

Woodfuel policies and practices in selected countries in Sub-Saharan Africa – a critical review

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Photo 1.
Traditional earth kiln by the roadside in Kitui East, Kenya.
Photo P. Sola.

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RÉSUMÉ

Politiques et pratiques en matière de bois-énergie dans certains pays d'Afrique subsaharienne – un examen critique

L'Afrique subsaharienne reste très dépendante des biocombustibles, qui couvrent 60 % de sa demande énergétique totale. Bien que le bois-énergie soit une source d'énergie importante pour des millions de personnes en Afrique subsaharienne, il est rarement suffisamment reconnu dans les politiques énergétiques. Depuis des décennies, les politiques gouvernementales ont supposé que la croissance économique et l'augmentation des revenus des ménages qui en résulterait entraîneraient un passage à des carburants plus « modernes ». Cependant, avec des niveaux de pauvreté toujours élevés et le manque d'accès à des sources d'énergie alternatives abordables, cette transition est loin de devenir une réalité. Cet article conceptualise la gouvernance du bois-énergie et analyse les politiques et les mécanismes institutionnels pertinents pour le sous-secteur du bois-énergie dans certains pays : Cameroun, République démocratique du Congo, Kenya et Zambie. Sur la base d'un examen structuré de la littérature, il évalue les politiques et les mécanismes juridiques existants et leur mise en œuvre, dans le contexte des pratiques actuelles le long des chaînes de valeur du bois-énergie dans ces mêmes pays. La principale conclusion est que, bien que le bois-énergie soit de plus en plus reconnu comme une source d'énergie majeure dans la plupart des pays, il est souvent associé à des résultats environnementaux négatifs et à des résultats socio-économiques positifs. Récemment, les gouvernements de plusieurs pays ont élaboré des politiques et des cadres législatifs pour guider, gérer, soutenir et réglementer la production et le commerce du bois-énergie. En dépit des dispositions légales, l'industrie du bois de feu fonctionne en grande partie dans le secteur informel et n'est pas réglementée et/ou réprimée dans certains endroits. La gouvernance des chaînes de valeur du bois-énergie est confrontée à des défis majeurs liés au manque de clarté des arrangements institutionnels et des mécanismes d'application, aux capacités limitées et aux comportements corrompus, ainsi qu'à l'insuffisance des investissements et du financement. Par conséquent, une gouvernance plus intégrée et mieux adaptée est nécessaire pour que les chaînes de valeur durables du bois-énergie deviennent une réalité.

Mots-clés : énergie du bois, charbon de bois, mise en application, bois-énergie, gouvernance, politiques, Cameroun, République démocratique du Congo, Kenya, Zambie, Afrique.

ABSTRACT

Woodfuel policies and practices in selected countries in Sub-Saharan Africa – a critical review

Sub-Saharan Africa (SSA) is still very dependent on biomass fuels, which cover 60% of its total energy demand. Although woodfuel is an important energy source for millions of people in SSA, it is rarely given sufficient recognition in energy policies. For decades, government policies have assumed that economic growth and the result increases in household incomes would be better than produce a switch to more “modern” fuels. However, with persistently high levels of poverty and lack of access to affordable alternative energy sources, this transition is far from becoming a reality. This article conceptualizes woodfuel governance and analyses policies and institutional mechanisms relevant to the woodfuel subsector in selected countries: Cameroon, Democratic Republic of Congo, Kenya and Zambia. Based on a structured review of the literature, it assesses existing policies and legal mechanisms and their implementation, in the context of current practices along woodfuel value chains in these same countries. The main finding is that although recognition of woodfuel as a major energy source has increased in most countries, it is often associated with negative environmental outcomes and positive socio-economic outcomes. Of late, governments in several countries have developed policies and legislative frameworks to guide, manage, support and regulate woodfuel production and trade. Despite the legal provisions, the woodfuel industry operates largely in the informal sector and is unregulated and/or suppressed in some places. Governance of woodfuel value chains is faced with the major challenges of unclear institutional arrangements and enforcement mechanisms, limited capacities and corrupt behaviour, as well as inadequate investment and financing. Therefore, more integrated and responsive governance is required for sustainable woodfuel value chains to become a reality.

Keywords: wood energy, charcoal, enforcement, woodfuel, governance, policies, Cameroon, Democratic Republic of Congo, Kenya, Zambia, Africa.

RESUMEN

Políticas y prácticas del uso de la leña como combustible en países seleccionados del África subsahariana – una revisión crítica

El África subsahariana (SSA) todavía es muy dependiente de los combustibles de biomasa, que abastecen el 60 % de su demanda total de energía. A pesar de que la leña es una fuente de energía importante para millones de personas en SSA, raramente se le concede suficiente reconocimiento en las políticas energéticas. Durante décadas, las políticas de los gobiernos han asumido que el crecimiento económico y los incrementos resultantes en ingresos de los hogares producirían un cambio a combustibles más « modernos ». Sin embargo, con niveles constantemente elevados de pobreza y una falta del acceso a fuentes energéticas alternativas asequibles, esta transición está lejos de convertirse en una realidad. Este artículo conceptualiza la gobernanza de la leña y analiza las políticas y los mecanismos institucionales relevantes para el subsector de la leña en los países seleccionados: Camerún, República Democrática del Congo, Kenia y Zambia. A partir de una revisión estructurada de la literatura, evalúa las políticas existentes, los mecanismos legales y su implementación, en el contexto de las prácticas actuales a lo largo de las cadenas de valor de la leña en estos mismos países. La conclusión esencial es que, a pesar de que el reconocimiento de la leña como fuente energética principal ha aumentado en la mayoría de países, a menudo está asociado con resultados medioambientales negativos y resultados socioeconómicos positivos. Recientemente los gobiernos de varios países han desarrollado políticas y marcos legislativos para guiar, gestionar, apoyar y regular la producción y el comercio de leña. A pesar de las provisiones legales, la industria de la leña opera ampliamente en el sector informal y no está regulada o se ha suprimido en algunos lugares. La gobernanza de las cadenas de valor de la leña se enfrenta con los mayores retos de disposiciones institucionales y mecanismos de refuerzo poco claros, capacidades limitadas y corrupción, así como inversiones y financiación inadecuadas. En consecuencia, se requiere una gobernanza más integrada y responsiva para que las cadenas de valor sostenibles para la leña se conviertan en una realidad.

Palabras clave: energía de madera, carbón vegetal, aplicación, leña, gobernanza, políticas, Camerún, República Democrática del Congo, Kenia, Zambia, África.

Introduction

Attention to woodfuel production and consumption in governance has fluctuated over the past decades. In the 1970s, concerns about woodfuel shortage, known as “the other energy crisis”, were triggered by the oil crisis that dominated the energy agenda during that period (Eckholm, 1975). 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 (World Bank, 2001). Large-scale woodfuel plantations and efficient-stove projects were implemented to assure woodfuel supplies and woodfuel became a policy priority. A decade later, in the mid-1980s, the woodfuel crisis did not appear to materialize on a large scale, as increasing urbanization and rising incomes slowed demand in many regions (Maurer *et al.*, 2005). However, the “woodfuel gap” proposition was criticized for its generic approach and lack of reliable data on woodfuel consumption and tree stocks (Leach and Mearns, 1988). It was found that woodfuel was also sourced from other areas rather 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 (Bhattarai, 2001; Trossero, 2002). In cases where local households faced scarcity, they often cope by reducing consumption and using alternative cooking fuels such as plant waste and cow dung. Charcoal became more popular in urban markets because of its higher energy content and less smoke when cooking compared to fuelwood (Arnold *et al.*, 2003). By the late 1980s, attention to the “woodfuel crisis” and related governance had waned considerably (Arnold *et al.*, 2006).

