CHAPTER 13
Peri-Urban Forests and Wood Energy: What Are the Perspectives for Central Africa[51]?

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Introduction

At the beginning of the twenty-first century, the city/forest relationship is a major issue for sustainable land management in many countries, particularly in inter-tropical zones. In Africa, especially Central Africa with all its ecological, social and economic diversity, wood as a domestic energy source will continue to play a dominant role for decades to come. Over the last 20 years, uncontrolled urbanization has impacted all Central African countries to varying degrees. There has been no adaptation in terms of infrastructure and energy consumption patterns to cope with this sharp rise in urban population (European Commission, 2007; CBFP, 2006; UNEP, 2008).

Forests, most notably peri-urban forests, play a key role in providing fuelwood and charcoal. Supply zones for wood and wood products are often laid out in concentric rings around cities. Informal supply chains frequently develop over time, with few instances of sustainable timber resource management. Peri-forest degradation affects not only the largest cities (e.g., Kinshasa) but also all major cities and towns in areas dominated by savanna (Matadi in DRC, Nkayes in Congo). Medium and small cities and village populations in forest areas are barely affected, for the time being, by the wood energy issue and are not of immediate concern.

The dynamics of growth, availability and management of the timber resource are often unknown; especially since suburban areas are frequently without official status and do not possess even the most basic management tools. In many cases, the management of timber resources is only one aspect of land management and therefore the management of wood as it relates to energy is often disrupted by other external considerations.

Africa's demographics and rapid urbanization have radically transformed the social context for urban people, but domestic energy consumption patterns have not kept pace. Linked to ever-increasing and persistent urban poverty, wood energy consumption remains the main cooking method (and/or heating) in many Central African cities. The issues in terms of gender, health and employment for the weakest members of society are often not resolved or even ignored. In these conditions, it will be difficult to reach the Millennium Development Goals. The predominance of wood energy supply to cities is also underpinned by a sizeable informal economy, in which fragmented and disjointed organizations develop as needed. They provide labor and are pivotal in redistributing income from the forest to urban markets.

Photo 13.1: Transportation of charcoal ("makala") in DRC.

The wood energy sector is growing in a very diverse institutional context. Some countries have adopted dynamic policies of energy and taxation, resulting in a drastic change in consumption patterns and a replacement of wood by alternative energy sources (often fossil fuels). Other countries, in contrast, are characterized by poor governance. Purposefully or not, insufficient land management is allowing the private sector to establish itself and to adapt to local conditions, without anticipating or planning for future trends. Finally, uncontrolled collection of resources often exceeds

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the recovery potential of forest stands especially given the short distance from peri-urban forests to urban markets. The environmental impacts of forest degradation and deforestation, can become critical and effect climate change, biodiversity, desertification and/or carbon-related processes. These impacts are found at all levels of spatial integration from the single plot to the global arena. The objective of this chapter is not to revive the old debate of the 1970s and 1980s regarding the fuelwood crisis, which was long awaited and then mainly forgotten. Instead, this chapter aims to provide some understanding and reflection on an oft-underestimated subject, but one with considerable impact on Central African forests.

The latest data show that wood energy in Central Africa is a fundamental cornerstone of the forest economy and household energy budgets (Nash and Luttrell, 2006). This raises interesting new questions:

- Do recent and projected human and social changes in Central Africa (e.g., demography, urbanization, livelihoods, conflicts, governance) necessitate modifying the traditional view of the wood energy sector?
- Are these changes compatible with a sustainable wood energy sector?
- Can alternative energies be integrated fast enough to decrease pressure on rural and forest spaces?
- Are wood energy resources and networks able to adapt to changing needs?
- Can they find their place in the sustainable management of Central African forests?
- Can they contribute to the conservation of degraded ecosystems and hence combat deforestation?

A Major Factor in Forest Degradation

Fast-Growing Consumption

Wood energy in Africa represents over 80 % of total domestic energy consumption across all countries. The same sector is also responsible for more than 90 % of total timber harvesting in forests and woodlands. Finally, in most countries in Africa, population growth and rapid urbanization do not go hand in hand with poverty alleviation or changes in energy consumption patterns, with the exception of a transition from wood to charcoal if living standards permit or if supply distances become too great. Fuelwood conversion into charcoal is accompanied by a significant loss in energetic power (European Commission, 2005; Debroux *et al.*, 2007; Binzangani, 2004).

Africa is the only continent where wood energy use for household consumption (particularly urban) should continue to grow in the coming decades. With an annual population growth rate above 3 %, the number of African cities with more than one million inhabitants will rise from 18 (1990) to 70 (2020), with some cities meeting or exceeding ten million inhabitants (Drigo, 2001; FAO, 2007a).

Annual *per capita* consumption of wood (firewood and charcoal) in urban Central Africa is equivalent to 0.99 m^3, almost twice that of West Africa with 0.58 m^3 (table 13.1) (FAO, 2007b).

