

Woodfuel for Urban Markets in the Congo Basin

A Livelihood Perspective



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Chapter 1

Introduction

1.1 Woodfuel in humid Africa, an understudied livelihood resource

Woodfuel is the first source of energy for households in Sub-Saharan Africa.¹ Rural households, of which an estimated 93% rely on wood energy for daily cooking, mainly use fuelwood. In urban areas, depending on the availability of alternatives, such as LPG, an estimated 58% of households depend on woodfuel (IEA, 2006). Charcoal, the solid residue left after carbonization of wood, is especially popular for urban markets because of its higher energy content, easier storing and transport, and less smoke production compared to fuelwood (Arnold *et al.*, 2003). Woodfuel for urban demand is often derived from converting forestlands for agriculture, or, when markets are attractive, it is directly harvested from forests or agroforestry systems. Smaller quantities are sourced from plantations or from waste wood of timber operations (Chidumayo and Gumbo, 2013). Whereas the consumption of fuelwood has remained relatively stable throughout the developing world, the demand for charcoal continues to increase in many African urban households (Arnold *et al.*, 2003; Girard, 2002). The number of people depending on traditional biomass as their primary cooking fuel is increasing in Sub-Saharan Africa, with an expected 720 million consumers in 2030 (IEA, 2006). Attention to woodfuel production, trade, and consumption has fluctuated over the past decades with renewed interest since the 2000s because of its possible contribution to poverty and energy issues (e.g. Mwampamba *et al.*, 2013b; Owen *et al.*, 2013; Rogers *et al.*, 2012).² On an international level, the renewable potential of woodfuel becomes recognized and climate change politics start to take an interest in its possibilities for carbon sequestration and reducing greenhouse emissions. Woodfuel is a renewable energy source when the tree stock is derived from sustainable production practices and when technologies are used that optimize energy efficiency at production and consumption level (Bailis, 2009; Trossero, 2002). New energy saving techniques, such as optimized fuel load, improved charcoal kilns, and cogeneration of electricity from charcoal, hold promises to modernize woodfuel use in developing countries (Bailis *et al.*, 2013; Bentson *et al.*, 2013; Butz, 2013). However, international organizations dealing with energy and development

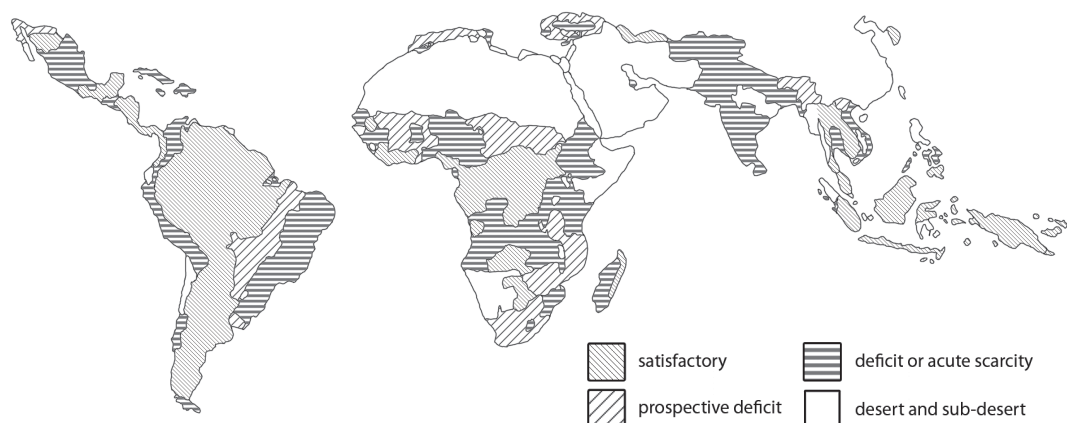
-
- 1 Woodfuel is defined as all types of biofuels originating directly or indirectly from woody biomass. In this study this includes fuelwood and charcoal. Fuelwood is understood as woodfuel in which the original composition of the wood is preserved. This category includes wood in its natural state and residues from wood-processing industries. Charcoal is defined as the solid residue derived from carbonization, distillation, pyrolysis and torrefaction of wood (FAO 2004).
 - 2 See Chapter 3.1.1 for a historical background of the debate.

often still present woodfuel as a traditional and undesirable energy source due for replacement by other 'modern' energy sources (Hiemstra-van der Horst and Hovorka, 2009; Openshaw, 2011). It is negatively associated particularly with health risks from (indoor) cooking smoke and pressure on wood resources (Guzmán and Hoz-Restrepo, 2008; Hofstad, 1997; Marien, 2009; Mwampamba, 2007; Smith, 2006). Poor people who depend on woodfuel are generally the ones who undergo these negative impacts (Bruce *et al.*, 2002; IEA, 2006; Nash and Luttrell, 2006) and urban users in particular suffer from high and increasing woodfuel prices (Marien, 2009). Despite the fact that there is sufficient woody biomass to meet demand in most countries, concentrated woodfuel demand, often related to land clearance for agriculture, has increased pressure on forest resources, which can lead to deforestation and degradation (Hofstad, 1997; Marien, 2009; Mwampamba, 2007; Openshaw, 2011). In Africa, deforestation caused by charcoal production is estimated at $14.07 \pm 5.27\%$ of total deforestation, which is relatively high compared to other regions (Central America: $2.5 \pm 1.80\%$; South America: $2.84 \pm 0.67\%$; Asia: $3.90 \pm 1.88\%$) (Chidumayo and Gumbo, 2013). However, the reality of woodfuel impacts on forests is quite diverse as woodfuel production is location-specific and mostly temporal. For instance, a review of the woodfuel situation in 18 African cities illustrated large variations in environmental outcomes: from low pressure and weak impact around some cities, to accelerated degradation of other peri-urban areas (FAO, 2010a).

The renewed interest in woodfuel does not only regard its relation to forestry and energy issues. The socio-economic characteristics of the woodfuel sector and the role of commercial woodfuel consumption is receiving more interest, as well, including woodfuel's role as a source of revenue for poor people (Arnold *et al.*, 2006; Sankhayan and Hofstad, 2000; Trossero, 2002; Vedeld *et al.*, 2007). In the past, many studies considered woodfuel as a subsistence good used in rural areas and focused mainly on production issues. Relatively little attention was given to woodfuel use in urban centers and the related processes of commercialization. However, in the 21st century it was noted that woodfuel still played an important role in many urban households in Africa (FAO, 2010a). Even though it is increasingly believed that woodfuel can provide important benefits to households, there are few quantitative studies about its income and how it contributes to rural and urban households (Angelsen and Wunder, 2003; Arnold *et al.*, 2006; Hyde *et al.*, 2000). Only a few recent studies offer insight into the extent to which woodfuel production and trade contribute to poverty reduction (e.g. Butz, 2013; Khundi *et al.*, 2011; Shackleton *et al.*, 2007; Zulu, 2010; Zulu and Richardson, 2013).

These studies show a variation in socio-economic impacts of woodfuel production and trade and illustrate that the specific livelihoods and contexts of those involved need to be taken into account. During the last decade these issues have received attention in studies on non-timber forest products and the livelihood impact of their production and trade (e.g. Arnold and Perez, 2001; Belcher *et al.*, 2005; Kusters *et al.*, 2006), and woodfuel studies can learn from these experiences. This thesis aims to contribute to a new generation of woodfuel studies by analyzing woodfuel as a livelihood resource in a value chain approach.

Figure 1.1. 1981 FAO Map of the fuelwood situation in developing countries



Source: FAO (1983)

It has long been assumed that woodfuel problems mostly occur in (semi-) arid regions. The early concerns in the 1970s and 1980s on an expected woodfuel gap between demand and supply mostly concerned arid and semi-arid Sub-Saharan Africa, the Himalaya region, the Andean plateau and densely populated areas in Central and Latin America (Eckholm, 1975; FAO; 1983) (Figure 1.1). Use of woodfuel in tropical humid forest areas has not been examined as it was considered abundant and a by-product of timber exploitation or conversion of forest lands to agriculture. However, recent observations on the role of woodfuel in humid regions of Africa show more diverse production patterns, as well as an increase in urban demand and a shift from consumption of fuelwood to charcoal. A growing woodfuel demand in urban centers has increased pressure on forest resources, which is problematic in the absence of incentives to restore or manage

those resources sustainably. Woodfuel does not only contribute to local livelihoods by serving as an energy source, but it also creates possibilities for many local people to gain an income from woodfuel production and trade. The financial impact is growing with the currently increasing prices in cities where there is little access to alternative sources of energy (Marien, 2009). Notwithstanding these new understandings of the role and significance of urban woodfuel use in the humid regions of Africa, there is still little information on the precise nature and development scope of woodfuel commerce in these regions, such as for example the Congo Basin.

This thesis analyzes woodfuel as a livelihood resource in the context of urban woodfuel supply in the Congo Basin. The Congo Basin, spreading across the Democratic Republic of Congo (DRC), Republic of Congo (ROC), the southeast of Cameroon, southern Central African Republic (CAR), Gabon and Equatorial Guinea, holds the second largest forest reserve in the world after the Amazon with important biodiversity (Billand, 2012). These forests do not only provide millions of people with game, wood, water, rich soils, construction material, fruits, and medicines for subsistence use and economic benefits (Hugues, 2011), but also contribute towards their energy needs. In most countries in the Congo basin, 80% to 90% of the population use woodfuel as main cooking fuel (Schure *et al.*, 2012). This woodfuel often constitutes 70% to 90% of the total national round wood production (FAO, 2011). Only in Gabon and Equatorial Guinea, where more households have access to gas as an alternative cooking fuel, is consumption of woodfuel considerably lower (Chapter 2.2). Simultaneously, the Congo Basin region represents some of the poorest people in the world with four out of six Congo Basin countries being categorized as ‘least developed countries’ in the Human Development Index (UNDP, 2013). This study contributes to the knowledge base on the woodfuel sector in the Congo Basin and possible outcomes for development and environment.

1.2 Analytical approach

Because interest in the socio-economic characteristics of the woodfuel sector only arose recently, there remains a lack of analytical models to study this issue. Therefore, this study takes inspiration from the scientific advances that have been made recently in studying the use of non-timber forest products (NTFPs). Woodfuel, together with timber and NTFPs, form the three major categories of forest product groups. Woodfuel

shares several characteristics with NTFPs, notably in respect of not constituting a clearly recognized institutionalized sector such as timber, and in its importance in local livelihoods in tropical countries. Notwithstanding these similarities, since the 1970s, woodfuel and NTFPs have mostly been debated separately and given alternating attention. This separation of debates may be reconsidered, as it will be further detailed in this study that discussions around livelihood implications target similar issues and that contemporary woodfuel studies can benefit from the contextualized perspectives on production, marketing, and livelihoods from NTFP studies.

Insights into the possible roles of NTFPs and woodfuel in livelihood strategies indicate possible outcomes related to developmental and environmental objectives. In recent decades, NTFP studies brought attention to the broader socio-economic context of forest products and related livelihood dynamics. With increasing market exposure, NTFPs increasingly provide for income generating activities (Ros-Tonen and Wiersum, 2005; Shackleton *et al.*, 2008; 2011). Not only forest adjacent villagers, but also peri-urban and urban citizens can be involved in production and trade of NTFPs. In addition to the characteristics of the forest product, the production conditions and presence of markets shape outcomes for the poor. Market conditions also influence the choices of where and how much forest resources are being extracted and thus the impact on the natural resource base (Belcher, 2005). More recently, the importance of access to markets has also been revealed for the woodfuel sector. Several studies illustrate how markets and market mechanisms influence distribution of benefits of rural and urban chain actors (Drigo *et al.*, 2002; Kambewa *et al.*, 2007; Luckert and Campbell, 2002; Nkoua and Gazull, 2011; Ribot, 1998).

The function of markets for NTFPs depends on the role that these products take in people's livelihood strategies. Integration of NTFPs in livelihood strategies can vary from: (1) a subsistence strategy, in which NTFPs are mainly harvested from wild resources for subsistence use, to; (2) a diversity strategy, in which NTFPs are used as an additional source of income besides other household activities, to; (3) a specialized strategy, in which NTFPs are a relatively large source of household income (Ruiz-Perez *et al.*, 2004). The role of markets for forest products is obviously more important in the diversity and specialized strategy than in the subsistence strategy. This holds at least until a certain stage of economic development, while further market integration often leads towards more specialization of income generating activities and less dependence on forest-based strategies (Ros-Tonen and Wiersum, 2005).

Growing urban markets for forest products provide cash-income-earning opportunities to peri-urban smallholders, especially for scarce products in demand (Robinson *et al.*, 2002). Markets for specialized, cultivated NTFPs where producers have secure tenure are relatively stable and well developed and concern higher-value products with good returns to investment (Sunderlin *et al.*, 2005). Strong local markets (combined with export markets) allow for income diversification of producers and traders, generally associated with less vulnerability (Belcher, 2005). Although high demand is generally related to the risk of overharvesting, markets can also stimulate more sustainable methods: “Where the market is sufficiently attractive, the product sufficiently valuable, and land/resource tenure secure, people invest in managing NTFPs” (Belcher *et al.*, 2005: 1447). Moreover, markets can have a specific resource management role, such as the Rural Wood Markets in Mali that involve a delimited forest with specific harvesting quotas and selling points (Hautdidier and Gautier, 2005). However, there are also limitations related to the potential of NTFP markets for developmental and environmental objectives. First of all, most products are sold in large quantities for low prices within a limited geographical scope (Belcher *et al.*, 2005). These markets for low-value, free-access NTFPs allow a lot of people to engage, but suffer from heavy competition and low profit margins (Sunderlin *et al.*, 2005). Other problems related to NTFP trade are: lack of market information; fragmented markets; low quantities and irregular supplies; perishable nature of the product; lack of storage facilities; poor infrastructure and high transportation costs; lack of organization among producers; lack of credit; and fluctuating prices and demand (Ros-Tonen and Wiersum, 2005). Poor people generally have weak or unequal access to both the resources and product markets because of high competition and costly entry barriers (Belcher, 2005). Especially in the case of higher-value, specialized forest products with developed markets, it is mostly the wealthier households that can benefit from these more valuable NTFPs, as these require tenure rights and sufficient assets for initial investments (Sunderlin *et al.*, 2005). The fragile market access and poor bargaining power of producers in remote areas make them dependent on traders who provide for credit, trade contacts, and transport (Belcher and Schreckenberg, 2007). Commercialization of NTFPs can lead to degradation of forest resources, which threatens the subsistence use of those same products by poor people (Belcher *et al.*, 2005).

Table 1.1. Possible outcomes of NTFP and woodfuel markets

Outcomes	Developmental objective	Environmental objective
Positive	Contributes to subsistence, diversification, and specialization strategies Provides cash-income (especially for higher-value products) Many people can engage for free-access NTFPs	Investments in sustainable harvesting or cultivation of (higher-value) NTFPs Market-led governance arrangements stimulate resource management
Negative	Limited income because of low prices, poor access, high entry barriers, and long distances Trade is restricted to local markets Irregular demand/ insecure sources Increased dependence on traders or more powerful chain actors	Low prices relative to alternatives (no inclusion of environmental/restoration costs) Forest degradation and species loss Deforestation

Source: Inspired by Arnold and Perez, 2001; Belcher *et al.*, 2005; Belcher and Schreckenber, 2007; Hautdidier and Gautier, 2005; Ros-Tonen and Wiersum, 2005; Ruiz-Perez *et al.*, 2004; Sunderlin *et al.*, 2005.

1.3 Theoretical concepts and overall analytical framework

The study's approach required the development of a specific analytical framework. This section elaborates the theoretical concepts that guided the study and the analytical framework. It discusses the concept of livelihoods and the Sustainable Livelihoods Framework and their strengths and weaknesses for studying forest product commerce and possible outcomes. Value chain analysis is presented for linking production and markets to overcome some of the limitations of the Sustainable Livelihoods Framework. The various concepts are integrated in a framework on livelihoods and value chain interactions that involves various actors and spatial contexts. This 'Livelihoods - Woodfuel Chain - Framework' puts the concept of institutions central in explaining access to resources and access to markets that co-determine livelihood strategies. Institutions can be either a formal construct, in the form of rules established and enforced by outside interventions, or an informal construct related to the conventions of local people. It is sometimes suggested that positive outcomes of value chains on livelihoods require formalization of the informal institutions. The function of formalization in shaping livelihood outcomes is the other central focus of the framework, besides the role of

institutions. The framework defines poverty reduction and sustainable use of the resource base as desired sustainable livelihood outcomes.

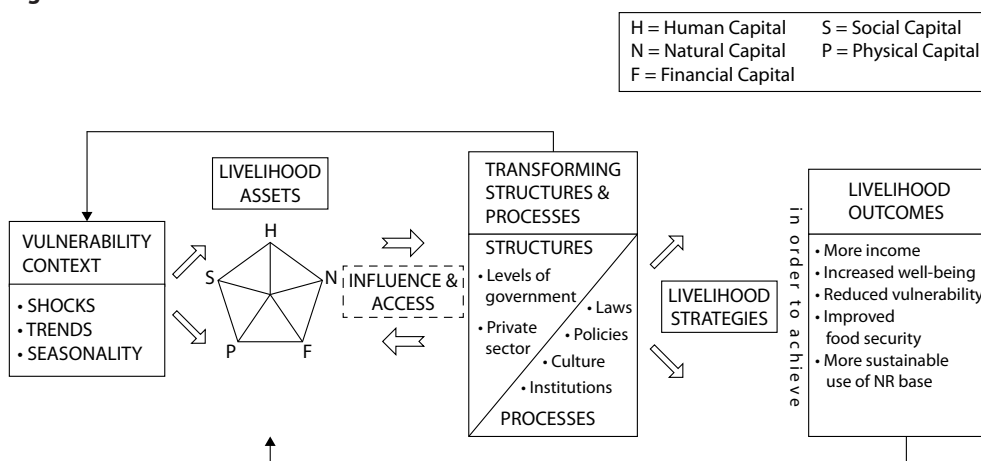
1.3.1 The Sustainable Livelihoods Framework

As the previous section illustrated, woodfuel production and trade can be part of various livelihood strategies that people use to sustain their lives (subsistence, diversity, specialized strategy). Livelihood is defined as “the control an individual, family, or other social group has over an income and/or a package of sources that can be used or changed to maintain a living” (Blaikie *et al.*, 1994: 9). A livelihood usually encompasses a multitude of livelihood activities. The combination of diverse subsistence and income-generating activities, often adding non-agricultural sources of income to rural livelihoods, contributes to ‘livelihood diversification’, defined as “the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living” (Ellis, 1998: 1). Livelihood strategies depend on personal skills and characteristics, social relations, the combination of different activities, and the season. In order to execute livelihood strategies, people use tangible assets like stores and resources and non-tangible assets in the form of claims and accesses (Blaikie *et al.*, 1994). These tangible and non-tangible assets are also conceptualized as five different ‘capitals’ in order to create models for social processes and environmental change: (1) Human capital; skills, knowledge, ability, and potential to labor and good health, (2) Social capital; social resources upon which people draw, including networks, membership of groups, and relationships of trust, (3) Natural capital; natural resource stocks from which resource flows are derived, (4) Physical capital; basic infrastructure and producer goods, and (5) Financial capital; financial resources that are available to people, including savings and credit (Ashley and Carney, 1999; Blaikie *et al.*, 1994; Chambers, 1995; De Haan, 2000; Neefjes, 2000; Scoones, 1998). ‘Sustainable livelihoods’ are achieved through access to this range of livelihood resources (Scoones, 1998). The Sustainable Livelihoods Framework (SL-Framework) (Figure 1.2) illustrates the main factors and processes involved in the concept of sustainable livelihoods by linking contextual conditions, livelihood assets, institutional processes, and organizational structures with livelihood strategies and five ‘sustainable livelihood outcomes’.³ These outcomes are: ‘more income’; ‘increased well-

3 The Sustainable Livelihoods Framework was developed by UK based scholars (e.g. Bebbington, 1999; Chambers and Conway, 1991; Carney, 1998; Ellis, 2000; Scoones, 1998) and is known for its adoption by DFID, followed by many others in the domain of development, sociology, and environmental studies.

being'; 'reduced vulnerability'; 'improved food security'; and 'more sustainable use of natural resource base ensured' (Ashley and Carney, 1999; Scoones, 1998).

Figure 1.2. Sustainable Livelihoods Framework



Source: Ashley and Carney, 1999: 47.

NTPF studies have demonstrated that both 'access to resources' and 'access to markets' are main features in explaining who, and to what extent, benefits from forest products (Belcher, 2005; Wiersum *et al.*, 2014). The SL-Framework has granted importance to the factor 'access to resources', with the factor 'access to markets' holding a less explicit position in the SL-Framework. 'Access to resources' is primarily conceptualized as 'natural capital' that people can acquire. This asset is influenced by both the vulnerability context and the 'transforming structures and processes' that shape access. Moreover, livelihood strategies have an impact on the natural resource base, which demonstrates the cyclical nature of the model. The factor 'access to markets' is not clearly indicated in the SL-Framework, which may be intentional, as the framework advocated for a broader view on poverty than solely the cash-income part or via market channels.⁴ Nonetheless, livelihood scholars, also those who contributed to the development of the sustainable livelihoods concept, did recognize the relevance of the role of markets in local livelihoods. Lack of access to markets, as part of basic services, had been identified as one of the

⁴ Carney (2003) argued that, in contrast to this criticism, the economic dimension, including markets, has always been part of SL approaches as the SL-Framework builds upon the asset vulnerability framework that originates from economic literature dealing with famine studies (Sen, 1981).

poverty dimensions (Chambers, 1995). The structural components of state, market, and civil society govern how people shape rules and relationships of resource access, use, and transformation (Bebbington, 1999). Informal and formal institutions, including credit arrangements and marketing networks, influence this access and the resulting livelihood strategies (Scoones, 1998). The ability to access markets, together with relations with market actors (social capital) that help in securing this access, contribute to the use of resources for people's livelihoods (Bebbington, 1999; Leach *et al.*, 1999).

In summary, livelihood scholars have given the most attention to the 'access to resources' as a factor affecting local livelihoods. They also grant importance to the place of markets as a structural component or by including market related social relations and institutions as parameters in the SL-Framework. However, this issue has not been systematically elaborated and the unclear role of markets in the SL-Framework has remained one of the main critiques. This is related to the limited elaboration of the box of 'structures and processes' and power issues, which constricts understanding of the institutional processes at the macro level that impact on livelihoods (Ashley and Carney, 1999; Carney, 2003; De Haan and Zoomers, 2005; Dorward *et al.*, 2003; Scoones, 2009). De Haan's (2000) notion of the 'multi-locality of livelihoods' in this era of globalization underlines that worldwide social relations and markets need to be taken into account to understand processes of inclusion and exclusion. Along a similar line, Scoones (2009) advocates for the livelihood perspective to include more political analysis in order to transcend the local level and better understand global markets and political processes labeled under 'context' in the original framework. These observations also fit recent recognition that production and trade of NTFPs is not only an activity of local, forest adjacent communities, but involves peri-urban and urban citizens, possibly beyond national borders (Ingram *et al.*, 2012; Jensen, 2009).

Different solutions have been proposed to adapt the SL-Framework or combine it with other tools to better capture dynamics concerning markets, power relations, and the macro scale (e.g.: Ashley and Carney, 1999; Carney, 2003; Dorward *et al.*, 2003). This study contributes to this broader understanding of options for sustainable livelihoods by integration of value chain analysis.

1.3.2 Value chains for linking production and markets

“The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production

(involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use” (Kaplinsky and Morris, 2001: 4). There is a wide variety of concepts and approaches linked to the study of “commodities along the routes they take from production to final consumption” (Bernstein and Campling, 2006: 240).⁵ The value chain concept has been adopted as the most inclusive concept for describing and analyzing the diversity of activities and products that are involved in these routes (Gereffi *et al.*, 2001).

The value chain concept can be both employed as a descriptive construct for tracking data on quantities, trade flows, values, and actors and, as recent work (mainly introduced by Gereffi’s use of ‘global commodity chains’ in the mid 1990s) shows, it can take a more analytical and normative angle (Kaplinsky and Morris, 2001). Value chain analyses have dealt with outcomes of globalization, about “the winners and the losers [...], how and why the gains from globalization are spread, and how the number of gainers can be increased” (Gereffi *et al.*, 2001: 2). It does so by providing insights into the distribution of income, barriers to entry, power relations and institutions, and the role of governments in supporting or regulating value chains (Kaplinsky and Morris, 2001). In recent years, studies on NTFPs have integrated value chain analysis while recognizing that trade flows and outcomes often go beyond those of forest adjacent villages, involving migration, urban citizens, and global economies (Jensen, 2009). This perspective on the entire chain of a commercialized product includes social, economic, technological, and ecological aspects of the product, the markets, and the production system (Kusters *et al.*, 2006; Ndoye and Awono, 2005; Sizer *et al.*, 2005). NTFP value chain analyses have been used to target various issues, such as quantification of value of products (Jensen,

5 Related concepts are “‘*filières*’ (see Raikes *et al.*, 2000), ‘commodity systems’ (Friedland 1984), ‘commodity chains’ (Hopkins and Wallerstein 1986; Hughes and Reimer 2004), ‘supply chains’ (Porter 1990), ‘global commodity chains’ (Gereffi and Korzeniewicz 1994), ‘value chains’ (Kaplinsky 2000), ‘cross-continental food chains’ (Fold and Pritchard 2005) and ‘global value chains’ (Gibbon and Ponte), among other terms” (Bernstein and Campling, 2006: 240). Raikes *et al.* (2000) provide a background analysis comparing the global commodity chain (GCC) approach and the French *filière* approach with their respective strengths. Wallerstein’s (1974) world systems theory made the first notion of ‘commodity chains’, defined as ‘a network of labor and production processes whose end result is a finished commodity’ (by Hopkins and Wallerstein, 1986, 1994), often an agricultural good. The ‘global commodity analysis’ detailed by Gereffi *et al.* (1994) from a political economy approach has mainly focused on industrial commodities. Besides the descriptive approach of input-output patterns and geographical situation, Gereffi *et al.* (1994) have opened up the GCC approach for analyzing governance, institutional framework, and power relations. The *filière* approach, developed by French agriculture research institutes (INRA and CIRAD) in the 1960s, was the first empirical tool to study agriculture commodity flows in the former colonies at a domestic level. Since then, three different traditions have emerged: (1) the empirical research tradition focused on mapping commodity flows and actors; (2) the quantitative tradition that deals with measuring inputs, outputs, and values; and (3) the anthropological tradition that focuses on markets and power, and thus comes closest to the GCC perspective (Raikes *et al.*, 2000).

2009), outcomes of commercialization in household livelihood strategies (Belcher and Schreckenberg, 2007), and governance between organizations and actors (Ingram *et al.*, 2012; Ribot, 1998; Te Velde *et al.*, 2006).

1.3.3 'Livelihoods - Woodfuel Chain - Framework'

For the purpose of this study, elements of SL-Framework were combined with elements of value chain analysis in an adapted analytical framework. The process of constructing this combined 'sustainable livelihoods' – 'value chain' – framework for the woodfuel sector has been a reiterative process that built upon premises of NTFP studies and qualities of the respective analytical concepts.

The SL-Framework was applied as an analytical tool to link contextual conditions, livelihood assets, institutional processes, and livelihood strategies with sustainable livelihood outcomes. Moreover, it was used in a normative sense through its people-centered approach, focusing on poverty reduction and more sustainable use of the resource base, two much-debated possible outcomes of NTFP trade. In order to overcome some of the SL-Framework's limitations in transcending the household level and including power issues and markets (Ashley and Carney, 1999; Carney, 2003; De Haan and Zoomers, 2005; Dorward *et al.*, 2003; Scoones, 2009), two concepts from the box of 'transforming structures and processes' have been elaborated. These are: 'institutions' that shape access to resources and access to markets, and 'formalization' as a dynamic process of transforming informal into formal institutions. These and other issues were explored in more detail by applying value chain analysis.

The study embraced both the descriptive and the analytical and normative character of value chain analysis. As a descriptive empirical tool it assisted in mapping the actors and socio-economic and environmental outcomes of woodfuel production and trade. For woodfuel, the chain starts where the tree grows and the wood is cut. It continues with transformation through drying, chopping, or carbonization of the wood, followed by packing and transporting of the woodfuel to urban markets, and ends with the consumption by households and businesses. While focusing on a national level, this use of value chain analysis may be most closely linked to the traditional empirical and quantitative French '*filière*' approach (see Raikes *et al.*, 2000). The concept of value chain served to specify the contextual arena of the framework, embedded in wider socio-economic, political, and natural environments to capture Central Africa's dynamic urban-rural interfaces. On an analytical level, following the anthropological tradition of

the *filière* approach or Global Commodity Chains (but on a national level) (Gereffi *et al.*, 2001; Raikes *et al.*, 2000), value chain analysis assisted in linking production and markets in a multi-local perspective, the assessment of informal and formal institutions shaping access for different actors, and the influence of outside interventions and formalization on internal organization of the chain. As a normative concept, value chain assisted in explaining differences in access and distribution patterns of value chain actors.

A preliminary version of the 'Livelihoods - Woodfuel Chain - Framework' (LWC-Framework) had specified the multiple contextual factors and characteristics of woodfuel as a livelihood resource, as identified in literature (Schure *et al.*, 2009). It was used in the exploratory and descriptive phase of the study, facilitating empirical understanding of woodfuel value chains. As indicators of 'socio-economic characteristics' of the value chain, the following parameters were selected for data analysis: volumes and values of woodfuel market; numbers of actors involved; revenues gained; livelihoods diversified; value of product throughout the chain; extent and equity of benefit distribution amongst actors; household energy provided; household expenditure; consumer perception of supply (Arnold *et al.*, 2006; Belcher, 2005; Ellis, 1999; Ribot, 1998; Sunderlin *et al.*, 2005). Indicators linking to environmental characteristics are: source of woodfuel harvesting; preferred tree sources; distance to tree sources; combined objective of clearing land for agriculture; restricted access to resource; conflicts related to accessing resource; investments in sustainable harvesting and/or cultivation of woodfuel resource; tree species harvested; woodfuel markets taking a resource management role; types of cooking stoves used (Abbot and Lowore, 1999; Chidumayo and Gumbo, 2013; Lattimore *et al.*, 2009).

1.3.4 The role of institutions

The initial descriptive framework was gradually modified into a more concise explanatory framework during the analytical research process. In this process, specific attention was given to the role of institutions as transforming structures. Based on empirical studies and insights from NTFP literature, the LWC-Framework was tailored to analyze the role of woodfuel institutions in determining access to resources and markets, and formalization of production and trade.

NTFP studies had demonstrated that both informal and formal institutions could be considered as structural components that shape access to resources and markets

(Belcher, 2005; Wiersum *et al.*, 2014). In this study, woodfuel institutions are defined as the formal and informal rules and regularized patterns of behavior between different actors in society and associated enforcement mechanisms that shape access related to woodfuel production and trade.⁶ Informal or ‘socially embedded’ institutions are upheld by socially shared, usually unwritten, conventions created and enforced among the actors involved. Formal or bureaucratic institutions can be considered as the rules enforced by an outside third party (often government agency or development organization), such as the rule of law and contracts (Cleaver, 2002; Leach *et al.*, 1999; North, 1993).

It is often suggested that informal institutions need to be further formalized in order to achieve more sustainable management of forest resources and woodfuel (De Soto, 1993; Laird *et al.*, 2010b; Owen *et al.*, 2013). This process gets specific attention in this study. In this context, formalization is defined as “the degree to which the supply network is controlled by explicit rules, procedures, and norms that prescribe the rights and obligations of the individual [company] that populate it” (Choi and Hong, 2002: 470). Gereffi *et al.* (2001) identified this link between external regulations with internal processes of the value chain as an important knowledge gap in current understanding of value chains. Indicators of formalization selected for this study are: 1) existence of written rules and policies dealing with (cross-sectorial aspects of) woodfuel value chains; 2) degree to which penalties for rule violations are clearly stipulated and enforced according to written rules and policies; and 3) ease and accessibility of formalizing (inspired by Hall and Haas, 1967; Helmke and Levitsky, 2004a; Ishengoma and Kappel, 2006).

1.3.5 Conclusion analytical framework

During a reiterative research approach, the livelihood perspective and value chain analysis toward studying use of forest products were gradually integrated in an LWC-Framework. This analytical framework specifies the transforming structures and processes and contextual conditions of the original SL-Framework in respect to woodfuel production and trade. Contextual conditions have been elaborated to capture production and market dynamics and different value chain actors. Considering the SL outcomes, attention was given specifically to two issues: (1) sustainable use of the natural resource base, considered as the preferred environmental condition; and (2) poverty reduction of the actors in the value chain as the desirable socio-economic outcome of woodfuel

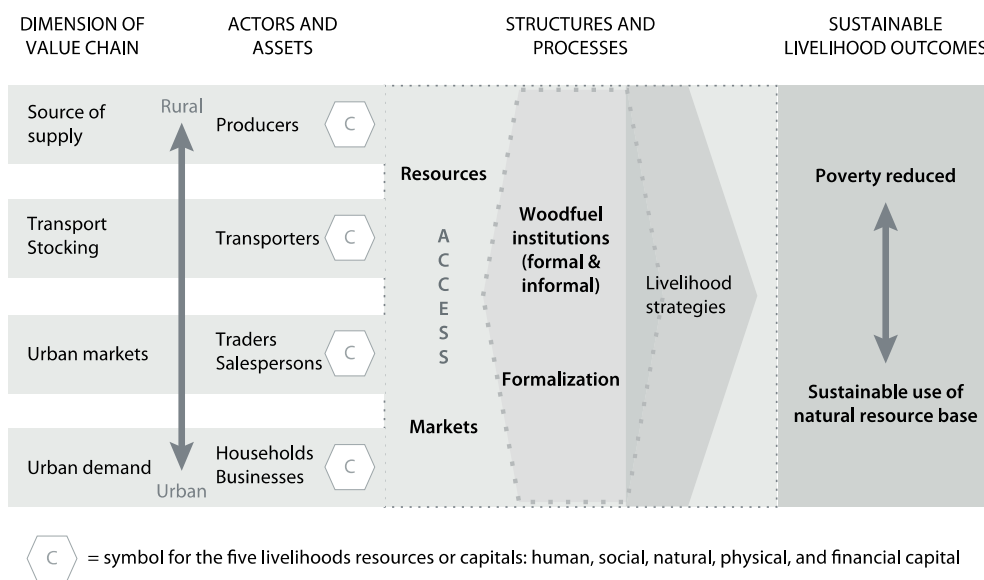
6 Drawing on the definition of institutions by Leach *et al.* (1999).

1

production and trade. A combination of livelihood strategies can help to mitigate and reduce poverty (Ellis, 1998; Scoones, 1998). Poverty reduction is defined as “the use of forest resources to help lift the household out of poverty by functioning as a source of savings, investment, accumulation, asset building, and lasting increases in income and well-being” (Sunderlin *et al.*, 2005: 1386).

Thus, the linking of livelihood perspective to value chain analysis provided an analytical framework for systematic assessment of woodfuel as a livelihood resource for different value chain actors around three analytical issues: (1) sustainable livelihood outcomes of woodfuel value chains with specific emphasis on poverty reduction and sustainable use of the natural resource base; (2) woodfuel institutions and how these shape access to resources and access to markets; and (3) formalization of woodfuel institutions as a way to mitigate livelihood outcomes. The final analytical framework as used in this study is summarized in Figure 1.3.

Figure 1.3. ‘Livelihoods - Woodfuel Chain - Framework’ (LWC-Framework)



1.4 Significance of the study

This study aims to contribute both toward analytical advances in woodfuel studies and toward a better understanding of the socio-economic and environmental characteristics of woodfuel trade to urban cities located in the humid African tropics.

The analytical relevance of the study is its focus on woodfuel as a livelihood resource in a value chain approach. In the past, focus has often been on woodfuel for subsistence use or as a consumer good, largely ignoring the trade aspect. The ‘Livelihoods - Woodfuel Chain - Framework’ (LWC-Framework) combines the concept of sustainable livelihoods with value chain analysis in order to render the role of markets more explicit and to acknowledge the multi-spatial character, the various actors involved, and the rural-urban interface of the sector. It assists in addressing three analytical issues. First, the research analyzes sustainable livelihood outcomes for different actors in the value chain. It focuses on poverty reduction and sustainable use of the natural resource base as main outcomes and discusses both the possible co-existence and contradictory outcomes that occur in contrasting resource and market conditions. Thus, it contributes to the scientific debates on how forests can improve the lives of the poor and on whether developmental and environmental goals can be compatible. Second, this study examines formal and informal institutions that shape access to resources and access to markets for value chain actors. This builds upon recognition in NTFP studies that access to markets is as important as access to resources in understanding possible outcomes and that institutional mechanisms can help to explain distribution to different actors (Belcher *et al.*, 2005; Mearns, 1995; Wiersum *et al.*, 2014). Third, the study examines the link between formalization of woodfuel institutions and livelihood outcomes. Developing formal institutions is often considered as the way to managing forest resources more sustainably in mainstream development thinking. However, formalization can have adverse effects for woodfuel producers and traders when it hinders their capacity to access the resource or markets (Ribot, 1995a; 1998). This research is one of the first attempts to assess relations between the formalization of woodfuel institutions and socio-economic outcomes for those involved by reviewing studies and data comparing the Central and West African region. The development and application of the LWC-Framework and lessons from the three in-depth analyses could contribute to future studies and theory building around related issues.

The empirical and policy relevance of the study is its contribution to better understanding of woodfuel value chains in the specific regional context and related

policy issues. Most studies on woodfuel have focused on dry-forest areas such as for example semi-arid African Sahel countries and attention to possible impacts of woodfuel trade in the Central African context, with largely humid forests, is relatively new. Better insights in woodfuel value chains can contribute to more effective policies and management of the wood energy sector (Chidumayo and Gumbo, 2013). This study contributes knowledge that concerns forest management, access to energy, and climate change mitigation policies in the countries of the Congo Basin and related developmental and environmental issues. It analyzes, for example, the contribution of the woodfuel sector to livelihoods of producers engaged in urban woodfuel supply in the Democratic Republic of Congo (DRC), one of the poorest countries in the world (UNDP, 2013). Part of the data collection links to the Makala Project (an EU-funded project about sustainable management of woodfuel in the DRC that serves as a pilot project for countries in the Congo Basin), which guarantees the dissemination of results to stakeholders of the wood energy sector at various levels.

1.5 Research objectives and questions

The objectives of this study are to:

- 1) Contribute to the empirical knowledge base of the woodfuel sector in the Congo Basin and identify major socio-economic and environmental outcomes with regard to woodfuel value chains.
- 2) Contribute to the analyzation of woodfuel as a livelihood resource by development and application of a combined ‘Sustainable Livelihoods’ – ‘value chains’ framework for explaining:
 - a. Sustainable livelihood outcomes of woodfuel for different actors in the value chain with emphasis on poverty reduction and sustainable use of the natural resource base;
 - b. Woodfuel institutions and how they affect access to resources and access to markets;
 - c. Formalization of the woodfuel sector and whether this contributes to livelihood outcomes.

These objectives were further operationalized into four main research questions:

- 1) What are the characteristics of the woodfuel value chains around urban centers in the DRC and what are their main outcomes for sustainable use of the natural resource base?
- 2) How do woodfuel production and trade contribute to livelihoods and poverty reduction of producers engaged in the urban supply in the DRC?
- 3) How do woodfuel institutions shape access to woodfuel resources and markets around urban centers in the DRC?
- 4) How is formalization of woodfuel institutions affecting livelihood outcomes of actors involved in woodfuel value chains of Central and West Africa?

1.6 Research design

1.6.1 Overall research design

The core of this research follows a comparative case study approach with a multiple-case embedded design for answering the first three research questions. These research questions are studied in the context of location-specific cases in the DRC. In order to answer the fourth research question, the data from this comparative case study were further contextualized by making a comparison on woodfuel formalization in Central and West Africa.

A case study is defined as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 1994: 13). Characteristics of the case study are:

- It targets detailed knowledge of the case in context, for one or a small number of cases (within-case analysis or cross-case comparisons).
 - It relies on multiple sources of evidence and methods.
 - Triangulation (of data, observer, methods, theories) is used for converging results.
 - Theoretical propositions guide data collection and analysis.
- ^a Study design emerges during study in a reiterative manner (George and Bennett, 2005; Robson, 2002; Yin, 1994).

The empirical study compared two cases of woodfuel value chains for the urban centers of Kinshasa and Kisangani. Multiple case studies are usually selected because they either predict similar results ('literal replication') or because they are expected to produce contrasting results for predictable reasons ('a theoretical replication') (Yin, 1994). The cases of woodfuel production and trade for the two different cities combine these two selection criteria, as both similar and different outcomes related to contextual factors are expected (Table 1.2). The study consisted of two phases: an explorative one and a more focused explanatory phase. For cross-sectional fixed data collection in both case-study areas a multi-method survey was carried out. For the embedded units of analysis, the main analytic strategy is survey analysis combined with content analysis of interview transcripts and observation notes. This embedded, quantitatively focused design aimed at statistical generalization for groups of actors within the cases. The analytic strategies for the overall qualitative design of the multiple case study are empirical validation and explanation building around the cases, which target analytic generalization (Yin, 1994).