The 2000s saw renewed interest in the woodfuel sector, as the renewable potential of woodfuel became recognized and climate change politics took an interest in its contribution to greenhouse emissions and mitigation options (FAO, 2017). It was recognized that energy models need to fit local contexts and realities of developing countries, where the subsector is more complex than initially thought. Various studies demonstrated that there were various negative environmental outcomes and socio-economic benefits to producers and traders resulting from woodfuel value chains (Sola *et al.*, 2017). Woodfuel consumption in Sub-Saharan Africa is expected to increase in the coming decades along with growing urban demand for charcoal (IEA, 2017). However, there are no adequate enabling conditions for managing and sustaining production and urban demand.

For decades, governments’ energy policies had assumed that economic growth and the resultant increases in household incomes would lead to woodfuel users switching to more modern fuels. However, with the persistent poverty levels, this transition is far from happening. There is evidence that instead of such a transition, energy mix in the urban areas is more popular where all wealth classes tend to use various energy sources including

woodfuel in some proportion. This is exacerbated by unreliable supply and high costs of alternative energy sources, such as electricity or Liquefied Petroleum Gas (LPG), forcing more and more people in the cities to use charcoal (Malimbwi and Zahabu, 2008; Sander *et al.*, 2014). In fact, in Kenya between the year 1989 and 2001, more people switched back to traditional fuels as unemployment and retrenchments increased, reducing the capacities of many households to afford modern fuels (EAA *et al.*, 2001). Even though woodfuel remains the most affordable energy source in form of charcoal for the urban poor and in form of fuelwood in the rural areas, governance systems for managing woodfuel value chains more sustainably remain less responsive and supportive (World Bank, 2011; Ghilardi *et al.*, 2013).

Although woodfuel value chains support millions of people and are a major source of energy for many they remain informal, illegal and suppressed, not accounted for in the national accounts, and their contribution to the national economy not officially recognised. Most of these problems are said to stem from poor governance. Thus, this paper presents a conceptual framework to disentangle different elements of woodfuel governance, analysing policies, legal frameworks and institutional arrangements for controlling, guiding and supporting woodfuel value chains and how they relate present practices. This assessment contributes to determining gaps in and obstacles for effective governance in the woodfuel value chains and options for improved management in selected Sub-Saharan African countries. The study’s results will inform development and engagement interventions within the CIFOR-led four-year program on “sustainable woodfuel value chains”, which is part of the EU-funded program “Governing multifunctional landscapes in Sub-Saharan Africa”.

Methods

The study is based on a literature review that was guided by a conceptual framework with three interdependent components for the governance of more sustainable woodfuel value chains (figure 1). The first component is the existence of an effective governance system with i) up to date and known policies and legislative frameworks, ii) institutional arrangements for enforcement and support to the woodfuel value chains and iii) strategies and plans for setting short term and medium-term priorities for implementation of the policies and legal instruments. The second component is the dynamic context which determines the drivers and magnitude of outcomes of both the value chains and the governance system. The last component is the woodfuel value chain comprising of all the actors from wood production to consumption and the associated processes.

Based on this framework the online literature search was conducted from various sources, including government websites, key woodfuel support organisations

(research and development) and bibliographic databases (Scopus, Google Scholar, Taylor and Francis and Web of Science). Both original research articles and review articles were included in this study. Table I below is a summary of the focus of the search. The information was categorised, analysed and subsequently synthesized according to three sections: i) characteristics of woodfuel value chains summarizing the operations in the selected countries, ii) the policy and legal frameworks in the selected countries and lastly, iii) the status of implementation of the governance system and expected outcomes on the woodfuel value chain and the context under which it is operating.

Results: Woodfuel policies and realities along the value chains

Characteristics of domestic woodfuel value chains

Sub-Saharan Africa (SSA) remains dependent on biomass fuels that provide over 60% of total energy demand (IEA, 2017). With only 30% of the population having access to electricity, biomass fuels play rather a critical role in household energy, mostly in the form of fuelwood and charcoal (Nziramanga, 2011). The countries of this study, Cameroon, the Democratic Republic of Congo, Kenya and Zambia, have large differences in available resources, population size, average GDP, urban populations and access to electricity (table II). Nonetheless, these countries all depend to a large extent on woodfuel as household energy source with 83%, 70%, 90% of households using it as their primary energy source in Cameroon, Kenya and the Democratic Republic of Congo (DRC), respectively (Madi, 2012; Kendagor and Prevost, 2013; Schure, 2014; Government of Kenya,

2015; Eba'a Atyi *et al.*, 2016). In Zambia, 82% of the urban households rely on woodfuel especially charcoal which is sometimes used in combination with electricity (Tembo *et al.*, 2015).

There is growing demand for charcoal in urban areas, driven by rapid population growth and high urbanization rates. In some countries, as much as 95% of the urban energy demand is met by charcoal (SEI, 2002). In Kenya, 82% of urban households and 34% of rural households depend on charcoal as a primary energy source, whilst the reverse is true for fuelwood with 89% and 7% in rural and urban households respectively (Mugo and Gathui, 2010). Likewise, charcoal trade to supply DRC's capital Kinshasa keeps increasing, supplying 75% of urban households in the capital city of DRC in 2010 (Schure, 2014). Unlike Kenya and DRC, Cameroon has large in-country woodfuel dependence variations, from around 30% in the capital Yaoundé, to 95% in Maroua and close to 100% in rural areas (Madi, 2012; Eba'a Atyi *et al.*, 2016). In Douala and Yaoundé (Cameroon biggest cities located not far from forest regions), the consumption of fuelwood and charcoal is about 0.37 kg/person/day and 0.12 kg/person/day, respectively, which is about half and three times that of small towns in the same regions (Eba'a Atyi *et al.*, 2016). However, in the northern region more fuelwood is consumed, estimated at 837,500 tons against 27,000 tons for charcoal per year (Eba'a Atyi *et al.*, 2016). Indeed, woodfuel trade is expanding across the continent due to population growth, high unemployment; lack of alternative and affordable, energy sources (Sustainable Energy for All *et al.*, 2013). In addition, there has been an increase in the number of industries and enterprises that depend on woodfuel for their operations (Chidumayo, 2013).