Compared to drier areas of Africa, the low population density (usually rural), combined with an abundance of natural resources and a highly dynamic system of regeneration, have masked the importance of wood energy harvested from forests. In fact, this sector is accountable for a higher level of harvesting than logging (formal and informal) (Van de Ven, 2008).

Table 13.1: Basic data on the wood energy sector in Africa

Africa (FAO classification)	Central	East	South	West	North
Country					
Area (millions ha)	529	399	590	503	940
Population (millions inhab.)	105	200	120	252	184
Forests					
Area (millions ha)	236	77	171	74	77
Area (%)	45	19	29	21	8
Area (ha)/inhabitant	2.2	0.4	1.4	0.7	0.4
Change 2000-2005 (%)	-0.3	-1.0	-0.7	-0.6	-0.7
Standing stock					
Volume (m^3/ha)	194	58	36	91	18
Total volume (millions m^3)	46,760	4,351	6,102	6,254	1,390
Biomass (m^3/ha)	315	172	99	175	51
Total biomass (millions m^3)	74,199	13,006	17,015	12,039	3,880
Carbon (t/ha)	157	86	50	85	25
Total carbon (millions t)	37,099	6,503	8,507	5,875	1,939
Production					
Wood energy (x1,000 m^3)	103,673	194,816	55,908	145,291	46,371
Industrial timber	12,979	10,526	26,356	17,128	3,458
Sawnwood	1,250	1,296	2,905	3,145	200
Some calculated ratios:					
Consumption of wood energy (m^3/inhab.)	***0.99***	***0.47***	***0.47***	***0.58***	***0.25***
Production of wood energy/total woody production (%)	***90***	***95***	***67***	***88***	***92***

Source: FAO – FRA, 2007.

Table 13.2: Relative importance of wood harvesting in DRC

	Annual volumes (x 1,000 m^3/an)	%	Economic value (x 1,000 $/an)	%
Source	1		2	
Formal timber sector	500	1	40,000	4
Informal timber sector	5,000	9	50,000	5
Wood energy	50,000	90	1,000,000	91

Sources: (1)Van de Ven, 2008; (2)Debroux, 2007.

Table 13.3: Annual wood production in Central Africa (in x1,000 m^3)

	FAO	COMIFAC countries
Wood energy	103,673	83,920
Industrial timber	12,979	11,876
Sawnwood	1,250	1,080

Source: FAO – FRA, 2007.

In the absence of strategies and management plans, these facts translate into the degradation of natural woodlands, forests, parks, trees and shrub savannas, which is particularly acute in the supply basins of cities and megacities. This degradation of wooded ecosystems can lead to deforestation, with well-documented and disastrous ecological, economic and social consequences.

Photo 13.2: Forest strips near cities are under great pressure.

Paradoxically, there is a lack of recent studies and data on wood energy in Central Africa and existing initiatives are often relatively unknown or underdeveloped. Nevertheless, several case studies illustrate the diversity of situations regarding supply and consumption that exist in Central African cities.

Bangui (Central African Republic)

The greater Bangui, capital of the CAR, has about 800,000 inhabitants and is growing at an annual rate of almost 3 %. Uncontrolled urbanization (in 2007, it covered 10 times the surface area of 1960) is mainly linked to poverty and insecurity (4 times higher in rural areas than in towns). The development of urban poverty is also worthy of mention. The city is diffuse and there are still plenty of open spaces and partially rural areas. Firewood represents 92 % of household energy. Energy sources depend on poverty level: more affluent people use more coal and gas. Annual consumption ranges between 280,000 to 500,000 metric tons of wood, representing an informal turnover of CFA 2 to 3 billion. Finally, urban attitudes are heavily influenced by rural lifestyles, including wood energy use. A UPF–FAO project aims to build support for a local strategy aimed at making wood energy resources and networks more sustainable in Bangui (FAO, 2008).

Cities in the Democratic Republic of Congo

Despite the Inga dam (one to two turbines operate out of eight), only 5 % of DRC's population have access to electricity. As a result, wood energy production accounts for 85 % of total energy consumption. Lubumbashi, for example, uses 1 million bags of coal per year. Wood energy resources are estimated at 70 million tonnes of oil equivalent (TOE), but wood energy production is predominantly careless, unplanned and not ecologically sound, with growing rings of deforestation around cities. Surveys in several cities in DRC showed a sizeable population of woodcutters and a strong migratory phenomenon from cities to areas where felling continues. Rural and urban poverty causes uncontrolled harvesting for subsistance. Wood energy is the main product transported by road (European Commission, 2005; Debroux *et al.*, 2007; Binzangani, 2004).