Table 1.2. Overview multiple case study embedded design

Study design	Unit of analysis	Methods	Analytic strategy
Multiple/ comparative case study	Cases: - Woodfuel value chain Kinshasa - Woodfuel value chain Kisangani	Literature/ document review	Explanation building
	Literal replication/similar results: - Urban center in the Democratic Republic of Congo - Woodfuel main source of urban household energy	In-depth, semi- structured interviews Stakeholder mapping Observation	
	Theoretical replication/ contrasting results: - Commercial demand (higher for Kinshasa) - Pressure on natural resource base (higher for Kinshasa) - Distance to public administrator (smaller for Kinshasa)		
Embedded design	Key actors per case study site: Producers, transporters, salespersons, consumers	Sample survey Interviews Observation	Survey analysis Content analysis of interview transcripts and observation notes

The quality of case study design depends on its validity and reliability (Yin, 1994). Possible threats identified to internal validity are incompleteness of data, due to overall lack of data about the sector or incompleteness of the conceptual framework that informed the survey questionnaires. A threat to generalizability of this study may be the specific Congolese setting. This study targets internal validity of explanatory data analysis by explanation building. Convergence of multiple sources of evidence and validation of research results by peers and respondents contributes to construct validity. Replication of research strategies between the two cases increases external validity. The synthesis study of the broader context of the Congo Basin (Chapter 2.2) identifies contextual factors that co-shape external validity of analytical generalizations. The use of study protocols and a database, shared at several stages of their development with peers, contributes to reliability of the study.

1.6.2 Methods and materials

A combination of methods was used to measure, value, and compare different aspects of livelihood outcomes connected with the woodfuel sector. This allowed triangulation of data. Each of the following chapters details the methodologies used for data collection and analysis. The general methodologies applied to finding answers to the research questions are the following:

- Literature review of scientific literature and document and data analyses from various sources, such as ministries, NGOs, and research institutes, provided information about the context, policy interventions, institutional structures, available data, and regulatory frameworks.
- In-depth semi-structured interviews with stakeholders and actors of the woodfuel value chain served to grasp understanding of roles, motivations, and patterns of change.
- Sample surveys with key actors (producers, transporters, traders, vendors, and consumers) assisted to obtain quantitative data about social, economic, and environmental aspects.⁷ A statistical software package (SPSS 16.0) was applied to analyze the data. Descriptive statistics were used to illustrate the socio-economic and environmental profile of value chains. Statistical analyses (chi-square test for independence, independent-samples t-test, and one-way between groups ANOVA)

⁷ See Ingram and Schure (2010) for the survey forms and Schure (2010) for an overview of the number of actors surveyed and selection criteria.

were conducted to compare differences between groups (regions, income groups, types of product).

- Observations were used in the exploratory phase to help map the main actors and gain overall understanding of the production and trade patterns and, during the survey phase, to obtain data on ‘illegal’ or hidden practices, such as the transport at night and bribes being paid by transporters and traders.

1.6.3 Research area

The Congo Basin Forest is the world’s second largest tropical forest after the Amazon. The major surface of this forest, 61% (about 130 million hectares), is situated in the DRC (Eba’a Atyi and Bayol, 2009). Despite these abundant natural resources, the DRC is one of the poorest countries in the world, being among the last of 187 countries on the Human Development Index (UNDP, 2013). The study area covers the supply zones for woodfuel to the DRC’s capital Kinshasa and to Kisangani, capital of the Orientale Province (Figure 1.4). The two sites allow a comparison of an area containing a savannah

Table 1.3. Socio-economic status of Kinshasa, Kisangani research locations

	Kinshasa Kinshasa Province	Kinshasa Bas-Congo Province	Kisangani Orientale Province	DRC
Surface (thousands km ²)	9.9	55.9	503.2	2,344.8
Population (millions)	5.8	3.2	6.6	64.3
Poverty rate (%)	41.6	69.8	75.5	71.3
Average household size	6.0	4.8	4.7	5.3
Primary school education rate (%)	74.8	71.1	76.6	76.3
Underemployment ^a (%)	53.1	73.4	71.9	72.7
Origin of household income (%):				
Informal sector	89.5	93.6	95.9	94.6
Public sector	6.1	4.0	2.9	3.6
Private sector	4.4	2.4	1.3	1.8
Average monthly household income (USD)	84.0	37.0	25.0	42.0

Source: (UNDP, 2009)

^aUnderemployment: people who involuntarily work less than 35 hours a week or earn less than the minimum salary.

and degraded forests zone around Kinshasa with the abundant forests around Kisangani. These two cities were selected because of their high woodfuel demand, although considerably higher in Kinshasa because of its higher population and greater distances to wood resources. The population of the Orientale Province is poorer than the population in the other main supply sites under study (Kinshasa and Bas-Congo province) (Table 1.3).

Figure 1.4. Study sites (Kinshasa and Kisangani) in the Democratic Republic of Congo



1.7 Outline of the thesis

Four empirical chapters and a conclusion follow this introductory chapter. Chapters 2, 3, 4, and 5 are related to the research questions 1, 2, 3, and 4, respectively.

Chapter 2 ‘Woodfuel value chains for urban centers in the Democratic Republic of Congo: Context, characteristics, and sustainable use of the resource base’ presents an overview of the status of woodfuel in the Congo Basin. Subsequently, it analyzes actors

and dimensions of the woodfuel value chains of the cities Kinshasa and Kisangani. It compares how socio-economic and environmental characteristics are different for the degraded high-demand supply area of Kinshasa and the Kisangani supply zone where the resource is still abundant, and discusses implications with regard to sustainable use of the natural resource base.

Chapter 3 ‘Producing woodfuel for urban centers in the Democratic Republic of Congo: A path out of poverty for rural households?’ focuses on the outcomes of the woodfuel sector for the largest group of actors of the value chain: the producers engaged in urban woodfuel supply in the DRC. It evaluates the role of woodfuel commerce within livelihood strategies and the poverty reduction potential of production and trade for producer households.

Chapter 4 ‘Institutions and access to woodfuel commerce in the Democratic Republic of Congo’ analyzes how institutions shape access to resources and access to markets in wood energy value chains in the DRC. Access to woodfuel commercialization co-determines the livelihood outcomes of the different actors involved. It particularly examines whether producers face exclusion from accessing the market and whether woodfuel institutions contribute to sustainable production.

Chapter 5 ‘Formalization of charcoal value chains and livelihood outcomes in Central and West Africa’ examines the link between the degree of formalization of charcoal institutions and livelihood outcomes for actors involved in woodfuel value chains. Lessons are drawn by comparing Central African countries, where policy and regulatory attention to woodfuel exploitation and trade are relatively new, with West African countries that have a longer experience, allowing insights into the conditions necessary to support successful institutions that benefit the multiple actors in the value chains.

The final Chapter 6 provides reflections on the analytical issues, the conceptual framework, and the methodology used. Subsequently, it presents the policy implications of the empirical research findings and offers a general conclusion.

Chapter 2

Woodfuel value chains for urban centers in the Democratic Republic of Congo: context, characteristics, and sustainable use of the resource base

This chapter presents research data that have also been published in the peer-reviewed book chapter: Schure, J., Ingram, V., Assembe-Mvondo, S., Mvula-Mampasi, E., Inzamba, J., & Levang, P. (2013a). La Filière Bois Énergie des Villes de Kinshasa et Kisangani. In J.-N. Marien, E. Dubiez, D. Louppe, & A. Larzilliere (Eds.), *Quand la Ville Mange la Forêt: Les Défis du Bois-énergie en Afrique Central* (pp. 27-44). France: Editions QUAE.

Chapter 2.2 'Regional context: woodfuel in the Congo Basin' summarizes findings from the peer-reviewed book chapter: Schure, J., Marien, J. N., De Wasseige, C., Drigo, R., Salbitano, F., Dirou, S., & Nkoua, M. (2012). Contribution of woodfuel to meet the energy needs of the population of Central Africa: prospects for sustainable management of available resources. In C. de Wasseige, P. de Marcken, N. Bayol, F. Hiol Hiol, Ph. Mayaux, B. Desclée, R. Nasi, A. Billand, P. Defourny, & R. Eba'a (Eds.), *The Forests of the Congo Basin – State of the Forest 2010* (pp. 109-122). Luxembourg: Publications Office of the European Union.

Abstract

Until recently, little information and data have been available on woodfuel trade in the Congo Basin. Based upon a review of recent studies, policy documents, and field research undertaken between 2009 and 2011, this chapter provides a synthesis on the status of woodfuel in Congo Basin countries and analyzes the actors and dimensions of woodfuel value chains in the Democratic Republic of Congo (DRC). It presents findings on socio-economic and environmental characteristics and discusses implications of current practices of woodfuel commercialization for sustainable use of the natural resource base. Throughout the Congo Basin, an increase of woodfuel demand has led to growing commercialization and a shift from consumption of fuelwood to charcoal in urban centers. The woodfuel value chains of Kinshasa and Kisangani, with contrasting resource and market conditions, share a high dependence on woodfuel by urban citizens and a large number of people involved in production and trade. Total volumes, values, and income generating activities for supply of Kinshasa by far exceed those of Kisangani because of a larger population and greater distances to the resource. Also, revenues and woodfuel prices are higher, which illustrates the income generating potential of scarce resources in demand. Pressure on the resource, especially prevalent in the Kinshasa supply zone, is reflected in the increasing distances between supply zone and urban markets, consumer perception of scarcity, restrictions on access, and conflicts related to accessing woodfuel sources. In conclusion, comparing woodfuel value chains of two cities demonstrates the location specificity of the importance of woodfuel trade in terms of socio-economic characteristics. It indicates that, notably in the resource-scarce, high-demand context, woodfuel commercialization provides livelihood opportunities to rural and urban citizens. It also shows that environmental characteristics differ largely between the two contexts, suggesting non-sustainable use of the resource in both of the regions, but with vaster impacts in the Kinshasa supply zone.

2.1 Introduction

Until recently, little data have been available on woodfuel trade in the Congo Basin in general, and its urban centers specifically. Between 2009 and 2011 a series of studies took place to collect such information (Schure *et al.*, 2012; 2013). This chapter provides a synthesis of the results of these studies and presents the current knowledge base on woodfuel in the Congo Basin and on two urban value chains in the Democratic Republic of Congo (DRC). This overview sets the scene for the following chapters. It provides information in respect to the first main research question:

What are the characteristics of the woodfuel value chains around urban centers in the DRC and what are their main outcomes for sustainable use of the natural resource base?

Its specific research aim is to compare the woodfuel situation of two urban supply zones, one located in an area of savannah and degraded forests and the other based in an area with abundant forests. This aim was operationalized into the following specific research questions:

- 1) What are the characteristics with regard to the actors of the value chain, looking specifically into urban consumption and income generating activities, and what are the differences between the two areas?
- 2) What are the characteristics with regard to the dimensions of the value chain, looking specifically to the source of supply for woodfuel production, and what are the differences between the two areas?
- 3) What are implications of the characteristics of the dimensions and actors of the woodfuel value chain for sustainable use of the natural resource base?

The analysis does not only provide a general overview of the woodfuel situation in both research areas, but also contributes information for improved management of forest resources for wood energy in the DRC.

2.1.1 Research approach

As discussed in Chapter 1, the Sustainable Livelihoods Framework (SL-Framework) was applied in this study as a people-centered conceptual tool that links contextual conditions, livelihood assets, institutional processes, and livelihood strategies with sustainable livelihood outcomes. This framework has been developed by several scholars (e.g. Bebbington, 1999; Carney, 1998; Chambers and Conway, 1991; Ellis, 2000;

Scoones, 1998) for better understanding of the processes influencing the development of sustainable livelihoods of people living in developing countries. The approach has been criticized for limiting its focus to the household level and devoting too little attention to the influence of markets on local livelihoods (Carney, 2003; De Haan and Zoomers, 2005; Dorward *et al.*, 2003; Scoones, 2009). As elaborated in Chapter 1, in this study the SL-framework was adjusted by linking it with value chain analysis in order to overcome the SL-Framework's limitations in transcending the household level and linking to markets. "The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use" (Kaplinsky and Morris, 2001: 4). Value chain analysis is a valuable analytical tool used to transcend the local level, to link local producers and urban consumer markets, and to gain better understanding of the diversity of actors involved in the value chain.

This chapter presents a general overview of the nature of the woodfuel value chain. Value chain analysis was used as an exploratory and descriptive tool that assisted in mapping the actors and dimensions of the value chain and identifying socio-economic and environmental characteristics of woodfuel commerce. The analysis on actors and socio-economic characteristics of the value chain focused on: (1) urban consumption (household energy, volume and value of woodfuel markets, household expenditure, consumer perception of supply, and types of cooking stove) and; (2) income generating opportunities (number of actors involved, types of activities, and distribution of value throughout the chain). The analysis on the dimensions and environmental characteristics focused on: (1) the supply zone (geographical spread and flow of woodfuel and distances between supply and urban markets) and; (2) the source of woodfuel production (land use, restrictions to access, selection of species, replanting). Considering the SL outcomes, attention was given specifically to sustainable use of the natural resource base as the preferred environmental condition.

The field study was conducted between September 2009 and April 2011. The study area covered the supply zones for woodfuel to DRC's capital Kinshasa and Kisangani, capital of Orientale Province (see Chapter 1.6.3 for a description of the study sites). These two research sites were selected in order to identify both similar and different outcomes. Both are large urban centers in the DRC where woodfuel is an important source of urban household energy. However, initial observations indicated important differences in the contexts of the woodfuel trade, such as that commercial demand and pressure on the

natural resource base is higher for Kinshasa. Interviews with administrations, research organizations, NGOs, and people involved in woodfuel production and trade provided an overview of the main issues in the woodfuel sector and assisted mapping of the value chain and its actors (Schure *et al.*, 2010). Based on this information and literature review, household level economic, social, and environmental aspects of woodfuel production and trade were studied, using a total of 4,266 surveys with producers, transporters, salespersons, and consumers (Ingram and Schure, 2010). Descriptive statistics were used to illustrate the socio-economic and environmental characteristics of woodfuel value chains (Schure *et al.*, 2011b). Statistical analyses (chi-square test for independence and independent-samples t-test) were conducted to compare differences between the regions. Observations at road control points and markets were held to understand trade patterns and collect data on the proportion of woodfuel that arrives in the markets. Twelve focus group meetings with producers, traders, and consumers in April 2011 served to share information with the respondents and to check upon interpretation of results and lacking issues.

2.2 Regional context: woodfuel use in the congo basin

Woodfuel is an essential source of energy throughout the entire Congo Basin region. In addition to households, various businesses depend on wood energy for their daily operations, including bakeries, breweries, brick makers, and aluminum forgers (Pouna, 1999; Schure *et al.*, 2011b). Woodfuel commerce for urban centers, mainly informal and uncontrolled, supplements income of hundreds of thousands of people in Central Africa, with the largest number of people at production level. Differences in its importance and utilization exist between the different countries and sub-regions. In the DRC, Republic of Congo (ROC), and Cameroon there is a sharp increase from use of fuelwood to charcoal in urban centers (Boundzanga, 2004; Schure *et al.*, 2012). Woodfuel consumptions vary from 138 thousand tons in Equatorial Guinea to 55 million tons in the DRC (FAO, 2011). In most countries in the Congo Basin, 80% to 90% of the population use woodfuel as their main cooking fuel. This woodfuel often constitutes 70% to 90% of the total national roundwood production. Only in Gabon and Equatorial Guinea are these percentages lower, which may be associated with availability of Liquefied Petroleum Gas (LPG) as alternative cooking fuel and higher overall living standards (Table 2.1) (Daurella and Foster, 2009). In Gabon and Equatorial Guinea, charcoal is consumed

by urban households who cannot afford to buy LPG or in periods of LPG shortages or for specific types of meals. In contrast, in DRC, ROC, and Cameroon charcoal is used by urban households throughout different income categories, with only the poorest households turning to fuelwood or sawdust as cheaper options (Schure *et al.*, 2012). In Central African Republic, although use of charcoal is slowly increasing, most urban households still use fuelwood (Salbitano, 2009).

In all Congo Basin countries, the supply of fuelwood and charcoal is mostly associated with land conversion of forest areas into farmlands (Drigo, 2009; Lamouroux and Boundzanga, 1994; Marien, 2009). In areas of high demand, such as around highly populated urban centers, this wood extraction augments to the point where virtually all types of fresh wood are cut for the purpose of woodfuel commerce. In abundant forest areas, producers still seek and select specific species that produce the highest quality charcoal. Other less frequent woodfuel resources are tree plantations and waste wood from timber cutting operations.

Table 2.1. Main characteristics of woodfuel use in Congo Basin countries

	Cameroon	CAR	ROC	DRC	Equatorial Guinea	Gabon
Population (thousands) ^c	19,175	4,318	3,941	64,204	681	1,477
Population density (people per km ² of land area) ^c	45	7	12	28	26	6
Urban population (% of total) ^c	53	39	64	35	40	87
GDP per capita (current USD) ^c	1,157	459	2,434	175	17,944	7,409
Woodfuel production (thousands m ³) ^a	17,664	3,200	1,315	75,446	190	1,070
Woodfuel production out of total national round wood production (%) ^a	79	70	35	94	31	24
Part of the population using woodfuel as main cooking fuel (%) ^b	83		83	90		34
Part of the population using LPG as main cooking fuel (%) ^b	11		8	0		62
Access to electricity (% of population) ^c	49		37	11	12	37

Sources: ^aDrigo, 2009; FAO, 2011; Ministère de l'Énergie et de l'Eau, 2009-2010; ^bDaurella and Foster, 2009; Schure *et al.*, 2011b; ^cWorld Bank, 2013.

Issues related to woodfuel production and trade observed for Congo Basin countries are the lack of organized transport and trade, weak land tenure, problems associated with the allocation of resources and profits, and overexploitation. Woodfuel is produced in an artisanal manner with low energy efficiency throughout the chain (Drigo, 2009; Marien, 2009; Salbitano, 2009; Schure *et al.*, 2011b). Although all countries have some woodfuel related legislation and policies, implementation and enforcement of these are generally low (Chapter 5). Producers access the resource mainly under customary rules, with less than 1% of charcoal traded in Cameroon and less than 3% of charcoal traded in DRC being produced under an official permit (MINFOF, 2009a; 2009b, Schure *et al.*, 2012). This means that local authorities play a strong role in granting access rights to producers. Pressure on the resource due to (over) harvesting of woodfuel and environmental impacts have been noted for: (1) peri-urban areas and protected areas; (2) dry zones and wooded savannah areas; and (3) forest fallows with shortening of agricultural production cycle and impoverishment of soils (Schure *et al.*, 2012). Of special concern are the increasing woodfuel prices for urban consumers that follow pressure on the peri-urban supply zone and the woodfuel collection from valuable landscapes, such as the mangrove forests near Douala in Cameroon or the Virunga National Park in the eastern part of DRC where many refugees aggregate (Bodson *et al.*, 2009; Ndenecho, 2007). Management options combining agroforestry, plantations, and management of fallows and degraded forests, as well as improving energy efficiency at the producer and consumer level, can offer opportunities to improve the sustainability of energy supplies for Congo Basin's major cities (Dubiez *et al.*, 2012; Schure *et al.*, 2012).

2.3 Urban woodfuel value chains in the DRC

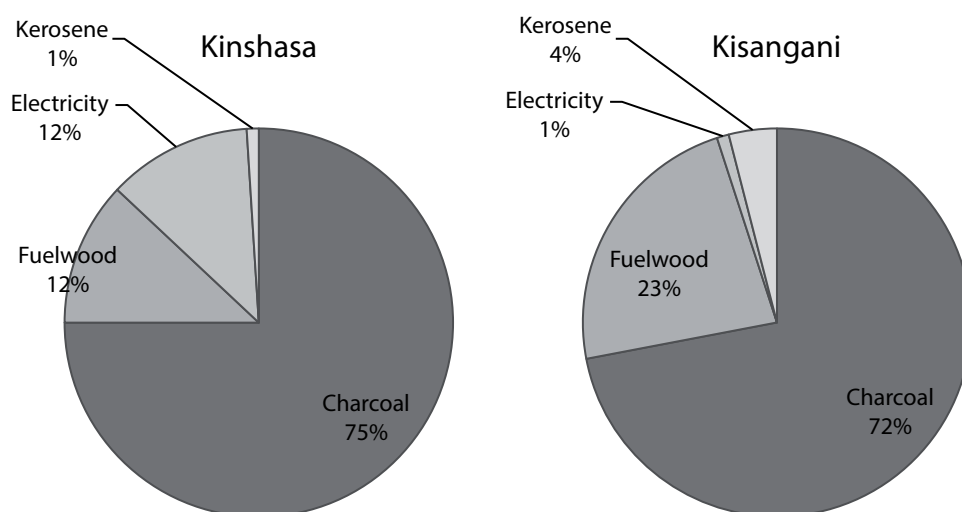
2.3.1 Socio-economic characteristics

Urban consumption of woodfuel

Woodfuel consumption in DRC's urban centers is increasing because of a growing population and a lack of alternative energy sources. The vast majority of households in Kinshasa (87%) and Kisangani (95%) depend on wood for their daily cooking energy

(Figure 2.1).⁸ Businesses, such as bakeries, breweries, restaurants, brick makers, and aluminum smelters, also rely on fuelwood or charcoal for their daily operations.

Figure 2.1. Sources of energy used for cooking in Kinshasa and Kisangani (%)



The woodfuel market of Kinshasa (4.8 million m³ of wood equivalent⁹ totaling 490,000 tons of charcoal and 60,000 tons of fuelwood in 2010, representing a market value of 143 million USD) is much larger than the market of Kisangani (200,000 m³ of wood equivalent totaling 16,000 tons of charcoal and 32,000 tons of fuelwood in 2010, representing a market value of 2.5 million USD).¹⁰ Overall figures illustrate the importance of the urban woodfuel markets in terms of volumes. The woodfuel markets of Kinshasa and Kisangani alone (5.0 million m³) exceed the volume of official national

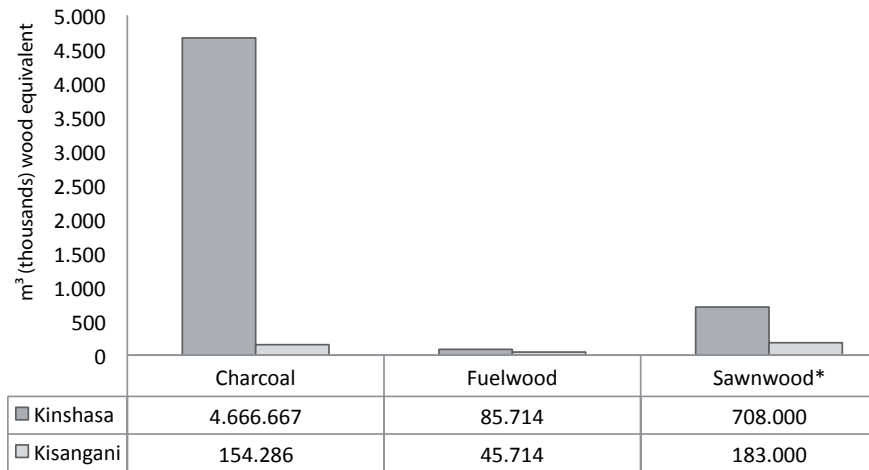
8 The chi-square test for independence could not be performed, as the data did not fit the assumption that the lowest expected frequency in any cell should be 5 or more. 2 cells (25%) have expected count less than 5. When repeated the test for 'electricity', 'fuelwood', and 'charcoal', the chi-square test for independence indicated a significant association between the city and the first type cookingfuel. Chi square test: $\chi^2 (2, n=723) = 59.2$, $p = .000$, Cramer's $V = .286$ (medium effect size).

9 For conversion between the weight of woodfuel (in tons) and volume of wood equivalent (m³), conversion factors used are: 1 ton of charcoal = 6.67 tons of wood equivalent (efficiency of 15%). 1 ton of wood = 1.38 m³ = 0.72 tons of wood (FAO, 2009).

10 This study based its data collection on surveying woodfuel quantities that passed the main trading points with corrections made for seasonal fluctuations, direct collecting or purchasing by consumers outside of markets, and illegal trade. For conversion between the national currency Congolese franc (CDF) and USD: 1USD = 827.0 CDF; 1 CDF = 0.00120919 USD. See Schure *et al.* (2011 for detailed calculations per product per city.

timber production (400,000 m³ (ITTO 2011)) by more than 12 times. When comparing figures with recent estimates of domestic timber markets, the wood equivalent of charcoal markets exceed these volumes, but fuelwood volumes are considerably lower (Figure 2.2).

Figure 2.2. Woodfuel and sawnwood traded in Kinshasa and Kisangani (m³ wood equivalent in 2010).



*The figures for roundwood equivalent of sawnwood are from a recent study by CIFOR (2010-2013) on DRC's domestic timber market (Essiane Mendoula *et al.*, 2013).

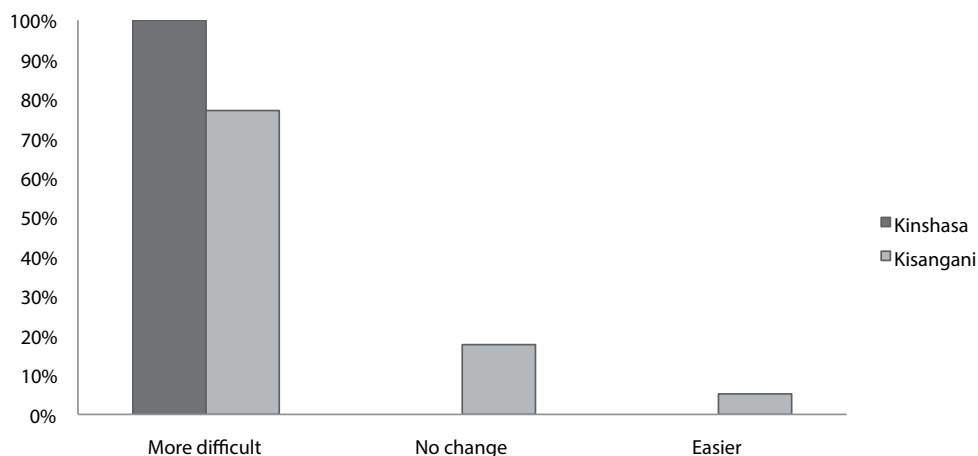
Households in both cities spend a similar amount on woodfuel (Kinshasa: $M=22.5$ USD, $\sigma=21$, Kisangani: $M=21.9$ USD, $\sigma=21.6$).¹¹ The fact that Kisangani households spend about the same amount, although prices are lower, can in part be explained by the fact that households are larger ($M=8.4$ ($\sigma=4.3$) members vs. $M=6.3$ ($\sigma=2.4$) members in Kinshasa). The share of charcoal as urban household energy increases with higher income levels. Conversely, fuelwood occupies a more important place for the poorest households. Overall expenditure for woodfuel increases with household income, but it is the poorest households (whose average income does not exceed 100 USD per month) who spend the largest share; more than 19% (19.2 USD ($\sigma=21.8$) against less than 12% (28.5 USD, $\sigma=27.3$) for wealthier families (those with incomes above 200 USD

11 Results of an independent-samples t-test showed no significant difference between the groups; $t(707)=.394$, $p=.693$ (two-tailed).

per month). In both cities, consumers observed a price increase of woodfuel over the past five years (72% in Kinshasa and 75% in Kisangani). The majority of consumers, especially in Kinshasa, were of the opinion that the supply of wood energy is becoming more difficult and burdensome (Figure 2.3).¹²

2

Figure 2.3. Public perception about the situation of charcoal supply

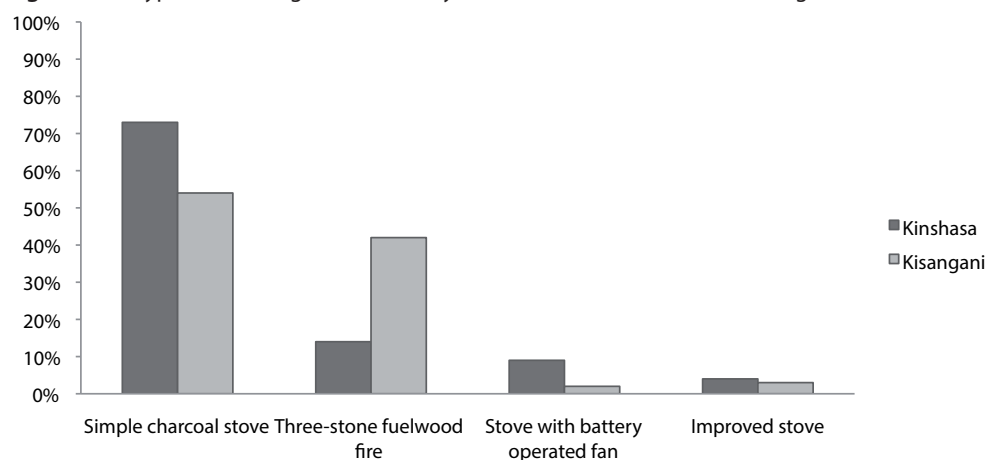


Different cooking stoves are being used by households in the two cities, mainly related to relatively more fuelwood use in Kisangani and more charcoal use in Kinshasa (Figure 2.4).¹³ The use of improved cooking stoves could contribute to a reduction of wood consumption and benefit poor households. To date, only 4% of households in Kinshasa and 3% of households in Kisangani use improved stoves.

12 For the association between the city of residence and the perception on charcoal supply: chi square test: χ^2 (2, n=579)=83.8, p=.000, Cramer's V=.380 (medium effect size).

For the association between the city of residence and the perception on fuelwood supply: chi square test: χ^2 (2, n=216)=42.5, p=.000, Cramer's V= .444 (strong effect size).

13 Chi-square test for independence: χ^2 (3, n=621)=66.7, p=.000, Cramer's V=.328 (medium effect size).

Figure 2.4. Types of cooking stoves used by households in Kinshasa and Kisangani

Actors and income generating opportunities

The urban woodfuel sector is an important provider of income generating activities. While 15,000 people are employed in the formal forestry sector (Eba'a Atyi and Bayol, 2009), more than 300,000 are involved in informal woodfuel production and trade for Kinshasa alone (Table 2.2).¹⁴

Table 2.2. Number of actors in the informal wood energy sector of Kinshasa and Kisangani

	Kinshasa	Kisangani
Production	290,000	10,000
Transport	900	1,600
Trade and Sales	21,000	12,100
Total	311,900	23,700

Most people are involved at the level of production (290,000 producers in the Kinshasa region and 10,000 producers in the Kisangani region). Kinshasa employs more producers in absolute and relative terms because of a larger woodfuel market and lower average

¹⁴ These estimates of the number of actors involved have been extrapolated from the mean production or trade quantities per producer or salesperson plus the mean number of persons that they employ. The number of transporters has been estimated based on the modes of transportation used for woodfuel in the different regions and their average carrying capacity.

production quantities.¹⁵ Values accruing to producers range from 38% to 71% of the retail price (57% for charcoal and 46% of fuelwood producers in Kinshasa zone and 71% for charcoal and 38% for fuelwood in Kisangani) (Figure 2.5b). This shows that producers end up with a relatively high proportion of the product's value, especially for charcoal in Kisangani, which shows that processing (carbonization) and independence in organizing transport and sales, thanks to short distances to the market, are beneficial to the producers' share. Distributions of revenues within groups of producers, with the exception of fuelwood producers in the Kisangani region, are skewed, with a minority of producers generating most revenues.¹⁶ Woodfuel revenues contribute substantially to average household income and most producers invest part of their revenues in other activities, which contributes to livelihood diversification (see Chapter 3 for an elaborate discussion on the poverty reduction potential of woodfuel trade for producer households).

Woodfuel commercialization also provides a range of income-generating opportunities for salespersons (estimated 21,000 persons in Kinshasa and 12,000 persons in Kisangani). Besides the traders, wholesalers, retailers, vendors, and market managers, other jobs include manual laborers packing and carrying the woodfuel and loading trucks. The role of traders is especially important in Kinshasa where they often fulfill a logistical role in organizing transport by truck and sales over larger distances. Whereas sales in markets used to be a women's activity, today most salespersons in the markets (around 70%) are men. Unemployment and increased woodfuel prices have attracted them into the profession and raised its status. Traders and wholesalers have generally specialized in sales of woodfuel, although some traders and transporters combine their businesses with other commodities, such as manioc or corn. Retailers are either specialized, located at special woodfuel markets, or they sell woodfuel as part of a wider assortment in small shops or at roadside markets in quarters of town. Salespersons are generally involved for a longer period of time (mean experience is 6.4 years ($\sigma=5.4$) in Kinshasa and 6.0 years ($\sigma=5.8$) in Kisangani) and they know how to distinguish the good quality wood species from the less preferable qualities.

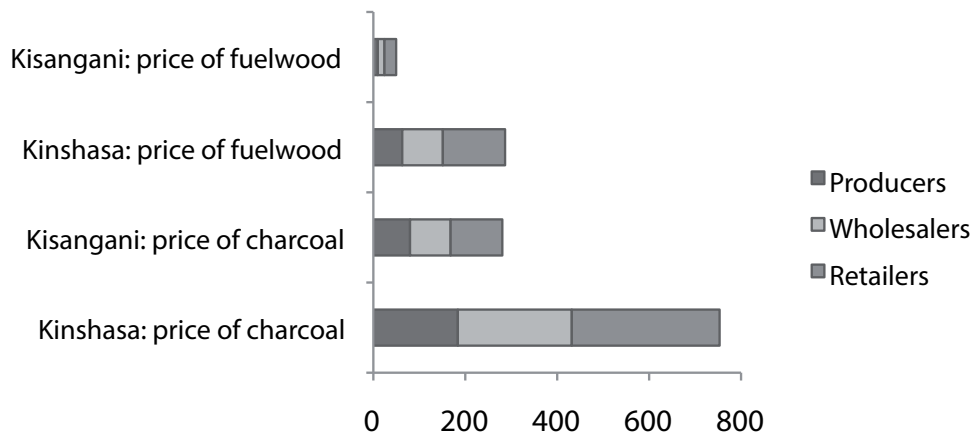
Wholesalers obtain around 20% of the retail price, except for charcoal in Kisangani where the role for wholesalers is limited and they only receive 8% of the product's value.

15 Kinshasa producers produce a mean 8.2 tons ($\sigma=9.9$) of charcoal and employ 3.8 persons. Kisangani producers produce 10.9 ($\sigma=14.2$) tons of charcoal per year while having 3.5 persons' labor. Fuelwood producers in Kinshasa produce a mean 10.6 tons ($\sigma=16.8$) together with 2.0 persons and those in Kisangani produce 31.5 tons ($\sigma=23.0$), also assisted by 2.0 laborers.

16 Skewness values are: 5.8 for fuelwood producers and 4.1 for charcoal producers in Kinshasa; .54 for fuelwood producers and 3.3 for charcoal producers in Kisangani.

Retailers of charcoal receive also about a fifth (23% in Kinshasa and 22% in Kisangani) of the end price (Figures 2.5a and 2.5b). For fuelwood, where no value adding is done by the producer, the retailers in urban markets end up with a relatively higher share of the product's end price; 35% of the value in Kinshasa and 43% of the value in Kisangani. This does not, however, reflect in higher overall revenues for them as the price of fuelwood is still relatively low and the bulky nature of fuelwood, compared to charcoal, implies higher costs for transport and stocking. Mean monthly revenues of salespersons are especially high for those based in Kinshasa (501.3 USD ($\sigma=506.0$) for charcoal per month and 241.3 USD ($\sigma=244.9$) for fuelwood per month) with higher prices and demand compared to Kisangani (170.2 USD ($\sigma=201.9$) for charcoal per month and 9.6 USD ($\sigma=20.6$) for fuelwood).¹⁷ Distributions of revenues within groups of wholesalers and vendors are positively skewed, which indicates that the majority of salespersons receive less than these average revenues.¹⁸ Net revenues could not be calculated from the dataset, as the information on costs was incomplete, however, traders and salespersons in both regions reported that they have high costs for transport and bribes.

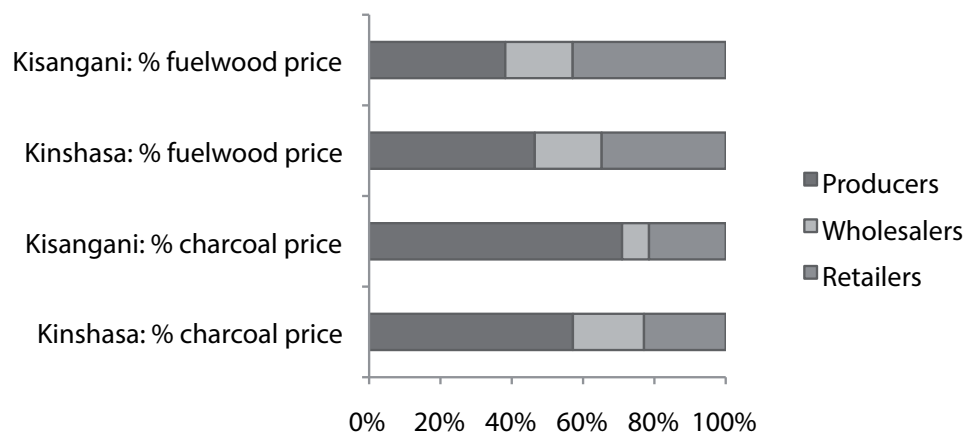
Figure 2.5a. Average prices for charcoal and fuelwood (USD/ton) at different levels of the value chain in Kinshasa and Kisangani



17 Results of an independent-samples t-test (equal variance not assumed) showed a significant difference between the revenues of salespersons for two regions. For charcoal: $t(461.8)=11.81$, $p=.000$ (two-tailed), Eta squared = .15 (medium to large effect size). For fuelwood: $t(76.9)=8.27$, $p=.000$ (two-tailed), Eta squared = .29 (large effect size).

18 Skewness values are: 1.5 for wholesalers and .9 for retailers of charcoal, 3.0 for wholesalers and 2.2 for retailers of fuelwood in Kinshasa; 2.8 for wholesalers and 2.8 for retailers of charcoal, 2.1 for wholesalers and 4.1 for retailers of fuelwood in Kisangani.

Figure 2.5b. Average prices for charcoal and fuelwood (% of total value) at different levels of the value chain in Kinshasa and Kisangani



2.3.2 Dimension of value chain and environmental characteristics

Supply zone

Distances between the source of woodfuel and urban markets differ significantly for the two cities.¹⁹ The supply zone of Kinshasa stretches to the southwest and northeast over a mean distance of 101.7 km ($\sigma=56.1$) for fuelwood and 134.8 km ($\sigma=105.3$) for charcoal. The provinces of Kinshasa and Bas-Congo provide most of the woodfuel (43% and 34% respectively) and the rest (23%) enters via the Congo River from the provinces of Bandundu, Equateur, and Orientale up to 1,000 km away (Figure 2.6). Kisangani, the capital of Orientale, is supplied via four roads (Buta, Ituri-Lubutu, Ubundu, and Opala) and two waterways (Yangambi and Ile Mbiye) (Figure 2.7). The mean distances of supply are 25.3 km ($\sigma=8.6$) for fuelwood and 36.8 km ($\sigma=34.7$) for charcoal. The much larger distances from the supply site to urban markets for the Kinshasa value chain are reflected in higher transport costs (Kinshasa: $M=4.4$ USD per bag of charcoal, $\sigma=4.8$, Kisangani: $M=.82$ USD per bag of charcoal, $\sigma=.97$).²⁰ Producers in both supply

19 Results of an independent-samples t-test (equal variance not assumed) showed a significant difference between the distances between supply site and urban market for two regions. For charcoal: $t(244.3)=12.47$, $p=.000$ (two-tailed), Eta squared = .29 (large effect size). For fuelwood: $t(15.4)=5.42$, $p=.000$ (two-tailed), Eta squared = .49 (large effect size).

20 Independent-samples t-test (equal variance not assumed): $t(293)=12.28$, $p=.000$ (two-tailed), Eta squared = .18 (large effect size).

zones (77% for Kinshasa and 94% for Kisangani) report that distances to the resource have increased over the past five years.