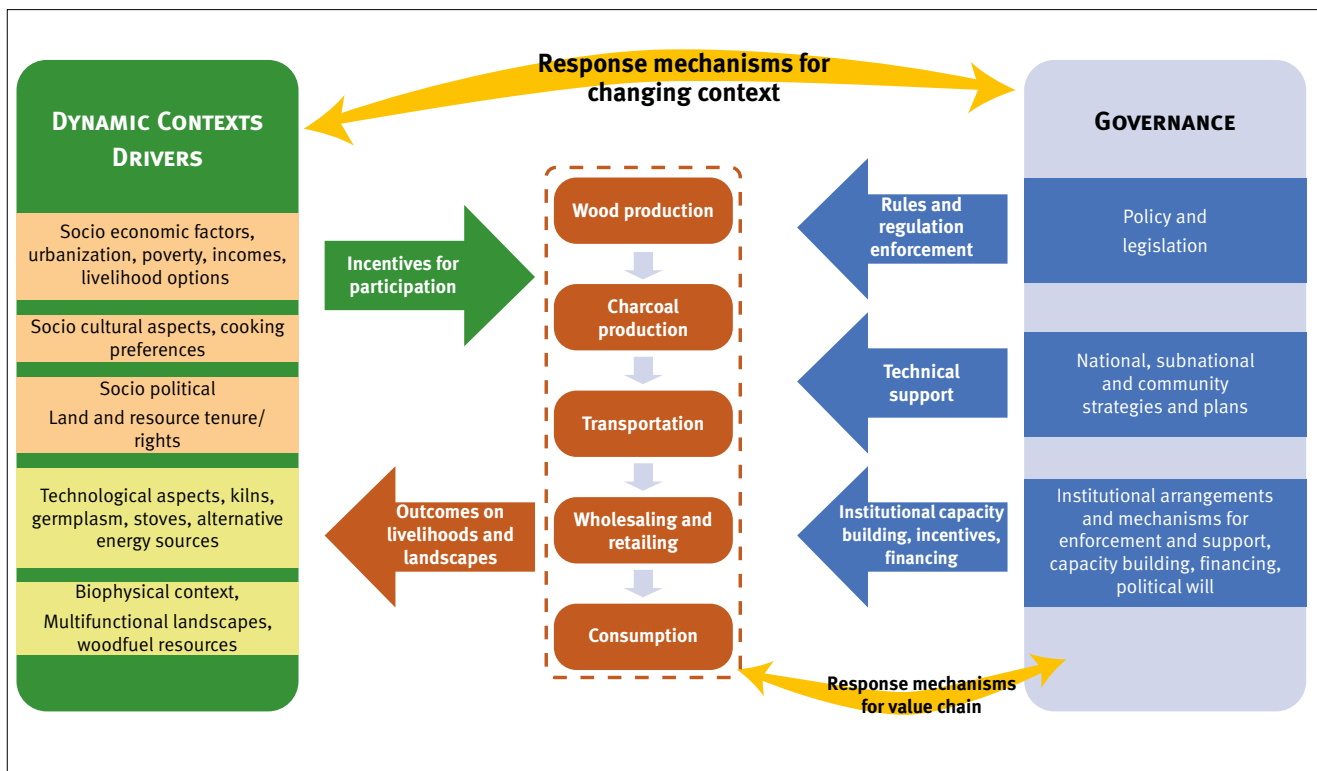


Figure 1. Conceptual framework Governance of more sustainable woodfuel value chains (Inspired by FAO, 2017).

Table I.

Scope of literature search based on the conceptual framework in figure 1.

Pillar		Key characteristics
Governance	Woodfuel Policy and legislation	Policy and legal provisions for woodfuel production, trade and utilization (woodfuel recognition) Rules, regulations and rights in woodfuel production, trade and consumption Regulatory agencies, coordination, planning and licensing Incentives, investments and financing (production and consumption technologies) Private sector engagement and research (production and consumption technologies)
	Woodfuel management strategy	Priority interventions for woodfuel production, trade and utilization: institutional coordination and planning, technological, regulatory, financing, research
	Institutional arrangements for implementing the legal framework	Mandate, roles, responsibilities, rights, capacity and legitimacy National and subnational government agencies, community organizations, leadership and representatives
Dynamic context	Environmental, economic, cultural and social drivers for woodfuel production, trade and consumption	Energy accessibility and affordability Livelihood options, poverty Supply and demand (availability of markets and resource base)
Woodfuel value chain	Levels of woodfuel production, trade and consumption	Supply and demand (availability of markets and resource base) Dependent populations national urban rural Population and woodfuel value chain actors Production areas, size of trade (volumes and revenue)

Table II.

Main characteristics of woodfuel use and forestland conversion in Cameroon, Democratic Republic of Congo, Kenya and Zambia.

	Cameroon	DR Congo	Kenya	Zambia
Population (thousands) ^a	23,439	78,736	48,462	16,591
Population density (people per km ² of land area) ^a	50	35	85	22
Urban population (% of total) ^a	55	43	26	41
GDP per capita (current USD) ^a	1,374.5	449.4	1,455.4	1,269.6
Forest area (% of land area) ^a	39.8	67.3	7.8	65.4
Net forest conversion (1000 Ha/year) ^b	-221.2	-311.7	0	-167
Woodfuel production (thousands m ³) ^b	10,426	83,538	26,400	9,901
Biofuels as residential energy (% of total residential energy) ^c	94	98	94	94
Woodfuel as primary cooking fuel ^{d,e,f,g}	83	90	85	>85
Access to electricity (% of population) ^a	60.1	17.1	56.0	27.2

Sources: ^aWorld Bank, 2018; ^bFAO, 2018; ^cIEA, 2018; ^dINS, 2008; ^eSchure, 2014; ^fGovernment of Kenya, 2015; ^gGumbo *et al.*, 2013.

Woodfuel is supplied through value chains (networks) that comprise systems of persons, organisations for producing, transforming (cutting, drying, carbonization, packaging) and transportation to local and regional markets (households, agro-industries and enterprises) (figure 2; table III). Unfortunately, across all the countries most of the charcoal is produced in low-efficient earth kilns with recovery rates that vary often between 10-20%. These low conversion rates imply more wood is used unnecessarily, increasing the rate of cutting (Schure *et al.*, 2019). To compound the problem further, most urban households use inefficient stoves for cooking which increases the demand further (IEA, 2017).

Increasingly woodfuel, especially charcoal is being associated with forest degradation and, albeit to a lesser extent with deforestation (Chidumayo and Gumbo, 2013; Mulenga *et al.*, 2015; Sola, 2017). Initially, outcomes of these unsustainable practices were observed in the peri-urban areas. However, overtime as these sources are exhausted, supply basins are noted to be further afield, and charcoal gets transported over hundreds of kilometres to main urban centres. For instance, most of the charcoal in Kenya comes from farmlands (55%) and drylands (89%) which are located some long distances away from the main cities like Nairobi, Mombasa and Nakuru (Kamweti *et al.*, 2009; Government of Kenya, 2012; Njenga and Shrenk, 2015). Cameroon shows the large variation of possible environmental outcomes, where the country's biggest urban centres Douala and Yaoundé which lie in the humid forest zone, are partly being supplied with woodfuel that is a by-product of agriculture or industrial wood processing, whilst the Far North Region in the dry-forest area faces a woodfuel deficit due to overexploitation for woodfuel production (Charpin and Richter, 2012).