Kinshasa (Democratic Republic of Congo)

The megacity of Kinshasa (8 to 10 million inhabitants) is located on the Batéké Plateaux in a forest-savanna mosaic environment. Wood energy supply is 5,000,000 m^3/year, almost exclusively from informal harvesting of degraded forest galleries within a radius of 200 km. Gallery forests are the most affected by degradation from wood harvesting. It is estimated that more than 60,000 ha are used annually by village communities, both for slash-and-burn agriculture and for wood energy harvesting. Traditional lengthy fallow rotations are becoming shorter. There is a gradual degradation of forest ecosystems within a radius greater than 200 km, and total deforestation in the peri-urban areas (50 km). Unresolved issues that contribute to the sector's lack of sustainability include: management and restoration of degraded forest ecosystems; agroforestry; land tenure security and the revitalization of village communities; gender and health issues; carbon issues; and sectoral economics. Mampu acacia plantations (8,000 ha near Kinshasa) play a valuable role and should serve as an example for developing a sustainable resource. These plantations are currently managed in blocks of 25 ha, combining crop rotation and wood energy plantations.

Goma (Democratic Republic of Congo)

For several decades, the eastern part of DRC has faced a situation of acute conflict. This situation has given rise to serious crises, including humanitarian crises due to the displacement of over one million refugees in the Goma area and ecological crises from the deforestation of Virunga National Park, the last refuge of mountain gorillas (more than half of the surface area has been deforested to date).

To deal with an estimated annual demand of 500,000 m^3 of fuelwood for Goma (300,000 inhabitants, 97 % with no alternative energy source) and more than 200,000 metric tons for refugees (600 metric tons per day, or 0.6 kg per person per day), multiple projects have been developed over the past 20+ years (EC, WWF, UNHCR). These projects have different objectives (ecosystem conservation, humanitarian assistance), but typically involve establishing community plantations of fast-growth exotic species (eucalyptus, acacia) to increase resources and reduce pressure on residual natural ecosystems. Ongoing and recurring instability in the region represent a challenge, which, unfortunately, is not unique to Goma in Central Africa (UNHCR, 2008; WWF, 2007).

Libreville (Gabon)

Located in a distinct forest environment, Libreville is growing fast (about 600,000 inhabitants in 2006). Traditionally, wood energy availability has not been problem; however, recent periurban deforestation has occured (e.g., urban development speculation). As a gas and oil producer for many years, Gabon has implemented a policy to support the natural gas sector. This has resulted in a subsidized domestic market for gas with gas cans available for most of the population (urban and suburban). Furthermore, hydropower is a reality and hydroelectric stations, either operational or planned, should supply most of the energy needed once electrical infrastructure is established in urban and peri-urban areas. Overall, wood energy represents only a small proportion of domestic consumption (Anonymous, 2008; CAEMC, 2009; DGEG, 2005).

Pointe-Noire (Republic of Congo)

A city of 1 million inhabitants, Pointe-Noire is a port and an industrial city located on the edge of a forest savanna mosaic. Located in the heart of an oil production zone, domestic energy consumption is paradoxically based around wood energy. Consumption (500,000 m^3/year) is divided equally between: (1) by-products of industrial plantations of eucalyptus (40,000 ha) under the management of the Eucalyptus Fibers Congo (EFC) firm and (2) informal harvesting in gallery forests. For plantations, the supply radius is less than 40 km; it is 80 km for natural forests. There is no deforestation process and degradation of natural ecosystems is relatively weak and limited thanks to the plantations, which serve both as a buffer against forest galleries and as a substitute for wood from natural ecosystems. Like elsewhere, the sector is largely informal.

The sustainable management of industrial plantations (genetics, soil x plant relations, socio-economic impacts), the dynamics of territorial integration, the economics of plantations versus natural forests, taking into account new carbon markets, and the feasibility of alternative energy are all points underpinning the sustainability of the domestic energy supply in Pointe-Noire. Fuelwood comes primarily from near-by eucalyptus plantations (20 to 40 km). Charcoal comes from further afield (40 to 50 km) and mainly from gallery forests, due to considerations of cost and transport. Transporting fuelwood requires 5 times as many people as charcoal (mostly carried on foot). The eucalyptus plantations account for 53 % of total wood energy, but production is concentrated around a few villages (5 villages account for 80 % of the total production) (Nkou, 2008).

Photo 13.3: Construction of a charcoal furnace in the Mampu plantations (DRC).

Pokola (Congo)

The *Congolaise industrielle des Bois* (CIB) concessions are located in the heart of the dense humid forests in northern Congo, in Pokola. CIB manages a concession of 1,300,000 ha of dense forest, under a management plan and is already FSC-certified for two FMU out of five. Given the low number of inhabitants in the region (15,000 inhabitants on the site and approximately 50,000 including the city of Ouesso), domestic consumption of wood energy is not a major issue. The CIB operates an annual volume of 350,000 m^3 and this leaves a significant amount of logging residue (left on the floor after felling) and sawmill waste (sawdust, flitches...). Sawmill waste (a total of almost 100,000 m^3) is at present mostly made available to private charcoal traders and a processing sector has developed. The charcoal produced is used in Pokola and neighboring towns, but also sometimes sent to Brazzaville (1,200 km by barge on the Sangha and Congo Rivers) where the energy situation is very acute. The establishment of a cogeneration unit from sawmill waste is being finalized and will save almost all of the energy (oil) being purchased and transported at great cost to Pokola.