Figure 2.6. Woodfuel flow in the Kinshasa supply zone

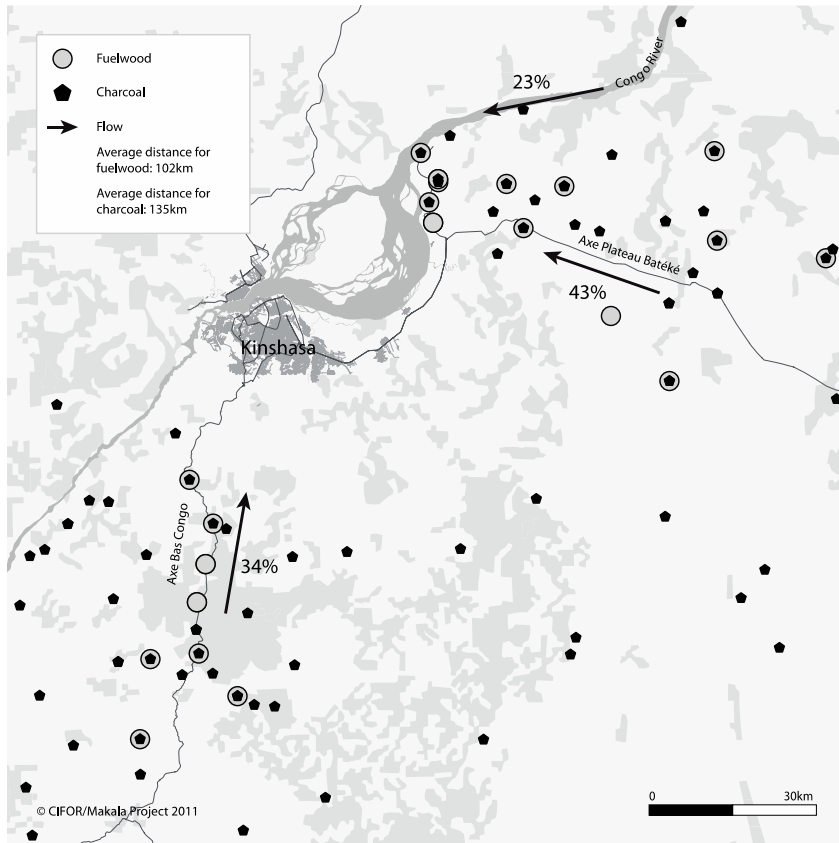
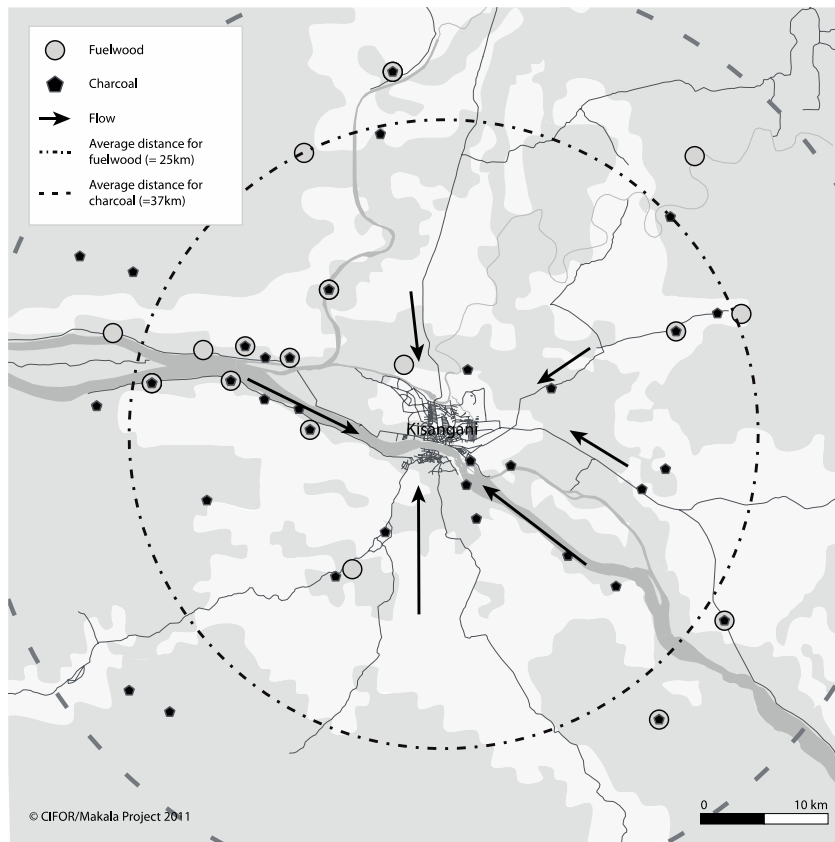


Figure 2.7. Woodfuel flow in the Kisangani supply zone

Source of woodfuel production, preferences and restrictions

Two thirds of the woodfuel produced for Kinshasa and Kisangani originates from shifting cultivation, while around one third comes from forests, which are generally degraded forests along rivers in the regions of Kinshasa and primary forests around Kisangani. The exception is fuelwood from Kisangani, of which only 15% is harvested from forests, because of the abundance of this resource available as by product from converting forests to farmland or timber logging. In Kisangani, the sources where woodfuel is harvested correspond with the preferred sources voiced by producers. Around Kinshasa, however, more producers (22%) would prefer forests and plantations instead of their current sources.²¹ Among the various species used for woodfuel production, major timber and non-timber forest products are commonly used. A third of producers (30%) in the

21 Chi-square test for independence: $\chi^2 (4, n=360) = 66.5, p = .000$, Cramer's $V = .430$ (medium to large effect size).

Kisangani region distinguish which species it uses for charcoal production. In contrast, almost none of the charcoal makers (1%) in the Kinshasa region distinguish between types of wood.²² Woodfuel production is often followed by agriculture production, especially in the Kinshasa region (in 89% of the cases vs. 69% of the cases in the Kisangani region).²³ There is no statistical difference between the maximum distances that producers travel between village and production site (Kinshasa: $M=4.7$ km, $\sigma=2.8$, Kisangani: $M=4.3$ km, $\sigma=3.4$).²⁴ Access costs to the resource are on average practically the same amount in the two supply regions: $M=12.2$ USD per production cycle ($\sigma=26.2$) in Kinshasa and $M=12.4$ USD per production cycle ($\sigma=16.9$) in Kisangani.²⁵ This shows that, despite differences in abundance and value of the resource, the range within which producers are prepared to work and transport the heavy load have the same maximum acceptable distances. Restricted accesses to certain zones (such as private concessions, plantations, or sacred sites) are more common in the Kinshasa region (observed by 49% of producers) compared to the Kisangani supply zone (9%).²⁶ Conflicts related to woodfuel activities are also more prevalent in the Kinshasa area (reported by 13% of producers vs. 6% of Kisangani producers).²⁷ Replanting trees for woodfuel use as possible restoration measure is rare. In Kinshasa, only 22% of the producers confirmed that they plant trees to secure their supply. None of the producers from Kisangani reported planting of trees for woodfuel.²⁸

2.3.3 Implications for sustainable use of the natural resource base

Supply of woodfuel is important in all Congo Basin countries, although less prevalent in Gabon and Equatorial Guinea. A shift from use of fuelwood to charcoal in urban centers has been observed for DRC, ROC, and Cameroon (Boundzanga, 2004; Schure *et al.*, 2012). Such urban demand, mostly combined with conversion of forests

22 Chi-square test for independence (with Yates Continuity Correction): χ^2 (1, $n=742$) = 108.5, $p= .000$, $\phi = -.386$ (medium to large effect size).

23 Chi-square test for independence (with Yates Continuity Correction): χ^2 (1, $n=868$) = 51.2, $p= .000$, $\phi = .246$ (small to medium effect size).

24 Independent-samples t-test (equal variance not assumed): t (841) = 1.95, $p= .052$ (two-tailed).

25 Independent-samples t-test (equal variance not assumed): t (227) = -.07, $p= .947$ (two-tailed).

26 Chi-square test for independence (with Yates Continuity Correction): χ^2 (1, $n=703$) = 129.3, $p= .000$, $\phi = .432$ (medium to large effect size).

27 Chi-square test for independence (with Yates Continuity Correction): χ^2 (1, $n=916$) = 11.9, $p= .001$, $\phi = .118$ (small effect size).

28 Chi-square test for independence (with Yates Continuity Correction): χ^2 (1, $n=681$) = 106.5, $p= .000$, $\phi = .402$ (medium to large effect size).

into agriculture land, is associated with pressure on surrounding tree sources, forest degradation, and possibly deforestation (Drigo, 2009; Lamouroux and Boundzanga, 1994; Marien, 2009). As part of sustainable livelihood outcomes, a sustainable use of the natural resource base for continuation of resource-based livelihood strategies had been identified as the preferred environmental condition. Insights into socio-economic and environmental characteristics of the actors and dimensions of the value chain provide understanding of the implications on such a sustainable use.

The large volumes of woodfuel markets, its function to secure energy supply of the majority of urban households, and the numerous livelihood activities it provides show the socio-economic importance of woodfuel value chains for actors in both cities. The socio-economic scale of woodfuel trade is reflected in environmental characteristics and especially in the dimension of the source of supply. Impacts show mostly, as expected, in the resource-scarce, high-demand supply zone of Kinshasa. Distances from the supply zone to the urban markets are large and increasing, and transport costs are high compared to the resource-abundant, less-demand zone context of Kisangani. Also, at the source of production, differences point to larger environmental outcomes, with fewer producers who can enter preferred tree sources, more conflicts related to access of woodfuel sources, and producers being less selective of tree species. In Kisangani, producers face fewer of these restrictions due to pressure on the resource base and a third of producers (30%) select specific species for woodfuel. There is little information on the conservation status of most of these species. For example, the International Union for Conservation of Nature (IUCN) Red List, an inventory of the global conservation status of plant and animal species, has only assessed a few woodfuel species (IUCN, 2011). Of these, some face risk of becoming endangered in the future, such as: *Milicia excels* (in both regions), *Pterocarpus angolensis* (in Kinshasa) and *Irvingia gabonensis* (in Kisangani), while two species: *Millettia laurentii* (in Kinshasa) and *Austranella congolensis* (in Kisangani), have been assessed as endangered and critically endangered, respectively.

The fact that access prices do not differ between the supply zones despite differences in abundance and prices suggests that there is no price being paid for environmental costs. Instead of investing in restoration of the resource, the activity as such moves further away. Producers in both supply zones (77% for Kinshasa and 94% for Kisangani) report that distances to the resource have increased over the past five years. Lack of investing in environmental restoration is confirmed by the fact that only around a fifth of producers in the supply zone of Kinshasa reported planting trees and none of the producers in the Kisangani zone planted trees for potential woodfuel use.

2.4 Conclusion

Throughout the Congo Basin, an increase of woodfuel demand for urban centers has led to growing commercialization and a shift from use of fuelwood to charcoal. This development puts pressure on resources around urban centers, but also creates opportunities for many peri-urban and urban citizens to be involved in production and trade. This study contributed to the relatively new trend in NTFP and woodfuel studies that applied value chain analysis (Brouwer and Magane, 1999; Ingram *et al.*, 2012; Jensen, 2009; Kambewa *et al.*, 2002; Ribot, 1998; Shively *et al.*, 2010; Te Velde *et al.*, 2006; Zulu, 2010).

Based upon extensive fieldwork in the DRC, the various actors and dimensions of the woodfuel value chains of Kinshasa and Kisangani have been identified and quantified. The data indicate the overall importance of urban woodfuel consumption, which is often underestimated according to Arnold *et al.* (2003) and Mwampamba *et al.* (2013). This woodfuel use consists of two components, i.e, fuelwood and charcoal. Most households and numerous businesses use charcoal, which shows that not only the poorest cohorts depend on charcoal as is often wrongly assumed (Mwampamba *et al.*, 2013). As expected, woodfuel prices and revenues are higher for the resource-scarce, high-demand context of Kinshasa, which illustrates the income-generating potential of scarce resources in demand (Robinson, *et al.*, 2002; Sunderlin *et al.*, 2005). In both cities woodfuel demand grows with increasing prices and distances between source of supply and urban markets. In order to meet these demands, well-established networks of producers and traders have evolved. Volumes, values, and the number of people involved in supplying the urban woodfuel demands of Kinshasa by far exceed those of Kisangani because of larger population and distances to the resource. Results confirm that production and trade of woodfuel are important activities for a large number of poor in the informal sector (Arnold *et al.*, 2006) although distribution of revenues within the actor groups is skewed. Over 300,000 people are involved in the woodfuel supply of Kinshasa alone, representing over 20 times the labor in the official forestry sector (15,000). Most cash-generating opportunities exist at the level of production.

Positive socio-economic outcomes of woodfuel trade are associated with trade-offs regarding the conservation potential of the resource (Belcher and Schreckenber, 2007). Pressure on the resource is reflected in the increasing distances between supply zone and urban market, transport costs, consumer perception of scarcity, restrictions on access, and level of conflicts related to access. This is especially visible in the Kinshasa supply

zone with large and increasing distances to supply (currently an average 102 km for fuelwood and 135 km for charcoal). In Kisangani, average distances are considerably smaller (25 km for fuelwood and 37 km for charcoal) with targeted harvesting of preferred wood species leading to degradation of the resource on a smaller scale. In both regions, woodfuel exploitation is mostly accompanied or followed by agricultural activities. This confirms new insights into woodfuel that woodfuel production is not a single or primary cause of deforestation, but that it is more likely to lead to forest degradation (as occurs in Kisangani), or, when it leads to overexploitation (as observed for Kinshasa), this is mostly combined with shifting cultivation with impacts occurring in certain regions and for certain actors (Arnold *et al.*, 2006; Chidumayo and Gumbo, 2012; Mearns, 1995). Only some producers in the Kinshasa supply zone, where prices are relatively high, do replant trees, which confirms that short-term and relatively cheap access to woodfuel resources discourages investments in replanting woodfuel resources (Arnold *et al.*, 2006; Luoga, 2000; Vermeulen *et al.*, 2011). The preferences of resources expressed by producers near Kinshasa show the potential for woodfuel plantations.

In conclusion, findings show that the environmental characteristics of urban woodfuel use are location specific and that the overall impacts are negative. In both regions there are few indications of a sustainable use of the woodfuel resource base; these negative environmental outcomes are greatest in the Kinshasa area. Possible mitigation of these outcomes by woodfuel institutions will be further discussed in Chapter 4 and Chapter 5. The socio-economic characteristics of woodfuel commercialization for the two cities indicate the importance of woodfuel in the livelihoods of the actors that are related to the various dimensions of the value chain, from rural to urban based. How woodfuel contributes to livelihoods and poverty reduction of the greatest group of actors, the producers, will be discussed in Chapter 3.

Chapter 3

Producing woodfuel for urban centers in the Democratic Republic of Congo: a path out of poverty for rural households?

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Abstract

Woodfuel is a renewable energy source with good potential for climate change mitigation. In the Democratic Republic of Congo (DRC), the sector employs over 300,000 people for the supply of Kinshasa alone, but the benefits to the poor are often unknown. This paper analyzes the contribution of commercial woodfuel production to livelihoods and poverty reduction in the DRC. Woodfuel revenues, especially those of charcoal, contribute substantially to producers' household income, ranging from 12% for fuelwood producers around Kisangani to 75% for charcoal producers around Kinshasa. It supports basic needs and investments in other livelihood activities (for 82% of charcoal producers and 65% of fuelwood producers), which helps to reduce poverty. The contribution of woodfuel commercialization to poverty reduction should be part of energy and forestry policies.

3.1 Introduction

Woodfuel can provide renewable energy, if the resource is managed sustainably (Trossero, 2002), but it is often regarded as an inferior fuel in developing countries. International institutions dealing with energy and development generally present woodfuel as a ‘traditional’ energy source that needs to be replaced (Hiemstra-van der Horst and Hovorka, 2009; Openshaw, 2011). The adverse health impacts of indoor-cooking smoke and the detrimental impacts on forest resources are the main negative associations with the sector (Smith, 2006; Guzmán and Hoz-Restrepo, 2008). Growing demand for woodfuel in urban areas has increased pressure on forest resources, which is especially problematic in the absence of incentives to restore or manage these resources sustainably (Hofstad, 1997; Marien, 2009; Schure *et al.*, 2012). Many international institutions present woodfuel as unsustainable, despite the fact that there is sufficient woody biomass to meet demand in most countries (Openshaw, 2011). The sector also creates rural development and employment (Arnold *et al.*, 2006; Marien, 2009; Sankhayan and Hofstad, 2000). In the first wave of woodfuel studies in the 1980s, it was already noted that the woodfuel story is complex and needs to consider the specific landscapes and livelihoods of those involved (Leach and Mearns, 1988). However, there are still few quantitative studies about the exact income contributions to producer households and to poverty reduction (Angelsen and Wunder, 2003; Arnold *et al.*, 2006; Hyde *et al.*, 2000). This knowledge is relevant, especially considering both the growing commercial woodfuel sector in Sub-Saharan Africa and the concentrated urban demand (Marien, 2009). Sustainable management initiatives and climate change mitigation policies that affect the woodfuel sector should not be addressed without a deep understanding of the possible outcomes on poverty.

This research aimed to analyze the contribution of the woodfuel sector to livelihoods of producers engaged in the urban woodfuel supply in the Democratic Republic of Congo (DRC). The DRC has abundant natural resources with roughly 130 million hectares of tropical forest, representing 60% of the Congo Basin forests. It is also one of the poorest countries in the world, being among the last of 187 countries on the Human Development Index (UNDP, 2013). Despite its size, there is little data available on the woodfuel sector in the Congo Basin, mainly because of the sector’s informal character. Recent observations in the DRC show an increased demand for urban woodfuel as a result of the growing population, the lack of alternative energy sources, and a shift from consumption of fuelwood to charcoal (Schure *et al.*, 2012). Households depend largely

on woodfuel for daily cooking (87% in Kinshasa and 95% in Kisangani). Businesses, such as bakeries, breweries, restaurants, brick makers, and aluminum forgers also use fuelwood or charcoal for their daily operations (Schure *et al.*, 2013a). The national program for Reducing Emissions from Deforestation and Degradation (REDD+) and its Forest Investment Program (FIP) (endorsed in June 2011) put an important focus on the woodfuel sector regarding potential production and consumption efficiencies to be gained (Ministry of Environment, Nature Conservation and Tourism, 2011). Related policies need to consider whether woodfuel markets contribute to poverty reduction, especially of producers who form the majority of actors in the chain from producer to consumer: While 15,000 people are employed in DRC's formal forestry sector, around 290,000 people are involved (at least part time) in woodfuel production for the six-million inhabitants of the city of Kinshasa alone (Chapter 2).

3.1.1 Historical overview: woodfuel and non-timber forest products, an alternating agenda?

Attention to woodfuel production and consumption has fluctuated over the past decades.²⁹ In the 1970s, concerns about woodfuel shortage, known as 'the other energy crisis', were triggered by the oil crisis (Eckholm, 1975). Within the context of the 'basic needs approach', many studies predicted a 'woodfuel gap' between demand and supply leading to depletion of forest resources with detrimental environmental and socio-economic impacts on the poor. Woodfuel became a policy priority and large-scale woodfuel plantations and efficient-stove projects were implemented to assure woodfuel supplies. A decade later, in the mid-1980s, the woodfuel crisis did not materialize on a global scale as increasing urbanization and rising incomes slowed demand in many regions (Arnold *et al.*, 2003). The 'woodfuel gap' proposition was criticized for its large-scale approach and guesswork regarding data on woodfuel consumption and tree stocks (Leach and Mearns, 1988). It was found that woodfuel was sourced from areas other than forests, including from trees on agricultural land, village woodlots, home gardens and public land, or consisted of 'deadwood', dry branches and other plant materials (Trossero, 2002). In cases where local households were faced with less supply, they often coped by reduced consumption and by using alternative cooking fuels such as plant waste and cow dung. Charcoal became more popular in urban markets because of its higher energy density and lower smoke-production compared to fuelwood (Arnold

29 See Arnold *et al.* (2006) for a comprehensive overview of the thesis and anti-thesis of the woodfuel crisis.

et al., 2003). Although the role of woodfuel commercialization was recognized, little attention was given to how such trade contributed to household incomes. By the late 1980s, attention to the ‘woodfuel crisis’ and related intervention schemes had waned considerably (Arnold *et al.*, 2006).

In the early 1990s, leading up to the 1992 UN Conference on Conservation and Development, non-timber forest products (NTFPs) became more visible on the development and environment agenda, following the publications of Peters *et al.* (1989) and others indicating that the value of NTFPs can be higher than that of wood. The reasons why woodfuel was largely ignored in this new NTFP agenda were that it was primarily regarded as a subsistence resource, and that as a wood product it did not present a sustainable harvesting scenario (Sills *et al.*, 2011). The quickly increasing number of NTFP studies that started in the mid-1990s provided insights on the roles of NTFPs related to agriculture, conservation, and poverty reduction. It became clear that forests play diverse roles in local livelihoods, which pleads for a ‘resource-in-context approach’ (Ros-Tonen and Wiersum, 2005). The earlier high expectations about reconciling environment and development objectives were lowered (Arnold and Perez, 2001; Ros-Tonen and Wiersum, 2005). Moreover, there was recognition of the growing prevalence of urban and peri-urban residents involved in NTFP trade. The NTFP studies gradually broadened their scope to include “a range of forest products (from medicinal plants to timber), a range of forest management intensities (from pure extraction to intensive forest management), and a range of markets (from international to local)” (Sills *et al.*, 2011: 43).

The 2000s saw renewed interest in the woodfuel sector. On an international level, the renewable potential of woodfuel was recognized and climate change politics took an interest in its possibilities for carbon sequestration and reducing greenhouse emissions (Bailis, 2009; Trossero, 2002). Van Ruijven *et al.* (2008) argued that energy and development models often originate in the developed world and need to fit the reality of many developing countries, where the sector is more complex than initially thought. This echoes Leach and Mearns’ (1988) early criticisms about the lack of attention to local context in dealing with woodfuel issues. The importance of considering the full range of livelihood activities is illustrated by studies of pioneer farmers in the Amazonian rainforest for whom production of charcoal simultaneously increased income and decreased deforestation by offering an alternative to agricultural expansion (Labarta *et al.*, 2008). However, it also became clear that concentrated woodfuel demand, often related to land clearance for agriculture, can be a driver of deforestation (Marien, 2009;

Mwampamba, 2007). This is of particular concern in Africa, where household woodfuel consumption is expected to increase in the coming decades along with increasing urban demand for charcoal (Girard, 2002). A review of the woodfuel sector of 18 African cities by the Food and Agriculture Organization (2010) highlighted large variations in environmental effects; from low pressure and weak impact to accelerated degradation of peri-urban areas. A similar variation is expected for producers' livelihoods. The role of woodfuel as a source of revenue was seen as deserving more attention, given that fuelwood and charcoal are important providers of employment (Sankhayan and Hofstad, 2000; Vedeld *et al.*, 2007). In this respect, woodfuel studies can learn from recent NTFP studies and their focus on livelihoods and combinations of markets and resources.

3.1.2 Conceptual framework: placing woodfuel in the context of livelihood strategies and poverty reduction

For the whole of Sub-Saharan Africa it is estimated that 13 million people are employed in the biomass (mostly wood) energy sector (Openshaw, 2010). The importance of woodfuel income and its contribution to the livelihoods of producer households has been highlighted, but few quantitative studies are available. Woodfuel production shows pro-poor features because of the low start-up costs, low technology and few skills needed, which makes it relatively accessible (Angelsen and Wunder, 2003). However, competition may be high and the actual profits small. It is often unknown whether the revenues are enough to lift households out of poverty (Arnold *et al.*, 2006). For this we need to understand how value is added over time and whether poverty reduces, but detailed data on costs and benefits and the actual returns to producers are mostly lacking in the informal sector (Neumann and Hirsch, 2000; Openshaw, 2010). Recent studies offer some insights into the extent to which the woodfuel sector contributes to poverty reduction, providing income to rural and urban poor (e.g. Butz, 2013; Khundi *et al.*, 2011; Shackleton *et al.* 2007; Zulu, 2010). For example, around urban centers in Uganda, charcoal revenues were found to contribute positively to annual household cash incomes by on average 122 USD per adult equivalent (Khundi *et al.*, 2011). In this case, the poorest people rarely participated in the charcoal production (Khundi *et al.*, 2011). In contrast, in Malawi, charcoal revenues did contribute to the income of poorer households (Zulu, 2010) and in Northern Tanzania women with few income generating

alternatives increasingly participate in charcoal making (Butz, 2013). This illustrates the various roles woodfuel revenues can play in different contexts.

A combination of livelihood strategies can help mitigate and reduce poverty. Poverty mitigation, related to forest products, is considered to be “the use of forest resources to meet household subsistence needs, to fulfill a safety net function in times of emergency, or to serve as ‘gap filler’ in seasonal periods of low income [...]”. Poverty reduction in contrast is defined as “the use of forest resources to help lift the household out of poverty by functioning as a source of savings, investment, accumulation, asset building, and lasting increases in income and well-being” (Sunderlin *et al.*, 2005: 1386). Wealthier households, compared to poorer ones, are likely to derive different kinds and quantities of benefits from forest products. Wealthier households may possess more land, enabling them to freely access resources, reduce production costs, invest in value-adding and transport to urban markets, and so capture higher prices. In contrast, poorer households may depend more on forest products for subsistence income and be more restricted to local markets (Paumgarten and Shackleton, 2009).

How commercial woodfuel production contributes to poverty reduction also depends on how revenues are spent, saved or invested. Spending on food, healthcare, education, shelter, and clothing meets basic needs. Durable assets that poor people accumulate can serve as safety nets in times of need. These in-kind savings can spread the risk of unpredictable and uncertain incomes and provide a buffer (Deaton, 1990). Saving cash can be especially challenging for the poor, as institutional mechanisms that facilitate saving, such as banks, financial education, and saving incentives, are often not in place and financial assets are under pressure of family demands (Beverly and Sherraden, 1999; Gugerty, 2007). Households may use a range of different mechanisms to insure themselves and accumulate capital, such as borrowing from neighbors, buying and selling assets and diversifying production, in which the collection and trade of forest products serves as a ‘natural insurance’ mechanism (Morduch, 1994; Pattanayak and Sills, 2001).

3.1.3 Objective, research questions and hypotheses

Building upon the insights derived from NTFP and livelihood studies, this paper assesses the role of woodfuel production and trade in local livelihoods. The objective was to analyze the contribution of the commercial woodfuel sector to livelihood strategies

of producers in the supply zones around the urban centers of Kinshasa and Kisangani in the DRC. It was guided by the following research questions:

- 1) What is the role of commercial woodfuel production in the livelihood strategies of producer households?
- 2) How does commercial woodfuel production affect income and poverty in producer households?
- 3) How does poverty affect commercial woodfuel production?

3

Three analytical hypotheses were distilled from the conceptual framework, to be confirmed or rejected by the research results:

- 1) Woodfuel commercialization contributes to diversifying producers' household incomes.
- 2) Income generated by commercial woodfuel production is limited (less than 25%) and finances mainly basic needs, indicating the modest contribution of woodfuel to poverty reduction.
- 3) Despite the pro-poor features of commercial woodfuel production, the poorest income groups benefit least, as they have fewer options to add value.

3.2 Methodology

3.2.1 Study area

The study area covers the supply zones for woodfuel to DRC's capital Kinshasa and Kisangani, capital of Orientale Province (Chapter 2.3). The two sites allow a comparison of an area containing savannah and degraded forest zones around Kinshasa with the abundant forests around Kisangani (Chapter 1.6.3). The population of the Orientale Province is poorer than the population in the other main supply sites under study (Kinshasa and Bas-Congo province) (Table 1.3).

3.2.2 Methods and materials

Surveys were conducted with people who indicated that they produce and sell fuelwood or charcoal as one of their activities. In the supply zones of Kinshasa, 200 fuelwood producers and 392 charcoal producers, and 73 fuelwood producers and 409 charcoal

producers from the Kisangani supply zone were interviewed between September 2009 and February 2010. Respondents were randomly selected in 14 villages in Kinshasa Province, 12 villages in Bas-Congo Province and 26 villages in Orientale Province. These villages had been identified based upon interviews with transporters and experts mapping the geographical distribution of production regions. Household level economic, social and environmental aspects of woodfuel production and trade were addressed in the structured questionnaire.³⁰ From May 2010 to April 2011, a year-long survey was conducted with producers in 10 villages in the Kinshasa supply zone and 7 in the Kisangani supply zone. Producers kept records of costs, prices, and production volumes, which were verified and collected monthly, to determine fluctuations and average cost structure. In April 2011, 49 in-depth, semi-structured interviews and 12 group interviews were conducted in 12 villages in the supply zones to collect data on saving and spending patterns. A statistical software package (SPSS 16.0) was used to analyze the data. Descriptive statistics were used to illustrate the socio-economic profile of producers. The annual net profit and return to labor of producers were calculated:

n = number of units sold

P = average selling price

MD = number of man-days or labor input

W_c = Labor cost

Σ^c = Total cost = Transportation + Taxes + Equipment + Access to resource + W_c

Annual net profit = $n * P - \Sigma^c$

Return to labor = $(n * P - \Sigma^c + W_c) / MD$

Statistical analyses (chi-square test for independence, independent-samples t-test, and one-way between groups ANOVA) were conducted to compare differences between groups (per region, income level, type of product). The continuous data on production quantity was analyzed using a logarithm to transform the data into a normal distribution to meet assumptions for parametric tests (t-test and ANOVA).

³⁰ See Ingram and Schure (2010) for a complete overview of the survey forms.

3.3 Results

3.3.1 Role of woodfuel in the producers' livelihood strategies

Producers in the supply zones of Kinshasa and Kisangani are mostly villagers who live and work in their village of origin. Fuelwood production, from cutting the wood to packing bundles for sale, is often done by family members and sometimes other villagers are hired for a daily fee or in kind compensation. Temporary urban-to-rural migration was observed to some extent, especially for large-volume producers of fuelwood for bakeries. The production cycle for charcoal, from cutting the wood to packing bags, mainly involves local men who are paid a daily fee (or sometimes a percentage of the production) by the landowner or the 'head producer'. In both regions, reciprocal labor exchange groups (*'ristourne'*) are common. These involve around ten producers working in turns to build one member's charcoal kiln. The host producer provides drinks and food and reciprocates by working on other members' kilns. Some urban citizens have also specialized in charcoal production. They mainly function as intermediaries and finance providers, hiring local villagers to produce charcoal. Producers of woodfuel represent average rural households in terms of working-age population and ethnic groups. Average total household income of producers in the Kinshasa supply zone is less than the international 1.25 USD per day poverty line standard, but is similar to other rural households in the region (cf. Table 1.3 and Table 3.1). In Kisangani, the average producer household income is higher than the provincial average. This might be explained by the fact that the households of the study are larger than average and live relatively close to the urban markets (compared to the province's average household).

Table 3.1. Average value of some socio-demographic variables among charcoal and fuelwood producers

	Kinshasa region		Kisangani region	
	Charcoal producers	Fuelwood producers	Charcoal producers	Fuelwood producers
Women producers (%)	3.4	5.8	4.9	50.7
Age (years)	34.2	33.6	34.2	42.7
Working experience in woodfuel (years)	7.1	7.5	7.7	14.0
Household size (number of members)	5.4	6.1	6.7	8.3
Total monthly household income (USD)	45	51	65	64

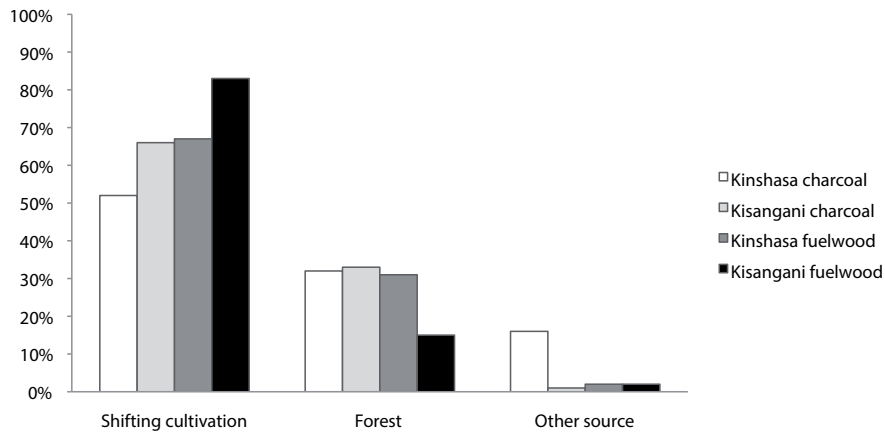
Agriculture is the primary income-generating activity for most producers in both regions. Other revenues mainly come from trading small commodities and timber exploitation. In the Kinshasa region, livestock also provides income; in the Kisangani region fishing generates revenues (Table 3.2). Producers around Kisangani rely more on NTFP collection and hunting in the more abundant forests. Virtually all producers depend on more than one activity for their household income. Opportunities of salaried employment, even temporary, are rare and only a few producers benefit from paid, seasonal jobs.

Table 3.2. Income generating activities mentioned by charcoal and fuelwood producers (% of producers who list this activity among their five most important income earning activities)

	Kinshasa region		Kisangani region	
	Charcoal producers	Fuelwood producers	Charcoal producers	Fuelwood producers
Agriculture	94.2	89.3	94.2	93.2
Trade in small commodities	20.9	23.5	17.6	17.8
Timber exploitation	10.8	29.1	13.4	9.4
Livestock	9.0	10.2	4.6	4.1
Fishing	1.1	-	10.6	1.4
NTFP collection	2.6	5.1	24.6	34.2
Hunting (bush meat)	2.1	2.6	12.8	12.3
Apiculture	0.8	-	0.6	-
Crafts worker	0.8	5.6	4.3	6.8
Paid seasonal labor	1.6	3.1	3.6	-
Paid full time work	-	-	1.8	-

Woodfuel is mostly sourced by clearing forests for agriculture – either by the woodfuel producer or the landowner (Figure 3.1). Two-thirds of the woodfuel produced for Kinshasa and Kisangani originates from agricultural activity (reopening of bush fallows in the shifting cultivation cycle), while around one-third comes from non-cleared forests: generally degraded gallery forests around Kinshasa and primary forests around Kisangani. For fuelwood for Kisangani this amounts to 85%, meaning that only 15% of commercial fuelwood production comes from forests with no link to agriculture. In Kisangani, the sources where woodfuel is harvested correspond with the preferred sources voiced by producers. Around Kinshasa, however, more producers (22%) would prefer forests and plantations instead of their current sources, as forests generally provide more and larger trees. This highlights the difficulties in finding and accessing new woodfuel resources and the potential for woodfuel plantations.

Figure 3.1. Sources for charcoal and fuelwood production per city



3.3.2 Production and net revenues

There is a significant difference ($p < 0.05$) in the mean production for both products from the two regions.³¹ During the study period, producers around Kinshasa produced on average 10.6 tons of fuelwood per year ($\sigma = 16.8$) compared to a significantly larger production in Kisangani of 31.6 tons of fuelwood per year ($\sigma = 23.0$). For charcoal the mean production around Kinshasa was 8.2 tons per year ($\sigma = 9.9$) and around Kisangani on average 10.9 tons of charcoal annually ($\sigma = 14.2$).

For fuelwood producers in Kinshasa, no significant differences ($p = 0.27$) in production quantities were found between different income groups. Conversely, in Kisangani, the lowest income group produced significantly larger quantities than higher income groups (Table 3.3).³² Charcoal production in both regions differs significantly (at the $p < 0.001$ level) between the four income groups.³³ The mean production is lowest for the low-income groups and highest for high-income groups (Table 3.3). In both regions, producer households in the middle range with a monthly income of 51-100

31 An independent samples t-test was conducted to compare production quantities of the two production zones. For charcoal the difference in means is very small: $t(761) = -2.58$, $p = .01$, effect size (eta squared) = 0.0067. For fuelwood the difference is much larger: $t(232) = -10.26$, $p = .000$, effect size (eta squared) = 0.31

32 $F(2,69) = 6.7$, $p = .002$, effect size (eta squared) = 0.16 (large).

33 A one-way between-group ANOVA was conducted to explore the impact of income level on production quantity of woodfuel. For charcoal: Kinshasa: $F(3, 345) = 14.0$, $p = 0.000$, effect size (eta squared) = 0.11 (medium to large), Kisangani: $F(3, 323) = 12.3$, $p = 0.000$, effect size (eta squared) = 0.10 (medium to large).

USD produce the highest quantities of charcoal. Households with monthly income over 100 USD have a slightly lower production.

Table 3.3. Mean production of fuelwood and charcoal (tons per year) per producer per income category

Income group	(USD/ month)	Both regions production (tons)	Kinshasa production (tons)	Kisangani production (tons)	
Fuelwood	Low ^a	< 50 USD	20.1 ($\sigma=26.5$)	11.4 ($\sigma=20.9$)	44.2 ($\sigma=25.5$)
	Mid	51-100 USD	12.3 ($\sigma=12.5$)	9.2 ($\sigma=10.6$)	18.8 ($\sigma=13.7$)
	High	> 100 USD	19.8 ($\sigma=16.5$)	12.4 ($\sigma=11.4$)	28.2 ($\sigma=17.6$)
Charcoal	Lowest	< 11 USD	4.3 ($\sigma=5.2$)	3.5 ($\sigma=3.7$)	5.3 ($\sigma=6.6$)
	Low	11-50 USD	6.2 ($\sigma=6.8$)	7.0 ($\sigma=7.8$)	5.1 ($\sigma=4.6$)
	Mid	51-100 USD	10.4 ($\sigma=11.5$)	11.4 ($\sigma=13.0$)	9.1 ($\sigma=9.1$)
	High	> 100 USD	9.0 ($\sigma=9.1$)	9.6 ($\sigma=8.2$)	8.9 ($\sigma=9.2$)

^a For fuelwood the one-way between groups ANOVA was conducted with three income groups instead of four (group one and two were combined) to meet the conditions for this test.

For producers in Kisangani, a significant association was found between household income level and land ownership. For charcoal producers, the richest income group (>100 USD/month) mostly (87%) accesses their own (customary) land for harvesting trees.³⁴ In contrast, for the poorer households only 35% have their own land, and the majority (65%) pays for access to trees. For fuelwood producers, there is only a small association, with the medium income group (51-100 USD) paying relatively often (41%) for access to trees, compared to poor and richer groups (10% and 14%).³⁵ In Kinshasa, no significant association ($p=0.371$) was found for either product. Due to higher pressure on land and resources in this area, just over a third of producers, across all income groups, pays for access to trees.

Woodfuel revenues contribute substantially to average household income: averaging 47% for fuelwood producers and 75% for charcoal producers in Kinshasa, and 12% for fuelwood producers and 38% for charcoal producers around Kisangani. There was no significant relation between the level of household income and place where woodfuel was sold.³⁶ Across all income groups, a fifth of producers sell in the village while most

34 Chi square test: $\chi^2(3, n=314) = 66.2, p = .000$, Cramer's $V = .459$ (large effect size).

35 Chi square test: $\chi^2(2, n=69) = 8.7, p = .013$, Cramer's $V = .013$ (small effect size)

36 Chi square test: $\chi^2(2, n=777) = 2.26, p = .323$

producers (80%) bring their product to urban markets. Woodfuel is produced mainly for cash income; only small quantities (<10% of fuelwood and <5% of charcoal) are exchanged for goods or consumed. The net profits are highest for charcoal and in the Kinshasa region (Figures 3.2a and 3.2b).³⁷

Figure 3.2a. Costs and net profits of charcoal and fuelwood production for producers (% of total revenues)

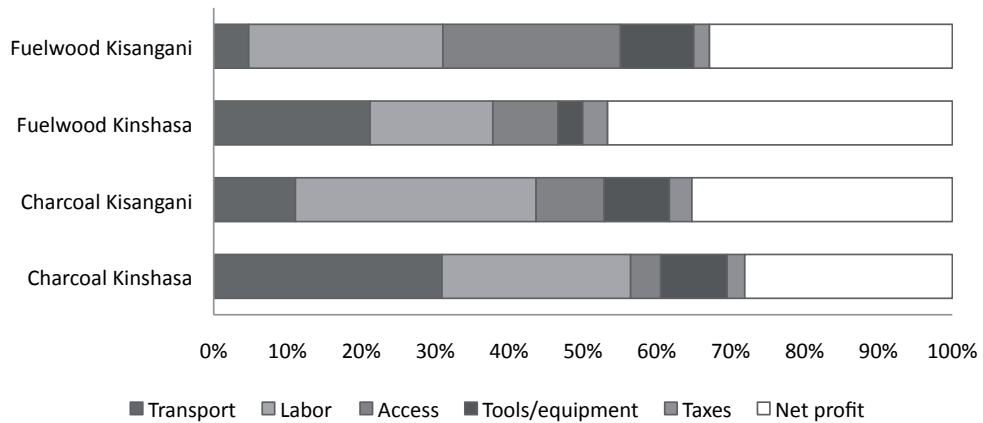
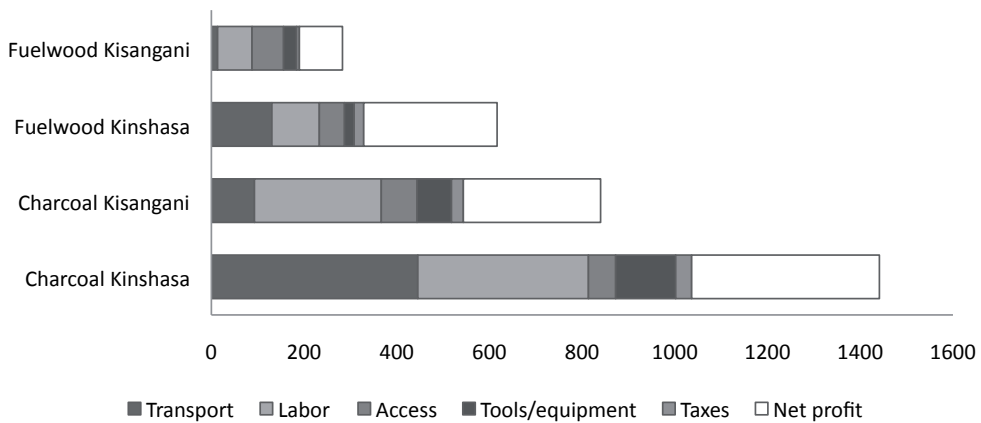


Figure 3.2b. Costs and net profits of charcoal and fuelwood production for producers (USD/year)



37 Annual net profit (NP) = (n * P) - (Σc)
 For Charcoal Kinshasa = (163.5 * 7,290) - (368,390 + 28,490 + 304,393 + 107,103 + 485,78) = 334,961 FC (405 USD);
 For Charcoal Kisangani = (166.1 * 4,181) - (76,832 + 21,168 + 226,316 + 61,302 + 63,944) = 244,902 FC (296 USD);
 For Fuelwood Kinshasa = (228 * 2,236) - (107,952 + 17,160 + 84,696 + 17,133 + 44,893) = 237,974 FC (288 USD);
 For Fuelwood Kisangani = (772 * 303) - (11,099 + 4,968 + 61,478 + 23,205 + 56,245) = 76,921 FC (93 USD).