Notwithstanding the negative environmental impacts,

woodfuel provides important contributions to livelihoods of those involved in production and trade. It contributes substantially to incomes of the rural poor and offers full-time employment for the landless (Njenga *et al.*, 2013; Sola *et al.*, 2017). Over 300,000 people are involved in woodfuel supply to Kinhasa alone (Schure, 2014) and it provides an estimated 90,000 full-time jobs in Cameroon (Eba'a Atyi *et al.*, 2016), whilst in Kenya almost 900,000 people were involved the charcoal industry in 2013 (Kenya Forest Service, 2013a) (table IV). In Zambia close to 500,000 people are employed along the charcoal value chain (Gumbo *et al.*, 2013; Mwitwa and Makano, 2012). Data on incomes and benefits is very scanty however, the industry was valued at USD1,6 million in Kenya in 2013 and Euros 36 million in Cameroon in 2016 (Kenya Forest Service, 2013b; Eba'a Atyi *et al.*, 2016).

Policies, legal frameworks and planning for sustainable woodfuel

After decades of relative neglect, in the 2000s many governments in SSA began to devise regulations and strategies for wood fuel including, licensing extraction and trade, promoting tree planting, use of improved technologies for charcoal production (carbonisation) and cooking. However, despite these efforts not many countries have dedicated policies and legislative frameworks regarding woodfuel production and trade, instead, they are spread across various sectors like environment, forestry, agriculture and energy.

Generally, most woodfuel-related legislation targets regulation of the harvesting, extraction and or charcoal production and transportation and less the retail and consumption end (table V). This fragmented approach is evidenced by that bans and moratoriums have been repeatedly proclaimed in various SSA countries that most often outlaw

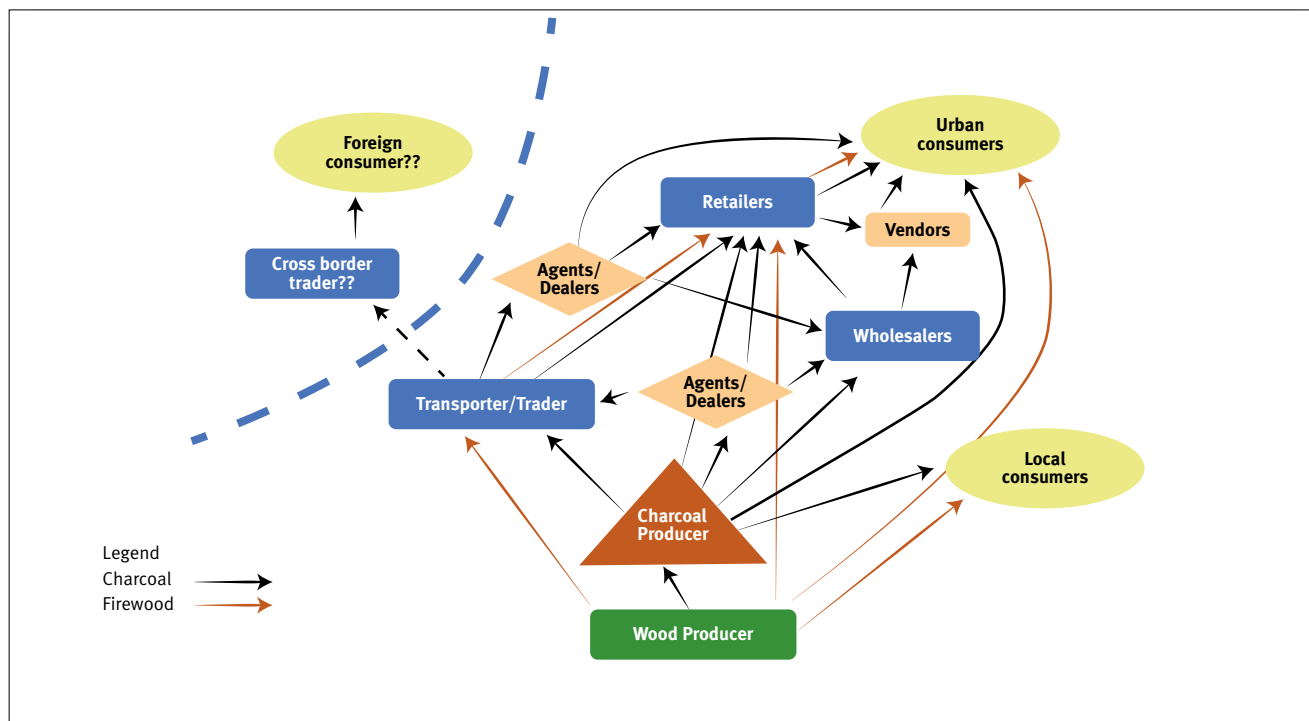


Figure 2. Woodfuel value chain networks; Adapted from: Sola and Gumbo, 2014.

Table III.
 Key actors along the woodfuel value chains.

Section	Operator	Function	Kenya	Cameroon	Democratic Republic of Congo	Zambia
Wood production	Private land and tree owners	Manage and sell trees from their land	√			√
	Wood collectors/producers Wood-cutters/fuelwood collectors	Villagers, who source for wood either legally or illegally in their village Sometimes organised by urban traders		√	√	√
Carbonization	Charcoal producers	Villagers who carbonize the wood from the clearing of agriculture land Professional charcoal makers who access trees by renting land or buying trees and wood	√	√	√	√
	Employees	Loaders and off loaders of charcoal kilns Packers and loaders of charcoal into vehicles	√	√	√	√
Transportation	Transporters	Truck owners/ hired drivers who transport of charcoal Move charcoal/fuelwood from production site to urban markets using various non-motorized and motorized modes of transport	√	√	√	√
Vending (Wholesaling and Retailing)	Traders, middlemen, brokers	Buy charcoal from producers and sell to wholesalers, retailers and vendors Buy charcoal from producers or transporters to sell to retailers, vendors Truck owners who organise for transportation of charcoal	√	√	√	√
	Wholesaler	Operate in markets and keep stocks/ depots of woodfuel Buy charcoal from producers or transporter, traders, to sell to retailers, vendors Linked to transporters or sponsor the making and transportation of charcoal Hire brokers				
	Retailers	Purchase and sells charcoal at market or small shops Buy charcoal from traders and wholesalers Resell the charcoal in smaller bags or buckets to consumers	√	√	√	√
Consumption	Households, institutions, industries, enterprises	Purchase and use the charcoal for cooking, heating, water boiling, ironing, economic operations	√	√	√	√

References : Kenya: Kenya Forest Service, 2013ab; Cameroon: Eba'a Atyi *et al.*, 2016; Democratic Republic of Congo : Schure *et al.*, 2013; Schure, 2014; Zambia: Chidumayo 2013; Chidumayo and Gumbo 2013; Gumbo *et al.*, 2013.

Table IV.
Proportion (%) of actors along the woodfuel value chain.

	Tree growers/ Wood producers	Collectors/ Producers	Transporters	Traders/ Wholesalers	Retailors	Total	Year of data
Cameroon	5	35	2	6	52	900,000	2018
Kenya		28	1	71		893,900	2013
Zambia		48	1	52		500,000	2012
Democratic Republic of Congo (Kinshasa and Kisangani)		89	1	10		335,600	2011

production but leave retailing and consumption legal, which often results in illegality across the whole value chain.