The wood energy sector has found a new place in the economy of Central African countries, without impacting the dynamics of the concerned natural forests. Production potential (logging residues, primary and secondary processing wastes) and the networks' economics (charcoal, cogeneration) are points that need validation.

What Discriminating Criteria Characterize the Wood Energy Sector?

The descriptions above illustrate the complexity of wood energy supply for Central African cities.

A Complex Issue to be Analyzed at Continent Level

This complexity is not unique to Central Africa, as witnessed almost everywhere in Africa. Some cities (Rabat, Cape Town) have gradually become free of the need for wood energy through proactive and voluntarist national policies. Others (Antananarivo) are experiencing a relatively favorable situation with large-scale production of wood and wood products from planted peri-urban forests (industrial or private). Although in dry zones, some cities (Bamako, Ouagadougou) have relied heavily on developing domestic energy strategies and markets to formalize, at least in part, the sectors, but without ensuring resource sustainability. In Mahajanga, a proposal was put forward to transfer the management of peri-urban timber resources to local communities with generally good results. In some cities in transition (Conakry), the problems of wood energy supply are still manageable, but the situation will change rapidly if nothing is done. Medium-sized cities may experience specific situations. Ifrane, for example, benefits from both sizeable local resources and a demand reoriented to other types of energy. In contrast, located in an area of violent conflict and scarce resources, Abéché has seen its energy balance disrupted by the massive presence of refugees. Finally, some cities (Abuja) are in very delicate situations, with sharp increases in urban populations due to conflicts and rural poverty, and with considerable ecosystem degradation in all their suburban supply basins. Together these examples make it possible to identify the main criteria for managing timber resources for wood energy.

Energy Subsitution Policies

Some countries have introduced policies to substitute wood energy sources for other sources, mostly fossil fuels (e.g., subsidizing natural gas or developing power plants). This substitution is essential to meet domestic energy needs and helps relieve pressure, at least in part, on timber resources.

Unfortunately there are few examples of this kind of voluntarism in Central Africa, where some countries are oil and gas producers and possess considerable hydroelectric potential.

Management of Existing Resources

Management systems for wood energy production forests are highly variable. They range from unmanaged informal extraction systems to management by public bodies, or even private stakeholders (industrial or not). These systems take into account the nature and degree of land and forest ownership by local stakeholders.

In Central Africa, peri-urban land is rarely secure in the long term. This situation makes it difficult to develop suitable sylvicultural practices and to implement private projects to create a dedicated resource.

Size of Urban Centers

The complexity of the sector and the quantification of the population's needs, especially urban populations, are proportional to the size of cities and the speed at which they are changing. In Central Africa, most cities are growing strongly, rapidly and in an uncontrolled fashion. In addition to natural growth, extreme poverty in rural areas and numerous armed conflicts periodically bring about significant population displacements. These abrupt changes cause major and immediate changes in the demand for wood energy.

Origin of the Resource

Wood energy resources can come from natural or planted forests. It can also come from by-products of logging (e.g slash, waste).

In Central Africa, most resources come from informal harvesting of the natural forests. Planted forests are still in a minority and the recovery valorization of logging by-products is still relatively unknown. Hence harvesting has maximum im-

pact on natural areas, leading to degradation of fragile and often fragmented ecosystems, particularly in peri-urban areas.

Supply/demand

Unlike fossil fuels or electricity, wood energy resources cannot be relocated. The supply distance is a very important factor in terms of availability and costs, and conditions the supply-demand relationship.

In Central Africa, supply is usually abundant in the forest zone, but insufficient in savanna areas, even for small towns. A demand greater than supply involves an increase in the supply distance, faster degradation of the close resources and a rise in cost. Refining these criteria, it is possible to define a comprehensive typology, that is still qualitative and provisional. This typology allows efficient segmentation of cases encountered in the field. Then for each type of situation, it would be possible to ask the most important questions and propose the most relevant response. The benefit of this approach is to integrate information that is often fragmentary and apparently not correlated. Figure 13.1 shows an example of a segmentation based not only on the examples cited for Central Africa, but also on the analysis of situations in other regions and cities of Africa.

Photo 13.4: Brick manufacturing is an activity that also consumes wood energy.