Labor returns for fuelwood production are somewhat below the average regional income in the Kinshasa supply zone (0.70 USD per day) and comparable to the average for the Kisangani zone (0.80 USD per day) (UNDP, 2009). The rate of return per man-day for charcoal production in both regions is relatively high: 1.95 USD per day in the Kinshasa zone and 1.60 USD per day in the Kisangani zone, which is twice the average regional daily income of adult men (UNDP, 2009). This supports the finding that net benefits from charcoal are higher than from fuelwood. Average net benefits are higher in the Kinshasa supply zone, despite higher average production quantities and lower production costs in the Kisangani supply zone (Table 3.4), reflecting the higher prices in an area of higher demand and more restricted supply.

Table 3.4. Net benefits of woodfuel production per region and per product

	Kinshasa		Kisangani	
	Fuelwood	Charcoal	Fuelwood	Charcoal
Net benefits per producer per year (USD)	288	405	93	296
Net benefits per ton produced (USD)	27	49	3	27
Net return per man-day (USD)	0.70	1.95	0.80	1.60

3.3.3 Woodfuel revenues' contribution to poverty reduction

The benefits from woodfuel income are both short-term (i.e. money used for daily needs) and long-term, where the revenue is invested. Charcoal making involves tough, dirty, physical labor, but it can relatively quickly provide cash, leading to its popular name of '*intervention rapide*'. Fuelwood collection is a more continuous activity, not seen as onerous, but like charcoal, it forms one of the few options that producers have to generate a cash income. Another important benefit is that fuelwood and charcoal production can be carried out without neglecting agricultural activities, which for the majority remains the primary source of subsistence. Woodfuel production takes place when cash income is needed and when time is available. This is often during agricultural slack periods, in the months after planting and before harvesting. Villagers make a clear distinction between these different benefits:

“If there would be only charcoal, the household would have no food. Charcoal doesn't give us chikwange [local staple food based on fermented cassava] or [cassava] leaves like our fields do. We make charcoal for one reason: to pay for something.”

Revenues from charcoal production and fuelwood are used to pay for daily needs, mainly food, and for cash expenses like education and healthcare (Table 3.5). The ‘quick intervention’ notion illustrates that it is a ‘gap-filler’ in times of need. This contribution to basic needs and gap-filling function highlights its clear role in poverty mitigation.

The contribution of woodfuel production to poverty reduction is illustrated by the ways in which producers invest part of woodfuel revenues into other household activities. The relatively large sums that can be produced at once contribute to specific household investment patterns that are similar for both regions. The main investment is in agriculture, with a small proportion invested in petty trade, livestock, and fishing (Table 3.5). These activities are a way of accumulating capital, diversifying income sources, and distributing risk.

Table 3.5. Dimensions of poverty reduction per woodfuel supply zone

Poverty dimension	Spending pattern	Kinshasa	Kisangani
Poverty mitigation	Producers spending WR ^a on:		
	Food (%)	91	99
	Education (%)	88	61
	Healthcare (%)	72	75
Poverty reduction	Fuelwood producers investing WR (%)	72	60
	Charcoal producers investing WR (%)	91	75
	Investment posts:		
	Agriculture (%)	91	87
	Commodity trade (%)	7	7
	Livestock (%)	1	2
	Fishing (%)	1	0

^aWR=Woodfuel revenues

For both cities, a significant correlation between income level and investments was found.³⁸ Among the poorest households (<11 USD per month), 79% of producers indicated that they invested part of their woodfuel revenues, whereas in less poor households (11-50 USD per month), 94% of producers invested. Charcoal revenues are almost always (92%) invested, even by the absolute poorest (90%).

38 Chi square test: $\chi^2(3, n=811) = 24.99, p = .000$, Cramer's $V = .176$. After controlling for product type, differences remain, but they are no longer significant for charcoal producers ($p = 0.064$).

Most producers (62%) indicated that they managed to save some of their overall household income. Saving in banks is rare (8%) among producers; over half of the households (58%) keep their cash at home. Saving was also achieved by buying goods, such as telephone cards, that can be resold later (21%) and with informal moneylenders (13%). Savings were mainly spent to cope with possible shocks (family issues, sickness, and funerals) rather than for (planned) investments. For longer-term objectives, instead of saving cash, most producers preferred to invest directly in agriculture by paying for seeds, land, or labor. This preference for tangible assets over cash is also reflected in production. Over half of charcoal producers (56%) delay selling their charcoal; they leave it in the kilns (56%) or stored in bags (45%) to be sold when prices improve or when they need cash. Producers wait an average of 26.7 days ($\sigma=11.5$) before selling.

3.4 Discussion and conclusion

The study shows that producers' livelihoods are characterized by diversification, with woodfuel revenues making an important non-agricultural contribution to household income. This supports the first hypothesis that woodfuel commercialization contributes to household diversification. Around Kinshasa, woodfuel production provides the most substantial, single contribution to household income for producers (on average 47% for fuelwood and 75% for charcoal). Around Kisangani, although smaller, charcoal still forms a considerable proportion (38%) of household income. For fuelwood this contribution to producers' household income is more limited (12%). The integration of commercial woodfuel production in livelihood strategies is a response to urban demand and the complementarity with agriculture.

Net returns from charcoal are higher than from fuelwood, being twice the average daily income, and rates of return to labor for fuelwood are almost the same as average income. Average net benefits are higher for Kinshasa, despite higher average production quantities in Kisangani, because of higher prices for scarce woodfuel resources.

In terms of poverty mitigation, woodfuel revenues help meet basic needs, as producers spend part of their income on food, education and healthcare. More important for poverty reduction, however, is that woodfuel provides capital for investments in other activities (mainly agriculture; some trade, livestock, and fishing). Even among the poorest households, most manage to reinvest some revenues. This contradicts the second hypothesis that predicted only a limited contribution to poverty reduction

from channeling incomes to investments. A novel finding is how woodfuel, especially charcoal, can also act as a household savings account. Most savings are spent for coping with shocks, rather than in accumulating assets. Yet, charcoal is stored strategically by over half of producers for future spending as well as price optimization. This shows how producers develop non-cash mechanisms that facilitate the accumulation of household resources (Beverly and Sherraden, 1999).

The reinvestment of woodfuel income in other household activities and saving also has a poverty reduction impact. Forests and trees provide “sources of rent extracted and invested in sectors with greater production potentials, allowing for a diversification of income sources” (Wunder, 2001: 1829). Khundi *et al.* (2011) suggest that charcoal revenues assist in filling income gaps for households with less agricultural production in Uganda. In contrast, this study in the DRC shows that woodfuel revenues contribute income both for daily needs and for investments in agriculture, which may contribute to higher agricultural capacity and productivity.

Production quantities vary greatly between poorer and richer producers, supporting the third hypothesis that poor producers tend to benefit least, but only for charcoal. This is, however, the more profitable and valuable product, and requires the highest level of labor and economic inputs, which the poorest are often unable to access. The poorest households produce less than half of the quantity generated by richer households, with the highest levels of production by the mid-level income category. This is in line with findings about charcoal revenues in Uganda (Khundi *et al.*, 2011), and other studies about forest products, which indicate that (moderately) wealthier households tend to benefit more (Belcher, 2005; Paumgarten and Shackleton, 2009). In contrast, fuelwood does not show a significant difference in production quantities among different income groups in Kinshasa, probably because it is just as easy to access for all households. In Kisangani, where the price of fuelwood is much lower, the poorest (<50 USD per month) sell the most fuelwood. Further research is needed to obtain a better understanding of underlying reasons explaining the variation in benefits for different producers.

Woodfuel revenues help in accumulating capital and reducing poverty, but caution is warranted for three reasons:

- 1) Overall income of producers is still low, with 55% of producer households living on an income of less than 50 USD a month, which reflects the generally high incidence of poverty in the DRC.
- 2) The poorest households benefit less from the woodfuel trade, especially for highly profitable charcoal.

- 3) Environmental costs are not internalized, and unsustainable harvesting is especially obvious around Kinshasa, posing a risk of losing this livelihood activity in the long-term.

This study has highlighted that woodfuel production can provide important and flexible benefits to producer households supplying urban markets. The commercial value of woodfuel thus creates opportunities for producers' livelihoods, but currently clearly trading off forest conservation. The potential of woodfuel for poverty reduction around DRC's urban centers should be integrated into forestry and energy supply plans, enabling development while maintaining the natural resource base.

Chapter 4

Institutions and access to woodfuel commerce in the Democratic Republic of Congo

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Abstract

Access to woodfuel commercialization codetermines the livelihood outcomes of the different actors involved. This paper analyzes how institutions shape access to resources and access to markets in wood energy value chains in the Democratic Republic of Congo (DRC). Connecting livelihood approaches to institutional studies and value chain analysis enables the impact of access mechanisms on different actors in the chain to be studied. Informal, socially embedded institutions generally govern access to resources, and the absence of enforcement by formal bureaucratic institutions does not hinder actors, particularly fuelwood and charcoal producers, from receiving a relatively high proportion of end price, making woodfuel an increasingly attractive livelihood option. However, both formal and informal institutions are unable to counter the effect of high levels of urban demand creating pressure on the forest and tree resource base. This indicates the low level of sustainability of the livelihoods depending on woodfuel trade and use under existing woodfuel institutions.

4.1 Introduction

Besides a high dependence on woodfuel to meet household energy needs, many people in developing countries also benefit from woodfuel markets to generate (part of) their cash income (Mwampamba *et al.*, 2013b; Schure *et al.*, 2013a; Vedeld *et al.*, 2007). This role of woodfuel as a source of revenue has come to be seen as deserving more attention (Arnold *et al.*, 2006; Openshaw, 2010; Sankhayan and Hofstad, 2000;). Although woodfuel commercialization has been considered to be relatively accessible by many people, it is often not clear who benefits because institutional mechanisms defining access patterns to resources and markets are often location specific and difficult to untangle in the informal settings in which they are commonly found (Arnold *et al.*, 2003; Ribot, 1998; Wiersum *et al.*, 2014). Unequal access to benefits and the proportion of risk borne by different actors has been related to skewed household income and to the spatial variability of resources and markets (Drigo *et al.*, 2002; Luckert and Campbell, 2002; Gazull, 2008). Poor people generally have weak or unequal access to both resources and product markets because of high competition and costly entry barriers (Belcher *et al.*, 2005; Sunderlin *et al.*, 2005). The fragile market access and weak bargaining power of producers in remote areas make them dependent on traders who provide credit, trade contacts and transport (Sunderlin *et al.*, 2005). Ribot's (1995a; 1995b; 1998) extensive study on distribution of benefits of woodfuel commercialization for West-African countries noted that the highest benefits accruing to merchants are facilitated by political ties and forest policies. Commercialization of forest products can lead to the degradation of forest resources, which threatens the subsistence use of these same products by poor people (Belcher *et al.*, 2005). Consumers also, literally, pay the price for decreasing resource availability. For example, fuelwood prices in Kinshasa and Kisangani grew by 10 and 16% respectively in 2010/2011, linked to increased costs of supply and demand (Schure *et al.*, 2011b). Addressing the full value chain, from production site through to the end consumer, helps to uncover the main challenges related to access to the resource; how production, markets, and prices are regulated; and practices of corruption (Chidumayo and Gumbo, 2013; Owen *et al.*, 2013). It is increasingly recognized that to assess these aspects, there is a need for refined empirical studies that: (1) consider the specific context (environmental, socio-economic and political) (Arnold and Persson, 2003; Soussan *et al.*, 1990); (2) consider both access to the resource and access to the market (Bebbington, 1999; Ribot, 1998; Wiersum *et al.*, 2014); and (3) study the institutional mechanisms that shape livelihood outcomes

for actors in woodfuel trade (Arnold *et al.*, 2003; Leach *et al.*, 1999; Mearns, 1995; Mwampamba *et al.*, 2013a; Ribot *et al.*, 1998). This paper aims to contribute to this new generation of studies by looking into institutions in woodfuel value chains of two urban centers in the Democratic Republic of Congo (DRC).

The DRC produced an estimated 77.7 million m³ of woodfuel in 2011, representing 94% of its total round wood production (FAO, 2013). The use of woodfuel (fuelwood and charcoal) is growing in cities due to population growth, the lack of alternative energy sources, high unemployment, and the weak implementation of forest legislation, and has become associated with forest degradation and deforestation (Marien, 2009; Schure *et al.*, 2012). The woodfuel markets of Kinshasa and Kisangani provide around 90% of their citizens' cooking energy needs. The volume of woodfuel for just these two cities (5.0 million m³ in 2010) exceeds the official national timber production (400 thousand m³) by more than 12 times. An estimated 312,000 people are involved in production and trade of woodfuel for the capital city Kinshasa, over 20 times greater than the workforce in the official forestry sector (15,000) (Schure *et al.*, 2013a). Most income opportunities exist at the level of production where fuelwood and charcoal production contribute to diversifying household income of the rural poor (Schure *et al.*, forthcoming). Notwithstanding the significance of woodfuel use in the country, there is still a lack of understanding of its precise nature and the main mechanisms involved in its production and trade. The main reason for this is that woodfuel production and trade are largely informal with little official data available and scant attention paid to the sector by national policies. The large volume of woodfuel trade used in urban centers, the numerous people involved and largely informal systems interacting with production and trade patterns raise questions, such as: Who benefits from accessing woodfuel commercialization?; And how do these access patterns work?

This paper aims to answer the research question "How do institutions shape access to woodfuel resources and to markets?", comparing two woodfuel value chains with two contrasting resource and market conditions in the DRC. It contributes to the theorizing of woodfuel as a livelihood resource, analyzing specifically how institutions shape access dynamics from the level of production to consumption. The research results aid an examination of whether producers are excluded from accessing markets and whether woodfuel institutions contribute to sustainable production.

4.1.1 Conceptual framework: institutions shaping access in woodfuel value chains

In woodfuel production and trade there are numerous institutions and interacting factors that influence whether and how actors in the value chain access resources and markets, and ultimately whether woodfuel production and trade contribute to their livelihoods.³⁹ This study focuses on the dynamic character of formal and informal institutions that shape access to resources and to markets for value chain actors. Bebbington (1999) argued that access should be central to livelihood studies and importance should be granted to institutional ‘spheres’ of state, market and civil society that govern how people can renegotiate rules and relationships of resource access, use and transformation. Informal and formal institutions at different scales, mediated by power relations, influence access to resources and the resulting livelihood strategies and ecological change (Leach *et al.*, 1999; Scoones, 1998). Markets are key institutions in the process of commoditization of resources (Leach *et al.*, 1999: 240). Leach *et al.* (1999) conceptualized institutions in their environmental entitlements framework based on economic institutionalism (North, 1990; 1993) combined with social studies. North’s (1993: 3) economic perspective on institutions as mediating entities that determine transaction and transformation costs makes a clear distinction between institutions and organizations: “If institutions are the rules of the game, organizations are the players.” “Institutions consist of formal rules, informal constraints (norms of behavior, conventions, and self-imposed codes of conduct) and the enforcement characteristics of both” [carried out by first, second or third parties in the form of self-imposed codes, retribution, social or legal sanctions] (North, 1993: 2). Leach *et al.* (1999) use this distinction of institutions, organization and the role of enforcement. However, instead of looking at only ‘rules of the game’, institutions are considered as the formal and informal “regularized patterns of behavior that emerge from underlying structures or sets of ‘rules in use’” (Leach *et al.*, 1999: 237). This notion emphasizes the constructive and dynamic character of institutions in which rules are constantly being made and remade, shaping constraints or incentives to people’s actions and in which people’s actions either strengthen or weaken institutions (Leach *et al.*, 1999; Woodhill, 2008).

Based on these constructs, this study defines woodfuel institutions as the formal and informal rules and regularized patterns of behavior between different actors in

39 These factors encompass for example the vulnerability context, private sector, government arrangements and control over assets, such as budget and technology (Ashley and Carney, 1999; North, 1990).

society and associated enforcement mechanisms that shape access related to woodfuel production and trade.⁴⁰ Informal or ‘socially embedded’ institutions are upheld by socially shared, usually unwritten, conventions created and enforced among the actors involved. Formal or bureaucratic institutions can be considered as the rules enforced by an outside third party (often government agency or development organization), such as the rule of law and contracts (Cleaver, 2002; Leach *et al.*, 1999; North, 1993).

Value chains are a concept linking the resources and market dynamics. They represent the arena where key actors (producers, traders, transporters and vendors) move back and forth, possibly switching roles and locations, while employing their various tangible and intangible assets (capitals) to execute their activities. In Central Africa, urban citizens often depend on peri-urban products such as crops and woodfuel, while peri-urban or rural citizens trade these products in urban markets. Trade patterns in peri-urban areas reflect dynamic urban-rural interfaces with the mix of factors and actors exacerbating rivalry and conflict over space and resources, such that competing claims are constantly being structured and renegotiated. This occurs in a context of plural governance arrangements, with the degree of political and legal control in Central Africa tending to decrease in relation to the distance from the capital city (Trefon, 2011).

Access to natural resources and access to markets reflect the ability of actors to participate and benefit from woodfuel commercialization. ‘Access to natural resources’ is conceptualized as ‘natural capital’ that people can acquire, influenced by both the vulnerability context and the ‘transforming structures and processes’ that shape access (Ashley and Carney, 1999). Market access is “the ability of individuals or groups to gain, control, or maintain entry into exchange relations” (Ribot and Peluso, 2003: 160). The ability to access markets, together with credit arrangements and relations with market actors (social capital) that help secure this access, contribute to use of resources to people’s livelihoods (Bebbington, 1999; Leach *et al.*, 1999; Scoones, 2009). The ultimate desirable outcome of access to woodfuel production and trade is the reduction in poverty of those involved and the more sustainable use of the natural resource base, to enable the continuance of woodfuel-based livelihood strategies.

40 Drawing on the definition of institutions by Leach *et al.* (1999).

4.2 Methodology

4.2.1 Study area

The study area covers the woodfuel supply and consumption zones of the DRC's capital Kinshasa and Kisangani, capital of Orientale Province (Chapter 2.3). These cities were selected because of their high woodfuel demand and as they allow a comparison of the savannah, degraded forests around Kinshasa with the abundant lowland humid forests around Kisangani (Chapter 1.6.3).

4.2.2 Study design and methods

Comparative case studies using these two urban woodfuel value chains were used. Similar results are expected in the sense that in both urban centers woodfuel is the main source of household energy. Theoretical replication predicts contrasting results related to the differences in commercial demand (higher in Kinshasa), pressure on the natural resource base (higher for Kinshasa), and distance to public administration (shorter for Kinshasa). A sampled survey of the key actors involved in the woodfuel value chain at the two case study sites as units of analysis was conducted. Explanation building around the cases and analysis of the survey using the research question constituted the main analytic strategy.

A combination of methods was used to measure, value and compare aspects of woodfuel institutions. Between September 2009 and April 2011, interviews with administrations and analysis of legal documents provided insights in formal or bureaucratic institutions that regulate access to woodfuel commercialization. Informal or socially embedded institutions were also studied, using a total of 4,266 surveys with producers, transporters, traders and consumers. Twenty-seven focus group meetings with producers, transporters, traders and consumers (households and businesses) in the supply and consumption zones of Kinshasa and Kisangani deepened understanding about how different actors access resources and markets and which institutions shape these access mechanisms. Observations at road control points and markets were made to investigate (illicit) tax collection and use of trade permits.

4.3 Results

This section presents the institutions shaping access to woodfuel commercialization. The production process and actors involved in the woodfuel value chain are introduced, followed by a description of the formal and informal institutions that define who benefits from access to resources and access to markets.

4.3.1 Woodfuel production and trade: setting the scene

Most consumers in Kinshasa (98%) and Kisangani (87%) purchase their charcoal in urban markets, some consumers in Kisangani obtain it from production sites or buy directly from transporters as they enter town. For fuelwood, 5% of Kinshasa households and 21% of Kisangani households collect wood themselves. All consumers (100%) in Kinshasa indicated that the supply of charcoal and fuelwood has become more difficult over the last five years. In Kisangani around two-thirds of consumers indicated that supply is more problematic for charcoal (77%) and for fuelwood (64%), with around one-third of consumers finding it unchanged (18% for charcoal and 29% for fuelwood) or easier than previously (5% for charcoal and 7% for fuelwood). For most urban households, tree resources are too far to collect fuelwood. Charcoal making, although using rudimentary techniques, requires expertise and experience. This means that it is primarily fuelwood collectors and charcoal producers who access woodfuel resources.

There are differences between Kinshasa and Kisangani in the ease of accessing the resource and the market. Whereas in Kisangani most woodfuel is transported by bicycle or boat to urban markets, woodfuel is transported to Kinshasa over longer distances by large trucks involving higher costs. Transport costs total 31% of total revenues of charcoal producers in the Kinshasa supply zone, while these costs constitute only 11% of total revenues of charcoal producers in the Kisangani supply zone. Unlike around Kinshasa, where every available tree is used, around Kisangani resource use is more selective, with preferred species exploited. These differences show the variation in context and environmental outcomes of the two supply zones, which are further elaborated in Chapter 2.3. Woodfuel depots, often located at strategic entrance points of town, constitute the transit points for charcoal and fuelwood arriving in Kinshasa before retailers on roadsides resell it to industrial buyers or via smaller markets to household consumers. These depots are recognized and licensed by the State services. In Kisangani,

woodfuel is mainly sold in markets, although some is sold directly to consumers or small businesses as it enters the city.

In conclusion, access to the resource and to the market is different in the two regions, reflecting contextual differences and higher pressure and demand in the Kinshasa region. The next section discusses the formal and informal institutions that further shape access to woodfuel commercialization.

4.3.2 Formal institutions shaping access

Access to resources

The forest sector is formally controlled by the Ministry of Environment (*Ministère de l'Environnement, Conservation de la Nature et Tourisme* (MECNT)), with authority for woodfuel shared by the Directorate of Forest Management (*Direction de la Gestion Forestière* DGF), responsible for streamlining the processing and use of wood as an energy source, and the Directorate of Horticulture and Reforestation (*Direction de l'Horticulture et du Reboisement* DHR). Regulatory frameworks for the woodfuel sector are embodied in the 2002 Forestry Code and the 1973 Land Law (currently under revision) and some related principles regarding energy and sustainable production are embedded in the 2011 Agriculture and Environment Codes (Pougoue and Bachelet, 1982; RDC, 2002; 2011a; 2011b; Zaïre, 1973). Under the Forestry Code, all trees are owned by the State, with the exception of trees on private land, in villages or agriculture plots. User rights for subsistence use of trees are enshrined in the law. Official concessions for commercial purposes should be obtained through the official land cadastre. In the forest domain, all deforestation, except for clearing land for agriculture of less than 2 ha, requires a felling permit. A ministerial decree of October 2002 specified permits for felling fuelwood and carbonization, which can be issued to Congolese living in rural zones. All transported forest products need to be accompanied by a 'circulation permit', issued by the forest administration at the place of exploitation. There are five legal options for managing woodfuel production: (1) public plantations; (2) private plantations; (3) reforestation of agricultural parcels; (4) woodfuel exploitation with a permit for fuelwood cutting and carbonization; and (5) rural community forests (Schure *et al.*, 2013a).

In practice, however, most wood is sourced from agricultural land and degraded forests. Official concessions among producers are relatively rare in both regions (Table 4.1). The few woodfuel plantations existing include the Mampu Project at the plateau Bateke that produces charcoal from 8000 ha of acacia trees (*Acacia auriculiformis*), the

neighboring reforestation project at Ibi village, that produces charcoal under the Clean Development Mechanism, and the EcoMakala Project in North Kivu. Reforestation to date is insignificant; despite the targets set by the National Forest Fund (500 ha per year from 1986 to 2006, recently raised to a target of 1,000 ha per year per province), 4,787 ha were planted between 1986 and 2006.⁴¹ The permit system for woodfuel does not capture the nature of production far from Kinshasa. Over half the producers (53% from the Plateau Bateke supply zone and 60% from the Lukaya supply zone) know that a permit system exists, but none of those interviewed possessed a permit. Data from the Ministry of Environment at Tshiangu in Kinshasa confirms this lack of implementation of permits: from 2009 to 2011, only 318 permits, for a total of 43,386 tons of charcoal were issued,⁴² representing less than 3% of Kinshasa's charcoal. Most producers (77% in the Plateau Bateke zone and 87% in the Lukaya zone) expressed interest in obtaining permits, but only if this reduced their current payments of bribes, fees to village chiefs, and if the State participated in reforestation and provided storage depots in town. Although producers generally work in groups, most (95%) are not members of a woodfuel related organization, with only one formal producers/traders association known: the 200 member *Association des Diamants Noirs* in Maluku, operating since 2005.

Access to markets

The Ministry of Environment issues sales permits for fuelwood and charcoal. At the Ministry of Energy, woodfuel falls under the auspices of the Directorate of New and Renewable Energies (*Direction de l'Énergie Nouvelle et Renouvelable*). In Kinshasa province until 2005, permits for woodfuel sales were granted by the Ministry of Environment and could be obtained by producers at the divisional office. Initially inspections were conducted at production sites, but due to a lack of resources these shifted to controls at markets, although this is seldom implemented. Instead an institutionalized system of illicit roadside tax collection operates, said taxes negotiated on the spot with transporters. Since 2005, the Kinshasa Urban Division of Energy under the Directorate General of Revenues (*Division Urbaine de l'Énergie via la Direction Générale des Recettes de Kinshasa*) levies woodfuel sales taxes in markets, with market managers and State agents collecting taxes. Producers and vendors therefore are required to pay two taxes to

41 Direction of Horticulture and Reforestation of the Ministry of Environment, personal communication, Kinshasa, August 2009.

42 Urban Division of the Ministry of Environment in Tshiangu (Kinshasa), personal communication, Kinshasa, 2012.

the two authorities on the same product. They also reported a multitude of other State services collecting taxes. Trefon *et al.* (2010) counted 10 other State services imposing taxes on woodfuel transporters and sellers. Taxes paid by transporters at various official control posts are generally not declared in official documents and do not enter the public treasury. Transport to Kinshasa often takes place at night to avoid this corruption. In Kisangani the Ministry of Environment levies taxes. The provincial Ministry of Energy has no role. At markets and river harbors, a myriad of at least seven State authorities collect taxes with incoherent and often illicit tax regimes.

In summary, current formal mechanisms regulating access to woodfuel resources and markets exist, but are characterized by non-implementation and non-enforcement, and are overshadowed by corruption. Policies are fragmented in their approach and do not cover the entire value chain nor address the various actors involved. Formal recognition and channels that allow the concerns of producers to be voiced are lacking. There is a wide gap between the intention of formal regulations regarding woodfuel, their enforcement by State officers and local practices (Table 4.2).

4.3.3 Informal institutions shaping access

Access to resources

Fuelwood production, from cutting the wood to packing bundles for sale, is often done by family members and sometimes villagers are hired for a daily fee or in-kind compensation. Temporary urban-to-rural migration of producers was observed to some extent, especially to deal with large-scale requests for fuelwood for bakeries. The production cycle for charcoal, from cutting the wood to packing bags, mainly involves local men paid a daily fee (or sometimes a percentage of the total production) by the landowner or the 'head producer'. In both regions, reciprocal labor exchange groups are common. These involve around ten producers working in turns to build a member's charcoal kiln. The host producer provides food and drink and reciprocates by working on other members' kilns. There are also permanent groups of professional producers who access trees on private or communal lands. In remote areas, they sometimes build a camp at the site. Some urban citizens also specialize in charcoal production. They mainly function as intermediaries, hiring villagers to produce charcoal. Most charcoal production is artisanal in the zones of Kinshasa and Kisangani, using traditional charcoal kilns with a low energy efficiency of 10% to 20% (Dikhulu Kianda and Lelo N'Kambu, 2000; Makala Project, 2012). There is no formal education for woodfuel production,

but 6% of charcoal producers mentioned they had received some type of training from experienced producers. The main factors influencing access to resources according to producers are the distance to the production site and the caterpillar-harvesting season. The latter prohibits cutting trees harboring caterpillars, a common and popular food. Producers also mention restricted zones, especially around Kinshasa (49% vs. 9% for Kisangani). These are mainly sacred sites, private forests, concessions or plantations. Accessing these areas can lead to conflicts, indicated by 13% of Kinshasa producers and 6% of Kisangani producers. Increased scarcity was one of the main causes of conflicts mentioned by Kinshasa producers. Other reasons include disagreements over land rights, access, prices and corruption.

The weak implementation of woodfuel sector regulations contrasts with the strong customary rules that largely govern access to resources. Access depends on whether the trees grow on village lands, private lands or on plantations. Around Kisangani, most trees are found on village lands, whereas in Kinshasa access is more complicated because of the mix of private lands and a large plantation. Three types of informal or customary access to resources were identified: 1) land ownership; 2) renting land; and 3) buying trees (Table 4.1). Land ownership is either by inheritance or long-term land purchase from local authorities. Renting land from local authorities or a landowner to produce woodfuel and possibly also crops can be agreed upon for a shorter period of time varying from a few weeks to a few years. When the sole purpose is woodfuel production, this is called *collaboration*. The fee is often paid in cash for fuelwood or a proportion of charcoal production. Buying individual trees is more common near Kisangani and costs around 10-30 USD per tree. Except for inherited land, all other types of access apply to both local producers and for producers from outside the region. For local charcoal producers, 'land ownership' is the main route to obtain access (61%). 'Outsiders' mostly work as *cooperants* (59%), renting land and paying part of their production in return. This results in higher access costs for charcoal producers from outside the region (70.5 USD per year) compared to costs paid by local producers (44.1 USD per year). Overall access costs for producers remain relatively low, amounting to 4% of total revenues for charcoal producers in the supply zone of Kinshasa and 9% of total revenues for charcoal producers near Kisangani. For all producers, access is mainly negotiated with the local traditional authorities (*chef de groupement* or *chef de terre*). In the Kinshasa region, the head of a charcoal producer group generally negotiates access on behalf of a group. For local producers these negotiations are relatively easy, although they involve implicit obligations such as respecting local traditions and sacred forests and sharing

part of the proceeds with village authorities. For producers from outside the region, payment is made to village elites, and maintaining good relations with villagers and respecting local norms are also key conditions to gaining and maintaining access. Costs differ depending on whether the producer is a local (lowest), from outside village lands (higher) or accessing private lands (highest) (Trefon *et al.*, 2010). Producers are largely exempt from official taxes because it is landowners (village notables or private owners) who are required to pay tax for woodfuel exploitation. During transport and trade, transporters and merchants have to deal with State authorities taxes, reflected in the high transportation costs.

Table 4.1. Types of access to the resource per woodfuel product per supply region (%)

Type of access to resource	Kinshasa		Kisangani	
	Charcoal	Fuelwood	Charcoal	Fuelwood
Traditional landowner	59.5%	53.6%	54.1%	73.6%
Renting land	33.2%	37.5%	26.0%	19.4%
Buying trees	2.7%	5.4%	14.7%	1.4%
Official concession holder	3.5%	3.6%	3.7%	1.4%
Other	1.1%	.0%	1.6%	4.2%

Local access rules also depend on the land tenure in the supply region. Around Kinshasa, in Bas-Congo, most land has been sold to concessionaries and access is often costly. Vermeulen *et al.* (2011) indicate that in Bas-Congo, where there is extreme pressure on wood resources despite local replanting customs, access is organized by the lineage chiefs (*chefs de lignées*) who provide lineage members with permanent agricultural lands and grant temporary contracts to outside producers. Further away from the capital, in the provinces of Bandundu and l'Equateur, free access to resources is offered by farmers who want forested land cleared for agriculture. In Plateau Bateke, customary chiefs control access to land. Access is always temporary, even for local villagers, and involves payments in cash or parts of production. This temporal nature makes reforestation or domestication unattractive, and aggravates the pressure on tree resources in the region (Vermeulen *et al.*, 2011).

Access to markets

Producers tend to work alone and are self-sufficient. The main factors influencing access to markets according to producers are high costs of corruption during transport, long distances, high transport costs, and the periods of high demand (year's end, return to school). Most (80%) accompany their product to the urban markets, or send a representative from their producer group. Some producers indicated they do not go to the city for fear of being poisoned, bewitched or robbed, as people recognize they are rural farmers. Most finance their own activities (99% in Kinshasa and 83% in Kisangani). Some Kisangani producers use informal loans and saving groups. Rules about dividing the benefits of production differ per location. In general the head producer hands out a daily fee or percentage of the production. Values accruing to producers range from 38% to 71% of the retail price (57% for charcoal- and 47% of fuelwood producers in Kinshasa zone and 71% for charcoal- and 38% of fuelwood producers in Kisangani zone).

Most (60%) charcoal producers sell to any buyer and 40% sell to the same buyer. These buyers are often intermediaries or traders (for 99% of Kinshasa producers and 92% in Kisangani). Producers from Kinshasa region rarely (1%) sell directly to households or restaurants, although 9% in Kisangani sell directly to household consumers. Prices are generally negotiated depending on the quantity of bags and quality of charcoal. For fuelwood, the main clients are local intermediaries (93% in Kinshasa and 79% in Kisangani), followed by restaurants (4%) and households (1% in Kinshasa and 18% in Kisangani). Rural intermediaries (*rabatteurs*), mainly men living in the supply zone, organize charcoal or fuelwood collection through groups of producers. When a truckload is ready, they contact urban traders, who then organize transport and pay producers. Both producers and traders pay these intermediaries. Urban intermediaries, known as *mama* or *papa manoeuvre* sometimes go to rural zones to collect woodfuel, pre-financed by urban customers. They also work in urban markets, organizing sales of truckloads of woodfuel arriving in the depots, using their personal networks to sell quickly and avoid paying too many taxes and bribes, a practice confirmed by Trefon *et al.* (2010).

Woodfuel commercialization provides a range of income-generating opportunities. Besides the wholesalers, retailers and vendors, other jobs include manual laborers carrying and packing the woodfuel and loading trucks. Some are paid in charcoal waste, in demand by users of battery-ventilated stoves in Kinshasa. Most traders are men (64% for charcoal and 58% for fuelwood sales in Kinshasa and 78% for charcoal and 73% for fuelwood sales in Kisangani). In the past women dominated retail, but unemployment

and increasing woodfuel prices have attracted men into the profession and raised its status (Ingram *et al.*, 2014).

In Kinshasa, no wholesaling was found to occur outside of the formal *depot* system. However a proportion of retail sales occur outside of the market system, out of view of State agents, with small bundles of fuelwood or bags of charcoal sold along the roadside in neighborhoods. In Kisangani, sales are less organized. In both regions, corruption and illicit taxing of woodfuel were observed along the road, at harbors and checkpoints, mostly targeting transporters. It is estimated that formalization would cost considerably more than the current largely informal arrangements. Producers supplying Kinshasa would pay 31 USD annually, instead of the current 22 USD, and producers from the Lukaya supply zone would pay 67 USD instead of 60 USD paid currently, plus the official permit costs.

Table 4.2. Woodfuel institutions shaping access to resources and access to markets

	Access to resources	Access to markets
Contextual factors	Increasing distances Conflict over access Difficulties accessing new woodfuel sources (Kinshasa) Degradation of preferred tree sources (Kisangani) Use of simple tools (some chainsaws) Seasonal restrictions: rains, agriculture activities	High costs of corruption Long distances High transport costs by boat/bike (Kisangani) or truck (Kinshasa) Periods of high demand
Formal woodfuel institutions	Forestry Code, Land Law Fuelwood and carbonization sales permit Legal options for sustainable production: plantations; reforestation; community forests, controlled by Ministry of Environment Restricted zones such as private forests or plantations (mainly Kinshasa)	Taxes levied by Ministry of Environment and Energy (Kinshasa) and other administrations Circulation permit Woodfuel depots (Kinshasa) Markets
Informal woodfuel institutions	Labor exchange Collaboration among producers Charcoal making skills and training Traditional land tenure Negotiation with local authorities Social relations with landowner Respecting local customs Gifts and payments Buying trees (Kisangani) Restricted zones such as sacred sites Informal loans or saving systems (Kisangani) Local replanting customs (Kinshasa)	Illicit tax collection along the road Unofficial markets/sales along roadside in neighborhoods Illicit taxes levied by state administrations at markets Informal loans or credit systems (Kisangani) (Most) producers accompany their produce to the market Collection of woodfuel by rural or urban intermediaries
Enforcement	Few plantations and reforestation initiatives exist Formal permit system seldom applied Traditional restrictions: sacred sites, caterpillar harvesting season Restriction to duration or function of traditional land tenure Weak capacity of State administrative bodies Overall lack of payment of formal taxes by absence of formal institutions	Formal and illicit taxes collected by various government authorities Formal permit system seldom applied Weak capacity of State administrative bodies No role by Ministry of Energy (Kisangani)

4.4 Discussion and conclusion

This section summarizes the main findings on how woodfuel institutions affect access to resources and to markets around two urban centers in the DRC. It concludes by discussing the ability of producers to access markets and the resource management potential of current woodfuel institutions.

4.4.1 Woodfuel institutions and access to resources

In the DRC, producers primarily access woodfuel resources, using simple tools and techniques, mostly as part of the process of shifting cultivation. Difficulties accessing the tree resources, especially visible in the resource-scarce setting around Kinshasa, are reflected by increasing distances producers travel to harvest trees, producer and consumer perceptions of scarcity, size of transport used, and level of conflicts related to access. The main formal institutions regarding woodfuel resources are regulatory provisions controlled by the Ministry of Environment that provide legal options for plantations, reforestation, woodfuel exploitation permits, and community forests. In practice however, the presence of formal institutions is very weak and these mechanisms are seldom implemented or enforced. Producers have little political visibility and generally work informally together on basis of labor exchange, sharing revenues or skills. Trefon *et al.* (2010) emphasized that these types of association serve individual economic interests rather than a spirit of collective, harmonious collaboration. Producers mostly access resources by directly approaching local traditional authorities. Trees are mainly accessed as the producer is a (traditional) landowner, or when land is rented or trees purchased (especially around Kisangani). The ease and costs of such access depend on resource scarcity in the specific region and whether the producer is a local or an outsider accessing village lands, or if private lands are accessed. The last option involves the highest costs, but any of these options require local traditions and taboos to be respected and part of the production to be shared or paid for. The absence of formal institutions in the supply zones enables producers, official landowners and traditional authorities to avoid paying official taxes. However, transporters and traders pay taxes and bribes, increasing the overall transport costs for producers and market prices for consumers. The lack of formal institutions at resource level does not mean that the system is ungoverned: informal institutions govern access, clearly stipulating the arrangements that make natural capital (woodfuel resources) relatively accessible to producers with sufficient human, social and

financial capital, and should not be confused with a state of anarchy described by some (e.g. Binzangi, 2004).

4.4.2 Woodfuel institutions and access to markets

Urban wood energy use in the DRC is increasing, with most consumers obtaining charcoal and fuelwood from markets, noting that supply has become more difficult and expensive in the past five years. Access to markets is determined by the costs of corruption and illicit taxes, distances, transport costs and demand. Markets in the two cities are organized differently and are controlled by distinct institutions: in Kinshasa virtually all resources pass through wholesale depots to consumers or smaller markets, in Kisangani woodfuel is sold either in markets or directly to consumers. Formally, the Ministry of Environment and Ministry of Energy are the responsible authorities, both focusing on markets in Kinshasa. In Kisangani, the Ministry of Energy plays no role. Woodfuel transport and market trade in both cities are subject to numerous other taxes, formal and illicit, by government authorities.