DRC, Kenya and Zambia are examples of countries that have enacted rules for licencing wood extraction, woodfuel movement, wholesaling and retailing. Still, an overall vision targets replacement of woodfuel as a primary energy source by other forms of renewable energy like hydroelectricity, wind, solar and even geothermal have a lot of investment whilst less funding is made available for technological innovations related to woodfuel.

Cameroon presents an interesting case where problems related to woodfuel are more pronounced in the northern regions than southern parts of the country that are more endowed with forest resources and has part of its woodfuel as a by-product from shifting cultivation and timber logging. Following this prioritisation, a woodfuel strategy has been developed for the Far-North region specifically. Current woodfuel policy and legislation is focussing more on dry areas where woodfuel production remains a challenge and harvesting may lead to forest degradation in areas of high demand.

Cameroon woodfuel policy and legal frameworks

Cameroon as a country has enough biomass to sustain its woodfuel supply. However, large differences between regions and increasing urban demand cause overexploitation and related environmental issues. Cameroon has no specific nationwide policy for the woodfuel subsector. The key legal instrument regarding the woodfuel subsector is the forestry law of 1994. Law N° 94/01 of 20 January 1994 regarding forestry, wildlife and fisheries regulations, with the provision to classify fuelwood and charcoal as “special forest products” with related restrictions. The 1995 Decree on forest regime implementation modalities regulate commercial production of woodfuel under two types of permits. These permits determine the location and quantities authorized: i) the permit for exploitation of special products (including charcoal); and ii) the permit for exploitation of fuelwood. The contribution of the woodfuel subsector to government revenues results from two main taxes (General Tax Code, Section 246): i) the regeneration tax (USD 0.02 per kg) applied to special products including charcoal and ii) tax on cubic meter of traded wood (USD 0.11 per cubic

Table V.
Regulations along the woodfuel value chain.

Section	Stakeholder	Kenya	Cameroon	Democratic Republic of Congo	Zambia
Wood production	Government institutions e.g. Forest and local authorities Provision of technical support Licensing (tree cutting permit Informal taxes (bribes)	✓	✓	✓	✓
Carbonization	Government institutions e.g. Forest and local authorities Production licences	✓	✓	✓	✓
Transportation	Government institutions e.g. police, forest and local authorities Licensing (movement permit, illegal taxes, process/transportation costs per bag Informal taxes (bribes)	✓	✓	✓	✓
Vending (Wholesaling and Retailing)	Government institutions e.g. local authorities Licensing (premise permit, Informal taxes (bribes)	✓	✓	✓	✓

References : Kenya: Kenya Forest Service, 2013ab; Cameroon: Eba'a Atyi *et al.*, 2016; Nlom, 2018; Bitondo *et al.*, 2018; Democratic Republic of Congo: Schure *et al.*, 2013; Schure, 2014; Zambia: GRZ 2007; Gumbo *et al.*, 2013.

meter)¹, which falls under the general taxes of the sub-sector. Additional government revenues come from the issuance of authorizations (licences) to collect dead wood in the northern regions of Cameroon as well as wood transporters in general.

Issues around sustainability have mainly been studied for the northern part of the country with a Sahelian climate, where population growth, woodfuel harvesting and bush fires put pressure on the remaining woodlands. Overexploitation of woodfuel has led to an expanding circle of deforestation around the cities of Maroua and Garoua leading to erosion and decrease of agriculture productivity (Folefack and Abou, 2009). In response, the government has designed a specific strategy for modernizing woodfuel value chains in the Far North Region of Cameroon (MIN-FOF-MINEPDED, 2017) with support of the German technical Cooperation (GIZ). The strategy includes four programs on: i) Management and restoration of the forest resource; ii) Securing and valorisation of wildlife resources in the protected areas; iii) valorisation of wood and non-wood products; and iv) steering, institutional management and governance in the woodfuel subsector.

Cameroon's National Energy Policy of 2008 recognizes the role of biomass and renewable energy but leaves woodfuel largely outside the scope of this national strategy (Ministère de l'Énergie et de l'Eau, 2008). In the absence of a national wood energy strategy, concerns remain about sustainability of trade flows, including, for example, the wood collection from valuable mangrove forests for charcoal supply of Douala and woodfuel exports to Chad and Nigeria from the northern regions of Cameroon.

Democratic Republic of Congo woodfuel policy and legal frameworks

DRC has no overall woodfuel strategy, but various legal clauses regarding woodfuel exist in the country's legislation on land, forestry, agriculture, and environment. The Law N° 035 of 5 October 2006 concerning forest exploitation stipulates that woodcutting for carbonization falls within the scope of forest exploitation regulation. Article 6 stipulates that valid permits for the cutting of fuelwood and carbonization are required and are issued to persons with Congolese nationality living in a local community. De facto and de jure, Congolese living in urban areas could not be beneficiaries of this permit system because it does not grant the holder the right to harvest wood for charcoal production in community forests. Only the regional legislative administrator can issue the permit after approval by the local forest administration. Law No. 05 of 17 June 2009 complements the 5 October 2006 by defining the set of legal documents for forest exploitation, including the license to cut fuelwood and the license for carbonization. It specifies that these cutting permits contain the following aspects: identity of the operator; delimitations of the cutting zone; taxes and quantities authorized, reference to the collecting title, and the period of validity (Schure *et al.*, 2013).

The 2016 order on community forestry (N° 025/CAB/MIN/ECN-DD/CJ/00/RBM/2016 of 09 February 2016) specifies conditions for cutting of woodfuel for commercialisation:

¹ Taxes are respectively 10 XAF and 65 XAF, converted into present value in USD using converter rate of October 26th, 2018 on www.oanda.com.

i) prior identification of zone dedicated to this activity and inclusion in the simple management plan, ii) the possession of a fuelwood cutting permit and charcoal permit by the producer involved, iii) the contract closed between the producer and the represented local community and its management entity. It is forbidden to cut classified species, but wood residues and dead wood of these species may be used. The volumes of wood or charcoal obtained based on the fuelwood cutting and charcoal permits are to be declared at the end of each trimester to the local authorities (MECNDD, 2016).

Recent policy discussions on climate change mitigation (REDD and NDC) and renewable energy grant importance to woodfuel, which offers opportunities for more coherent policies regarding woodfuel value chains. The 2013 national strategy framework for REDD described an inclusive approach to improving the woodfuel subsector that includes development of a national strategy on woodfuel and alternatives and promotion of sustainable production, more energy efficient processing and improved cook stoves (MECNT, 2013). The national REDD+ strategy framework of 2015 includes objectives regarding increased energy production to replace forest biomass, reduction and improved sustainability of woodfuel from natural forests, improved sustainable production of woodfuel outside of natural forest and more efficient use of wood energy (RDC *et al.*, 2015). The DRC's national determined contribution (NDC) state that promotion of improved stoves and carbonisation and woodfuel plantations are expected to contribute 0,35 Mt of the 70 Mt reduction of CO₂ (RDC, 2015). The country's 2013 strategy on Sustainable Energy for All towards the 2030 horizon, comprises improving woodfuel value chains by better carbonisation technology, promotion of improved cooking stoves and alternative energy sources to reduce woodfuel use by 50% (Sustainable Energy for All *et al.*, 2013).

