the collection of wood to delivery to markets in town) the equivalent number of full-time jobs for fuelwood and charcoal is estimated at 88,126. To these upstream jobs should be added jobs related to the marketing of these products in urban markets. These jobs estimated at FTEs are actually distributed among hundreds of thousands of people who work part-time in the sub-sector. The number of people involved in supplying Maroua with fuelwood was estimated at 100,050 (Madi, 2012).

Contribution to food security

Available studies estimate that population relies on fuelwood for their food security. Nkamleu *et al.* (2002) estimated that 31% of Yaoundé households depend entirely on fuelwood for cooking, this proportion rises to 50% for Mbalmayo and 69% for Ebolowa. Madi (2012) estimated that 95% of the proportion of Maroua households uses only fuelwood to cook food. In total, 83% of Cameroon’s households depend on woody biomass as their main source of energy (INS 2008).

Sustainability of the fuelwood sub-sector

The volume of harvests and quantities traded raise questions about the sustainability of the benefits of the fuelwood sub-sector. In forest regions including Douala and Yaoundé,

fuelwood remains a by-product of agriculture or wood processing in sawmills. Shortage is not feasible by 2035. The same applies to the West and North-West Regions, where in addition to collecting wood in natural vegetation to develop farmlands, the populations have gradually established a sort of balance that includes the use of planted trees, which are not felled primarily for firewood supply, but firewood is collected as waste from timber, logging of posts for industrial purposes and felling of poles.

In the northern regions of the country, the situation is more complex. Although no simulation has been made for the Adamawa Region³, this region also seems immune to resource shortage in the medium term. In the North Region, the regional balance appears positive, Brainstore Consulting (2013b) estimates that there’s even a regional surplus of 16,187 tons annually.

The estimates agree on the deficit of fuelwood in the Far North Region, despite the slight differences observed. The simulation model developed by Charpin and Richter (2012) indicates that only 69% of regional demand for wood could be satisfied in a sustainable manner in the Far North Region, and that in 2022, approximately only 50% of the demand could be supplied in a sustainable manner. This appears to be exacerbated by fuelwood exports to neighbouring Chad. So it is urgent to promote sustainable use of fuelwood and conservation of forest resources.

CONCLUSION

The fuelwood sub-sector represents a turnover estimated at over € 287.1 million per annum and an added value of over € 232 million per annum making it the largest sub-sector in the forest-wildlife sector after the timber sub-sector (industrial and artisanal). Moreover, the value of self-consumption of fuelwood is estimated at nearly € 119 million per annum.

On the social front, the fuelwood sub-sector is certainly more important than the timber sub-sector not only going by the number of full-time equivalent jobs it provides (here estimated at 90,000), but also because it plays a crucial role in food security given that about 80% of the people of Cameroon (16 million) depend on it to cook their food.

The economic and social importance of fuelwood is much more pronounced in the three northern regions, which represent nearly 44% of the sub-sector’s turnover and more than 45% of its added value. Because of the poverty level of the population and due to more difficult access to other energy sources, the role of fuelwood in food security is crucial in the northern regions of the country and particularly in the Far North region where even in the city (Maroua), 95% of people rely exclusively on fuelwood for cooking.

The contribution of fuelwood to State revenue is marginal while sums of up to € 1.5 million are collected from actors of the sub-sector by networks of parallel taxation.

³ Simulations were not made for the Adamawa as was the case in the North and Far North because the Forestry Administration believes that the Adamawa is not in crisis given that it is less populated than the other northern regions and it is endowed with more woody resources (shrubby savannahs and forest galleries).

As concerns sustainability of the sub-sector, apart from the Far North and probably the North Regions whose fuelwood resource management must be given special attention for fear of an impending crisis due to overexploitation of the resource, sustainability concerns are not justified in the case of Cameroon. Resources are considerable and fuelwood remains in many cases a by-product of agriculture or the logging of timber or poles. On the contrary, the sector suffers from a lack of organization both with regard to public services and private actors. The legislation is inadequate and institutional framework inappropriate. These organizational, legal and institutional shortfalls may in turn aggravate the situation in the Far North and North Regions by promoting the destruction of resources in addition to promoting illegality and depriving the State of needed resources. Fuelwood energy will continue to play an important role in the next 15–20 years and its demand will definitely increase over the next 5–10 years.

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