Access to markets is mainly informal and self-organized by individual producers and traders. Exchange relations are important, but do not inhibit the majority of actors from accessing markets: most of them finance their activities through informal credit. The lack of formal credit systems and prepayments reflects the overall lack of trust between producers and traders (Trefon *et al.*, 2010). Producers sell mainly to different buyers, primarily intermediaries, typical of market-based governance networks, with 'arms-length' exchange transactions where information flows are limited and there is no technical assistance (Gereffi *et al.*, 2005). Intermediaries play a logistical rather than financial role, bulking up, speeding up collection, transport and sales, and avoiding or minimizing taxes. Still, many authorities illicitly and legally collect taxes, increasing costs. However, these costs are lower than the formally required taxes and permits. Woodfuel markets thus generate cash revenues not only for around 335,600 producers, traders, transporters, and vendors, but also for a network of State actors benefiting personally, while few revenues reach the public treasury.

4.4.3 Implications of institutions governing access to woodfuel trade

Given the value of the product and the urban-rural trade dynamics, access to resources and markets is relatively inclusive. The woodfuel chains in two regions in the DRC

show that access can be open to the less privileged and rural actors. This is in contrast to the situation often portrayed for poor producers in value chains (Van den Berg and Boomsma, 2007; Webber and Labaste, 2009). Access to woodfuel resources is generally easier for local producers and more expensive for producers from outside of the village or on private lands. This means that sufficient financial capital is a precondition for accessing tree resources, but that this is feasible for most producers, not only a wealthy elite. Omnipresent local institutions, common in the DRC and in Central Africa, such as group working and saving, working ‘in collaboration’ with landowners, and payment either in cash or a share of production, facilitate access to resources for poorer producers. Most producers (80%) have direct access to markets, irrespective of their household income. Producers are aware of urban market prices and they gain 38% to 71% of the average retail price. This is high compared to, for example Malawi, where producers gain 20% to 33% of the retail price (Kambewa *et al.*, 2007). This also gives them a better position of power, compared to, for example producers, who experience being cheated over prices by urban traders in Senegal, shaped by the powerful position of merchants, in turn co-shaped by credit arrangements and a formal permit system (Ribot, 1998). The absence of such institutions in the DRC, contradicts the contention that fragile market access, low levels of collective action, and low bargaining power of producers leave them dependent on traders for credit, trade contacts and transport (Sunderlin *et al.*, 2005).

While woodfuel institutions create constraints on access to resources and access to markets by formal rules, in practice they do little to contribute to sustainable production. Actors are aware of the environmental impacts of production but have few incentives, through either formal or informal institutions, to change their behavior to take account of longer-term product and chain sustainability. Formal institutions currently have fragmented perspectives towards the woodfuel sector, with the tax and permit systems inadequately positioned to promote sustainable management of the resource or chain. The absence of State authorities in the supply zones where woodfuel resources are located, means that reinvestments in reforestation, tree planting, sustainable harvesting practices or fuel-efficient production methods to reduce resource use are woefully inadequate in the face of current and growing demand. Equally, alternative sources of energy supply have not been forthcoming to meet demand. Actors are not aware of the myriad of official rules and arbitrarily enforced regulations. This is reflected by producers’ willingness to pay for official permits if other taxes, especially corruption, were controlled and the sector was invested in by the State. This parallels similar observations in forest product

chains in Cameroon (Foundjem-Tita, 2013). Market-based mechanisms can regulate trade and stimulate sustainable production (Beukering *et al.*, 2007; Hautdidier and Gautier, 2005). Neither formal nor informal institutions governing markets in the DRC promote or reward sustainable management of woodfuel resources, but rather invoke resource mining, signaled by high and increasing prices. Despite the fact that high woodfuel prices could make domestication and cultivation strategies commercially attractive in the face of resource scarcity in the Kinshasa supply zone (Homma, 1992), reforestation initiatives by producers remain rare. This is aggravated by the fact that access to the resource is often temporary, even for local villagers, such as observed on Plateau Bateke (Vermeulen *et al.*, 2011), rendering long-term investments unattractive. While informal institutions governing access to resources do have restrictions for specific areas and seasons, partially protecting some of the resource base from exploitation, these are insufficient to mitigate the economic capital that can be gained from exploiting this lucrative product. The often-observed coexistence of local and external governance mechanisms regarding forest products should ideally reinforce instead of obstruct outcomes (Wiersum *et al.*, 2014). This is not the case in the woodfuel supply zones of Kinshasa and Kisangani, where coexistence of customary and statutory rules instead leads to conflict and tension between stakeholders and little awareness or consensus on resource management options (Trefon, 2011). Ideally, taxing woodfuel should capture actual value, and include the price of resource management and restoration (Owen *et al.*, 2013). In reality this is not the case. As the costs of access to high value charcoal production remain relatively low, the internalized, ‘real costs’ of restoration and more sustainable production practices are not included in woodfuel market pricing.

To conclude, woodfuel institutions shaping access materialize foremost as informal arrangements that follow local environment and customs and mostly result from social relations and an economic rationale (Table 4.2). Formal institutional mechanisms do exist, but these are either insufficiently implemented or unenforced and do not reflect the size and the importance of the woodfuel market and challenges facing the value chain. Instead the woodfuel chain is characterized by a large number of illicit tax collectors, with revenues not reaching the treasury and thus not reinvested to improve long-term chain sustainability. This confirms the complexity of access to forest product markets with multiple types of fragmented institutions governing production and trade (Wiersum *et al.*, 2014). Competing claims are observed at different levels of the woodfuel value chains in the DRC. Low-paid officials conducting market and road checkpoint controls are unmotivated to enforce the official permit system. Intermediaries providing logistical

support in markets secure their profit margin by avoiding or negotiating market taxes, contradicting or bribing the efforts of tax collection officers. Nevertheless many people benefit from the informal arrangements governing the Congolese woodfuel chains and it is likely that woodfuel producers would benefit less if current regulations were more strictly enforced. However, both formal and informal institutions are unable to enhance the positive benefits and mitigate deforestation and degradation impacts, particularly in the more resource scarce, degraded, savannah supply zone of Kinshasa. This suggests that new strategies are required, promoting the positive aspects of informality in terms of short-term livelihood benefits, while supporting initiatives that contribute to long-term resource sustainability. Although problems in the lowland humid forests supply zone around Kisangani, with access to resources, increasing transport distances and costs, are less dramatic than in the Kinshasa supply zone, they are strong signals of the increasing fragility and low level of sustainability of livelihoods of those depending on woodfuel trade and use in the DRC.

Chapter 5

Formalization of charcoal value chains and livelihood outcomes in Central and West Africa

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Abstract

This paper examines the link between formalization of charcoal institutions and livelihood outcomes in Central and West Africa. In general, the woodfuel trade commenced informally, little controlled by legal or bureaucratic means. Developing formal institutions is often considered as a way of managing charcoal production more sustainably. However, formalization can have adverse effects for charcoal producers and traders when this hinders their capacity to access the resource or markets. In order to assess the relations between the formalization of charcoal institutions and socio-economic outcomes for those involved, this study combines a value chain and livelihoods perspective. A review of case studies and empirical data shows that: (1) West African countries, with a longer history of dealing with woodfuel issues, have more formal mechanisms in place to deal with charcoal management and these are more embedded into cross-sectorial energy and environmental policies; (2) Despite regulatory mechanisms dealing with woodfuel in all countries, institutions are mainly embedded in informal institutions and based upon customary rules, which allows large numbers of actors to be involved, but also leads to substantial unsustainable and unofficial production, corrupt practices, and loss of tax revenues; (3) Formal mechanisms can have negative consequences, such as: conflicts of interest over tax revenues, difficulties in avoiding 'free riders' from sustainable management initiatives, and disproportional benefits reaped by more powerful urban-based actors. Comparing the West African countries with Central African countries, where attention is relatively new, indicates that conditions for successful charcoal institutions are: devolving power and responsibilities for woodfuel management to a local level, monitoring woodfuel trade, instituting (tax) incentives for sustainably produced charcoal, and reinvesting taxes in social and environmental aims.

5.1 Introduction

Woodfuel consumption is the major source of household energy in Sub-Saharan Africa: an estimated 93% of households in rural areas and 58% in towns and cities rely on it for daily cooking (IEA, 2006). Fuelwood is the main form of woodfuel in rural areas, while charcoal is widely used in urban households as a smokeless cooking fuel with high heat value. The production of fuelwood has remained relatively stable throughout the developing world, but charcoal production keeps increasing in many African urban households (Tomaselli, 2007). This increased charcoal demand puts pressure on peri-urban wood sources, especially in the absence of management of the sector (Arnold *et al.* 2006). The environmental costs of charcoal production are often not internalized in the product price, which contributes to resource depletion and ultimately threatens the sustainability of the livelihood activity (Chidumayo and Gumbo, 2013; Luoga *et al.*, 2000). However, in many cases woodfuel is considered unsustainable when in fact there is a considerable surplus of woody biomass (Openshaw, 2011). Charcoal does offer a sustainable scenario when it replaces fossil fuels and is managed as a ‘renewable fuel’, i.e. involves rotation growth (Marien and Mallet, 2004). Moreover, charcoal production provides employment to many rural poor suppliers of urban markets (Marien, 2009). The challenge is how these diverse outcomes can be best understood and managed; especially considering that production often takes place in the informal sector. This informal character causes constraints for sustainable management of charcoal exploitation (FAO, 2007).

Options for charcoal management can target different aspects of the value chain, such as agro-forestry, plantations, control of trade, and improved energy efficiency at producer and consumer levels (Schure *et al.*, 2012). Earlier studies on governance of forest products have criticized many government initiatives for being reactive and opportunistic with general weaknesses of: 1) inconsistent, poorly coordinated laws; 2) regulation based on a limited understanding of the product; 3) insufficient consultation with harvesters and chain actors; and 4) ineffective implementation (Laird *et al.*, 2010b). Despite these weaknesses, as for other heavily traded forest products, building formal institutions is often considered as the path to manage charcoal production more sustainably. However, it can have adverse effects for charcoal producers when formal institutions hinder their capacity to access wood resources and markets, or when policies advantage more powerful urban actors (Ribot, 1995a). Moreover, as with many other forest products, access to and control over woodfuel resources are often managed

by customary rules and practices. Recognition of these types of existing woodfuel management is crucial for any interventions in the charcoal sector (Bensel, 2008).

The objective of this study was to examine the link between the degree of formalization of charcoal institutions and livelihood outcomes for actors involved in woodfuel chains in Central and West African countries. Lessons are drawn by comparing countries where policy and regulatory attention to woodfuel exploitation and trade are relatively new with those countries with a longer experience, allowing insights into the conditions necessary to support successful institutions that benefit the multiple actors in the value chains.

5.2 Linking formalization of charcoal institutions to socio-economic benefits of value chain actors

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To assess the relations between the formalization of the sector and socio-economic outcomes for those involved, the study combined institutional studies with a value chain analysis and a livelihoods approach. Value chain analysis focuses on the actors and their relations at all levels and their often complex networks. Value chain analysis offers a framework to analyze the activities and processes involved in taking a product from the forest, eventual production, transformation, and processing to delivery to final consumers and, ultimately, disposal (Kaplinsky and Morris, 2001). The charcoal value chain starts where the tree grows and the wood is cut. It continues with transformation through carbonization of the wood, packing and transporting of the charcoal to urban markets, and ends with the consumption of the charcoal by households and businesses. The main actors involved in this process are the producers, traders, transporters, and vendors. Value chain analysis assists the mapping and categorizing of the economic processes involved in charcoal production and trade, and understanding why, how, and where states, institutions, organizations, households, and individuals are positioned. Territoriality is an important factor in that activities, nodes, and flows within a chain are geographically situated and have implications for actors and their livelihoods at different locations (Gereffi *et al.*, 2005).

To relate value chain analysis and livelihoods, a multi-disciplinary conceptual framework for assessing charcoal institutions in Central and West African countries was developed. This framework consists of two main variables: (1) the degree of formalization and (2) the socio-economic benefits for actors in the value chain.

5.2.1 Formalization of charcoal institutions

Institutions can be understood as “regularized patterns of behavior between individuals and groups in society” (Leach *et al.*, 1999: 225). “Diverse institutions, both formal and informal, and often acting in combination, shape the ways in which differentiated actors access, use, and derive well-being from environmental resources and services and, in so doing, influence the course of ecological change” (Leach *et al.*, 1999: 240). Formal institutions can be considered as the rules enforced by an outside third party, such as the rule of law. Informal institutions are upheld by socially shared, usually unwritten, rules created and enforced among the actors involved (Helmke and Levitsky, 2004; Leach *et al.*, 1999). Key characteristics of the latter include their variety and flexible, dynamic spatial and temporal nature and weak voice in policy and government (Chambwera *et al.*, 2011). In this paper ‘charcoal institutions’ are defined as the formal and informal regularized patterns of behavior between different actors in society that shape access, rights, and obligations related to charcoal production and trade. These patterns of behavior that shape consequences of urban charcoal production take place both within the market and between the market and the State (Ribot, 1993).

Formalization in the context of supply networks can be defined as “the degree to which the supply network is controlled by explicit rules, procedures, and norms that prescribe the rights and obligations of the individual [companies] that populate it” (Choi and Hong, 2002: 470). The willingness of actors to operate in the formal sphere depends on the anticipated benefits and the levels of law enforcement (Hall and Haas, 1967; Ishengoma and Kappel, 2006). Property rights and formalized titles will motivate people to make longer-term investments, which contribute to sustainable behavior (De Soto, 1993). For the woodfuel sector, the forestry code and land tenure law are important regulatory frameworks. However, it is also important to focus on policies in other sectors, such as trade, structural adjustment, poverty reduction, debt, agriculture, infrastructure, energy, and mining that often intervene with forest policy objectives (Sizer *et al.*, 2005). Statutory control of forest product value chains takes three main forms: 1) controlling the trade by defining quotas, fixing prices, licensing the traders, and levying taxes or other fees; 2) controlling the access to land and granting harvesting rights to private entities; and 3) controlling harvest by licensing harvesters (Pierce and Burgener, 2010).

Formalization of forest products can have adverse consequences when new regulations criminalize extraction practices, marginalize harvesters, enable or promote

corruption, and obstruct effective customary laws (Arnold and Perez, 2001; Laird *et al.*, 2010b). Ribot (1995a) presented an example of these unintended outcomes in Senegal, where forest policies facilitate the access to resources by powerful traders leading to highly unequal benefit distribution between rural charcoal producers and urban traders. However, operating informally also carries its costs, mainly in the form of penalties and bribes (Ingram *et al.*, 2012; Ishengoma and Kappel, 2006). Informality has been linked to dependence – the degree of authority actors in a chain have over aspects of their work and the share of work-related risks that they absorb in a chain (Change, 2009; Chen *et al.*, 2004). Moreover, under high commercial pressure local customary laws may become less effective in mitigating negative environmental outcomes or ensuring social equity (Laird *et al.*, 2010a). In these situations formal institutions can help to shape better outcomes, especially when actors gain a voice and incentive to enter the formal sector (Ishengoma and Kappel, 2006). Participation in resource management and decision-making can co-determine positive outcomes of woodfuel management (Park, 1997; Ribot, 2009).

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5.2.2 Socio-economic benefits to actors in the woodfuel value chain

Woodfuel production and trade is part of strategies that actors in chains use to sustain their livelihoods. A livelihood is defined as “the control an individual, family, or other social group has over an income and/or a package of sources that can be used or changed to maintain a living” (Blaikie *et al.*, 1994: 9). The strategies used depend on personal skills and characteristics, access and use of different tangible and non-tangible capitals (social, physical, financial, economic, political, and natural), and combining of different activities (Chambers, 1995).

Although it is generally believed that woodfuel provides important benefits to households, there are few quantitative studies about the exact contribution in terms of income and other livelihood benefits (Arnold *et al.*, 2006). Ribot’s (1993) study of charcoal in Senegal argues that problems and solutions are often described for urban woodfuel supply and commercialization and that the recognition of the threats for rural households is minimal. These urban-oriented policies tend to favor the position of urban traders and wholesalers who make substantial profits, whereas villagers and producers gain a small proportion of the end price (Ribot, 1998). The extent to which the sector provides employment is often not reflected in national statistics due to production and trade taking place mainly in the informal sector. In Sub-Saharan Africa it is estimated

that 13 million people are employed in the biomass (mostly wood) energy sector (Openshaw, 2010). The benefits acquired from this depend on access to the resource, labor and markets, and control over the price (Ribot, 1998). Access to and distribution of benefits and enduring of risks are often unequally divided depending on social ties and financial means (Ribot, 2009; Sizer *et al.*, 2005).

5.2.3 Analytical framework and research questions

Guided by the conceptual framework, two analytical hypotheses were distilled to guide the research:

- 1) Formalization is likely to primarily advance urban actors further along the chain.
- 2) In countries with formalized charcoal institutions rural actors gain more benefits than in countries with informal institutions.

An analytical framework was developed consisting of two variables and six indicators to assess the nature and impact of charcoal institutions (Table 5.1).

Table 5.1. Analytical framework for analyzing main characteristics of charcoal value chains in Central and West Africa: formalization and socio-economic benefits

Variable	Indicator
Formalization	Existence of written rules and policies dealing with (cross-sectorial aspects of) charcoal value chains ^a
	Degree to which penalties for rule violations are clearly stipulated and enforced according to written rules and policies ^a
	Ease and accessibility of formalizing ^{b,e}
Socio-economic benefits to value chain actors	Number of actors involved in the charcoal sector ^d
	Net revenues gained in the charcoal value chain (as part of overall household income) ^{c,d}
	Extent and equity of benefit distribution among actors ^d

Inspired by: ^aHall and Haas, 1967; ^bHelmke and Levitsky, 2004; ^cBelcher, 2005; ^dRibot, 1998; ^eKappel and Ishengoma, 2006.



On the basis of this analytical framework, the research hypotheses were operationalized into two empirical research questions:

- 1) What is the status of formalization of charcoal institutions in Central and West Africa?
- 2) Who benefits from the charcoal trade and how is this related to the process of formalization?

5.3 Research methodology

A literature review was conducted for the charcoal value chains of the selected cities and countries. Scientific literature was complemented with reports and policy documents. Case studies and empirical data on charcoal value chains in Central and West Africa were selected from this literature. This database was complemented by cases from surveys by CIFOR in Kinshasa, Kisangani and Yaoundé. Overall, nine cases covered charcoal value chains to large urban centers with high charcoal demand, mostly capital cities, and their supply zones (Table 5.2). In Central Africa the cities included were: Bangui (capital of Central African Republic - CAR), Brazzaville (capital of Republic of Congo), Kinshasa (capital of the Democratic Republic of Congo - DRC), Kisangani (capital of the Oriental Province in the DRC), and Yaoundé (capital of Cameroon). In West Africa the cities included Bamako (capital of Mali), Dakar (capital of Senegal), Niamey (capital of Niger), and Ouagadougou (capital of Burkina Faso) (Figure 5.1).

Empirical data from all cases were analyzed with respect to formalization and livelihood outcomes of actors. Data from the literature review and surveys was categorized according to the pre-defined variables and indicators (Table 5.1). As relatively limited data exist on the charcoal sector due to its informal character, data analysis was semi-quantitative. Indicators were scored on a 5-point scale (1=very low, 2=low, 3=medium, 4=high, 5=very high) when possible. The remaining indicators were labeled with short descriptions. This scoring (Table 5.5) was done in an iterative process by the researchers. The comparative analysis was based on logical deduction.

Table 5.2. Key data for selected cities and their woodfuel supply zones

	Central Africa				West Africa				
	CM Ydé	DRC Kin shasa ^a	DRC Kisan gani ^a	Congo Brazza ville ^b	CAR Bangui ^d	BF Ouaga dougou	Senegal Dakar	Niger Niamey ⁱ	Mali Bamako
	2009	2010	2010	1994	2010	2006	2006	2006	2007 1994
Urban woodfuel dependence	-	87%	95%	90%	92%	95% ^h	84% ^{k*}	95% ^{l*}	97% ^{m*}
Charcoal market in 1000 tons	(214)	490	16	(25)	30	(23) ^{g*}	150 ^f	(200) ^j	38 ^{e**}
Value in million USD	(380)	143	2.5	(16)	6	(425) ^h	60 ^f	15 ⁱ	30 ^j

Sources: ^a(Schure *et al.*, 2011a), ^b(Lamouroux and Boundzanga, 1994); figure for four main cities together (Brazzaville, Pointe-Noire, Dolisie and Nkayi), ^c(Ministère de l'Energie et de l'Eau, 2010); figure for the entire country, ^d(Drigo, 2009), ^e(Hautidier, 2007), ^f(Denton, 2004), ^g(DURADEVE Consulting Group, 2011), ^h(Ministère de l'Environnement et du Cadre de Vie, 2010), ⁱMaty, 2003 cited by (Ichaou, 2004); figure is for entire woodfuel volume, ^j(Heuraux *et al.*, 2011), ^k(Ministère de l'Energie, 2007), ^l(Ministère des Mines et de l'Energie, 2007), ^m(Ministère de l'Energie et de l'Eau, 2007).

Figure 5.1. Selected urban centers for study on formalization of charcoal institutions

5.4 Results

5.4.1 Formalization of charcoal institutions

Central Africa

Although the woodfuel sector in Central Africa has mostly an informal character, formal policies and rules do exist in all four countries.

In Cameroon, management of the woodfuel sector is prescribed in the 1994 forest law. Non-commercial use of woodfuel falls under users' rights. Commercial production of woodfuel is regulated by the 1995 Decree on forest regime implementation modalities under two types of permits: 1) for the exploitation of special forestry products, which includes charcoal, and; 2) for fuelwood exploitation (Cerutti *et al.*, 2009). Some woodfuel has been produced under community forestry arrangements (Minang *et al.*, 2007). Regarding the energy sector, the national Energy Policy recognizes the role of biomass and renewable energy but the role of woodfuel is rarely discussed in the national energy strategy (*Ministère de l'Energie et de l'Eau*, 2008).

In Congo, a permit system for woodfuel is applied for transport and retailing. The recently endorsed 'National Program of Afforestation and Reforestation' (*Programme National d'Afforestation et de Reboisement - PRONAR*) promotes the development of woodfuel plantations and is considered an important initiative toward guaranteeing future urban supply. It builds upon the experiences of the eucalyptus plantations near the economic capital Pointe-Noire that have been supplying woodfuel since 1994 (Nkoua and Gazull, 2011). There is no national strategy for wood-fuel substitutes (Schure *et al.*, 2012).

The CAR has recently given more prominence to woodfuel in national policy. The 2008 forest law grants a sectorial focus to woodfuel. The Strategy on Urban and Peri-urban Forestry, a participatory decision making document accepted by a ministerial board in 2008, includes the woodfuel sector as a key policy objective. A legislative platform was introduced to optimize the wood energy sector and a new action plan introduced woodfuel-oriented forestry and agroforestry initiatives. Timber concessions within Bangui's wood supply zone are now considering woodfuel production for Bangui as a specific objective, which also helps to prevent uncontrolled harvesting (Salbitano, 2009). At the level of household consumption, the Ministry of Forest, Fisheries and Environment started a campaign to introduce kerosene as an alternative energy, but without a clear subsidy program (Schure *et al.*, 2012).

The DRC has regulations to manage woodfuel exploitation embedded in the country's legislation on land, forestry, agriculture and environment (Schure *et al.*, 2013a). Legal options for managing woodfuel production are: (1) public plantations; (2) private plantations; (3) reforestation of agricultural parcels; (4) permits for felling and carbonization; and (5) community forestry. The national Reducing Emissions from Deforestation and Degradation (REDD) program creates momentum for improved management, as the recently endorsed Forest Investment Program (FIP) grants an

important place to the potential production and consumption efficiencies to be gained in the woodfuel sector. However, woodfuel, the major household energy source, plays virtually no role in the national energy policy (Schure *et al.*, 2011b).

While all four countries have woodfuel policies, a large gap exists in practice. Commercial charcoal production in Bangui is largely unrecorded, there is very little control and virtually no one pays taxes (Salbitano, 2009). In Brazzaville, it was estimated that only 10% of the quantity of woodfuel that entered the city was officially registered. This is mainly due to the fact that control by the forest services only takes place at the city's entry points during office hours, while much transport takes place at night to avoid paying taxes (Gibert, 1978, Nkoua, personal communication). The practical outcomes of regulations are minimal due to the poor implementation of the permit system and reforestation. Between 2009 and 2011, less than 3% of the charcoal produced for Kinshasa had been produced with an official permit. Despite the legal options for woodfuel plantations, most wood is sourced from (newly slashed) agricultural land and (degraded) forests. A partial shift of responsibility from the Environment Service to the Energy Department in the Province of Kinshasa has led to fragmented and increased taxes. Most of these taxes collected do not reach the province's coffers. In Kisangani a myriad of institutions (Mines and Energy, Environment, Rural Development, Small and Medium Enterprises, General Direction of Migration, Marine Police, Market Administration, Local Police, etc.) are present at trading points, levying (often informal) taxes, increasing costs for traders and vendors (Schure *et al.*, 2011a). In Cameroon, less than 1% of the estimated charcoal production is authorized by Special Forestry Product permits (Schure *et al.*, 2012). None of the producers interviewed around Yaoundé possessed a permit and, as in the other countries, producers and transporters negotiate bribes when passing Forestry service checkpoints.

The fact that much of the woodfuel production and trade is informal and few formal producer groups exist does not mean that the activity itself is unorganized. At the local level there are rules, mainly dictated by customary practices, about who can access woodfuel and under what conditions. In the DRC, only 3.5% of the producers supplying Kinshasa and Kisangani own an official forest concession and access is commonly secured by renting land or buying trees from the customary landowner or village chief. For producers in the supply zone of Yaoundé, access is also mainly (78%) under customary rules and only around a fifth of the producers possess official land titles. Especially in the areas where there is more pressure on the resource, an increase of

conflicts between villagers, private landowners, and forest concession holders has been noted (Salbitano, 2009; Schure *et al.*, 2011b).

The large quantities of charcoal produced without official permits illustrate the predominantly informal and illegal character of the sector and the difficulties in accessing the formal system. Producers have few incentives or disincentives to comply with formal systems and customary rules define access to the resource. The costs of obtaining a permit, lack of information, and distance to the issuing entities are the main obstacles for producers. Moreover, they are not assured that a permit would bring them benefits in terms of less ‘unofficial tax levying’ along the road. The vested interests of informal taxing with officials and controlling entities at road blocks and markets are deeply embedded in most Central African countries, which impedes the commitment of these actors to support any changes of the system (Schure *et al.*, 2011a). Table 5.4 highlights how governance issues affecting business in general are particularly unfavorable in Central Africa, with only small improvements noted in Cameroon and DRC over the past few years. The four Central African countries all score poorly on the corruption index. This shows that, not only the charcoal sector, but the entire business environment still has a long way to go before formal practices are well embedded.

West Africa

In the four studied West African countries - Burkina Faso, Mali, Niger, and Senegal - policies and strategies related to the energy sector were developed to regulate the growing woodfuel demand and increasing scarcity of supply. The participation of local people in the sustainable management of forest resources was promoted as an important aspect of sustainable woodfuel supply.

In Burkina Faso, the sustainable production of woodfuel takes place within dedicated forest management areas (*Chantier d'Aménagement Forestier (CAF)*) through participatory management of forest resources. Decree 98-306/PRESS/PM/MEE/MCIA regulates the exploitation and marketing of forest products, defines the actors involved in the commercial exploitation, and describes the taxes and fees payable for these products. In addition to the taxes that need to be paid for cutting, storage, and transport permits, a forest fee is due to finance the forest management fund and the village investment fund.

In Mali, the 95-003 forestry law regulates the exploitation, commerce, and transport of wood and defines rural management structures and rural woodfuel markets. The commercial exploitation of woodfuel requires a cutting permit and since 1995 differential taxation has been applied depending on the character of the production

zone; whether it is through controlled rural woodfuel markets, oriented rural woodfuel markets, or uncontrolled exploitation (Gazull *et al.* 2006). The different tax regimes, according to the sustainability of production zones, are key tools in promoting the sustainable exploitation of forest resources. Local communities can gain rights to exploit forest resources via rural woodfuel markets, based on a sustainable management plan.

Niger also imposes differential taxation determined by the distance from urban centers and the status of the supply zone (uncontrolled exploitation, controlled, or oriented rural woodfuel market) (CILSS-PREDAS, 2005). Compared to Mali, the differential tax system seems to be more efficient in Niger because, in addition to the status of the woodfuel production zone, the distance is taken into account. The 92-037 forestry law in Niger sets the legal framework for the management of natural forests; the exploitation, commercialization, and transport of woodfuel; the conditions for the rural woodfuel markets; and the mechanisms for redistribution of woodfuel tax revenues (CILSS-PREDAS, 2006). In both Mali and Niger, domestic energy strategies for improving wood energy supply of major cities refer to sustainable management of forest resources with participation of local people (SED, 2000a; 2000b).

Also in Senegal the involvement of local people in managing forest resources has been formalized. The 1996 national decentralization law allows rural communities to control the extraction of forest products gathered inside of their territorial boundaries. The Ministry of Environment annually defines the charcoal production quotas, the regions where the production can take place, and the production season. The 1998 forestry code requires the Forest Service to gain permission from the rural council before any commercial production takes place (Ribot, 2009).

Specifically in participatory forest management programs, inequities associated with charcoal production could be reduced and converted into local benefits (Post, 2003). For instance, an appropriate use of woodfuel revenues by the forest management fund and village investment fund can assist to rehabilitate forest resources and build infrastructures for local development. Positive results from local participation in resource management have been reported in Niger and Senegal where there has been a considerable annual increase in the forest stock following decentralization of forest management (De Miranda *et al.*, 2010). In Burkina Faso, specifically in the Center-West region, participatory management of natural forest has contributed through the village investment fund (worth about 47,000 USD annually between 1990 and 2010) to strengthening socio-economic infrastructure at the local level, i.e. by contributing to the construction of schools, cereal banks, water pumps, etc. (*Ministère de l'Environnement*

et du Développement Durable, 2012). Also in Niger there have been positive impacts on people's livelihoods because of better access to social infrastructure for health and education, forest resources, and decision-making mechanisms (Alio 2004). In Senegal, villagers who participated in forest-management projects, supported by donors such as USAID and the World Bank, earned substantially higher incomes from charcoal production (Poteete and Ribot, 2011).

Despite these positive impacts of participatory forest management and the existence of legal frameworks for charcoal production and trade a low level of enforcement still characterizes the woodfuel sector in West Africa. Consumption of woodfuel is much higher than the legally produced quantities, showing the high proportion of informal, illegal, and uncontrolled production. This also represents a loss of potential tax revenues (Table 5.3). A recent study in Burkina Faso, Mali, and Niger emphasized the lack of forest control at all levels in the woodfuel value chain due to the weak capacities of the Forest Services (Bodian *et al.*, 2012). In Senegal, there is an incomplete implementation of differential taxation with consequences on the competitiveness of the product according to where it is harvested (PROGEDE, 2009). The forest law in Senegal, intended to decentralize power, share the profits of charcoal production, and limit the negative impacts of charcoal production, never materialized (Faye, 2006; Ribot, 2009; Wurster, 2010). The central Forest Service continues to fix and allocate quotas for regulating charcoal production, maintaining their powerful position and withholding real rights from rural councils (Bá, 2005; Poteete and Ribot, 2011; Ribot, 2009). In Mali, it is more profitable to risk the payment of a tax penalty than to pay for cutting permits because of the weak forest control (Heuraux *et al.*, 2011); and in Burkina Faso, woodcutters show free riding behavior instead of contributing to the Forest Management and Village Investment Funds (Delnooz, 2003). The Forest Management Fund that should pay for the regeneration of the resource serves rather to support salaries and administrative costs—about 80% of this fund according to a forest agent (interview with a forest agent, 2012). Military personnel in Burkina Faso are involved in exploiting and selling illegal woodfuel from areas without sustainable forest management (CEEFF/Burkina Faso, 2001; Ouédraogo, 2002).

Table 5.3. Official woodfuel production and value of lost tax revenues

	Burkina Faso	Senegal	Mali	Niger
Official controlled production as proportion of overall production	6% of woodfuel demand from forest management areas ^a	41% on average of charcoal consumption from official production ^b	10% of woodfuel officially controlled ^d	13% of woodfuel demand from rural woodfuel markets ^c
Estimated value of lost tax revenues (million USD)	2.0 ^e	-	1.8 ^f	1.7 ^g

Sources: ^a(Ministère de l'Environnement et du Cadre de Vie, 2004), ^b(Bâ, 2006), ^c(Ministère des Mines et de l'Énergie, 2007), ^d(Haseer 1997, cited by Gazull 2009), ^e(Ouédraogo, 2006), ^f(Hautdidier, 2007), ^g(Ichaou, 2004).

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Entry barriers to the woodfuel sector are not only formal ones. Even when all the required permits are obtained and financial resources are available, difficulties entering the market remain if the trader lacks the proper connections. Economically and politically powerful actors, mainly merchants and wholesalers, hold the power in the chain. If the president of the rural council in Senegal refuses to sign off for charcoal production, he becomes a victim of pressure, threats, and bribes until he agrees (Ribot, 2009). Charcoal producers often lack the information and level of organization to counterbalance this pressure by external urban-based actors (Yameogo, 2008). The overall ease and accessibility of formalizing businesses remains challenging in the West African region despite a slow progress in the regulatory business environment over the past decade (Mo Ibrahim Foundation, 2011) (Table 5.4). Corruption remains a major issue complicating business (Transparency International, 2012).

Table 5.4. Formal business environment

Ranking	Central Africa				West Africa			
	CM	DRC	Congo	CAR	BF	Senegal	Niger	Mali
Ease of doing business ^a	161	178	181	182	150	154	173	146
Improvement 2006-2011 ^b	+0.08	+0.13	-0.02	+0.01	+0.25	+0.18	+0.11	
Reforms ^a	Y	Y	N	N	Y	Y	N	Y
Corruption ranking ^d	134	168	154	154	100	112	134	118
Corruption score ^e	2.4	2	2.2	2.2	3	2.9	2.5	2.8
Governance ^c	45.0	32.4	42.4	32.6	51.1	57.5	44.2	53.6
Sustainable economic opportunity ^c	47.5	28.9	40.5	35.8	58.6	53.1	44.6	46.9

Sources: ^a(World Bank/IFC, 2012): global ranking out of 183 countries, with 183 lowest. ^bScore of the regulatory environment for local entrepreneurs measured by 9 Doing Business indicator sets over a 5-year period. ^cMo Ibrahim Foundation 2011 scoring of 100 where 0 is lowest. ^dTransparency International 2011 ranking of 183 countries. ^eTransparency International 2011 score indicates perceived level of public sector corruption on a scale of 0 - 10, 0 indicates a country is perceived as highly corrupt and 10 as very clean.

5.4.2 Livelihood outcomes: who benefits?

Central Africa

As the woodfuel markets in the urban centers comprise considerable volumes and values, the question is, what are the livelihood outcomes of this trade? One of the key questions is who benefits, and where, in the chain? Work creation and supplementing household income for actors is often presented as one of the major impacts of the trade. Although exact and contemporary data on the benefits and their distribution are scarce, at least an estimated 350,000 people in Central Africa and 90,000 in West Africa are involved along the chains, and probably many more (Table 5.5). In Brazzaville, in the 1970s it was estimated that 800 to 1,200 people (mainly women) were retailers. Profits for women retailers in Brazzaville were very small after paying for costs of wood, transport, and labor. Those few involved in wholesale and transport made considerably higher profits (Gibert, 1978). However, Nkoua and Gazull (2011) recently described the relatively equal distribution of revenues between actors in the woodfuel chain in Congo's economic capital Pointe-Noire, especially between producers and wholesalers. Unequal distribution occurs among the rural actors because of their varying distances to the market and unequal costs of access to the resource and to investment capital.

In the DRC, the large demand in Kinshasa provides important income opportunities for production (290,000 people), transport (900), and sales (21,000) of charcoal for the largest number of people in any of the countries studied (Schure *et al.*, 2013a). The largest numbers of people benefitting from the cash-generating opportunities in woodfuel are at production level. Most producers (80%) sell the charcoal themselves at the urban market and on average they receive 60% to 70% of the final market price. Charcoal income contributes to 75% of total household income for producers in the Kinshasa region. Around 24,000 people (10,000 producers, 1,600 transporters, and 12,100 retailers) are involved in the informal woodfuel chain supplying Kisangani, where charcoal income of producers contributes on average to 38% of household income. This income provides households with capital to pay for basic needs, and particularly also, to invest in other activities (mainly in agriculture and some in petty trade, livestock, and fishing). The investment of charcoal revenues into other activities by producers in DRC suggests that charcoal contributes to household income diversification and possibly reduces poverty. Overall, however, the producers' income is low, with over half earning less than 50 USD a month, reflecting the country's high poverty levels (Schure *et al.*, forthcoming). In the supply zone of Bangui an estimated 15,000 producers, 3,400 transporters, and 4,250 retailers work in the sector (Drigo, 2009). The volatile nature of the woodfuel sector creates uncertainty for all those involved: a broken vehicle can halt transport and a price increase at wholesaler level can leave many retailers with less profits or losses (Gibert, 1978). This is compounded by the seasonal nature of supply and demand. The data suggest that producers are generally the most numerous group in the chains, followed by retailers, with transporters and wholesalers numerically the smallest groups of actors.

Table 5.5. Overview of formalization in charcoal value chains in Central and West Africa

Variable and Indicators	Central Africa			West Africa				
	CM Ydé	DRC Kinshasa Kisang.	Congo Brazza ville	CAR Bangui	BF Ouaga dougou	Senegal Dakar	Niger Niamey	Mali Bamako
Formalization								
Written rules, and policies	3	3	3	4	4	4	4	3
Degree to which penalties for rule violations stipulated and enforced	1	1	2	2	3	3	3	3
Ease and accessibility of formalizing	1	1	2	2	4		4	4
Socio-economic benefits to actors								
Number of actors involved	-	>324,000	>1,200 traders	>22,650	> 50,000	16,200 - 19,300	>15,000	13,500
Net revenues from charcoal (% of producers' household income)		Kimshasa: 75% Kisangani: 38%	83%					
Extent and equity of benefit distribution (n° of actors)	Relatively equal	Relatively equal	Unequal (rural)	Unequal	Unequal	Unequal	Unequal	Unequal
			Relatively equal					

Score: 1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high

West Africa

Also in West Africa the woodfuel sector provides substantial employment for those involved in its production and commercialization. In Niger, surveys in 2003 indicate that the sector provides direct incomes for approximately 15,000 people in rural areas (CILSS-PREDAS, 2006). In 1997, a similar number of rural-based people (14,300) were engaged in the charcoal value chain of Senegal where there were around 10,000 laborers, 300 foremen, and 4,000 producers, while the other actors such as transporters (1,000), wholesalers (1,000), and retailers (3,000) were mostly based in urban areas (GEFME, 2004). According to Ribot (1998), the charcoal market includes roughly 11,000 migrant woodcutters, 2,900 merchants, 300 wholesalers, and 2,000 retail vendors. The total number of people implicated in the charcoal value chain in Senegal is estimated between 19,300 (GEFME, 2004) and 16,200 people (Ribot, 1998). In Mali, it is estimated that 13,500 people are engaged in charcoal production to supply Bamako (Gazull, 2009). For Burkina Faso, the number of woodcutters supplying Ouagadougou is considerably higher than in the other West African countries, estimated at 50,000 in 2000 (Ouédraogo, 2002).

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In terms of revenues generated, these are significant in forest management areas in Burkina Faso and Senegal. In Burkina Faso, managed forests generated more than 1.4 million USD in 2009 (DURADEVE Consulting Group, 2011). A woodcutter earns between 50.9 and 254.5 USD per campaign from woodfuel production (Kaboré, 2002), which contributes on average 83% to the producer's overall income (Ouédraogo, 2009). The monthly profit for wholesalers supplying Ouagadougou is considerably higher and lies between 61 and 1,014 USD (*Ministère de l'Environnement et du Cadre de Vie*, 2004). In Senegal, revenues gained from charcoal production within participatory management zones alone were estimated at 7.9 million USD in 2007 (PROGEDE, 2009). Sustainable forest management facilitated by a project generally showed positive impacts on incomes of the people engaged. For instance in Senegal, six charcoal producer groups supported by a USAID project that organized collective sales earned a profit of 4.64 USD per bag compared to the 1.20 USD per bag normally earned (USAID, 2008). In Burkina Faso it was estimated that forest management has led to an increase of annual income of 29.3 USD per person (Thiam, 1998b in Kaboré, 2002).

Benefits are unevenly distributed among stakeholders in woodfuel chains in Burkina Faso, Mali, Niger, and Senegal, with wholesalers and transporters making the greatest profits (about 30 to 40% of the revenues) (Bodian *et al.*, 2012).