Kenya woodfuel policy and legal frameworks

The main policy and legislative framework in Kenya for guiding and regulating the development, management and utilisation of forest, woodlands and trees for woodfuel is spread across several sectors which include Agriculture, Energy, Environment, Forestry at both national and subnational levels. Most of policies and legal instruments have evolved over the years with woodfuel only getting fully recognised as a major energy source in the 1990s. The energy policies for a long time focused on development and promotion of electricity in both urban and rural areas. Likewise, the forest sector downplayed the role of woodfuel.

One of the main legislations of the 1990s is the Environmental Management and Coordination Act N° 8 of 1999 which provided regulatory framework for local level management of environmental resources (including woodfuel) and integration of environmental concerns in national policies, plans, programmes and projects. It gave the District Environment Committees (DECs) mandate to control harvesting of trees for timber, charcoal and fuelwood (Government of Kenya, 1999). The Chapter 385 Forests Act 1942 (revised in 1982 and 1992) equally stated that people are required to have licenses or permits to access and use products from state, local authority or provisional forests (Nachmany *et al.*, 2014).

The subsequent Forest Act of 2005 provided for the establishment of a semi-autonomous agency, the Kenya Forest Service (KFS) charged with the management, conservation and regulation of all types of forests (Government of Kenya, 2005). This act was later repealed by the Forest Conservation and Management Act of 2016 which took into cognizance the provisions of the Constitution of 2010 especially issues of devolution (Government of Kenya, 2016).

In 2009 the Kenya Forest Service published Forest (Charcoal) rules which extended their mandate to granting licenses/permits to Charcoal Producer Associations (CPAs) and Charcoal transporters, for them to legally produce and trade in charcoal. Firstly, the commercial charcoal producers should belong to a registered Charcoal Producer Association (CPA) with registration certificates before they can acquire charcoal production licenses issued by the Kenya Forest Service (KFS). Those producing for own use are exempt from this regulation (Government of Kenya, 2005; 2016). Secondly, to be issued with this license the applicant is required to obtain a harvesting permit issued by the Forest officer upon submission of a letter from his/her Area Chief confirming land ownership (Government of Kenya, 2005; Mbuthi, 2009). Thirdly, to move charcoal from production areas to the markets, transporters must apply for movement permits from KFS. This is acquired upon submission of a “certificate of origin” and receipts of the purchased charcoal, endorsed by the owner of the land where it was produced. Lastly, wholesalers and retailers of charcoal are also expected to keep records of the sources of their charcoal, including certificates of origin and movement permits (Government of Kenya, 2005; Mbuthi, 2009; Government of Kenya, 2016). Likewise, exportation and/or importation of charcoal or charcoal products require possession of a permits issued under the Forest (charcoal) regulations 2009 (Government of Kenya, 2016).

In addition to the forest policy and legislative framework, the Energy Policy of 2004 has two of its major objectives being i) to ensure sufficient energy supplies to meet demand on a sustained basis while minimizing the environmental impacts associated with biomass energy and ii) ensuring there is an enabling framework for the efficient and sustainable production, distribution and marketing of charcoal (Mugo and Gathui, 2010; MoE, 2012). It also aims to promote and invest in development and use of renewable energy technologies, which include charcoal and fuelwood as well as promoting use of fast-growing trees for woodfuel production (Mugo and Gathui, 2010; MoE, 2012; Nachmany *et al.*, 2014).

In the Draft Energy Policy 2012 additional objectives were included covering issues of i) commercialization and uptake of renewable energy technologies such as modern production and cooking technologies for woodfuel, and ii) sustainable production and use of woodfuel resources (MoE, 2012). However, the draft National Energy and Petroleum Policy of 2014 brings in a new thrust of putting in place strategies and mechanisms to eliminate wood fuel, charcoal and kerosene as a household energy sources by 2022 (Ministry of Energy and Petroleum, 2014). The Constitution of 2010 also encouraged all land owners to establish and

maintain 10% tree and forest cover (Government of Kenya, 2010). Thus, post 2010 all policies and legal instruments had to be revised to be in line with the constitution to incorporate this and other issues such as public participation, community and gender rights, equity in benefit sharing and devolution (MEWNR, 2014).

Several attempts were made to craft a new Forest policy since 2005 that is supportive of woodfuel development including regulation of production and marketing of charcoal as well as sustainable production and utilization of woodfuel without success (Mbuthi, 2009). It was not until 2014 that a policy was enacted; the National Forest Policy 2014 which has an additional unique objective of establishing chain-of-custody and certification system for trade in wood and wood products (MEWNR, 2014).

In addition to the policies and legal instruments, several national development related plans and strategies were developed incorporating issues of woodfuel production, development, utilization and regulation. Generally, the strategies included issues of institutional capacity building, environmental management, forest and or woodland management, tree planting, agroforestry/ farm forestry, development and promotion of alternative renewable energy sources and improved technologies for production and consumption of woodfuel (Kuboka, 2001; Mbuthi, 2009; Ministry of Energy and Petroleum, 2014). In the 2000s, the strategies/ plans for woodfuel development were very much influenced by the national focus on industrialization and improving quality of life as well as environmental management (Government of Kenya, 1996; Mbuthi, 2009). This became reinforced by the Vision 2030's Second Medium Term Plan 2013-2017 that targets for Kenya to become a middle income country by 2030, most of woodfuel strategies were influenced by the need for economic growth and accelerated industrialization thus seeking to invest in renewable energies like solar, wind, geothermal as much as investing in improving efficiency of woodfuel use and subsequently eliminating it as the major household energy source (Ministry of Devolution and Planning, 2013).

Zambia woodfuel policy and legal frameworks

Policy and legislation for environment and natural resources management in Zambia is spread over more than many legislations and strategies which can be characterized as fragmented, with dispersed responsibility across at least ten line-ministries. There has been a recognition at higher levels that charcoal production must be tackled and as such Zambia's Vision 2030, targets increased access to electricity from the current levels of 3% to 51% in the rural areas by 2030 (GRZ, 2006). Furthermore, a host of other policies and strategies also call for reduction in woodfuel use, including: Second National Biodiversity Strategy and Action Plan of 2015; National Policy on Environment of 2007; National Policy on Climate Change of, 2017; National Climate Change Response Strategy of 2012; and National Agriculture Policy of 2016. Charcoal production is officially regulated by the Forestry Department through the Zambia National Forest Policy (GRZ, 2014) and Forests Act (GRZ, 2015), but enforcement has remained weak (GRZ, 2014; GRZ, 2015). In the law

it one is not allowed to produce and transport charcoal for sale without license (Chidumayo, 2013).

The current charcoal production licensing system consists of a stumpage levy per cubic metres of stacked cord wood. The stumpage levy is mandatory, regardless of the tenure of land on which the charcoal is produced. The current system requires that the producer pays the stumpage fee at the Forestry Department office in charge of the area in which the charcoal is produced. However, an initiative is underway to formulate new guidelines and regulations for charcoal production and trade through wider stakeholder consultations. The core tenets to this strategy is the need to have charcoal producers organised and accountable as a group to both the community supplying the feedstock for charcoal production and the government. Some progress has been made in this regard by FAO's Forest Farm Facility that has pioneered the establishment for charcoal producers' associations albeit still in the formative stages (Ziba and Grouwels, 2017). Community and/or group involvement in such ventures is provided for under Section 29 of the Forests Act of 2015 on community forest management and lately, an enabling statutory instrument, the Forests and Community Forest Management Regulations provides room for communities to be involved in charcoal production as an enterprise (GRZ, 2018).