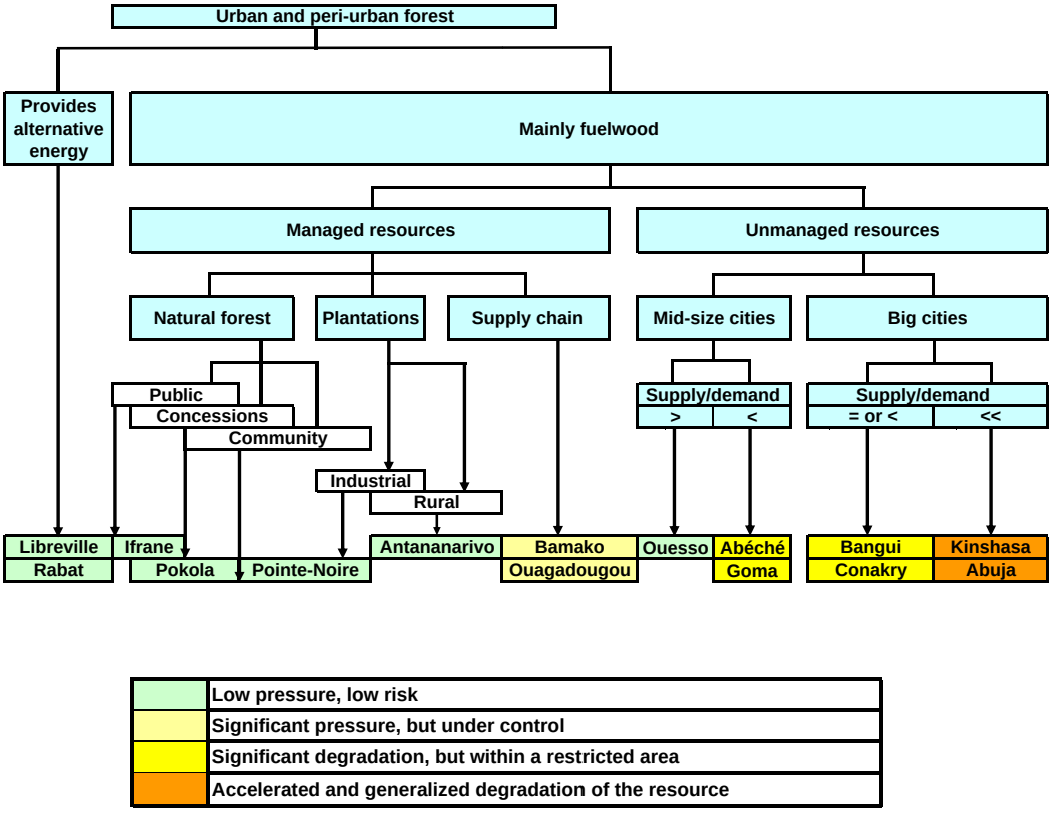

Figure 13.1: Discriminative typology of the wood energy situation applied to some cities in Central Africa

Multiple Impacts of the Wood Energy Sector in Central Africa

The wood energy problem is becoming acute in Central Africa. Besides a complex background and some alarming observations, we should ask the question whether new perspectives and opportunities could modify current trends. While some could be risky, others may alleviate the worsening situation, or even reverse the trends in areas of negative change. These new opportunities are in no way a substitute for better governance and a coherent and rational management of peri-urban areas, especially in terms of the socio-economic and institutional aspects.

A Major Contribution to Carbon Balances

Regardless of its connection to slash-and-burn shifting cultivation, the wood energy sector is the primary factor for global carbon balance and forest degradation in Africa. While many efforts have focused on forest management in concessions, very little has been done in this sector and its impacts. Taking into account the carbon/wood ratio traditionally used by FAO (0.50) and distribution of products (see table 13.4), we calculate the following global balance for Central Africa.

Table 13.4: Carbon stocks global balance for Central Africa and C flows according to wood usage

(x1,000 tonnes C/an)	Total exploited	Remainder on the plot (humus)	Exported from the plot (life cycle C+ long)	% of total C exported from forests by logging
Energy	57,563	5,756	51,807	82
Industry	8,110	1,216	6,894	11
Sawmill	6,250	1,785	4,465	7
Total	**71,923**	**8,757**	**63,166**	**100**

Source: Marien et al., 2008.

Wood energy accounts for more than 80 % of carbon exports from forest exploitation in Central Africa.

Africa currently represents only 3 % of the global carbon market. Hence there is considerable margin for improvement. This challenge can be addressed in a reasonable time-frame as basic skills and project identification resources are introduced gradually through ongoing activity.