In Senegal, ten percent of the net profits remain with woodcutters – mainly Guinean migrant laborers- and only four percent of the woodfuel gross revenues accrue to village institutions (Ribot, 1998). The woodfuel sector in Burkina Faso was valued at 425 million USD: around 76 million USD earned by woodfuel local producers, 79 million USD by transporters, 47 million USD by retailers, 7.7 million USD by the government and decentralized communities via taxes, and the remaining amount shared between other actors (*Ministère de l'Environnement et du Cadre de Vie*, 2010). Forest management projects generate significant incomes and highest profits are gained by wholesalers, transporters, and the State (Sawadogo, 2006). In Mali, revenues for charcoal producers were a quarter of the value of wholesaler revenues (Gazull, 2009).

In Niger and Senegal, the distribution of benefits is due to the power of wholesalers and transporters and their ability to fix prices, and the weak market access of producers (De Miranda *et al.*, 2010). In Senegal, differences are attributed to the better access of merchants to credit arrangements, information, and social relations (Ribot, 1998). In all the West African countries the urban-based woodfuel actors, such as wholesalers and transporters, are numerically the smallest groups of actors in the chains and also those gaining the highest benefits.

5.5 Discussion and conclusion

The analysis of charcoal institutions and outcomes for the livelihoods of actors in the value chains in Central and West African countries provides insights into the main characteristics of formalization in different countries and the trends in the two regions (Table 5.5). These empirical findings allow a further assessment of two research hypotheses.

5.5.1 The status of formalization of charcoal institutions in Central and West Africa

In both regions, clear tendencies to formalize institutions governing the chains have been observed. In Central Africa, formal policies and rules regarding the charcoal sector are mainly embedded in forest policies and rarely figure in any other sectorial policies. There is a notable absence of woodfuel strategies in national energy plans. The formal mechanisms involve different coercive forms of statutory control, mainly targeting

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harvest and trade of charcoal by a system of permits. CAR seems to be the most advanced with its recent integrated woodfuel approach, perceiving woodfuel supply as part of peri-urban forestry planning, strongly linked to agriculture and urban consumption patterns. Despite these existing legal options in the region, large gaps in practice remain when it comes to implementation of woodfuel policies. These reflect general problems with forest product governance, such as poorly coordinated laws, little consultation with chain actors, and ineffective implementation (Laird *et al.*, 2010b). Charcoal production and trade are largely unrecorded and uncontrolled. In Cameroon and DRC, less than 3% of total charcoal production for urban centers is permitted. Producers and transporters generally have to negotiate bribes when passing Forestry and other official checkpoints. Informal charcoal institutions thrive in the absence of functioning formal institutions. Access to the resource is organized among the various actors, often based upon customary rules, varying according to the local circumstances. Retailers in markets often are subject to local trading regulations. Although the existence of these informal types of institutions shows that the sector is organized and local rules of access have an important function in dividing and protecting resources, their effectiveness is insufficient to counterbalance environmental impacts or internalize environmental costs in regions where charcoal has become a lucrative good. In Central Africa, there is less control and power by urban-based actors compared to West Africa, which may partly be explained by the absence of functioning permit systems and a much lower level of scarcity, except for Kinshasa (Schure *et al.*, 2012). Producers often bring their own charcoal to the market and although costs of transport weight heavily, they still reap the greatest proportion of revenues per bag of charcoal. The study in Congo confirms that the distribution of benefits depends not on the type of actor, but intra-group differences among producers depend on the distance to the markets (Nkoua and Gazull, 2011).

There is a higher degree of formalization in West Africa than in Central Africa, likely as a result of a longer history of regulating woodfuel and forest management decentralization. However, as in Central Africa, even with regulations in place, rules are often only partially enforced and implementation is often ineffective. This can be explained by weak institutional capacities and low levels of financial and human resources. These factors also explain the levels of corruption encountered, particularly during transport, as its large scale makes the product an easy, visible target. This leads to high rates of unofficial production and a loss of tax revenues for State coffers. Urban-based actors in both regions gain higher profits compared to rural producers who are often not well organized and lack economic and political power. This low level of

collective action among producers is particularly noticeable outside of the organized forest management areas. Some producers in Burkina Faso free ride to avoid paying taxes that could benefit their communities. Nevertheless, in Senegal, the existence of dedicated forest management areas with a participatory approach, encouraging charcoal producers to organize and to contribute to taxes with local social and environmental aims, illustrates that increases in income and associated benefits for producers is possible. These producers achieved higher profits after organizing their own charcoal marketing. The rural woodfuel markets of Mali and Niger also highlight the positive impact of devolving responsibilities to local communities of managing woodfuel production. Differentiation in taxing products from controlled areas, as implemented in Niger, appears a good incentive for more sustainable production. However, difficulties remain in 'fair' distribution of rights related to the power relations among actors and related interests in tax collection and expenditure.

5.5.2 Who benefits from charcoal trade and how is this related to the process of formalization?

Positive outcomes for villagers and the resource base resulting from formalized and decentralized woodfuel chain governance include the reinvestment of taxes in local social and environmental projects, and lower, more attractive taxing of controlled charcoal production and community woodfuel plantations. Negative, unintended consequences of formal mechanisms also have occurred, such as conflicts of interest over tax revenues, continued difficulties in monitoring and permitting trade, sustainable production, free riders, and rich or powerful urban actors dominating access to permit systems.

Work creation in the form of many jobs in production and trade is one of the greatest socio-economic benefits for actors in the woodfuel value chains. Another major impact of the trade is that it provides a more-or-less continuous main source of energy for the populations of major urban areas in Central and West Africa. The informal character of the sector makes it an accessible-but not particularly high status-source of income for tens of thousands of people. The low entry barriers for producers, wholesalers, transporters, and retailers are largely not determined by regulation, apart from the exceptions of managed forests in West Africa, but by the business environment (i.e. access to capital) and distance to markets. The trade in woodfuel provides an important source of cash and household revenues for all actors, particularly for the groups with lowest incomes, the producers and retailers. For these actors the trade is also fairly low

risk: being non-perishable, an undifferentiated product, and having slightly seasonally fluctuating but generally stable and continuous demand and prices with a large number of consumers.

The evidence from the literature review confirms the first hypothesis that formalization is more likely to advance urban actors further along the value chain. Higher profits ensue from risk taking, investing in infrastructure, and information and by adding value through bulking, transport, and distribution, often over long distances in difficult terrain, which restrict the number of actors able to operate in the transport and wholesale part of the chains. Classical economics and value chain theories (Kaplinsky and Morris, 2001) hold that higher levels of risk are rewarded with higher profits. In the business value chain literature distributional equity of profits is an outcome of competitiveness and risk management (Porter, 1988). In contrast, in the development-focused value chain literature, unequal distribution of benefits is viewed as a development issue (Helmsing and Vellema, 2011; KIT and IIRR, 2008). These diverging views highlight that the aim of formalization of the woodfuel sector has primarily not been development, but managing and controlling economically valuable resources. More pro-poor focused policies are apparent in West Africa. For example, in Burkina Faso, Niger, and Senegal the proceeds of woodfuel from dedicated forest management areas are invested in social and environmental programs from which communities benefit. However, distributional equity among actors in the chain does not appear to have been tackled. The implementation of woodfuel regulations is generally weak, large proportions of potential tax revenues are not collected, or when they are collected, the costs weigh heavily on actors, particularly those with the lowest profit margins.

The evidence points to a partial affirmation of the second hypothesis, that countries with more formalized charcoal institutions, such as those in West Africa, have systems in place to distribute benefits to rural actors. However, the implementation of these systems and the actual benefits for these rural citizens remain low. Within the four studied West African countries, charcoal institutions are more formalized in Senegal compared to Burkina Faso, Mali, and Niger. High levels of scarcity and pressure on resources have largely stimulated formalization of institutions. Through formalization, more of the actors, particularly urban-based actors, involved in the chain have gained and used their voice to ensure that the policies and institutions governing the sector ensured beneficial outcomes in terms of access to and control of charcoal resources along the chain. Rural actors have received less attention as they are generally unorganized and lack power to

access benefits and are less visible to policy makers and regulators. This finding indicates that as well as facilitating access through formal mechanisms, hierarchies and effective decentralization processes at the village level need to be addressed (Ribot, 1995b).

5.5.3 Conclusion

Considering the hypotheses, it can be concluded that despite the existence of legal mechanisms, the charcoal value chains in Central and West African countries are mostly characterized by lack of formal governance or incomplete implementation, and a predominance of informal rules and market-led arrangements. West African countries have stronger formal charcoal institutions and these are more embedded into cross-sectorial national energy and environmental policies. Conversely, in Central Africa this coherence with energy policies has been mostly lacking and as a result there exists little coordination between sectors and few incentives to actors in the chain to operate sustainably. There are many vested interests in the informal systems with producers and rent-seeking actors along the chain and few motivations or disincentives to change. Formalization only occurs once the pressure on the resource is acute enough that government intervention is required. Especially the West African countries, with higher levels of overexploitation of woodfuel resources and decentralization of forest management, show some enabling formal mechanisms that might counter the status quo.

The charcoal permit systems highlight the barriers to creating meaningful, effective, sustainable, and inclusive systems for woodfuel management. Permits need to be accessible by the rural producers who are frequently located long distances from urban areas. Distance, procedures, and costs are obstacles for functioning systems. Systems of corruption, such as paying euphemistically named “informal” taxes, are deeply embedded. This operating environment adds significant costs and risks and is an important part of the chain context that needs to be considered in formalization. Failure to do so could add additional costs and burdens and create more difficulties in controlling black markets. Another theme is the lack of transparency and apparent, large discrepancies between receipts of revenues from permits and taxes and reinvestment in woodfuel resources and communities. Participative approaches with the actors and sectors of the woodfuel chain, building upon enabling formalization practices in West African countries could assist in improving outcomes for both livelihoods and the resource base. These experiences suggest that devolving responsibilities of woodfuel

management to a more local level, taking account of functioning customary systems, reinvesting taxes in social and environmental outcomes, monitoring woodfuel trade, and providing incentives for sustainably produced charcoal can provide enabling mechanisms to formalize and create more sustainable value chains that continue to provide positive livelihood benefits to thousands of people in the chains and millions of consumers. Caution should be exercised, given the possible unintended outcomes related to power and distribution of benefits among the actors.

These conclusions can only be considered tentative. The cases highlight the lack of quantifiable knowledge about livelihood outcomes along the charcoal value chain. The paucity of data is partly due to the mostly informal character of charcoal production and trade. In order to further assess possible benefits and constraints of formalization as these processes develop, more empirical studies are needed about the organization and governance of charcoal production and trade as an integrated value chain process.

Chapter 6

Reflections and conclusion

6.1 Introduction

Woodfuel has long been studied as a subsistence good with most attention being given to social and environmental impacts of possible deficits in dry and semi arid areas (Arnold *et al.*, 2003; Eckholm, 1975). Recently, it has been found that throughout the humid forest zone of the Congo Basin, an increase of commercialization and a shift from use of fuelwood to charcoal in urban centers have put pressure on peri-urban forest resources (Marien, 2009). At the same time, these trends have created opportunities for many peri-urban and urban citizens to be involved in production and trade (Arnold *et al.*, 2003; Schure *et al.*, 2012). These findings coincide with a more general reappraisal of the role and significance of woodfuel as a source of energy (e.g. Mwampamba *et al.*, 2013; Openshaw, 2011; Owen *et al.*, 2013; Rogers *et al.*, 2012). This thesis adds to this new generation of woodfuel studies. It presents new empirical information on the importance of urban woodfuel and its impact on livelihood conditions as well as sustainable resource use in the Congo Basin. Earlier studies on forest product use have often taken a fragmented approach by considering either production or consumption (Belcher and Schreckenber, 2007; Chidumayo and Gumbo, 2013). In this study, a more holistic approach was used, building upon recognition that arose in the 1980s and 1990s on the complexity of localized issues related to non-timber forest product (NTFP) harvesting and use and the importance of examining livelihoods in combination with resources and markets (Belcher, 2005; Ros-Tonen and Wiersum, 2005; Ruiz-Perez *et al.*, 2004; Shackleton *et al.*, 2008). In order to gain broad understanding of socio-economic and environmental issues, such as value of the product throughout the chain, the role of woodfuel in livelihood strategies, and access to markets, this study combined a livelihood perspective with value chain analysis. Whereas forest livelihood studies focus on the role of forest product use for poverty alleviation of producers and environmental sustainability, value chain analysis assists in capturing production and market dynamics, including the various actors involved and the rural-urban setting. Yet, use of value chain analysis in studies of NTFPs and woodfuel is relatively new (Brouwer and Magane, 1999; Ingram *et al.*, 2012; Jensen, 2009; Kambewa *et al.*, 2002; Ribot, 1998; Shively *et al.*, 2010; Te Velde *et al.*, 2006, Zulu, 2010). The 'Livelihoods – Woodfuel Chain Framework' (LWC-Framework) has been developed for the purpose of this study. This analytical framework was applied to systematically assess woodfuel as a livelihood resource for different actors and three related analytical issues: (1) sustainable livelihood outcomes of woodfuel value chains with emphasis on poverty reduction of

producers and sustainable use of the natural resource base; (2) woodfuel institutions and how these shape access to resources and access to markets; and (3) formalization of woodfuel institutions as a way to mitigate livelihood outcomes.

In the following sections, first (Chapter 6.2), reflections on the analytical issues are given. These involve an overview of the contextual setting of the study with attention to the role of woodfuel for the different value chain actors and its impact on poverty reduction, wider developmental objectives, and sustainable use of the resource base. Moreover, a reflection is given on the role and outcomes of woodfuel institutions and their formalization. Subsequently (Chapter 6.3), the analytical framework of this study is reassessed, followed by a reflection on the methodology applied (Chapter 6.4). The final part presents the policy implications of the empirical research findings (Chapter 6.5) and the general conclusion (Chapter 6.6).

6.2 Reflection on analytical issues

6.2.1 The significance of woodfuel commerce and sustainable livelihood outcomes in two urban regions of the DRC

This reflection on the significance of woodfuel commerce and potential sustainable livelihood outcomes is based on the research findings presented in Chapter 2 and Chapter 3. First, it discusses the main socio-economic characteristics of woodfuel value chains and their possible contributions to livelihoods and wider developmental objectives. It analyzes differences between the resource-scarce, high-demand context of Kinshasa and the resource-abundant, less-demand context of Kisangani. Subsequently, it looks into the environmental characteristics of the value chains and how these are likely to affect sustainable use of the natural resource base for woodfuel production. These collective findings are framed in the broader debate on the potential of forest products in development and conservation efforts.

In order to assess the importance of woodfuel in urban areas in the Congo Basin, the woodfuel value chains of Kinshasa have been compared to those of Kisangani. The data confirmed the importance of woodfuel use for the vast majority of households in both cities (87% in Kinshasa and 95% in Kisangani). In Kinshasa, the proportion of woodfuel use is somewhat less because a portion of households uses electricity as cooking fuel, using woodfuel as an additional source because of irregular power supply.

Kerosene is not often used for cooking (1% in Kinshasa and 4% in Kisangani) and none of the households reported use of LPG. Charcoal is the number one cooking fuel for most households (75% in Kinshasa and 72% in Kisangani) and numerous businesses. This shows that it is virtually all consumers, not only the poorest cohorts, who depend on charcoal as is often wrongly assumed (Mwampamba *et al.*, 2013). However, the poorest households are more likely to use fuelwood than charcoal. The size and market value of woodfuel, often underestimated in terms of economic relevance (Arnold *et al.*, 2003; Mwampamba *et al.*, 2013), are high, with total volumes of woodfuel markets of the two cities (4.8 million m³ in Kinshasa and 200 thousand m³ in Kisangani) exceeding the volume of official national timber production (400 thousand m³) by more than 12 times. However, much of the domestically used timber is not formally registered. Comparing woodfuel to the mostly informal domestic markets for sawnwood shows less vast differences, but still woodfuel exceeds timber markets in terms of volumes (Kinshasa: 4.8 million m³ woodfuel vs. 700,000 m³ RWE sawnwood, Kisangani: 200,000 m³ woodfuel vs. 180,000 m³ RWE sawnwood (Essiane Mendoula *et al.*, 2013; Schure *et al.*, 2013). Volumes and values for supply of Kinshasa by far exceed those of Kisangani because of a larger population and higher prices.

Production and trade of woodfuel are important activities for large numbers of people throughout the value chain (Arnold *et al.*, 2006). Around 15,000 people are employed in the formal forestry sector (Eba'a Atyi and Bayol, 2009) (and an unknown number in the informal domestic timber sector). In contrast, more than 335,000 people are involved in the informal woodfuel production and trade for Kinshasa and Kisangani. Most people (300,000) are involved at the level of production, mainly a men's activity (96% of charcoal producers and 82% of fuelwood producers are men). The integration of commercial woodfuel production in livelihood strategies is a response to urban demand and the complementarity with agriculture. Woodfuel commercialization contributes to household diversification, with woodfuel adding to non-agricultural portions of household income. Against some expectations that presume small proportions of income from forest products (Belcher and Schreckenberg, 2007), it is found that around Kinshasa woodfuel production provides the most substantial single contribution to producers' household income (on average 75% for charcoal and 47% for fuelwood). Around Kisangani, although smaller, charcoal still forms a considerable proportion (38%) of household income. For fuelwood this contribution to producers' household income is more limited (12%) because of relative abundance and low prices. Producers obtain 38% to 71% of the average retail prices. This is high compared to the

reported proportions that producers receive in other countries: 11% in Burkina Faso (Ouédraogo, 2007); 15% in Senegal (Ribot, 1998); 20% to 33% in Malawi (Kambewa *et al.*, 2007); and 23% to 33% in Tanzania (Van Beukering *et al.*, 2007). In terms of poverty mitigation, woodfuel revenues help meet basic needs, as producers spend part of their income on food, education, and healthcare. More important for poverty reduction, however, is that woodfuel provides capital for investments in other activities (mainly agriculture, some trade, livestock, and fishing). Even among the poorest households, most (79%) manage to reinvest part of their woodfuel revenues. This contradicts the common assumption that predicted only a limited contribution to poverty reduction from channeling incomes to investments (Arnold *et al.*, 2006; Sankhayan and Hofstad, 2000; Zulu and Richardson, 2013). A novel finding is how woodfuel, especially charcoal, can act as a household savings account. Over half of producers (56%) store charcoal strategically for future spending as well as price optimization. Trade and sales of woodfuel for the two cities employ 33,000 persons, or about 10% of the number of people involved in production. Besides the traders, wholesalers, retailers, and vendors, other jobs in woodfuel commercialization include manual laborers carrying and packing the product and loading trucks. Traders or intermediaries can be both rural and urban based and they mainly provide a logistical role, organizing the transport and facilitating access to markets and salespersons (Chapter 4). Salespersons, nowadays often men (around 70%), are specialized in sales of woodfuel with expertise in distinguishing good quality woods from bad ones. In line with earning patterns of producers, highest revenues are obtained in Kinshasa and for charcoal. Highest costs are involved for paying transport and bribes.

Considering the livelihood importance of woodfuel, its commercialization has further development potential for both rural and urban chain actors. First, woodfuel provides energy to millions of urban consumers and many businesses, and thus guarantees a basic need that otherwise would not be secured in the absence of reliable and affordable alternative energy sources. Second, production and trade contribute to development of a range of income-generating activities and, especially, to cash-income and livelihood diversification of (mostly) rural based producer households and revenues of specialized salespersons in urban centers. This potential is gendered, as mainly men are involved in production and sales. Khundi *et al.* (2011) have suggested that in Uganda charcoal production assists in filling income gaps for households with less agricultural production. In contrast, this study in the DRC shows that woodfuel revenues of producers contribute income both for daily needs and for investments in

agriculture, which may contribute to higher agricultural capacity and productivity than would be the case without such investments. However, it cannot be concluded that woodfuel production automatically lifts households out of poverty, as overall income of producers is still low, reflecting the high incidence of poverty in the DRC. Also, it seems, in line with findings from high-value NTFP market studies (Belcher, 2005; Khundi *et al.*, 2011; Paumgarten and Shackleton, 2009; Sunderlin *et al.*, 2005), that poorest households benefit least when it comes to the higher-value product charcoal, as charcoal requires financial means for investment in the charcoal manufacturing process. Poorest cohorts produced less than half of the quantity of valuable charcoal that was generated by richer households. Highest revenues for both producers and salespersons are obtained for charcoal and for Kinshasa, which illustrates the usefulness of adding value to the product (carbonization and packing) and the income-generating potential of scarce resources in demand (Robinson *et al.*, 2002; Sunderlin *et al.*, 2005).

The study on environmental characteristics of the woodfuel value chains confirmed pressure on the resource, which is reflected in, among others, the increasing distances and prices, consumer perceptions of scarcity, and conflicts producers encounter related to access. These developments are especially visible in the resource-scarce Kinshasa supply zone where woodfuel exploitation, combined with conversion of forests to agriculture lands, leads to deforestation of gallery forests and large distances to the source of supply (currently an average 102 km for fuelwood and 135 km for charcoal). In Kisangani, average distances are considerably smaller (25 km for fuelwood and 37 km for charcoal) with targeted harvesting of preferred wood species leading to degradation of the resource on a smaller scale. This confirms new insights on woodfuel that woodfuel production is not a single or primary cause of deforestation, but is more likely to lead to forest degradation (as occurs in Kisangani), or, when it leads to overexploitation (as observed for Kinshasa), this is mostly combined with shifting cultivation with impacts occurring in certain regions and for certain actors (Arnold *et al.*, 2006; Chidumayo and Gumbo, 2013; Mearns, 1995). Short-term and relatively cheap access to woodfuel resources discourages investments in replanting woodfuel resources (Arnold *et al.*, 2006; Luoga, 2000; Vermeulen *et al.*, 2011). Only some producers (22%) in the Kinshasa supply zone, where prices are relatively high, do replant trees for possible woodfuel production against none of the producers in the Kisangani supply areas, where prices are low and the resources relatively abundant. These findings on environmental characteristics suggest that at present there is no sustainable use of the natural resource base for woodfuel production.

Table 6.1. Possible versus actual outcomes of woodfuel markets in the DRC

Outcome	Developmental objective		Environmental objective	
	Possible outcomes	Actual outcomes	Possible outcomes	Actual outcomes
Positive	Contributes to subsistence, diversification, and specialization strategies	Confirmed	Investments in sustainable harvesting or cultivation of (higher-value) NTFPs	Not confirmed. There are few investments made
	Provides cash-income (especially for higher-value products)	Confirmed (especially for charcoal)	Market-led governance arrangements stimulate resource management	Not confirmed. There are no market-led governance arrangements to stimulate sustainable management
	Many people can engage for free-access NTFPs	Confirmed		
Negative	Limited income because of low prices, poor access, high entry barriers, long distances	Not confirmed. Income is relatively high and the activity is accessible	Low prices relative to alternatives (no inclusion of environmental/restoration costs)	Confirmed
	Trade is restricted to local markets	Not confirmed. But trade is restricted to the urban markets	Forest degradation and species loss	Confirmed
	Irregular demand/insecure sources	Not confirmed. Demand is relatively stable		
	Increased dependence on traders or more powerful chain actors	Not confirmed. Producers operate independently	Deforestation	Confirmed as co-driver of conversion of forests to farmlands.

Source: Possible outcomes were identified by literature review (Table 1.1). Actual outcomes are based on original research results.

This study confirmed the challenges in combining developmental and environmental objectives as observed by several NTFP studies (Arnold and Perez, 2001; Belcher and Schreckenber, 2007; Ros-Tonen and Wiersum, 2005). When examining possible versus actual outcomes of NTFPs and woodfuel markets (Table 6.1), woodfuel value

chains in the DRC seem to meet mostly positive developmental objectives (contribute to diversification and specialization strategies, provide cash-income, engage many people), but this occurs at the expense of environmental objectives (overharvesting, environmental prices not internalized, forest degradation, no investments or market-led governance arrangements for resource management).

6.2.2 The role of woodfuel institutions in shaping access for value chain actors and formalization as a way to mitigate sustainable livelihood outcomes

This reflection on the role of woodfuel institutions and formalization is based on the research findings presented in Chapter 4 and Chapter 5. Whereas in the past most woodfuel studies have been either steered by ‘ecoscarcity approaches’⁴³ or ‘modernization approaches’⁴⁴, nowadays there is a growing volume of woodfuel studies that focuses on the institutional dynamics behind woodfuel markets (e.g. Owen *et al.*, 2013; Ribot, 1993; 1998; Sander *et al.*, 2013). This study first examined the role of formal and informal woodfuel institutions with specific emphasis on whether producers face exclusion from accessing the market and whether woodfuel institutions contribute to sustainable practices. Subsequently, it looked into the potential of formalization in mitigating livelihood outcomes by comparing the developments in the Central African region with those in the West African region that has a longer track record of dealing with woodfuel issues. The findings contribute to the gap in current knowledge on the role of outside interventions on changes within the value chain (Gereffi *et al.*, 2001). These reflections also point to potential improvements of the woodfuel sector, which will be elaborated when discussing policy implications (Chapter 6.5).

Research findings on the woodfuel chains in the two regions showed that access can be open to the less privileged and rural actors. Informal, socially embedded institutions generally govern access to resources and the absence of enforcement by formal bureaucratic institutions does not hinder actors, particularly fuelwood and charcoal producers, from

43 ‘Ecoscarcity approaches’ followed the woodfuel gap thesis with Malthusian calculations of woodfuel demand curves, centred on resource scarcity issues. See Robbins (2004) for criticism on Ecoscarcity or Modernization approaches dominating in environmental studies with lack of acknowledging political dynamics (Political Ecology approach).

44 ‘Modernization approaches’ focused on (lacking) adoption of technological solutions for more efficient production or consumption as answer to environmental problems. See Robbins (2004) for criticism on Ecoscarcity or Modernization approaches dominating in environmental studies with lack of acknowledging political dynamics (Political Ecology approach).

receiving a relatively high proportion of the end price. Sufficient financial capital is a precondition for accessing tree resources, but this is feasible for most producers, not only a wealthy elite. Omnipresent institutions, common in the Congo Basin, such as working and saving in groups, working in collaboration with landowners, and payment either in cash or a share of production, facilitate access to resources for poorer producers. Most producers (80%) have direct access to markets, irrespective of their household income. Producers are aware of urban market prices, which are identified as one of the key factors to entering NTFP trade (Te Velde *et al.*, 2006). This gives them better bargaining power compared to, for example, producers who experienced being cheated over prices by urban traders in Senegal, shaped by the powerful positions of merchants (Ribot, 1998). These patterns of dependence do not exist to such an extent in the DRC where intermediaries play a logistical role (bulking up, speeding up collection, transport, and sales, and avoiding or minimizing taxes) rather than a financial role, contradicting the contention that fragile market access, low levels of collective action, and low bargaining power of producers leaves them dependent on traders for credit and market information (Sunderlin *et al.*, 2005; Te Velde *et al.*, 2006).

While woodfuel institutions theoretically may shape either constraints or opportunities to access resources and to access markets, in practice they do little to contribute to sustainable production. Neither formal nor informal institutions governing access to woodfuel trade in the DRC promote or reward sustainable management of resources, but rather invoke resource mining. The absence of State authorities in the supply zones where woodfuel resources are located means that the reinvestments in reforestation, tree planting, sustainable harvesting practices, and fuel efficient production methods made to date are woefully inadequate in the face of current demand. Instead, the woodfuel chain is characterized by the presence of many illicit tax collectors, with revenues not reaching the treasury and thus not reinvested to improve long-term chain sustainability. Actors are not aware of official rules and regulations in the myriad of tax collection and arbitrary ruling at the ground. This confirms the complexity and fragmentation of forest product markets with multiple types of formal and, sometimes illegal, informal institutions governing production and trade (Trefon, 2011; Wiersum *et al.*, 2014). Despite the fact that high woodfuel prices could make woodfuel domestication and cultivation strategies commercially attractive in the face of resource scarcity (Homma, 1992), in the Kinshasa supply zone, restoration initiatives among producers remain rare. This is aggravated by the fact that access to the resource is often temporary (Vermeulen *et al.*, 2011), rendering long-term investments unattractive.

Ideally, taxing woodfuel should capture actual value and include the price of resource management and restoration (Owen *et al.*, 2013). In reality this is not the case with relatively low access-costs to charcoal production and lack of internalized, ‘real costs’ of restoration and more sustainable production practices in woodfuel pricing. While informal institutions governing access to resources do have restrictions for specific areas and seasons, partially protecting some of the resource base from exploitation, these are insufficient to mitigate impacts on a larger scale. The frequently observed coexistence of local and external governance mechanisms regarding forest products should ideally reinforce instead of obstruct outcomes (Wiersum *et al.*, 2014). This is not the case in the woodfuel supply zones of Kinshasa and Kisangani, where coexistence of customary and statutory rules instead leads to conflict and tension between stakeholders and little consensus on resource management options (Trefon, 2011). Nonetheless, many people benefit from the informal arrangements governing the Congolese woodfuel chains and it is likely that woodfuel producers would benefit less if current regulations were more strictly enforced. The willingness of actors to operate in the formal sphere depends on the anticipated benefits and the levels of law enforcement (Hall and Haas, 1967; Ishengoma and Kappel, 2006). There are many vested interests in the informal systems with producers and rent-seeking actors along the chain and few motivations or disincentives to change. Producers and transporters in the DRC, who currently negotiate bribes at road checkpoints and markets, would pay about two times the price if everything was formally regulated and controlled. This goes against the commonly held assumption that associates the informal sector with increased transaction costs and reduced net incomes (De Soto, 1993; Zulu and Richardson, 2013). However, the existing institutions are unable to counter the effect of high levels of urban demand creating pressure on the forest and tree resource base, indicating the low level of sustainability of the livelihoods depending on woodfuel trade under current woodfuel institutions (Figure 6.1a).

Notwithstanding the fact that formal institutions are not necessarily functioning better than the informal ones, formalization of informal harvesting activities and developing formal institutions is often proposed to manage forest resources more sustainably (Laird *et al.*, 2010a; Sander *et al.*, 2013). Formal mechanisms are associated with: long term investments based on property rights; fighting bribery and corruption; replacing ineffective customary laws; and improving the legal status of chain actors (Chen *et al.*, 2004; De Soto, 1993; Ishengoma and Kappel, 2006; Laird *et al.*, 2010b). However, adverse consequences of formalization have also been reported, such as when new regulations criminalize extraction practices, marginalize harvesters, enable

corruption, and obstruct effective customary laws (Arnold and Perez, 2001; Laird *et al.*, 2010b; Ribot, 1998). In order to assess the impacts of formalization, this study examined the link between the degree of formalization of woodfuel institutions in Central and West African countries and livelihood outcomes for actors involved. In both regions, clear tendencies to formalize institutions governing the chains have been observed. The formal mechanisms involve different coercive forms of statutory control, mainly targeting harvest and trade of charcoal by a system of permits. West African countries, with a longer history of dealing with woodfuel issues, have more formal mechanisms in place to deal with woodfuel management and these are more embedded into cross-sectorial energy and environmental policies, which is found to be key to managing biomass energy (Owen *et al.*, 2013). Some of the enabling mechanisms identified include: devolving responsibilities of woodfuel management to a more local level; taking account of functioning customary systems; monitoring woodfuel trade; and providing incentives for sustainably produced charcoal. Tax incentives (such as promoted via woodfuel markets in Mali and Niger) and formalized titles could motivate people to make longer-term investments, which contribute to sustainable behavior (De Soto, 1993). Positive outcomes for villagers and the resource base resulting from formalized and decentralized woodfuel chain governance include: the reinvestment of taxes in local social and environmental projects; community woodfuel plantations; and lower taxing of controlled charcoal production. Negative unintended consequences of formal mechanisms have also occurred, such as: conflicts of interest over tax revenues; difficulties in monitoring and permitting trade; and disproportional benefits reaped by more powerful urban-based actors (Figure 6.1b).

Overall, these outcomes suggest that the aim of formalization of the woodfuel sector has primarily not been socio-economic development with attention to the poorer segments of society, but managing and controlling economically valuable resources by market organizations. Distributional equity among actors in the chain does not appear to have been tackled. Despite regulatory mechanisms dealing with woodfuel in all countries, woodfuel institutions are mainly still embedded in informal institutions and based upon customary rules, which allows large numbers of actors to be involved, but also leads to substantial unsustainable and unofficial production, corrupt practices, and loss of tax revenues. Comparing the West African countries with Central African countries where attention to woodfuel issues is relatively new, suggests that participative approaches with the actors of the woodfuel chain that build upon enabling formalization practices could assist to improve outcomes for both the resource base and livelihoods.

In view of the fact that hundreds of thousands of people in the chains and millions of consumers rely on woodfuel for cash income or household energy, a normative approach to the development of woodfuel value chains and their distributional qualities (Gereffi et al., 2005; Helmsing and Vellema, 2011; KIT and IIRR, 2008) is needed. This requires types of formalization that include attention to development and pro-poor objectives. Ideally this should build upon the strength of existing informal systems (c.f. Figure 6.1b and Figure 6.1c).

Figure 6.1a. Present situation of institutions interacting with sustainable livelihood outcomes in the Democratic Republic of Congo

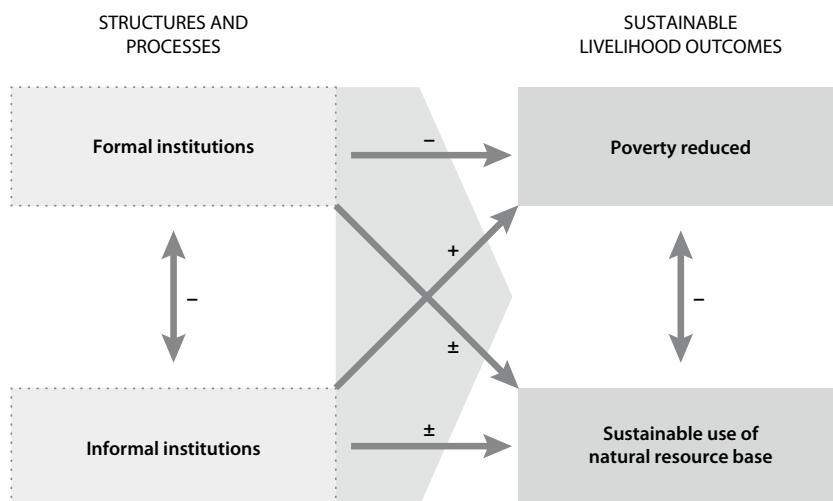


Figure 6.1b. Scenario of institutions interacting with sustainable livelihood outcomes after formalization, based on experiences in West Africa

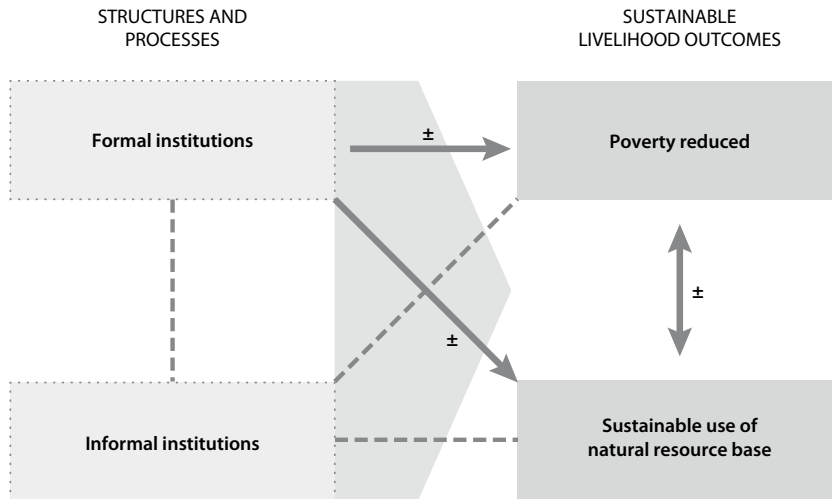
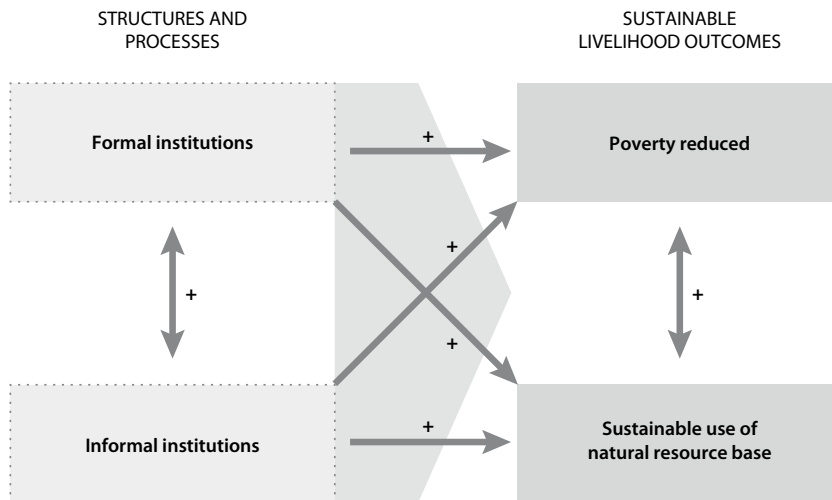


Figure 6.1c. Ideal scenario of institutions interacting with sustainable livelihood outcomes



6.3 Reassessing the analytical framework

This section briefly recaps use of the ‘Livelihoods - Woodfuel Chain - Framework’ (LWC-Framework) and discusses its suitability and applicability for woodfuel studies with similar objectives.

The analytical framework extended the Sustainable Livelihoods Framework (SL-Framework) with value chain analysis (Chapter 1.3). This SL-Framework links contextual conditions, livelihood assets, institutional processes, and organizational structures with livelihood strategies and sustainable livelihood outcomes.⁴⁵ It has been a valuable tool for putting poor people central to analysis and looking at wider household assets and access mechanisms. The consideration of wider livelihood systems responds to lessons from the past four decades of NTFP and woodfuel studies that focused attention on livelihoods of actors involved and the production and marketing context (Leach and Mearns, 1988; Ros-Tonen and Wiersum, 2005; Sills *et al.*, 2011). Although SL-Framework has been widely applied by practitioners and academics, it has also been criticized for its limitations in transcending the household level and weak linkages to markets and power relations (Carney, 2003; De Haan and Zoomers, 2005; Dorward *et al.*, 2003; Scoones, 2009). Value chain analysis, which increasingly gets attention in NTFP studies these days, was considered to be a useful addition to SL-Framework in order to render the role of markets more explicit and acknowledge the multi-local and rural-urban character of the sector (Chidumayo and Gumbo, 2013; Kambewa *et al.*, 2007; Ribot, 1998). The study started from a French *filière* type of approach, a rather descriptive and static view of the elements of the value chain, to specify the dimensions and actors of the value chain in Central Africa’s dynamic rural-urban interfaces (Raikes *et al.*, 2000; Trefon, 2011). Although woodfuel trade in the Congo Basin is mostly a domestic matter with restricted geographical spread, the study gradually incorporated further aspects from Gereffi’s *et al.* (2005) concept of global value chains analysis. This contribution to understanding of value chains that addresses issues such as distribution of income, barriers to entry, power relations, institutions, and the role of governments had opened up usage of the concept in a normative and analytical sense (Kaplinski and Morris, 2001). Specific attention was given to the study of institutional mechanisms. These mechanisms were considered essential in understanding access patterns to woodfuel (Mearns, 1995). Within SL-Framework, institutions had figured as a structural component (Bebbington, 1999; De

45 The Sustainable Livelihoods Framework has been developed by UK based scholars (e.g. Chambers and Conway, 1992; Scoones, 1998; Carney, 1998; Bebbington, 1999; Ellis, 2000) and is known for its adoption by DFID, followed by many others in the domain of development, sociology and environmental studies.

Haan and Zoomer, 2005; Carney, 2003). Opening up this black box and drawing on economic and sociological institutionalism to further operationalize formal and informal institutionalism (following Leach *et al.*, 1999 building on North 1990) was based on the basic understanding that institutions are both a social construct and shape the behavior and actions of people in the environment. This vibrant and cyclical nature of woodfuel institutions, in this study defined as ‘the formal and informal regularized patterns of behavior between different actors in society and associated enforcement mechanisms that shape access related to woodfuel production and trade’⁴⁶, mirrors a dynamic field in which actors gain or construct access to resources and markets. The function of formalization in shaping livelihood outcomes was the other central focus of the LWC-Framework, besides the role of institutions. The framework defined poverty reduction and sustainable use of the resource base as desired sustainable livelihood outcomes.