Status of policy implementation and enforcement of the legal framework

In spite of the achievements in formulating policies and enacting the requisite legislations for guiding, managing and supporting the woodfuel production to consumption systems in several countries, implementation and enforcement remain a great challenge, specifically poor enforcement and compliance, weak institutional arrangements and support mechanisms as well as inadequate investment and financing in the subsector.

Poor enforcement and compliance

Despite legal provisions in most of the countries, the charcoal industry operates largely in the informal sector, with the whole supply chain from production to trade largely unregulated (Ndegwa, 2011; Kenya Forest Service, 2013a). For instance, in spite of the adoption of charcoal rules aimed at formalizing the industry in Kenya, as much as 90% of charcoal is "illegally" and or "informally" produced (Kenya Forest Service, 2013b; Delahunty-Pike, 2012). Moreover, corruption is greatly entrenched in this forestry/energy sector with rent-seeking officials reducing incomes and distorting the pricing of charcoal through private taxes. The mis-match of regulation and lack of implementation might contribute to businesses being unviable under official regulations and proneness to corruption as operators have to pay their at various control and check points way through to remain in business (Kenya Forest Service, 2013a; Schure, 2014). In DRC, cutting and carbonization permits system for woodfuel are hardly being implemented; charcoal production under official permits represented less than 3% of consumption by the country's capital Kinshasa between 2009 and 2011

(Schure, 2014). In fact, most of the charcoal traded is unlicensed and or partially licensed making it illegal (Schure *et al.*, 2010; MENR, 2018).

Weak institutional arrangements and support mechanisms

Mandate and responsibilities for supporting, promoting, developing and regulating woodfuel production, utilization and marketing are spread over many government agencies. Such that even where policies and legal frameworks exist there is no clarity in the implementation mechanisms. For instance, in Kenya, there seem to be two operational overlapping charcoal licensing systems. One led by KFS and the other by the Counties as provided in the Environment Management and Coordination Act 1999 (amended 2012) and the Forest Charcoal Rules of 2009 (Kenya Forest Service, 2013a). Some counties have gone ahead to enact their own legislation regarding charcoal production and trade. Examples include Elgeyo/ Marakwet County Charcoal Bill, 2017 and Kitui County Charcoal Management Act (Government of Kenya, 2014; 2017). This duplicity is because the legislation provides for concurrent management of forest sector between KFS and County Governments under the two-tier system of governance, especially during the transition phase (Government of Kenya, 2010). The time for this phase has since elapsed and no seamless system or transfer of responsibilities has been affected in most counties.

This lack of transparency and consistency in implementation and enforcement in Kenya make charcoal "illegally legal". In some parts of the country it is illegal to produce and or transport charcoal from rural areas while it is perfectly legal to sell and use in the cities. In addition, banning charcoal production and or transportation has been happening periodically in most countries without the most desired outcomes (Mutimba and Barasa, 2005). For instance, in the years 2003 and 2005, commercial charcoal transportation in Narok district was banned, but the district managed to supply 40% of charcoal used in Nairobi. Again, KFS imposed a total ban on charcoal production in 2012 in Kitui County, yet many transporters delivered their charcoal to the urban centres by paying bribes at checkpoints along the highways (Kenya Forest Service, 2013ab). In fact, most of the charcoal in the country is "illegally" produced since most of the Charcoal Producers Associations have not been registered as required by Forest Charcoal Rules 2009 (MENR, 2018).

DRC is not any different, the country lacks a comprehensive woodfuel plan and overall capacity to govern the subsector throughout its provinces. There are governance challenges in the country lack of technical expertise, as well as competition among ministries and executing agencies in providing licenses and collecting fees (Sustainable Energy for All *et al.*, 2013; Schure, 2014). Producers and traders are generally not aware of their official obligations and rights and agencies involved are not motivated to change this status quo (Schure *et al.*, 2013).

In Zambia enforcement is carried out by the Forestry department with the support of other law enforcement agencies such as the Zambia Police. The National Policy on the Environment of 2007 was supposed to address the scattered policy framework for environment and natural

resources management but has not been backed by strong political commitment and financial resources. Thus, this has not yet been translated into real action. Furthermore, the Forestry Department is not able to effectively carry out monitoring and control activities in the forests due to inadequate financial, human and operational resources (GRZ, 2016).

Inadequate investment and financing

The woodfuel subsector is characterised by low technology adoption, mostly due to lack of capital to invest in more expensive and efficient biomass conversion and cooking technologies by producers and users. One other chronic problem is the limited budgets allocated to the subsector which frustrates all efforts to support research, development and capacity building strategies, plans and initiatives (Government of Kenya, 2015; Kenya Forest Service, 2013ab; MENR, 2018). Woodfuel plantations and alternative sustainable sourcing options are few and have difficulties competing with cheaper illegal exploitation under the present institutional framework (Paul and Fraser, 2014; Schure *et al.*, 2019).

Discussion and conclusion

Historically and even now, SSA countries do not have comprehensive policies and legal frameworks to guide woodfuel value chain activities. In some countries, including Cameroon, Chad, Ethiopia, Kenya, Malawi and Tanzania, bans have been imposed on production or transportation of charcoal, often leading to unintended negative consequences (Mutimba and Barasa, 2005). Existing policies and strategies downplay or ignore the economic potential of woodfuel. In fact, it has been shown that national energy policies have for a long time focused on development and promotion of electricity in both urban and rural areas, with less investment and support dedicated to woodfuel (Owen *et al.*, 2013). A general strategy is to eliminate woodfuel as a primary energy source, even if evidence suggests that dependence will remain and even increase in the medium term.

On the other hand, there is continued use of inefficient production and consumption technologies and practices that result in increased tree cutting for woodfuel. Thus, these factors coupled with the lack of suitable woodfuel governance contribute to the degradation of woodlands, forests and agriculture lands endangering livelihoods of many dependent thereof.

Woodfuel has been, is and will remain the primary energy source for many in Sub Saharan Africa for decades to come. This paper reconfirms importance of woodfuel specifically in the focus countries, Cameroon, Democratic Republic of Congo, Kenya and Zambia, with 70 to 90 percent of households and numerous enterprises using woodfuel as their primary energy source. This review shows that: i) even though woodfuel policies and legislation exist, most often they are neither known nor enforced, which could be result of partial recognition of the value of woodfuel, especially in the national and subnational accounts; ii) there are poor and

unclear institutional arrangements for supporting, guiding and controlling woodfuel activities; iii) there is inadequate enforcement and compliance; and finally iv) there is limited investment and financing in this forestry/energy sector all of which lead to poor governance of the woodfuel subsector.

Therefore, it is important to explore and generate evidence of what policy and technological options as well practices work to influence investment and adoption. However, without proper institutional arrangements for supporting and regulating the woodfuel value chains the subsector will remain uncompetitive and not generating enough returns and revenue to re-invest in proper production to consumption systems.