However, is there a true carbon market for wood energy in Africa? The wood energy sector (plantations or natural forests) is considered neutral in terms of carbon volume. This only applies for forest renewal which mirrors harvesting (carbon storage = timber production = wood export = carbon emission from combustion) and without inputs likely to induce carbon costs or, on the contrary, better storage or improvement of yields throughout the sector. But the international situation is changing rapidly. The Bali Conference (2007) endorsed the concept of avoided deforestation and degradation (REDD). It is a complementary process to that established in Kyoto (1997) for plantations. Through a market mechanism, the process aims to promote activity to prevent natural forest degradations. However, analysis of past events, like for the CDM, suggests that this process, if it comes to fruition, will take a long time to develop and will be restrictive. Finally, the opportunity costs of the REDD process need clarification (Kasulu and Hamel, 2008; Mallet and Marien, 2008).

A Major Contribution to Forest Degradation

Fuelwood collection is often associated with an unsustainable system of fallow and/or slash-and-burn. The fallow period leads to localized deforestation, but in Central Africa, the natural dynamics allow natural forest resilience since the rotation period is sufficient. The fires mainly affect the fallow and shifting agricultural zones, which are the major areas for wood energy production.

Inseparable in many cases from shifting cultivation, wood energy harvesting is an important factor in degradation, and even deforestation. In Central Africa (COMIFAC zone), areas subject to management (mainly concessions and protected areas...) represent only 46 % of the total forested area of the Congo Basin. Traditional, individual or community management methods do not resist once anthropogenic pressures begin to increase considerably. This is particularly the case in all outlying forests that are not subject to management plans. These forests bear the brunt of pressure to supply fuelwood to local people (CBFP, 2006).

Substitution by Alternative Energies

It is commonplace to state that the cost of fossil fuels has fast become one of the major development drivers for world economies.

If wood energy is considered neutral vis-à-vis the carbon balance, there is a risk that air pollution will be aggravated if combustion efficiency is not improved. Forest residue utilization is underdeveloped but growing demand and the recovery of all residues could negatively impact soil, diversity… We are moving towards global competition between the energetic and industrial valorization of wood, especially resources from plantations, and a gradual increase in resource prices. The choice between agriculture for energy and for food is more an economic choice than a food security choice. Wood energy helps ease the pressure on agricultural areas and the forseeable increase in prices (one to two comparisons between wood energy strategy and cereal energy strategy). The combination of wood energy and crops (agroforestry, integrated cropping, and forest plantations) should therefore be promoted.

Large-scale biofuel cultivation will also compete for land access (agricultural conversion, deforestation, forest management). For example, there are large-scale palm oil plantations in DRC but the social and environmental impacts are relatively unknown. However, the potential development of biofuel crops should not have a major direct impact on peri-urban forestry and wood energy availability as the areas needed for their implantation are outside supply basins. According to FAO, developing countries, including Central Africa, should prioritize the better management of wood resources, leaving energy crops on the backburner (risks for access to land and for food security).

Energy Cost and Access to the Resource

Wood energy is rarely in competition with other energy sources in Central Africa. Unfortunately, it is often the only source of energy available, especially for domestic consumption. Only cities where gas is subsidized have seen a real change in consumption. Little is known about how wood energy cost and price are structured. The informal nature of the sector makes calculations difficult and the few examples of thorough analysis refer mainly to African drylands (Mali, Burkina Faso). Furthermore, there is low price elasticity for consumption as urban demand often exceeds supply.

However, price changes can be seen in the markets. In the dry season, charcoal prices tend to drop since the process is easier to carry out and access trails to production areas are more practicable. Charcoal from dense forest species or acacia is more valued than other species (eucalyptus). On the other hand, the transport distance does not impact purchase prices on urban markets, but affects the “roadside” purchase price and therefore the income of woodcutters and producers (Horgan, 2002; Ouedraogo, 2008).

Photo 13.5: A charcoal furnace, which can operate for several weeks at a time.

Food and Domestic Energy

Urbanization in Africa is in transition. The new urban dwellers, mostly former rural dwellers, retain certain habits. They grow plots on the immediate outskirts of the city or have a small herd.

Urbanization is accompanied by an increasingly strong demand for agricultural commodities. Farming and market gardening are thus galvanized by demand and develop often on periurban wooded areas. However, can we talk about competition between the food and energy uses of peri-urban forests? The surface areas involved cannot be compared. Wood energy supply for a city of one million inhabitants in Central Africa (nearly 1 m^3/inhabitant per year) represents annual harvesting of 10,000 ha of productive plantation (100 m^3/ha on average), and up to 100,000 ha of degraded natural forests, according to stands' natural productivity and land use pattern. For the same number of people, only several thousand ha of correctly managed market plots are required to meet fruit and vegetable needs in the same urban area. On the other hand, extensive agriculture and itinerant livestock production on the periphery of Central Africa represents a competition risk for wooded peri-urban areas. Slash-and-burn cultivation is everywhere in Central Africa. Areas are alternately assigned to agriculture and relatively long tree fallow, providing a sizeable share of urban wood energy supply. Fallow duration is the key point in this type of land management and determines whether the system is sustainable. As growing tension surrounds products supply, rotations become shorter and soils become more depleted (Trefon, 1997; Trefon, *et al.*, 2007).