The LWC-Framework has proved useful in several respects. First, during its application as a descriptive empirical tool in the first research phase, it greatly contributed to identifying characteristics of two woodfuel value chains in the DRC, exploring similarities and differences between contrasting resource and demand conditions. The framework was conducive to capturing different dimensions and actors related to urban consumption, income-generating activities, and the supply zone. Second, in the explanatory analytic research phase, both the value chain perspective (where different actors interact and may benefit in unequal ways) and the focus on formal and informal institutions have helped to uncover the political character of access to resources and markets and distributions of livelihood outcomes. The study confirmed that issues related to distribution and sustainability can be explained by looking into institutional mechanisms. This supports an approach to woodfuel studies that put analysis of institutional dynamics before technological and neo-Malthusian types of explanations (Mearns, 1995). Third, also as part of the explanatory phase, this research has been one of the first attempts to assess relations between formalization of woodfuel institutions and socio-economic outcomes for those involved. This assisted in scrutinizing mainstream assumptions that formal mechanisms are more effective than informal ones in mitigating environmental and social impacts of commercial woodfuel production. Summarizing the benefits of the LWC-Framework, it builds upon the strengths of value chain analysis to provide insights into the value of products, distribution of income, barriers to entry, and institutions (Kaplinsky and Morris, 2001). Moreover, it has contributed to extending the SL-Framework to broader understanding of options for sustainable livelihoods, by

46 Inspired by Leach *et al.*, (1999)

including markets, social relations, and institutional processes outside of the local level, which answers some of the earlier critiques posed on the SL-Framework. This also fits recent recognition that production and trade of NTFPs is not only an activity of local forest adjacent communities but involves peri-urban and urban citizens, possibly even beyond national borders (Ingram *et al.*, 2012; Jensen, 2009).

As discussed in Chapter 1 the LWC Framework was gradually developed in a reiterative approach. The original data collection was based on a preliminary and mostly descriptive framework, which was further refined during the analytical phase of the study. Consequently, the actual application of the LWC-Framework in this study is still explorative and several potential analytical issues were not yet taken into account. First, the scope of the framework is broad, which furthers inclusiveness during the analysis, but also implies the risk of overburdening of data collection. In order to prevent such overburdening, after the first phase of this study, it was decided to focus on the production site for detailed analysis. This means that the LWC approach assisted in mapping and identifying the various dimensions and actors in the woodfuel value chain, but that for detailed study of the livelihood impacts its scope was limited to the largest actor category of producers. In future studies additional attention still needs to be given to the precise livelihood impacts on the other actor categories in the value chain. Second, the focus on livelihood dynamics was helpful in untangling underlying processes, such as how actors gained access to resources and markets. However, it also led to underexposure of institutional mechanisms related to governance issues, such as access to decision-making. Third, this study included analysis on distribution of benefits and institutional mechanisms shaping access, but it has not yet used the full potential of the LWC-Framework in assessing power issues and political relations, weaknesses that had been identified for the original SL-Framework (De Haan and Zoomers, 2005; Dorward *et al.*, 2003; Scoones, 2009).

In conclusion, connecting SL-Framework and value chain analysis was found to be useful in broadening the livelihood perspective to assess sustainable livelihood outcomes of woodfuel commerce and it shows promise for further refinement. The reiterative process and interdisciplinary character of the framework helped to deepen analysis of three analytical themes: (1) sustainable livelihood outcomes of woodfuel value chains with specific emphasis on poverty reduction and sustainable use of the natural resource base; (2) woodfuel institutions and how these shape access to resources and access to markets; and (3) formalization of woodfuel institutions as a way to mitigate livelihood outcomes. The main advantages of applying the LWC-Framework have been its inclusive

character to production and market dynamics, value chain actors, and institutional mechanisms shaping access and distribution of outcomes. The ‘Livelihoods - Woodfuel Chain Framework’ proved the relevance of linking the original production-oriented livelihood framework with a value chain approach in which the livelihood strategies of other actor categories are also considered and for specifying the institutional processes shaping the transformation processes as indicated in the original livelihood framework. Future studies could possibly enhance use of the Framework to better understand mechanisms related to governance and power relations.

6.4 Reflection on methodology

As illustrated by the various chapters (2-5) presenting the research results a combination of research methods was used to measure, value, and compare different aspects of livelihood outcomes connected with the woodfuel value chain. This cross-method approach fitted the research design and followed recent trends of bridging the gap between qualitative and quantitative methodological schools of thought (George and Bennett, 2005; Robson, 2011). Because the field research fitted within the framework of an existing project about woodfuel in the DRC, opportunities existed to extend and complement methods and data from the project to the dissertation (and vice versa).⁴⁷ This turned out to be a successful way to avoid the gap between academic research and practical policy-oriented research, with key data already being used in current policy development in the DRC. However, it also complicated the study because of the different types of information needs and analyses required throughout the process. Within this context, the reliability and validity of the data need some further reflection.

In many aspects this study was a first attempt to provide accurate data on the woodfuel sector in the DRC. It is expected to serve as a baseline study for future work. In order to obtain proper data, there were several challenges in the data collection. First, although the research benefited from project funds that facilitated large scale data collection, some related difficulties in obtaining accurate data were found in gaining a uniform understanding and approach by the team of enumerators, both during survey and data entry. Second, the one-off survey was found unsuitable for targeting actors who were distrustful in sharing information (especially the group of transporters). Third,

⁴⁷ Part of the data collection links to the Makala Project, an EU-funded project (2009-2013) about sustainable management of woodfuel in the DRC (<http://makala.cirad.fr/>).

basic data on the woodfuel sector was mainly non-existent or needed a careful and time-consuming approach of paying several visits to provinces' offices and administrations before data was being shared. Finally, a threat to generalizability of this study may be the specific Congolese setting.

In order to overcome the challenges and guarantee reliability and validity of research results, the following measures were taken. Besides training of enumerators, frequent monitoring of fieldwork and data entry and checking upon interpretation of certain subjects afterwards helped to avoid and repair abnormalities in the data set. Convergence of multiple sources of evidence and validation of research results by peers and respondents contributed to construct validity. Replication of research strategies between the two cases increased external validity. The use of study protocols and a database, shared at several stages of their development with peers, contributed to the reliability of the study. The reiterative nature of the research project created the opportunity to return to sensitive groups or subjects at a later stage using less invasive techniques (interview and observation). The synthesis study of the broader context of the Congo Basin helped to identify contextual factors that co-shape external validity of analytical generalizations. The study showed that shared characteristics among Congo Basin countries are the importance of woodfuel for household energy, pressure on the tree resource near populated areas, and the lack of implementation of policy and regulation for more sustainable production and consumption. However, DRC also showed extreme features in the sense that relative and absolute woodfuel productions are highest and its population is the poorest of the region. This has been taken into account when generalizing lessons, plus the fact that Kinshasa and Kisangani showed different patterns of socio-economic and environmental outcomes. The latter confirms that point of departure of any woodfuel study should be local dynamics.

The original base-line information approach of the study was subsequently further extended by considering several analytical issues in more detail. This was facilitated by the further adaptation of the original descriptive-oriented use of the value chain approach towards a more analytical approach based on the combined SL – Value Chain Framework. In the subsequent analyses the research findings were compared with studies from earlier on and from other countries. The review on formalization and livelihood outcomes in West and Central Africa was based on the information at hand, but also restricted by it. The comparisons can be considered as provisional only, due to the lack of longitudinal data. The one-year-long, monthly survey of actors proved helpful to capture fluctuations in prices, costs, and volumes that are associated with seasonal

changes. Other topics, however, such as persistence or reduction of poverty over a longer period of time for households that are involved in woodfuel production or the outcomes of formalization processes as they occur, would benefit from longitudinal study design over a longer time period, which unfortunately was not feasible within the scope of this research project.

6.5 Policy implications on woodfuel value chains and sustainable livelihood outcomes

This study provided insights into woodfuel value chains in the Congo Basin and related outcomes for sustainable use of the resource base and poverty reduction. It did not only have an academic focus, but also a policy focus. Several policy briefs based on this study have been published and shared with policy makers.⁴⁸ This section summarizes the main policy implications.

Woodfuel is often considered a traditional or irrelevant source of energy and only receives marginal attention in national energy policies (Openshaw, 2011; Owen *et al.*, 2013). This perspective needs to be revised considering the numerous people involved, its potential to offer a renewable alternative to fossil fuels, and the fact that no alternative energy is available in the short term. Improving the sector should consider the dependence on wood energy by a large part of the population, the contribution of wood energy security to urban populations, and the important employment provision related to woodfuel trade. Over the past few years, woodfuel gradually received more attention by policy makers in the Congo Basin countries and some interesting initiatives arose. In Republic of Congo, the National Program of Afforestation and Reforestation that was launched in 2011 promotes the development of woodfuel plantations. In Central African Republic, the Strategy on Urban and Peri-urban Forestry, accepted in 2008, included the woodfuel sector as a key policy objective and introduced woodfuel-oriented forestry and agroforestry initiatives. Results from the Makala research project (to which this study was associated) are being referred to in recent policy developments

48 See for policy briefs: Dubiez *et al.* (2012); Marien *et al.* (2013); Schure *et al.* (2011a; 2011b; 2012). Presentations have been held at yearly project meetings in Kinshasa and at international conferences (World Forestry Congress, 2009; The International Union of Forest Research Organizations, 2010; Poverty Environment Network Conference, 2011; Congress of the International Society of Ethnobiology, 2012; *Conférence Gestion Durable de la ressource bois énergie en RDC et au Congo Brazzaville*, 2013) to share results and exchange ideas with scholars and policy makers internationally.

in the DRC, which shows that the importance of the woodfuel sector is gaining some ground in the policy arena.

However, despite these recent developments that recognize its potentials, there remain many issues related to sustainable use of the natural resource base, the livelihoods of actors involved, and role of woodfuel institutions that need further attention. The woodfuel value chains studied indicated that in general there is no sustainable use of the woodfuel resource. Growing urban demand increases pressure on the peri-urban resource base and despite the legal options for woodfuel plantations, most wood is sourced from (newly slashed) agricultural land and (degraded) forests without official permit. Woodfuel cultivation or replanting is not a common practice because land property is unsure and access mostly short-term, which hampers these types of long-term investments (Chidumayo and Gumbo, 2013; Vermeulen *et al.*, 2011). State authorities are mostly absent in the supply zones where woodfuel resources are located and their reinvestments in the woodfuel sector are inadequate in the face of current demand. Woodfuel production and trade contribute to income generation and livelihoods of the many actors involved. However, from a normative point-of-view in which the poorest are specifically considered, it is clear that present-day woodfuel management has few development objectives. This needs to be reconsidered since production and trade of woodfuel involve many people for whom these activities contribute to household income and the poverty reduction potential of woodfuel has been confirmed for producer households. While all Congo Basin countries have woodfuel policies, these are mainly characterized by non-implementation and non-enforcement and are over-shadowed by corruption. Policies are fragmented in their approach and do not cover the entire value chain nor address different actors involved, a weakness that has also been noted for other Sub-Saharan African countries (Zulu and Richardson, 2013). Experiences from the West African region suggest that devolving responsibilities of woodfuel management to more local level, taking account of functioning customary systems, reinvesting taxes in social and environmental outcomes, monitoring woodfuel trade, and providing incentives for sustainably produced charcoal can provide enabling mechanisms to create more sustainable value chains. Management alternatives should take into consideration the fact that issues are often location specific and that wood energy production and trade remains primarily an informal sector. The largest group of actors, the producers, are aware of environmental impacts and are interested in sourcing from plantations or in taking part in official permit systems when this prevents illicit taxing and money would be reinvested in the sector (as has also been observed by Foundjem-Tita, 2013

for trade in forest products in Cameroon). Until now, producers have had few incentives or disincentives to comply with formal systems and customary rules define access to the resource. Producers are not assured that a permit would bring them benefits in terms of less illicit tax levying along the road. Moreover, most actors in the value chain are not aware of official rules and regulations in the myriad of tax collection and arbitrary ruling at the ground. Reaching consensus about responsibilities in the current Central African context of tensions and hybrid governance by state administration and traditional authorities remains problematic (Trefon, 2011). The vested interests of illicit taxation with officials and controlling entities at road blocks and markets are deeply embedded, which impede the commitment of these actors to support any changes in the system. Although the overall value of woodfuel trade is high, as are potential tax revenues, the wide distribution of supply zones and trade poses challenges to monitoring of sustainable production practices.

New techniques that are described to be promising for the African wood energy sector, such as optimizing fuel load, improved charcoal kilns, and cogeneration of electricity from charcoal (Bailis *et al.*, 2013; Bentson *et al.*, 2013; Butz, 2013) would benefit from a conducive business environment with appropriate regulations. These should also accommodate new management options that combine agroforestry, plantations, and management of fallows and degraded forests, as well as improve energy efficiency at the producer and consumer level to improve the sustainability of energy supply for the DRC's major cities. Local management of tree resources can be supported by various activities, such as: (1) the development of Simple Management Plans for future use of landscape units by communities; (2) the dissemination of Assisted Natural Regeneration (ANR) techniques for preservation of multi-use tree species; and (3) the reintroduction of trees for multiple uses in the agricultural system. Such activities need local appropriation and must be embedded in national decentralization processes (Dubiez *et al.*, 2012). The demand and supply of woodfuel should be central to pro-poor energy policies, with poverty-reduction opportunities sought in policy interventions that target locally specific incentives and penalties (Shackleton, 2007; Zulu and Richardson, 2013). The greatest challenge is to preserve the pro-poor qualities of the current self-organized systems while targeting more sustainable production methods. New strategies are required, promoting the positive aspects of informality in terms of short-term livelihood benefits, while supporting initiatives that enhance long-term resource sustainability.

6.6 General conclusion

Woodfuel has long been studied as a subsistence resource in (semi-) arid regions of the developing world, with the peak of attention in the 1970s and early 1980s when a woodfuel crisis was predicted and a low point in the 1990s when the crisis had not materialized to the expected extent (Arnold *et al.*, 2006). Since the early 2000s, there is renewed interest in woodfuel, mainly in regard to its potential as a renewable energy source. This potential is perceived differently in the developing and developed world. In developing countries charcoal is mostly still considered a transitional energy source that is due for replacement by modern types of energy, whereas in Europe, the renewable energy strategy for 2020 grants an important place to wood pellets as a source for heat and electricity generation (FAO, 2010b; Owen *et al.*, 2013). However, the view on woodfuel in Sub-Saharan Africa is gradually becoming more refined, as it has been acknowledged that outcomes vary from place to place and that the renewable character of woodfuel offers opportunities for climate change mitigation measures. Urban woodfuel demand on the African continent is expected to increase in the coming decades and its commercialization offers income-generation activities to poor people (IEA, 2006). Recently it has been acknowledged that these repercussions of growing urban woodfuel use deserve more attention, also in terms of localized impacts in regions that have long been ignored, such as in humid tropical areas. It is within these trends that this thesis has focused on woodfuel as a livelihood resource in the context of urban woodfuel supply in the Congo Basin, a region richly endowed with forest reserves and with great poverty among its population.

The review study on the Congo Basin and the empirical work on two woodfuel value chains in the Democratic Republic of Congo with contrasting resource and market conditions have contributed to the knowledge base on the woodfuel sector in the Congo Basin and provided insights on possible outcomes for development and environment. The study confirmed the enduring importance of woodfuel and that urbanization has resulted in growing commercialization of charcoal in the Congo Basin countries. The increase of urban demand by households and businesses means an increase of income-generating activities associated with production and trade. Although charcoal is popular for its energy density (33 MJ/kg, or twice that of wood) and is more easy to store and transport compared to fuelwood, the low energy efficiency of traditional earth charcoal kilns (around 15%) means that 7 kg of wood are needed to produce 1 kg of charcoal, which puts additional pressure on peri-urban wood resources. Woodfuel is mainly

sourced from conversion of forestlands to farmlands, which indicates that it can be a combined driver of deforestation and degradation in peri-urban areas, together with agriculture. In areas where the pressure is high enough and prices attractive, tree species are cut indiscriminately for the purpose of trade. Although charcoal is often described as a 'transition fuel' from fuelwood to 'modern' energy sources, such as LPG and electricity, the present trend shows an increase of urban charcoal consumption and replacement by alternative fuels is not expected in the coming decade. The original 1981 FAO map (Figure 1.1) that drew attention to areas in the world with a presumed deficit or acute scarcity of woodfuel had classified the Congo Basin region as an area with satisfactory resources. Although in these countries, as in many places in the world, the available net biomass is sufficient on a national scale, localized impacts do occur, resulting in consumers burdened with increasing prices and peri-urban citizens with degrading tree resources. This suggests that any global map of 'the woodfuel situation' needs a greater level of detail, possibly picturing environmental impacts as many small, red dots, also in places of humid tropical Africa. Most of these dots would be found around urban areas, and other smaller ones in protected areas or in other vulnerable landscapes. The localized outcomes of woodfuel have been further confirmed by the empirical study comparing the resource-scarce, high-demand context of Kinshasa's woodfuel supply with the value chain of the resource-abundant, less-demand context of Kisangani.

The analytical relevance of this thesis is its focus on woodfuel as a livelihood resource in a value chain approach. In the past, focus has often been on woodfuel for subsistence use or as a consumer good, largely ignoring the trade aspect. For the purpose of this study, the 'Livelihoods - Woodfuel Chain - Framework' (LWC-Framework) has been developed in a reiterative process. This analytical framework built upon premises of NTFP studies and combined the concept of sustainable livelihoods with value chain analysis. It broadened the livelihood perspective to assess outcomes of woodfuel commerce while granting a more explicit role to markets and acknowledging the multi-spatial character, the various actors involved, and the rural-urban interface of the sector. The LWC-Framework has been applied to contribute toward analytical advances in woodfuel studies, and, in particular, to explain sustainable livelihood outcomes of woodfuel value chains, the role of formal and informal institutions in shaping access to resources and markets, and changes that occur under formalization of woodfuel institutions.

The development potential of woodfuel commercialization has been confirmed by this thesis as woodfuel production and trade were found to contribute to diversification

and specialization strategies, provide cash-income, and engage many people. The value chain perspective proved helpful in putting more focus on commercial woodfuel consumption, including the role of woodfuel as a source of revenue for rural and urban citizens. Furthermore, it assisted in analyzing sustainable livelihood outcomes for different actors in the value chain. However, the environmental outcomes of overharvesting, environmental costs not being internalized in product price, forest degradation, and lack of investments or market-led governance arrangements for resource management suggest a non-sustainable use of the resource base. These findings confirmed that there remain great challenges to combine developmental and environmental objectives as woodfuel value chains in the DRC meet mostly positive developmental objectives, but this occurs at the expense of environmental objectives. These trends are being reinforced under existing institutional mechanisms (Figure 6.1a).

Study of formal and informal woodfuel institutions in the two regions has shown that despite the existence of regulatory mechanisms, woodfuel value chains are mainly embedded in informal institutions and based upon customary rules. Access to resources and to markets can be open to less privileged, rural actors, facilitated by omnipresent institutions, common in the Congo Basin region, such as working and saving in groups, working in collaboration with landowners, and payment either in cash or a share of production. However, both formal and informal institutions are unable to counter the effects of high levels of urban demand creating pressure on the forest and tree resource base. This illustrated that issues related to sustainable livelihoods cannot just be explained as a supply and demand matter, as was assumed in the fuelwood gap thesis, but outcomes depend both on the context and on the institutional mechanisms in place. This supports an approach to woodfuel studies that puts analysis of institutional dynamics before any technological or neo-Malthusian types of explanations (Mearns, 1995).

Comparing Central and West African countries showed tendencies to formalize woodfuel institutions in both regions. Based on the longer experiences in West African countries, the findings suggested that participative approaches with the actors of the woodfuel chain that build upon enabling formalization practices could assist to improve outcomes for both the resource base and livelihoods. At the same time, processes of formalization of woodfuel value chains are still associated with both positive and negative sustainable livelihood outcomes (Figure 6.1b). One of the greatest dilemmas identified in the present study was the positive outcome of informality in terms of short-term livelihood benefits and its negative impacts on resource sustainability. The normative ideal scenario where only positive environmental and developmental objectives are

attained under institutional mechanisms (Figure 6.1c) is highly unlikely to materialize. The optimism on such ‘win-win’ scenarios for NTFPs, as expressed in the 1990s, has been replaced by more diverse and realistic views (Arnold and Perez, 2001; Belcher *et al.*, 2005). However, painting the ‘ideal scenario’ indicates that developmental objectives and pro-poor approaches are rarely part of present woodfuel policies. Ideally solutions would be sought that build upon the strengths of existing informal mechanisms, so that the informal and formal mechanisms would reinforce each other. In order to further assess possible benefits and constraints of formalization as these processes develop, more (longitudinal) empirical studies are needed about the organization and governance of woodfuel production and trade as an integrated value chain process.

The ‘Livelihoods – Woodfuel Chain Framework’ (LWC-Framework) shows promise for application in studies with similar objectives, such as for analysis of socio-economic and environmental outcomes of urban woodfuel supply and how these are affected by outside interventions. It has proved useful in providing an integrated analytical framework that focuses on production and market dynamics, as well as rural and urban actors, and that contributes to understanding dynamics related to institutional mechanisms and livelihood outcomes. The study demonstrated that the separation of debates between NTFPs and woodfuel over the past four decades needs to be reconsidered, as contemporary woodfuel studies and NTFP studies target similar livelihood issues. A continuance of these types of studies and comparative works from different regions will increase understanding of the enduring role of woodfuel for rural and urban people, as a source of household energy and as a source of livelihoods for producers, transporters, traders, and salespersons. This includes attention to effective pro-poor strategies related to access to woodfuel commerce and further study on how livelihoods of actors in the value chain alter when transitions in the resource base or energy supply take place. Such transitions could involve changes to less woodfuel use, as observed in some Asian countries, or an increase in use, as expected on the African continent, and imply changes on local levels in the shifting supply areas of urban markets. Longitudinal research approaches and systematic assessments comparing actors within and outside of the value chain could contribute to better insights on poverty reduction mechanisms related to woodfuel commerce. Also, further research is needed on the underlying mechanisms explaining the variations in benefits for different actors, including the role of power relations and governance. Finally, bringing together woodfuel research on developed and developing nations could help to bridge the technological gap and contradicting

perspectives that depict woodfuel as an unwanted traditional source of energy on one side of the world and as a renewable modern type of energy on the other side.

Abbreviations and acronyms

ANR	Assisted Natural Regeneration
CAF	<i>Chantiers d'Aménagement Forestier</i> (Dedicated forest management areas)
CAR	Central African Republic
CIFOR	Center for International Forestry Research
CIRAD	<i>Centre de coopération internationale en recherche agronomique pour le développement</i> (Centre for International Agricultural Research for Development)
DGF	<i>Direction de la Gestion Forestière</i> (Directorate of Forest Management)
DGRK	<i>Direction Générale des Recettes de Kinshasa</i> (Directorate General of Revenues Kinshasa)
DHR	<i>Direction de l'Horticulture et du Reboisement</i> (Directorate of Horticulture and Reforestation)
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization of the United Nations
FC	<i>Franc Congolais</i> (Congolese Franc)
FIP	Forest Investment Program
FNP	Forest and Nature Conservation Policy Group
IEA	International Energy Agency
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
LPG	Liquefied Petroleum Gas
LWC-Framework	Livelihoods – Woodfuel Chain – Framework
MECNT	<i>Ministère de l'Environnement, Conservation de la Nature et du Tourisme</i> (Ministry of Environment, Nature Conservation and Tourism)
MINFOF	<i>Ministère de la Forêt et de la Faune</i> (Ministry of Forest and Fauna)
NTFPs	Non-timber forest products
PRONAR	<i>Programme National d'Afforestation et de Reboisement</i> (National Program of Afforestation and Reforestation)
REDD	Reducing Emissions from Deforestation and Degradation
ROC	Republic of Congo
RWE	Round Wood Equivalent
SL-Framework	Sustainable Livelihoods Framework
UNDP	United Nations Development Programme

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Summary - Woodfuel for urban markets in the Congo Basin

Woodfuel is the first source of energy for households in Sub-Saharan Africa and use of charcoal increases in urban centers. This thesis adds to a new generation of woodfuel studies that started in the early 2000s because of woodfuel commerce's possible contribution to poverty and energy issues. Whereas in the past, woodfuel studies had mainly concentrated on subsistence use and production issues, now the role of urban demand and commercialization receives more interest, including the potential of woodfuel as a source of revenues. As woodfuel studies have traditionally focused on the more vulnerable semi-arid and arid regions in the world, there is little information on the nature and development scope of woodfuel commerce in Africa's tropical humid forest regions. This thesis analyzes woodfuel as a livelihood resource in the context of urban woodfuel supply in the Congo Basin, a region richly endowed with forest reserves and with great poverty among its population. For the purpose of this study, the 'Livelihoods - Woodfuel Chain - Framework' (LWC-Framework) has been developed in a reiterative process. This analytical framework built upon premises of NTFP studies and combined the concept of sustainable livelihoods with value chain analysis in order to render the role of markets more explicit and to acknowledge the multi-spatial character, the various actors involved, and the rural-urban interface of the sector. Application of the LWC-Framework contributed to the objectives of this thesis, which are to:

- 1) Contribute to the empirical knowledge base of the woodfuel sector in the Congo Basin and to identify major socio-economic and environmental outcomes with regard to woodfuel value chains.
- 2) Contribute to the analyzation of woodfuel as a livelihood resource by explaining of:
 - a) Sustainable livelihood outcomes of woodfuel for different actors in the value chain, with emphasis on poverty reduction and sustainable use of the natural resource base.
 - b) Woodfuel institutions and how they affect access to resources and access to markets.
 - c) Formalization of the woodfuel sector and whether this contributes to livelihood outcomes.

The research followed a comparative case study approach with a multiple-case embedded design. A combination of qualitative and quantitative research methods (literature review, semi-structured interviews, observation, and sample surveys) was used to

measure, value, and compare different characteristics and outcomes of woodfuel value chains. The empirical study compared two cases of woodfuel value chains for the urban centers of Kinshasa and Kisangani with contrasting resource and market conditions. Data from the case studies were further contextualized within the wider Congo Basin region and by a comparison on woodfuel formalization with the West African region.

Chapter 2 provides a synthesis on the status of woodfuel in Congo Basin countries and analyzes the actors and dimensions of woodfuel value chains in the Democratic Republic of Congo (DRC). This overview sets the scene for the following chapters, while targeting the first research question: “What are the characteristics of the woodfuel value chains around urban centers in the DRC and what are their main outcomes for sustainable use of the natural resource base?” Findings showed that throughout the Congo Basin, an increase of woodfuel demand has led to growing commercialization, although less prevalent in Gabon and Equatorial Guinea. A shift from consumption of fuelwood to charcoal has been observed for urban centers in DRC, Republic of Congo (ROC), and Cameroon. These developments put pressure on resources around urban centers, but also create opportunities for many peri-urban and urban citizens to be involved in production and trade. The woodfuel value chains of Kinshasa and Kisangani, with contrasting resource and market conditions, share a high dependence on woodfuel, especially on charcoal, by urban citizens and numerous businesses. Total volumes, values, and income generating activities for supply of Kinshasa by far exceed those of Kisangani because of a larger population and greater distances to the resource. Production and trade of woodfuel are important income-generating activities for a large number of poor in the informal sector, with over 300,000 people involved in woodfuel supply of Kinshasa alone. Positive socio-economic outcomes of woodfuel trade are associated with trade-offs regarding environmental objectives (Arnold and Perez, 2001; Belcher and Schreckenber, 2007). Pressure on the resource is reflected in the increasing distances between supply zone and urban market, transport costs, consumer perception of scarcity, restrictions on access, and conflicts related to access. This is especially visible in the Kinshasa supply zone with large and increasing distances to supply (currently an average 102 km for fuelwood and 135 km for charcoal). In Kisangani, average distances are considerably smaller (25 km for fuelwood and 37 km for charcoal) with targeted harvesting of preferred wood species leading to degradation of the resource on a smaller scale. In both regions, woodfuel exploitation is mostly accompanied or followed by agricultural activities. This confirms new insights on woodfuel that woodfuel production is not a single or primary cause of deforestation, but that it is more likely to lead to forest

degradation (as occurs in Kisangani), or, when it leads to overexploitation (as observed for Kinshasa), this is mostly combined with shifting cultivation with impacts occurring in certain regions. In conclusion, comparing woodfuel value chains of two urban centers demonstrated the location specificity of the importance of woodfuel trade in terms of socio-economic characteristics. It indicated that, notably in the resource-scarce, high-demand context, woodfuel commercialization provides livelihood opportunities to rural and urban citizens. It also showed that environmental characteristics differ largely between the two contexts, suggesting non-sustainable use of the resource in both of the regions, but with vaster impacts in the Kinshasa supply zone.

Chapter 3 focuses on the outcomes of the woodfuel sector for the largest group of actors of the value chain: the producers engaged in urban woodfuel supply in the DRC. It centers on the second research question: “How do woodfuel production and trade contribute to livelihoods and poverty reduction of producers engaged in the urban supply in the DRC?” It is generally believed that the woodfuel sector is relatively accessible but there are few studies on its exact contributions to income and to reducing poverty. This study showed that woodfuel commercialization contributes to diversification of producers’ households. Woodfuel revenues, especially those of charcoal, contribute substantially to household income, ranging from 12% for fuelwood producers around Kisangani to 75% for charcoal producers around Kinshasa. It supports basic needs and investments in other livelihood activities (for 82% of charcoal producers and 65% of fuelwood producers). Net returns from charcoal are higher than from fuelwood, being twice the average daily income, and rates of return to labor for fuelwood are almost the same as average income. Average net benefits are higher for Kinshasa, despite higher average production quantities in Kisangani, because of higher prices for scarce woodfuel resources. These findings illustrate the usefulness of adding value to the product (carbonization and packing) and the income-generating potential of scarce resources in demand. In terms of poverty mitigation, woodfuel revenues help to meet basic needs, as producers spend part of their income on food, education, and healthcare. More important for poverty reduction, however, is that woodfuel provides capital for investments in other activities (mainly agriculture, some trade, livestock, and fishing). Even among the poorest households, most (79%) manage to reinvest part of their woodfuel revenues. A novel finding is how woodfuel, especially charcoal, can act as a household savings account. Over half of producers (56%) store charcoal strategically for future spending as well as price optimization. However, it cannot be concluded that woodfuel production automatically lifts households out of poverty, as overall income

of producers is still low, reflecting the high incidence of poverty in the DRC. Also, it seems that, in line with findings from high-value NTFP market studies (Belcher, 2005; Khundi *et al.*, 2011; Paumgarten and Shackleton, 2009; Sunderlin *et al.*, 2005), that poorest households benefit least when it comes to the higher-value product charcoal.

Access to woodfuel commercialization co-determines the livelihood outcomes of different actors involved. Chapter 4 looks into the third research question: “How do woodfuel institutions shape access to woodfuel resources and markets around urban centers in the DRC?” It particularly examines whether producers face exclusion from accessing the market and whether woodfuel institutions contribute to sustainable production. Main findings are that formal mechanisms regulating access to woodfuel resources and markets do exist, but that these are characterized by non-implementation and non-enforcement. Policies remain fragmented in their approach and do not cover the entire value chain nor address different actors involved. There is a wide gap between the intention of formal regulations regarding woodfuel and their enforcement by State officers and local practices. Informal, socially embedded institutions generally govern access to resources, and this study showed that access can be open to the less privileged and rural actors. Sufficient financial capital is a precondition for accessing tree resources, but this is feasible for most producers, not only a wealthy elite. Omnipresent institutions, common in the Congo Basin, such as working and saving in groups, working in collaboration with landowners, and payment either in cash or a share of production, facilitate access to resources for poorer producers. Most producers (80%) have direct access to markets, irrespective of their household income, and they are aware of urban market prices, which give them better bargaining power. Patterns of dependence between producers and traders, as observed by some (Ribot, 1998; Sunderlin *et al.*, 2005; Te Velde *et al.*, 2006), do not exist to such an extent in the DRC where intermediaries play a logistical role (bulking up, speeding up collection, transport and sales, and avoiding or minimizing taxes) rather than a financial role. While woodfuel institutions shape constraints and opportunities to access to resources and access to markets, in practice they do little to contribute to sustainable production. Informal institutions governing access to resources do have some restrictions for specific areas and seasons, partially protecting some of the resource base from exploitation, but these are insufficient to mitigate impacts on a larger scale. The absence of State authorities in the supply zones where woodfuel resources are located means that the reinvestments in reforestation, tree planting, sustainable harvesting practices, and fuel efficient production methods made to date are woefully inadequate in the face of current demand. Instead, the woodfuel

chain is characterized by the presence of many illicit tax collectors, with revenues not reaching the treasury and thus not reinvested to improve long-term chain sustainability. Actors are not aware of official rules and regulations in the myriad of tax collection and arbitrary ruling at the ground. There are many vested interests in the informal systems with producers and rent-seeking actors along the chain and few motivations or disincentives to change. Coexistence of customary and statutory rules leads to conflict and tension between stakeholders and little consensus on resource management options. Although at present, there are many people who benefit from the informal arrangements governing the Congolese woodfuel chains, these livelihood activities may not sustain in the unsustainable production patterns that are not being mitigated by the existing woodfuel institution.

Chapter 5 examines the fourth research question: “How is formalization of woodfuel institutions affecting livelihood outcomes of actors involved in woodfuel value chains of Central and West Africa?” Developing formal institutions is often considered as a way of managing charcoal production more sustainably. However, formalization can have adverse effects for charcoal producers and traders when this hinders their capacity to access the resource or markets. This study showed that there are tendencies in both regions to formalize institutions governing woodfuel value chains. The formal mechanisms involve different coercive forms of statutory control, mainly targeting harvest and trade of charcoal by a system of permits. West African countries, with a longer history of dealing with woodfuel issues, have more formal mechanisms in place to deal with woodfuel management and these are more embedded into cross-sectorial energy and environmental policies. Some of the enabling mechanisms identified include: devolving responsibilities of woodfuel management to a more local level; taking account of functioning customary systems; monitoring woodfuel trade; and providing incentives for sustainably produced charcoal. Tax incentives (such as promoted via woodfuel markets in Mali and Niger) and formalized titles could motivate people to make longer-term investments. Positive outcomes for villagers and the resource base resulting from formalized and decentralized woodfuel chain governance include: the reinvestment of taxes in local social and environmental projects; community woodfuel plantations; and lower taxing of controlled charcoal production. Negative unintended consequences of formal mechanisms have also occurred, such as: conflicts of interest over tax revenues; difficulties in monitoring and permitting trade; and disproportional benefits reaped by more powerful urban-based actors. Overall, these outcomes suggest that the aim of formalization of the woodfuel sector has primarily not been development, but managing

and controlling economically valuable resources. Distributional equity among actors in the chain does not appear to have been tackled. Despite regulatory mechanisms dealing with woodfuel in all countries, institutions remain mainly embedded in informal mechanisms and based upon customary rules, which allows large numbers of actors to be involved, but also leads to substantial unsustainable and unofficial production, corrupt practices, and loss of tax revenues. Comparing the West African countries with Central African countries, where attention is relatively new, suggests that participative approaches with the actors of the woodfuel chain that build upon enabling formalization practices could assist to improve outcomes for both the resource base and livelihoods.

The final Chapter 6 provides reflections on the analytical issues, the conceptual framework, and the methodology used. Subsequently, it presents the policy implications of the empirical research findings and offers a general conclusion. This study confirmed the challenges in combining developmental and environmental objectives, as observed woodfuel value chains in the DRC seem to meet mostly positive developmental objectives (contribute to diversification and specialization strategies, provide cash-income, engage many people), but this occurs at the expense of environmental objectives (overharvesting, environmental prices not internalized, forest degradation, no investments or market-led governance arrangements for resource management). Study of institutions in the two regions showed that despite existence of regulatory mechanisms, woodfuel value chains are mainly embedded in informal institutions and based upon customary rules. Financial capital is a precondition for accessing tree sources and markets, but this is feasible for most producers, not only a wealthy elite, facilitated by omnipresent institutions, such as working and saving in groups, working in collaboration with landowners, and payment either in cash or a share of production. Both formal and informal institutions are unable to counter the effect of high levels of urban demand creating pressure on the forest and tree resource base. Comparing the Central and West African region showed tendencies to formalize woodfuel institutions in both regions and based on the longer experience in West African countries it suggested that participative approaches with the actors of the woodfuel chain that build upon enabling formalization practices could assist in improving outcomes for both the resource base and livelihoods.

The development of the 'Livelihoods – Woodfuel Chain – Framework' (LWC-Framework) was found useful in broadening the livelihood perspective to assess sustainable livelihood outcomes of woodfuel commerce. The main advantages of applying the LWC-Framework have been its inclusive character to production and market dynamics, value chain actors, and institutional mechanisms shaping access and

distribution of outcomes. Use of mixed methods, convergence of multiple sources of evidence, and validation of study protocols and findings with peers and respondents contributed to the validity of research results. The reiterative nature of the research project allowed integrating solutions to some of the challenges encountered along the way. Policy options for woodfuel should consider the contribution of wood energy security to urban populations and the important income generating activities related to woodfuel value chains. The relatively new discipline of livelihoods – woodfuel value chain – studies would benefit from more longitudinal and comparative works that analyze the institutional mechanisms that shape livelihood outcomes for value chain actors. These studies could assist in understanding differences for different regions, in mitigating outcomes for chain actors, and in bridging the current contradicting perspectives on use of wood energy in different parts of the world.

Résumé - Bois énergie pour les marchés urbains dans le bassin du Congo

Le bois énergie est la première source d'énergie des ménages en Afrique subsaharienne et l'utilisation du charbon de bois est en augmentation dans les centres urbains. Cette thèse s'ajoute à une nouvelle génération d'études sur le bois énergie qui a démarré au début des années 2000, car le commerce du bois énergie pourrait éventuellement répondre aux problèmes de la pauvreté et de l'énergie. Si, par le passé, les études sur le bois énergie ont surtout porté sur la subsistance et la production, on s'intéresse maintenant davantage au rôle de la demande urbaine et de la commercialisation, y compris au fait que le bois énergie peut être source de revenus. Comme les études sur le bois énergie ont traditionnellement concerné les régions semi-arides et arides les plus vulnérables du monde, il existe peu d'informations sur la nature et l'étendue du développement du commerce du bois énergie dans les forêts tropicales humides d'Afrique. Cette thèse analyse le bois énergie comme source de revenus dans le contexte de l'approvisionnement des centres urbains en bois énergie dans le bassin du Congo, riche en forêts et dont la population vit dans une grande pauvreté. Pour les besoins de cette étude, le cadre Moyens de subsistance - chaîne bois énergie (LWC Framework en anglais) a été élaboré dans un processus itératif. Ce cadre analytique s'est appuyé sur les hypothèses d'études sur les PFNL (produits forestiers non ligneux) et a associé le concept de moyens d'existence durables à l'analyse des chaînes de valeur en vue de mieux cerner le rôle des marchés et de reconnaître le caractère multispatial et d'interface rurale-urbaine du secteur ainsi que les divers acteurs en jeu. L'application du cadre Moyens de subsistance - chaîne bois énergie a servi les objectifs de cette thèse, qui sont de:

- 1) Contribuer à la base de connaissances empiriques de la filière bois énergie dans le bassin du Congo et déceler les principaux résultats socioéconomiques et environnementaux liés aux chaînes de valeur du bois énergie.
- 2) Contribuer à l'analyse du bois énergie en tant que source de revenus en expliquant:
 - a) En quoi le bois énergie est source de revenus durable pour divers acteurs de la chaîne de valeur, en s'attachant plus particulièrement à la question de la réduction de la pauvreté et à l'utilisation durable de cette ressource naturelle;
 - b) Les institutions du bois énergie et leur incidence sur l'accès aux ressources et aux marchés;
 - c) La formalisation de la filière bois énergie et en regardant si celle-ci permet d'améliorer les moyens de subsistance.

Pour ces travaux de recherche, la méthode suivie a été celle de la comparaison d'études de cas. Un ensemble de méthodes de recherche qualitatives et quantitatives (revue de littérature, entretiens semi-structurés, observation et enquêtes par sondage) a été utilisé pour mesurer, évaluer et comparer différentes caractéristiques et effets des chaînes de valeur du bois énergie. L'étude empirique a comparé deux cas de chaînes de valeur du bois énergie pour les centres urbains de Kinshasa et de Kisangani dont les marchés et les ressources présentent des caractéristiques très différentes. Les données issues des études de cas ont été mises en perspective dans le contexte régional du bassin du Congo et comparées par rapport à l'officialisation de la filière bois énergie en Afrique de l'Ouest.