Payments for Environmental Services

Periurban forests provide a range of products and services both locally and globally. The sustainable development of a peri-urban forestry mainly for wood energy will help maintain and even strengthen or create many services, particularly environmental ones. Often non-monetary, these environmental products and services are most often common goods that are essential for both rural and urban communities nearby.

Some forest products (NTFP, such as leaves, fruits, lichens, game, resins, fodder...) have a clear monetary value. These products can be quantified and integrated neatly into the calculation of global forest value.

Other products and services (often of signifcant environmental value) are equally important but it is more difficult to assess their value. Soil protection, erosion control or siltation control, space structuring, leisure, water quality, treatment of wastewaters and bioremediation, biodiversity and ecosystem conservation, are all examples of these non-monetary environmental goods and ser-

vices (see chapter 8). These products and services have strong (but unquantified) global value and long-term worth for urban people. Unlike many rural communities who understand and manage their land sustainably, urban people are unable to sufficiently influence change to modify the observed trends. Wood energy represents a considerable asset for monetizing peri-urban forests and promoting sustainable management. It is easy to quantify the value of the forest and all the levels of the wood energy supply chain for cities. Several countries have shown that the development of a resource dedicated to wood energy competes directly with other land uses. It is also necessary that the benefits of these measures be attributed to the stakeholders involved in their management. This is only possible with well-established boundaries, authorities and measures for the public and private spheres. Most Central African countries now have appropriate legislation. The concrete application of these laws, fiscal transparency and land tenure security are essential links in building a virtous dynamic.

Photo 13.6: Bundles of wood along the road, ready for sale.

Land Management in Peri-Urban Zones

Peri-urban woodlands are a key source of wood energy, and the sustainable management of these woodlands is a major issue for people in cities and towns of Central Africa, especially the poorest people and women, those most affected by concerns of access to wood energy. Indeed, interventions should aim at combating poverty and insecurity among the urban poor. Diversifying income and employment to peri-urban rural populations is a major challenge for authorities in order to maintain a rural fabric, limit uncontrolled migration to cities and suburbs, and help reintegrate people to their local environment.

Forests are one of many elements that make up the peri-urban space. The implementation of a sustainable management approach for peri-urban areas, including forests and woodlands, can only be achieved with an appropriate strategy. Certain principles of this strategy can be defined by integrating the wood energy issue into urban and peri-urban planning. Wood energy resources are mobilized within a given territory, in which spaces and plant formations have a variety of functions (production, soil and water protection, fallow periods for fertility restoration, forests, land for settlements and infrastructure….) and are appropriated under different, even contradictory conditions. A strategy to develop forest plantations and manage degraded forests sustainably needs to take these different functions into account and development should not conflict with other important functions in the area. The initial aim is not to prepare a management plan for peri-urban areas *stricto sensu*, but rather to develop criteria and indicators to assess the relevance of places and conditions for developing wood energy resources sustainably. A comprehensive spatialized framework for intervention both at global level and with a "landscape" approach will allow the drafting of a Master Plan for the sustainable management of peri-urban areas where wood energy resources are managed.

Is Wood Energy Compatible with Sustainable Forest Management in Central Africa?

Developing Voluntary Public Policies

Public policies in Central Africa are most likely to change the situation, and even reverse the trends observed on the ground. Support for alternative energy, tax incentives, land tenure security, establishment of regulated markets, improving infrastructure, training... are all elements directly under state jurisdiction. Unfortunately, with very few exceptions, wood energy is largely ignored in public policies. A quick look at the few lines on the subject in laws and forestry codes confirms this.

A clear institutional environment and secure tax rules are conducive to the emergence of long-term forest development projects in the public sphere, especially in the private one. Their investment capacity and responsiveness mean private stakeholders can react quickly to development and forest resource management opportunities for wood energy production.

Improving Energy Processing

Much has been written and many projects have been initiated; however, traditional techniques are still the rule despite poor yields. This point certainly deserves more attention because the blockages are not technical and the costs for developing better technologies (charcoal, cooking) are not prohibitive. For example, a simple improvement to the carbonization wheels (not to mention the metal kilns or other more expensive equipment) could already double the performance. The problem therefore lies elsewhere. Wood energy is not rare enough in Central Africa to have a considerable and lasting impact on sales prices. In addition, the fragmentation of the profession and a largely informal sector are not conducive to setting a baseline pricing structure (especially for labor costs) or clear competition on urban markets.