Le chapitre 2 présente une synthèse du statut du bois énergie dans les pays du bassin du Congo et analyse les acteurs et les dimensions des chaînes de valeur en République démocratique du Congo (RDC). Ce panorama annonce les chapitres suivants, tout en ciblant la première question de recherche: "Quelles sont les caractéristiques des chaînes de valeur du bois énergie autour des centres urbains en RDC et quels sont leurs principaux effets sur l'utilisation durable de cette ressource naturelle?" Il a été constaté que, dans tout le bassin du Congo, la hausse de la demande en bois énergie s'est traduite par le développement de la commercialisation, le phénomène étant cependant moins important au Gabon et en Guinée équatoriale. Dans les centres urbains de la RDC, de la République du Congo et du Cameroun, on a observé que la consommation du bois de chauffe a été délaissée au profit de celle du charbon de bois. Ces évolutions exercent une pression sur les ressources situées autour des centres urbains, mais créent aussi des opportunités pour de nombreux citoyens, urbains et périurbains, qui peuvent ainsi intervenir dans la production et le commerce. Même si elles présentent des conditions de marché et de ressources très différentes, les chaînes de valeur du bois énergie de Kinshasa et de Kisangani ont en commun une grande dépendance des citoyens urbains et d'un grand nombre d'entreprises par rapport au bois énergie, et surtout au charbon de bois. Le total des volumes, des montants et des activités rémunératrices liés à l'approvisionnement de Kinshasa dépassent de loin ceux de Kisangani parce que la population est plus importante et que la distance par rapport à la ressource est plus grande. La production et le commerce du bois énergie sont des activités économiques de poids pour un grand nombre de pauvres du secteur informel, 300 000 personnes intervenant seulement dans l'approvisionnement de Kinshasa en bois énergie. Les résultats socioéconomiques positifs du commerce du bois énergie vont de pair avec les compromis relatifs aux objectifs environnementaux (Arnold et Perez, 2001; Belcher et Schreckenberg, 2007). La pression subie par la ressource se révèle dans l'allongement de

la distance entre la zone d'approvisionnement et le marché urbain, les frais de transport, la perception de la pénurie par le consommateur, les restrictions d'accès et les conflits liés à l'accès. C'est particulièrement visible dans la zone d'approvisionnement de Kinshasa, où la distance déjà grande s'allonge (la moyenne actuelle étant de 102 km pour le bois de chauffe et de 135 km pour le charbon de bois). À Kisangani, la distance moyenne est nettement plus réduite (25 km pour le bois de chauffe et 37 km pour le charbon de bois), avec une exploitation ciblant les essences recherchées, ce qui conduit à une dégradation de la ressource sur une petite échelle. Dans ces deux régions, la plupart du temps, l'exploitation du bois énergie s'accompagne ou est suivie d'activités agricoles. Ceci confirme des indications récentes sur le bois énergie: la production de bois énergie n'est pas la cause première ou unique de la déforestation, mais est davantage susceptible d'entraîner une dégradation forestière (c'est ce qui se passe à Kisangani), ou bien, lorsqu'elle est à l'origine d'une surexploitation (comme on l'observe à Kinshasa), elle va en général de pair avec la culture itinérante dont les conséquences s'observent dans certaines régions. En conclusion, la comparaison des chaînes de valeur du bois énergie de deux centres urbains a permis de démontrer la spécificité géographique de l'importance du commerce du bois énergie en termes de caractéristiques socioéconomiques. Elle a indiqué que, notamment dans un contexte de forte demande et de pénurie de la ressource, la commercialisation du bois énergie donne la possibilité aux citoyens du monde rural et des villes de gagner de l'argent. Elle a aussi montré que les caractéristiques environnementales de ces deux contextes sont très différentes, laissant entrevoir un usage non durable de la ressource dans les deux régions, mais aux répercussions plus graves dans la zone d'approvisionnement de Kinshasa.

Le chapitre 3 traite des résultats de la filière bois énergie pour le plus grand groupe d'acteurs de la chaîne de valeur: les producteurs qui approvisionnent les villes de la RDC en bois énergie. Il répond à la deuxième question de recherche: "Comment la production et le commerce du bois énergie contribuent-ils aux moyens de subsistance et à la réduction de la pauvreté des producteurs qui approvisionnent les centres urbains de la RDC?" On pense généralement que la filière bois énergie est relativement accessible, mais peu d'études existent sur sa contribution exacte en termes de revenus et de réduction de la pauvreté. Cette étude a montré que la commercialisation du bois énergie contribue à la diversification des activités des ménages de producteurs. Les recettes provenant du bois énergie, surtout celles du charbon de bois, comptent pour une bonne part des revenus des ménages, allant de 12% pour les producteurs de bois de chauffe autour de Kisangani à 75% pour les producteurs de charbon de bois autour

de Kinshasa. Elles permettent de satisfaire les besoins fondamentaux et d'investir dans d'autres activités lucratives (pour 82 % des producteurs de charbon de bois et 65% pour les producteurs de bois de chauffe). Représentant deux fois le revenu journalier moyen, les gains nets provenant du charbon de bois sont plus élevés que ceux du bois de chauffe qui sont à peu près équivalents au revenu moyen. Les avantages nets moyens sont plus importants à Kinshasa, même si la moyenne des volumes produits est plus forte à Kisangani, parce que la pénurie de la ressource en bois énergie fait augmenter les prix. Ces résultats illustrent l'utilité qu'il y a à ajouter de la valeur au produit (carbonisation et emballage) et du potentiel de revenu pouvant être escompté des ressources à la fois rares et demandées. En termes d'atténuation de la pauvreté, les recettes issues du bois énergie permettent de satisfaire les besoins de base, car les producteurs dépensent une partie de leurs revenus en nourriture, en éducation et en soins de santé. Ce qui est plus important encore pour la réduction de la pauvreté est le fait que le bois énergie fournit des capitaux pouvant être investis dans d'autres activités (principalement l'agriculture, l'élevage du bétail, la pêche et certaines activités commerciales). Même chez les ménages les plus pauvres, la plupart (79%) réussissent à réinvestir une partie des recettes du bois énergie. La découverte inattendue est que le bois énergie, et surtout le charbon de bois, peut servir de compte d'épargne pour les ménages. Plus de la moitié des producteurs (56%) stockent le charbon de bois dans une optique stratégique en vue de dépenses futures ainsi que pour en optimiser le prix. Cependant, on ne peut pas en conclure que la production de bois énergie fait sortir les ménages de la pauvreté, car le revenu global des producteurs est toujours bas, ce qui témoigne de l'ampleur de la pauvreté en RDC. Il semble aussi que, dans le droit fil des résultats d'études de marché portant sur les PFNL se vendant un bon prix (Belcher, 2005; Khundi *et al.*, 2011; Paumgarten et Shackleton, 2009; Sunderlin *et al.*, 2005), les ménages les plus pauvres sont ceux qui tirent le moins d'avantages du charbon de bois, produit se vendant plus cher.

L'accès à la commercialisation du bois énergie détermine en partie les conditions de vie des différents acteurs concernés. Le chapitre 4 cherche à répondre à la troisième question de recherche: "Comment les institutions du bois énergie déterminent-elles les ressources et les marchés du bois énergie autour des centres urbains de la RDC?" Il examine en particulier si les producteurs risquent d'être exclus de l'accès au marché et si les institutions du bois énergie contribuent à la production durable. D'après les principales constatations, des mécanismes officiels réglementant l'accès aux ressources et aux marchés du bois énergie existent bien, mais ils se caractérisent par une absence de mise en œuvre et de sanctions. Les politiques publiques sont fragmentées

dans leur approche, ne couvrent pas la totalité de la chaîne de valeur et ne tiennent pas compte des différents acteurs concernés. L'écart est grand entre l'intention des réglementations officielles liées au bois énergie et leur application par les représentants de l'État et les pratiques locales. Des institutions informelles et intégrées au tissu social régissent généralement l'accès aux ressources, et cette étude a montré que l'accès peut être ouvert aux ruraux les moins privilégiés. Un capital financier suffisant est un préalable pour accéder aux arbres, ce qui est à la portée de la plupart des producteurs et pas uniquement réservé à une élite fortunée. Fréquentes dans le bassin du Congo, des institutions omniprésentes, telles que le travail et l'épargne de groupe, le travail en collaboration avec les propriétaires terriens, et le paiement en liquide ou bien en part de production, facilitent l'accès aux ressources pour les producteurs les plus pauvres. La plupart des producteurs (80%) accèdent directement aux marchés, quels que soient les revenus du ménage, et ils connaissent les prix pratiqués sur les marchés urbains, ce qui leur confère un plus grand pouvoir de négociation. Les schémas de dépendance entre producteurs et négociants, observés par certains (Ribot, 1998; Sunderlin *et al.*, 2005; Te Velde *et al.*, 2006), n'ont pas cette ampleur en RDC où les intermédiaires jouent un rôle logistique (regroupement, accélération du ramassage, transport et vente, en évitant ou en réduisant les taxes au minimum) plutôt qu'un rôle financier. Si les institutions du bois énergie déterminent les contraintes et les opportunités en matière d'accès aux ressources et aux marchés, elles font peu dans la pratique pour contribuer à la pérennité de la production. Les institutions informelles régissant l'accès aux ressources imposent effectivement des restrictions sur certaines zones et à certaines saisons, ce qui protège en partie les ressources de l'exploitation, mais celles-ci ne suffisent pas à atténuer les impacts à grande échelle. L'absence d'autorités publiques dans les zones d'approvisionnement en bois énergie a pour conséquence que les réinvestissements réalisés à ce jour dans le reboisement, la plantation d'arbres, les pratiques de récolte durables et les méthodes de production efficaces sont malheureusement inadéquats face à la demande actuelle. Au contraire, la chaîne bois énergie se caractérise par la présence de nombreux percepteurs de taxes illicites, dont les recettes ne parviennent pas dans les caisses de l'État et ne sont donc pas réinvesties dans l'amélioration de la pérennité à long terme de la filière. Face à cette myriade de prélèvements de taxes et de décisions arbitraires, les acteurs ignorent les prescriptions et la réglementation officielles. De nombreux intérêts sont en jeu dans cette organisation informelle avec, tout au long de la chaîne, des personnes à la recherche de rentes et des producteurs, et parallèlement à cela, les motivations ou les incitations pour changer sont rares. La coexistence du droit coutumier et de textes de loi

génère des tensions et des conflits entre les intervenants et permet rarement d'aboutir à un consensus sur les solutions de gestion des ressources. Bien qu'à présent nombreux sont ceux qui bénéficient de l'organisation informelle qui régit la filière bois énergie congolaise, la pérennité de ces activités lucratives n'est pas assurée compte tenu des schémas de production non durable qui ne sont pas atténués par l'institution existante du bois énergie.

Le chapitre 5 examine la quatrième question de recherche: "Comment l'officialisation des institutions liées au bois énergie affecte-t-elle les conditions de vie des acteurs impliqués dans les chaînes de valeur du bois énergie de l'Afrique centrale et de l'Afrique de l'Ouest?" La mise en place d'institutions officielles est souvent considérée comme le moyen permettant de gérer la production de charbon de bois plus durablement. Cependant, l'officialisation peut porter préjudice aux producteurs et aux négociants de charbon de bois lorsqu'elle les empêche d'accéder à la ressource et aux marchés. Cette étude a montré que des tendances se dessinent dans les deux régions pour officialiser les institutions régissant les chaînes de valeur du bois énergie. Les mécanismes officiels comportent différentes formes coercitives de contrôle, visant principalement la récolte et le commerce du charbon de bois par l'attribution de permis. Faisant face depuis longtemps aux problèmes du bois énergie, les pays d'Afrique de l'Ouest ont mis en place des mécanismes plus officiels quant à la gestion du bois énergie, lesquels sont inscrits dans les politiques énergétiques et environnementales intersectorielles. Certains des mécanismes favorables identifiés sont: la dévolution à un niveau plus local de la responsabilité de la gestion du bois énergie, la prise en compte des systèmes coutumiers qui s'appliquent, le suivi du commerce du bois énergie et des incitations à produire du charbon de bois durable. Des incitations fiscales (comme cela a été proposé au Mali et au Niger via les marchés du bois énergie) et des titres officiels pourraient motiver les personnes à réaliser des investissements sur le plus long terme. Une gouvernance décentralisée et officielle de la chaîne bois énergie aurait des retombées positives sur les villageois et la ressource: réinvestissement des taxes dans des projets sociaux et environnementaux locaux, plantations communautaires d'arbres et réduction de la fiscalité pour la production contrôlée de charbon de bois. Des conséquences négatives inattendues découlant des mécanismes officiels se sont aussi produites, telles que: conflits d'intérêts à propos des recettes fiscales, difficultés dans le suivi du commerce et la délivrance de permis, profits disproportionnés récoltés par des intervenants urbains plus puissants. En général, ces effets laissent à penser que le but premier de l'officialisation de la filière bois énergie n'a pas été le développement, mais la gestion et le contrôle de ressources économiquement

intéressantes. La répartition équitable entre les acteurs de la chaîne ne semble pas avoir été résolue. En dépit de mécanismes de réglementation du bois énergie dans tous les pays, les institutions s'enracinent surtout dans un cadre informel en s'appuyant sur le droit coutumier, ce qui permet à un grand nombre d'acteurs de participer, mais donne lieu aussi à une production non durable et non officielle importante, à la corruption et à un déficit de recettes fiscales. La comparaison des pays d'Afrique de l'Ouest avec ceux d'Afrique centrale, où l'attention portée à ces questions est relativement récente, indique que les approches participatives avec les acteurs de la chaîne bois énergie, qui s'appuient sur le cadre propice des pratiques d'officialisation, pourraient permettre d'obtenir de meilleurs résultats pour la ressource comme pour les moyens de subsistance.

Enfin, le chapitre 6 livre une réflexion sur les problèmes d'analyse, le cadre conceptuel et la méthodologie utilisée. Ensuite, il présente les conséquences à tirer des découvertes de la recherche empirique pour les politiques publiques et dégage une conclusion générale. Cette étude a confirmé qu'il ne sera pas aisé de satisfaire à la fois les objectifs environnementaux et ceux du développement. En effet, les chaînes de valeur du bois énergie observées en RDC semblent surtout atteindre les objectifs positifs du développement (contribuer aux stratégies de diversification et de spécialisation, fournir un résultat en trésorerie, faire intervenir de nombreuses personnes), mais ceci se réalise aux dépens des objectifs environnementaux (surexploitation, prix environnementaux non internalisés, dégradation forestière, pas d'investissements ni d'organisation de la gouvernance suscitée par le marché pour la gestion de la ressource). L'étude des institutions dans les deux régions a montré que, malgré l'existence de mécanismes de réglementation, les chaînes de valeur du bois énergie s'inscrivent surtout dans des institutions informelles et s'appuient sur le droit coutumier. Le capital financier est une condition préalable à l'accès aux arbres et aux marchés. La plupart des producteurs en disposent, et pas seulement l'élite fortunée, grâce aux institutions omniprésentes, telles que le travail et l'épargne de groupe, le travail en collaboration avec les propriétaires terriens, et le paiement en liquide ou bien en part de production. Qu'elles soient formelles ou informelles, les institutions sont incapables de battre en brèche les effets de la forte demande des villes qui exerce une pression sur les arbres et les forêts. La comparaison entre l'Afrique de l'Ouest et l'Afrique centrale a dégagé des tendances à l'officialisation des institutions du bois énergie dans ces deux régions et, en raison de l'expérience plus longue des pays d'Afrique de l'Ouest, elle indique que les approches participatives avec les acteurs de la chaîne bois énergie, qui s'appuient sur le cadre propice

de l'officialisation, pourraient permettre d'améliorer les résultats pour la ressource comme pour les conditions de vie.

La mise en place du cadre Moyens de subsistance - chaîne bois énergie s'est révélée utile en explorant les perspectives de subsistance pour évaluer l'incidence du commerce du bois énergie sur des conditions de vie durables. Les principaux avantages de l'application du cadre Moyens de subsistance - chaîne bois énergie ont été son caractère inclusif en matière de production et de dynamique de marché, d'acteurs de la chaîne de valeur et de mécanismes institutionnels déterminant l'accès et la répartition des résultats. Le recours à des méthodes mixtes, la convergence de diverses sources de données scientifiques, la validation des protocoles d'étude et des découvertes avec les pairs et les personnes interrogées ont contribué à la validité des résultats de la recherche. La nature itérative du projet de recherche a permis de trouver des solutions à certains des problèmes rencontrés en chemin. Les politiques publiques concernant le bois énergie devraient tenir compte de la contribution de la filière à la sécurité énergétique des populations urbaines et de l'importance des activités lucratives en lien avec les chaînes de valeur du bois énergie. La discipline relativement récente des études portant sur les conditions de vie et la chaîne de valeur du bois énergie bénéficierait de travaux comparatifs et plus longitudinaux qui analyseraient les mécanismes institutionnels déterminant les résultats en termes de moyens de subsistance pour les acteurs de la chaîne de valeur. Ces études pourraient permettre de comprendre les différences existant entre diverses régions, d'atténuer les conséquences pour les acteurs des chaînes et de relier les points de vue contradictoires actuels sur l'utilisation du bois énergie dans différentes parties du monde.

Samenvatting – Houtenergie voor stedelijke markten in het Kongobekken

Hout is de belangrijkste energiebron van huishoudens in sub-Sahara Afrika en het gebruik van houtskool in stedelijke gebieden groeit. Deze dissertatie maakt deel uit van een nieuwe generatie van houtenergie-studies sinds de begin jaren 2000. De hernieuwde interesse komt voort uit de erkenning, dat handel in houtenergie mogelijk bijdraagt aan het oplossen van armoede en energieproblemen. Waar in het verleden houtenergie- studies zich nog voornamelijk concentreerden op het kappen voor eigen huishoudelijk gebruik en productievraagstukken, is er nu meer aandacht voor de rol van stedelijke vraag en commercie. Dit omvat het potentieel van houtenergie als bron van inkomsten. Omdat houtenergie-studies zich traditioneel meer gericht hebben op de kwetsbare droge en semi-aride gebieden in de wereld, is er weinig informatie over het karakter en het ontwikkelingsperspectief van de handel in Afrika's tropische humide bos regio's. Deze dissertatie analyseert houtenergie als een bron van levensonderhoud in de context van stedelijke brandhoutbevoorrading in het Kongobekken. Deze regio is rijkelijk bedeed met bossen en kent tegelijkertijd grote armoede onder haar bevolking. Het 'Livelihoods - Woodfuel Chain- Framework' (LWC-Framework) (Levensonderhoud - Houtenergie Keten - Raamwerk) is op iteratieve wijze ontwikkelt voor het doel van deze studie. Dit analytisch raamwerk borduurt voort op uitgangspunten van studies over niet-hout bosproducten (*non-timber forest products (NTFPs)*) en combineert het concept van duurzame middelen van bestaan (*sustainable livelihoods*) met waardeketen (*value chain*) analyse. Het geeft een expliciete rol aan markten en erkent het multi-ruimtelijke karakter, de verschillende actoren die er bij betrokken zijn en de ruraal-urbane interactie van hout energie handel. Toepassing van het LWC-raamwerk heeft bijgedragen aan de doelen van deze studie. Deze doelen zijn:

- 1) Bijdragen aan de empirische kennisbasis over de houtenergie sector in het Kongobekken en het identificeren van belangrijke sociaaleconomische en milieu uitkomsten van houtenergie ketens.
- 2) Bijdragen aan het analyseren van houtenergie als een bron van levensonderhoud door het verklaren van:
 - a) Duurzame gevolgen van houtenergie op het levensonderhoud van verschillende actoren in de waardeketen, met nadruk op armoede vermindering en duurzaam gebruik van hout als natuurlijke grondstof.

- b) Houtenergie instituties en hoe deze de toegang tot de bron van deze natuurlijke grondstof en de toegang tot markten beïnvloeden.
- c) Institutionaliseren van de houtenergie sector en of dit bijdraagt aan duurzaam levensonderhoud van de betrokkenen.

Het onderzoek volgde een vergelijkende *case study* benadering met een *multiple-case embedded design*. Een combinatie van kwalitatieve en kwantitatieve onderzoeksmethoden (literatuurstudie, semigestructureerde interviews, observatie, en *sample survey*) werd gebruikt voor het meten, taxeren en vergelijken van verschillende kenmerken en uitkomsten van houtenergie waardeketens. De empirische studie vergeleek twee houtenergie ketens, met tegengestelde omstandigheden qua natuurlijke omgeving en markten, voor de stedelijke centra van Kinshasa en Kisangani. Gegevens uit de *case studies* werden vervolgens in context geplaatst van het bredere Kongobekken en op thema institutionalisering vergeleken met de West-Afrikaanse regio.

Hoofdstuk 2 geeft een overzicht van de houtenergie situatie binnen de landen van het Kongobekken en analyseert de betrokken partijen en de dimensies van houtenergie ketens in de Democratische Republiek Congo (DRC). Dit overzicht vormt het uitgangspunt voor de hierop volgende hoofdstukken. De eerste onderzoeksvraag is “Wat zijn de kenmerken van de houtenergie waardeketens rond stedelijke centra in de DRC en wat zijn de belangrijkste uitkomsten voor het duurzaam gebruik van de natuurlijke grondstof?” Resultaten laten zien dat een stijging van de vraag naar houtenergie in het gehele Kongobekken heeft geleid tot toenemende commercialisering, weliswaar in mindere mate in Gabon en Equatoriaal-Guinea. In de stedelijke centra van de Democratische Republiek Congo, de Republiek Congo en Kameroen heeft een verschuiving plaatsgevonden van gebruik van brandhout naar gebruik van houtskool. Deze ontwikkelingen zetten druk op bron van de natuurlijke grondstof rond stedelijke centra, maar creëren tegelijkertijd tal van mogelijkheden voor peri-urbane en stedelijke burgers om betrokken te zijn bij de productie en handel. De steden Kinshasa en Kisangani, met contrasterende peri-urbane ecosystemen en markten, zijn beiden sterk afhankelijk van gebruik van houtenergie door burgers en tal van bedrijven. De volumes, waarde en werkgelegenheid van de sector is in Kinshasa vele malen groter dan in Kisangani door de grotere bevolking en langere afstanden tot het bos. Productie en handel van houtenergie zijn belangrijke inkomsten-genererende activiteiten voor een groot aantal armen in de informele sector. Voor de toeleverantie van alleen al Kinshasa zijn naar schatting meer dan 300 000 mensen betrokken. Positieve sociaaleconomische

uitkomsten van houtenergie handel worden geassocieerd met negatieve gevolgen met betrekking tot milieudoelstellingen (Arnold en Perez, 2001; Belcher en Schreckenber, 2007). De druk op de bron uit zich in de toenemende afstanden tussen leveringsgebied en stedelijke markt, de stijgende transportkosten, de perceptie van schaarste bij de consument en beperkingen tot toegang bij de producent. Dit is vooral zichtbaar rondom Kinshasa met grote afstanden tot productie gebieden (gemiddeld 102 km voor brandhout en 135 km voor houtskool). In Kisangani zijn de gemiddelde afstanden aanzienlijk kleiner (25 km voor brandhout en 37 km voor houtskool) en worden vaak specifieke houtsoorten geselecteerd, wat leidt tot degradatie en aantasting van de bron op kleinere schaal. In beide regio's wordt de kap van hout meestal vergezeld of gevolgd door agrarische activiteiten. Dit bevestigt nieuwe inzichten dat productie van houtenergie geen alleenstaande of primaire oorzaak van ontbossing is, maar wel kan leiden tot degradatie van bossen (zoals gebeurt in Kisangani), of, wanneer er sprake is van overexploitatie (zoals waargenomen voor Kinshasa) dit vaak in combinatie is met zwerflandbouw. De vergelijking van de houtenergie ketens heeft laten zien dat er grote sociaaleconomische belangen mee gemoeid zijn en dat de precieze uitkomsten locatie-specifiek zijn. Met name in de context met grotere schaarste en hogere vraag, biedt de hout energie handelsmogelijkheden voor levensonderhoud van rurale en stedelijke burgers. De milieu uitkomsten tonen een algeheel niet-duurzaam beeld van de houthandel en zijn in beide regio's zeer verschillend en met grotere gevolgen rondom Kinshasa.

Hoofdstuk 3 richt zich op de effecten van de houtenergie- sector voor de grootste groep van belanghebbenden: de producenten van brandhout of houtskool. Het hoofdstuk centreert zich rondom de tweede onderzoeksvraag: "Hoe draagt de productie van hout energie voor stedelijke markten bij aan het levensonderhoud en armoedebestrijding van de producenten in de DRC?" Het wordt over het algemeen aangenomen dat de houtenergie- sector relatief toegankelijk is, maar er zijn weinig studies beschikbaar over de precieze bijdragen aan de inkomsten en aan de vermindering van de armoede. Deze studie toonde aan dat commercialisering van houtenergie bijdraagt aan de diversificatie van inkomstenbronnen. De inkomsten, vooral die van houtskool, dragen substantieel bij aan het gezinsinkomen, variërend van 12% voor brandhout producenten rondom Kisangani tot 75% voor houtskool producenten leverend aan Kinshasa. Dit ondersteunt basisbehoeften en investeringen in andere activiteiten (voor 82% van houtskool producenten en 65% van brandhout producenten). Netto inkomsten van houtskool representeren tweemaal een gemiddeld dag-inkomen en zijn hoger dan de inkomsten

van brandhout die ongeveer een gemiddeld dag-inkomen bedragen. De winst is hoger voor Kinshasa, ondanks dat producenten in de Kisangani regio gemiddeld grotere hoeveelheden produceren, vanwege de hogere prijzen voor schaarsere hout bronnen. Deze bevindingen tonen het nut aan van het toevoegen van waarde aan het product (carbonisatie en verpakking) en de inkomsten genererende mogelijkheden van schaarse middelen bij hoge vraag. In termen van armoede- verlichting helpen de gegeneerde inkomsten bij het voldoen van basis levensbehoeften en worden deels besteed aan voedsel, onderwijs en gezondheidszorg. Belangrijker nog in het licht van armoedebestrijding is dat houtenergie voorziet in kapitaal voor investeringen in andere activiteiten (voornamelijk landbouw, en deels in handel, veeteelt en visserij). Zelfs onder de armste gezinnen slagen de meesten (79%) erin om een deel van hun inkomsten uit houtenergie te investeren. Een nieuwe bevinding is dat houtenergie, met name houtskool, kan fungeren als een spaarrekening voor huishoudens. Meer dan de helft van de producenten (56%) kiest ervoor om houtskool strategisch op te slaan voor toekomstige uitgaven en/of in afwachting van een hogere marktprijs. Ondanks deze positieve bijdragen kan echter niet worden geconcludeerd dat de houtenergie productie huishoudens ook daadwerkelijk uit de armoede tilt, want de totale inkomsten van de producenten blijven nog steeds erbarmelijk laag. Bovendien lijkt het erop, in overeenstemming met de bevindingen van NTFP marktstudies (Belcher, 2005; Khundi *et al.*, 2011; Paumgarten en Shackleton, 2009; Sunderlin *et al.*, 2005), dat juist van het winstgevende houtskool de armste huishoudens het minste kunnen profiteren.

Toegang tot commercialisering van houtenergie is mede bepalend voor de sociaaleconomische uitkomsten voor de verschillende betrokken partijen. Hoofdstuk 4 gaat in op de derde onderzoeksvraag: “Hoe bepalend zijn houtenergie instituties voor de toegang tot de natuurlijke grondstoffen en tot de markten rondom stedelijke centra in de DRC?” Er wordt met name onderzocht of producenten uitgesloten worden van de toegang tot markten en of de houtenergie instituties duurzame productie bevorderen. De belangrijkste bevindingen zijn dat er wel degelijk formele regelgeving over de toegang tot de houtenergie bron en tot de markten bestaat, maar dat de uitvoering hiervan grotendeels uitblijft. Bestaand beleid heeft een gefragmenteerde benadering en beslaat niet de gehele waardeketen noch de verschillende betrokken actoren. Er is een brede kloof tussen de intentie van de formele regelgeving en de handhaving daarvan door overheidsbeambten in de lokale praktijk. Het zijn meestal informele, sociaal ingebedde instituties die de toegang bepalen. Deze studie toonde aan dat deze toegang wel degelijk kan worden verleend aan de minder bevoorrechte actoren op het platteland. Het hebben

van voldoende financiële middelen is weliswaar een voorwaarde voor de toegang tot hout, maar dit blijkt haalbaar voor de meeste producenten, niet uitsluitend voor een rijke elite. Instituties die sterk verankerd zijn in het Congobekken, zoals het werken en sparen in groepsverband, afspraken met landeigenaren en betaling in deel van de productie, vergemakkelijken toegang voor armere producenten. De meeste producenten (80%) hebben directe toegang tot markten, ongeacht hun inkomen, en ze zijn zich bewust van de marktprijzen wat ze een stevige onderhandelingspositie biedt. Grote afhankelijkheidsrelaties tussen producenten en handelaren, zoals omschreven in een aantal casussen (Ribot, 1998; Sunderlin *et al.*, 2005; Te Velde *et al.*, 2006), bestaan niet in die mate in de DRC waar tussenhandelaren een meer logistieke in plaats van financiële rol hebben. Terwijl houtenergie-instituties beperkingen en mogelijkheden voor toegang tot de bron en de markten mede bepalen, betekenen zij in de praktijk weinig voor een bijdrage aan duurzamere productie. Informele instituties vormen weliswaar restricties voor toegang tot houtkap voor specifieke gebieden en seizoenen wat overexploitatie kan behoeden, maar deze inbreng is te beperkt voor een impact op grotere schaal. De afwezigheid van autoriteiten in productie gebieden, betekent dat investeringen in herbebossing en duurzame productiemethoden tot dusver ontoereikend zijn in het licht van de huidige vraag. In plaats daarvan kenmerkt de houtenergie-keten zich door corruptie tijdens transport en handel, waarbij geïnde (belasting) gelden de overheidsschatkist niet bereiken en niet dienen ter verbetering van de sector. Actoren in de keten zijn vaak niet op de hoogte van officiële rechten en plichten door de wirwar van legale en illegale belastinginningen en arbitraire toepassing van regels. De gevestigde belangen in de huidige informele systemen zijn diep verankerd en het merendeel van de actoren ervaart geen enkele prikkel om hier verandering in te brengen. Het naast elkaar bestaan van de traditionele regels en officiële wetgeving leidt tot spanningen tussen de verschillende autoriteiten en gebrek aan overeenstemming over duurzaam beheer. Hoewel er momenteel een groot aantal mensen dagelijks profiteert van de informele systemen van de houtenergie ketens, zijn de huidige instituties niet in staat om de niet-duurzame productie patronen te doorbreken.

Hoofdstuk 5 gaat in op de vierde onderzoeksvraag: “Hoe beïnvloedt de formalisering van houtenergie instituties de gevolgen voor levensonderhoud van actoren in de ketens van Centraal- en West Afrika?” De ontwikkeling van formele instituties wordt vaak beschouwd als een eerste stap tot duurzamere productie van houtskool. Echter, formalisering kan nadelige gevolgen hebben voor producenten en handelaren als nieuwe regels hun toegang tot hout of tot markten inperken. Deze studie toonde aan dat in beide

regio's tendensen bestaan om de instituties voor houtenergie te formaliseren. Formele mechanismen krijgen vaak de vorm van wettelijke controle systemen, vaak gericht op het aan banden leggen van productie en handel door een systeem van vergunningen. West-Afrikaanse landen, met een langere geschiedenis van het omgaan met houtenergie kwesties, hebben meer formele mechanismen voor beheer en deze zijn beter ingebed in cross-sectoraal energie- en milieubeleid. Een aantal van mogelijke mechanismen zijn: decentralisatie van houtenergie management, controle en restricties van handel en het bieden van stimulansen voor duurzaam geproduceerde houtskool. Fiscale prikkels (zoals gepromoot via de houtmarkten in Mali en Niger) en formele landtitels motiveren mensen om lange termijn investeringen te doen. Positieve resultaten voor de rurale bevolking en de bossen die voortvloeien uit geformaliseerd en gedecentraliseerd bestuur zijn: de herinvestering van opbrengsten in lokale sociale en ecologische projecten, plantages voor gemeenschapsdoeleinden, en lagere belasting op gecontroleerde houtskool productie. Negatieve, soms onbedoelde, gevolgen van formele systemen zijn eveneens geconstateerd, zoals: conflicten over belastinginkomsten; moeilijkheden en belangenverstremming bij het toezicht op de handel en disproportionele voordelen voor de vaak machtigere stedelijke actoren. De resultaten tonen een beeld van formalisering met als belangrijkste doelen natuurbeheer en controle van economisch waardevolle goederen, met geen, of veel minder, oog voor mogelijke ontwikkelingsdoelstellingen. Zaken als de verdeling van mogelijke inkomsten en voordelen uit de handel zijn nauwelijks onderwerp van beleid. Ondanks het bestaan van regulerende mechanismen over houtenergie in alle betrokken landen, blijven de instituties voornamelijk ingebed in informele mechanismen en op basis van traditionele regels. Dit maakt het mogelijk dat velen een graantje kunnen meepikken van deze handel, maar zorgt er ook voor dat het grootste deel van de productie niet duurzaam is, niet in de statistieken opduikt en dat corruptie en verlies van inkomsten voor de staat kunnen voortbestaan. De vergelijking van de ervaringen van West-Afrikaanse landen met die van Centraal-Afrikaanse landen waar deze kwesties pas recentelijk aandacht hebben gekregen, suggereert, dat management praktijken, met een participatieve benadering door actoren van de keten, kunnen bijdragen aan meer duurzame oplossingen.

Het afsluitende hoofdstuk 6 geeft een reflectie op de analytische vraagstukken, het conceptuele kader en de methodologie. Vervolgens worden de beleidsimplicaties van de empirische onderzoeksresultaten gepresenteerd en volgt een algemene conclusie. Dit onderzoek bevestigt de moeilijkheden van het combineren van ontwikkeling- en milieudoelstellingen. De bestudeerde houtenergie waardeketens in de DRC draagt bij aan

ontwikkelingsdoelstellingen (diversificatie en specialisatie strategieën, cash-inkomsten, groot aantal mensen betrokken), maar dit gebeurt ten koste van milieudoelstellingen (overexploitatie, milieukosten niet geïnternaliseerd, bosdegradatie, geen investeringen of beter beheer gestimuleerd door de markt of overheid). Studie naar de bestaande instituties in de twee regio's toonde aan dat ondanks het bestaan van regulerende mechanismen, in de praktijk de houtenergie ketens met name gestuurd worden door informele instituties en traditionele regels. Financieel kapitaal is weliswaar een voorwaarde voor de toegang tot de houtbron en markten, maar dit is haalbaar voor de meeste producenten en niet alleen voor een rijke elite, gefaciliteerd door alomtegenwoordige informele systemen, zoals het werken en sparen in groepsverband, samenwerking met landeigenaren, en betaling in deel van de productie. Zowel formele als informele instituties zijn niet in staat om de druk op natuurlijke grondstoffen onder de grote stedelijke vraag te verlichten. Het vergelijken van de Centraal- en West Afrikaanse landen toonde een trend tot formalisering van houtenergie instituties in beide regio's. Op basis van de langere ervaringen in West-Afrikaanse landen wordt voorgesteld, dat houtenergie management een participatieve aanpak behelst met oog voor ontwikkelingsuitkomsten voor actoren in de keten.

De ontwikkeling en toepassing van het '*Livelihoods - Woodfuel Chain- Framework*' (LWC-Framework) (Levensonderhoud – Houtenergie Keten - Raamwerk) bleek nuttig te zijn om levensonderhoud in een breder perspectief te bekijken door resultaten op het gebied van duurzaam bestaan in de houtenergie productie mee te wegen. De belangrijkste voordelen van het toepassen van het raamwerk waren het inclusieve karakter wat betreft productie en dynamiek van de markt, alle betrokkenen in de keten en institutionele mechanismen voor toegang en verdeling van de mogelijke uitkomsten. Het gebruik van een combinatie van methoden, convergentie van bronnen en validatie van onderzoeksprotocollen en bevindingen bij collega's en respondenten hebben bijgedragen aan de validiteit van de onderzoeksresultaten. Het iteratieve karakter van het onderzoeksproject heeft het mogelijk gemaakt om ontwerp en methodiek tijdens het traject verder aan te passen aan de ondervonden uitdagingen. Beleidsopties voor houtenergie moeten de bijdrage aan de energiezekerheid van de stedelijke bevolking en de inkomstengenererende activiteiten in de keten in ogenschouw nemen. De relatief nieuwe discipline van *livelihood* - hout energie waardeketen - studies zou kunnen profiteren van meer longitudinaal en comparatief werk over de institutionele mechanismen die mede de uitkomsten voor betrokkenen bepalen. Deze studies kunnen helpen bij het beter begrijpen van de verschillen in de verschillende regio's en de uiteenlopende resultaten

voor alle spelers in het veld, en in het overbruggen van de huidige tegengestelde perspectieven op het gebruik van houtenergie in verschillende delen van de wereld.

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process closely and I could never have done this without his trust and support. My son Moritz was born during the final year of the thesis and I thank him for the hours of sleep that he did allow us to get and for his presence, which made focusing on this thesis and other important things in life so much easier.

Jolien Schure
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About the author

Jolien Schure was born June 21, 1979, in Ede, the Netherlands. She graduated from kindergarten four years later, in Butha Buthe, Lesotho, which did not only mark a first educational achievement, but also planted the seed for her life-long fascination with Africa.

In 2002, she obtained a Master's degree at the Centre for International Development Issues Nijmegen (CIDIN). Her Master's thesis, under the supervision of Professor Leo de Haan, was based on extensive field research with the Bagyeli pygmies in Southwest Cameroon, aimed at uncovering impacts of the Chad-Cameroon oil pipeline during construction activities. After completing her Master's, Jolien was selected for the one-year program Advanced Master in International Development (AMID), during which she worked for the Netherlands institute for Southern Africa (NiZA) and deepened her skills and knowledge related to working for international organizations and global development issues. Her research for the Advanced Master's degree dealt with capacity enhancement of NGOs in Southern Africa on the topic of Corporate Social Responsibility in the extractive industries.

After successfully finalizing this dual Master's program in 2003, Jolien continued working for NiZA. During the 4.5 years that she worked as program officer, she co-founded a regional capacity building project and coordinated research and policy influencing on the subject of natural resources in Africa. In 2006, she had the honor to be part of an election monitoring team in the Democratic Republic of Congo to observe its first democratic elections in four decades. In early 2007, the thirst for more in-depth knowledge on natural resources and (lack of) development led her to take on a research position for the Bonn International Center for Conversion (BICC), in Germany. Research assignments on the link between natural resources, governance, and armed conflict brought her to Sierra-Leone, Liberia, and Ivory Coast. In 2008, Jolien took part in a joint UN Expert Panel - Kimberly Process mission to monitor the diamond embargo in Ivory Coast.

In early 2009, Jolien moved to Cameroon to take on an associate expert position for the Center for International Forestry Research (CIFOR) in Yaoundé. She participated in studies on forest-product value chains and coordinated research work for the Makala project about woodfuel around urban centers in the Democratic Republic of Congo. Based on these woodfuel studies she started a PhD fellowship with the Forest and Nature conservation Policy group (FNP) of the University of Wageningen under supervision of

Professor Bas Arts, Associate Professor Freerk Wiersum and Dr. Patrice Levang. After the three-year stay in the Congo Basin region, she returned to the Netherlands in January 2012 where she obtained a part-time position at FNP, which allowed her to finalize the PhD work. She also started her own research company (schure-research.com) that provides research and advice to various international organizations.

Her current research interests are: livelihoods, value chains, woodfuel and renewable energy sector, forest products, mining sector, natural resources management and development issues in Sub-Saharan Africa. Jolien lives with her husband (Frank) and son (Moritz) in Amsterdam.

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Name of the learning activity	Department/Institute	Year	ECTS* 1=28 hrs
A) Project related competences			
French language training	Pr. Nguembe, Yaoundé	2009-2010	3
Statistics, data analysis and SPSS	Pr. Ndoumbe, CIFOR	2010	1.5
B) General research related competences			
“From tree to tea to CO2 in the Democratic Republic of Congo: a framework for analyzing the market chain of fuelwood around Kinshasa and Kisangani”.	XIII World Forestry Congress	2009	2
Academic writing course	CIFOR	2009	1
Writing of research proposal	CIFOR/WUR	2009-2010	6
A practical course on the methodology of fieldwork	CERES	2010	2.5
Qualitative data analysis for development research	CERES, ISS	2010	1.5
Quantitative methodology and economics	CERES	2010	1.5
“The fuelwood market chain of Kinshasa: socio-economic and sustainability outcomes of the number one household energy in the Democratic Republic of Congo”	XXIII IUFRO World Congress	2010	2
“Firing socio-economic questions in the forest: what are the impacts of fuelwood in the Democratic Republic of Congo?”			
FNP research seminars	WUR, FNP	2011	1
Writing and presenting scientific paper	WGS	2011	1.2
“Woodfuel and wellbeing in the Congo Basin”	Poverty Environment Network’s science workshop	2011	2
Voice and presentation	WASS	2012	0.5
“Formalisation of charcoal value chains and livelihood outcomes in Central- and West Africa”	13th Congress of the International Society of Ethnobiology	2012	2
“Bois énergie en RDC: Analyse de la filière des villes de Kinshasa et Kisangani”	Makala Project	2013	2
C) Career related competences/personal development			
CERES annual meeting	CERES	2010	1
Career perspectives	WASS	2012	1.6
Supervision 2 Msc-theses	CIFOR/ University of Yaoundé 1	2010-2011	2
Supervision of field practicum 1 course	FNP	2012	2
Total			36.3

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