Sustainable Management of Natural, Degraded Peri-Urban Forests

Wood and biomass energy supply to cities is directly related to the presence of a resource at a distance compatible with the economics (even informal) of the sector. Besides planted forest and urban parks, almost all supplies come from natural forests, regardless of land, administrative or territorial status. Anthropogenic pressure and the lack of woodland and natural peri-urban forest management generate significant negative impacts: economic (rural income, costs for urban dwellers), social (employment and rural exodus, poverty, ethnic and gender, post-conflict situation) and ecological (environmental goods and services, land-use competition). The concept of sustainable forest management (and certification) mostly applies to private forests (mostly industrial plantations), concessions or protected areas, and parks and areas with special status. However, the main production areas for woody biomass energy are in peri-urban forests and savanna located in the supply basin of target cities and where no rational management is implemented. There are often multiple and confusing reasons for the lack or even the absence of management.

The overall degradation of peri-urban forests poses numerous and fundamental questions to be addressed before envisaging proposals for suitable and viable management systems. For example, we still know little about ecosystem dynamics and resiliency, community and traditional management systems, territorial and social dynamics or the restoration and rehabilitation of forests mechanisms and tools. Once these bases are better defined, it will be possible to define the principles of adaptive management, which could be termed as "simple management plans." The goal is to manage the forests, gallery forests and riparian forests ... in question, sustainably, with progressive appropriation by local communities, the only guarantors and beneficiaries of a sound implementation. This process will take a long time, if only because of the lack of basic knowledge. However, it is undoubtedly the greatest challenge facing peri-urban forestry in both dry and humid zones of Africa (Smektala, 2003). New projects should help us better anticipate the reality and feasibility of this type of management, still widely unknown (e.g., the "Makala" project for Kinshasa and Kisangani, 2009-2013). New projects should help us better anticipate the reality and feasibility of this type of management, still widely unknown (eg the "Makala" project for Kinshasa and Kisangani, 2009-2013).

Developing Peri-Urban Forest Stands Solely for Wood Energy

If forest plantations were of interest to international investors and institutions a few decades ago, results are mixed, particularly in Africa (Mallet and Marien, 2005):

Industrial plantations of fast-growing species (eucalyptus, acacia, pine) were concentrated in a few countries where conditions are favorable. They are most often backed by corporations or large groups and facilitated the development of large internationalized branches, especially for paper pulp. South Africa, Congo and Morocco are examples. These plantations benefit from new technologies (genetics, forestry...) and are regarded as crops. In this case, local people only use the harvesting residues unless these are left on the ground to maintain soil fertility and plantation sustainability. Rising energy costs also leads to the development of a domestic valorization in

the form of cogeneration, for example. Thus there will probably be not be significant volumes available for people in cities near the plantations. Conversely, these industrial plantations or rather the way they are established, can sometimes present conflicting problems in terms of social management and relations with local people who derive no particular benefit.

Suburban private plantations of fast-growing species only develop if there is land security, a promising local market and a favorable institutional environment. In Madagascar (Antananarivo), the dynamics are completely private and develop without outside intervention. In DRC (Kinshasa-MAMPU), the private sector partially took over international funding and the success now encourages local people to develop the plantations themselves based on the initial plantations (plantations with an additional agricultural component). The profitability of this type of wooded area is often good to very good because the rotations are short, productivity is high and prices attractive. These plantations often do not benefit from modern technology and thrive in a mostly informal framework. And yet this is one of the best solutions for addressing wood energy needs (and timber) in cities.

Agroforestry plantations and parks often develop in peri-urban areas and are also the result of private and community initiatives. They are found in many countries, particularly in dryland Africa. Conflicts between livestock producers and farmers have led to scarcity of available rural areas, strong pressure and accelerated degradation of resources and ecosystems. These fallow lands, tree-covered parks and agroforestry systems (especially fruit trees), produce a growing proportion of the wood energy consumed in urban areas (Harmand and Bale, 2007; Peltier *et al.*, 2007).

Traditional forest development projects, launched in many countries in the 1960s and 1970s often turned out to be half-successes or failures, and provided a negative image of the very principle of forest plantations for a long time. These large-scale plantation projects were set up under the authority of state forestry services using international co-funding (grants or loans). If the diagnosis was mainly carried out properly (soil restoration, demand for wood and wood products, peri-urban afforestation ...), the achievements sometimes lacked realism. Some critical factors for such half-successes can be identified with hindsight: t**echnical** factors, badly understood or unsuitable techniques; **ecological** factors, introduced species unsuited to plantation areas; **economic** factors with short-term planning, costs out of line with expectations or widely overestimated balance sheets; **institutional** factors with relatively ineffective or absent state management; and, in particular, **social** factors, with poor land control (public or collective), leading to claims and conflicts with both local and herder populations.

However, these woods still continue to provide wood energy in peri-urban zones of some African cities. It is therefore important to learn from these half-successes and boost production on a cleaner, more modern basis. If the public sector does not have the vocation to be the management operator for these plantations, it should provide support in terms of technology (seed quality, extension...), territory (land security) and fiscal support (clear taxation) in order to promote the development of private peri-urban plantations with guaranteed profitability from ever-growing demand and higher energy costs.