Facilitating transition from woodfuel energy sources to other modern technologies is a noble and desired initiative. However, it should be based on realities and be properly planned for in a phased approach. In the meantime, there is urgent need to promote good woodfuel governance and practice, with responsive policies and legal frameworks, effective institutional arrangements and availability of affordable production and cooking technologies; if woodfuel resources and associated livelihoods are to be sustained.

Current policy development that follow climate change mitigation, renewable energy development agendas create momentum for building more effective woodfuel governance mechanisms. Thus, more integrated woodfuel governance that considers local context, informal markets and decentralised government entities is required to attain more sustainable woodfuel value chains in the decades to come.

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References

- Arnold M., Kohlin G., Persson R., Shepherd G., 2003. Fuel Wood Revisited: What has Changed in the Last Decade? Center for International Forestry Research, Jakarta, Indonesia. https://www.cifor.org/publications/pdf_files/OccPapers/OP-39.pdf
- Arnold M., Kohlin G., Persson R., 2006. Wood fuels, livelihoods and policy interventions: Changing perspectives. *World Development*, 34: 596-611.
- Bitondo D., Achille Biwolé A., Ayissi Z. M., 2018. Analyse préliminaire des chaînes de valeur du bois-énergie et ses circuits d'approvisionnement dans la ville de Douala, Cameroun. CIFOR, Yaoundé, 58 p.

- Bhattarai T., 2001. Trees outside forests: The woodfuel production context. Proceedings of the Fuelwood-Crisis or Balance Workshop, June 6-9, Goteborg University for CIFOR, Marstrand, Sweden, 280-289.
- Charpin M., Richter F., 2012. L'énergie renouvelable - vers une modernisation de la filière bois-énergie. Vision 2035. Eco-Consulting Group. 36 diapositives.
- Chidumayo E. N., 2013. A review of charcoal in Zambia. Report prepared for FAO and Forestry department in Zambia. Makeni Research Station, Lusaka.
- Chidumayo E. N., Gumbo D. J., 2013. The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. *Energy for Sustainable Development*, 17 (2): 86-94. 10.1016/j.esd.2012.07.004
- Delahunty-Pike A., 2012. Gender Equity, Charcoal and the Value Chain in Western Kenya. PISCES Working Brief, November 2012, Nairobi, 16 p. https://www.africportal.org/documents/12849/GenderCharcoalValueChain_1.pdf
- EAA, ITDG, KEFRI, 2001. Historical Framework: Major events that have affected Inter-Fuel substitution in Kenya (1960s to present). Draft report on the DFID KAR-Fuel Substitution Project. <https://assets.publishing.service.gov.uk/media/57a08d27ed915d3cfd001852/88019HistoricalFrameworkKenya.pdf>
- Eba'a Atyi R., Ngouhou Poufoun J., Mvondo Awono J.-P., Ngougoure Manjeli A., Sufo Kankeu R., 2016. Economic and Social importance of fuelwood in Cameroon. *The International Forestry Review*, 18 (S1): 52-65. <https://doi.org/10.1505/146554816819683735>
- Eckholm E. P., 1975. The other energy crisis: firewood. Worldwatch Institute, University of Michigan. Worldwatch Paper n° 1, 22 p.
- FAO, 2017. The charcoal transition: greening the charcoal value chain to mitigate climate change and improve local livelihoods. Rome: FAO. <http://www.fao.org/3/a-i6935e.pdf>
- FAO, 2018. FAOSTAT. Data 2016. www.fao.org/faostat/en/ Accessed 25 June 2018.
- Folefack D. P., Abou S., 2009. Commercialisation du bois de chauffage en zone sahélienne du Cameroun. *Sécheresse*, 20 (3): 2-8.
- Ghilardi A., Mwampamba T., Dutt G., 2013. What role will charcoal play in the coming decades? Insights from up-to-date findings and reviews. *Energy for Sustainable Development*, 17 (2013): 73-74.
- Gond V., Dubiez E., Boulogne M., Gigaud M., Péroches A., Penneac A., *et al.*, 2016. Forest cover and carbon stock change dynamics in the Democratic Republic of Congo: case of the wood-fuel supply basin of Kinshasa. *Bois et Forêts des Tropiques*, 327: 19-28. <https://core.ac.uk/download/pdf/46682553.pdf>
- Government of Kenya, 1996. Kenya Economic Reforms For 1996-1998: The Policy Framework Paper Prepared by the Government of Kenya in collaboration with the IMF and the World Bank, February 16 1996. <https://www.imf.org/external/np/pfp/kenya/kenya.pdf>
- Government of Kenya, 1999. The Environmental Management and Co-Ordination Act, 8 (1999). Government printers, Nairobi. http://kenyalaw.org/kl/fileadmin/pdfdownloads/AmendmentActs/2015/EnvironmentalManagementandCo-ordination_Amendment_Act_2015_No5of2015_.pdf
- Government of Kenya, 2005. Kenya The Forests Act, 2005. Government Printers, Nairobi. <https://www.fankenya.org/downloads/ForestsAct2005.pdf>
- Government of Kenya, 2010. The Constitution of Kenya, 2010. National Council for Law Reporting and Authority of the Attorney General. <http://kfcg.co.ke/wp-content/uploads/2016/07/Constitution.pdf>
- Government of Kenya, 2012. Sessional paper No. 10 of 2012 on Kenya Vision 2030. Nairobi, Kenya, Office of the Prime Minister Ministry of state for Planning, National Development and Vision 2030, 173 p. <http://vision2030.go.ke/inc/uploads/2018/05/Sessional-paper-No.-10-of-2012-On-Kenya-Vision-2030.pdf>
- Government of Kenya, 2014. The Kitui County Charcoal Management Act, 6 (2014). Government Printers, Nairobi, Kenya. <http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/KituiCountyCharcoalManagementAct2014.pdf>
- Government of Kenya, 2015. Kenya: Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). Executive Summary. National Environment Management Authority. <https://unfccc.int/resource/docs/natc/kennc2.pdf>
- Government of Kenya, 2016. The Forest Conservation and Management Act, 34 (2016). Government Printers, Nairobi. <http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/ForestConservationandManagementActNo34of2016.pdf>
- Government of Kenya, 2017. The Elgeyo/Marakwet County Charcoal Bill, 2017, Special Issue, Supplement No.2 (Bills No.2). Government Printers, Nairobi. <http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/ElgeyoMarakwetCountyFinanceAct2015.pdf>
- GRZ (Government of the Republic of Zambia), 2006. National Long Term Vision 2030. Ministry of Finance and National Planning, Government Printers, Lusaka. http://www.oneplanetnetwork.org/sites/default/files/vision_2030.pdf
- GRZ (Government of the Republic of Zambia), 2014. Zambia National Forest Policy. Government Printers, Lusaka.
- GRZ (Government of the Republic of Zambia), 2015. Forests Act, 2015. (Act of no.4 of 2015). Government Printers, Lusaka. <http://www.parliament.gov.zm/sites/default/files/documents/acts/The%20Forest%20Act%202015.pdf>
- GRZ (Government of the Republic of Zambia), 2016. Report of the Auditor General on Sustainable Forest Management. Government Printers, Lusaka http://www.parliament.gov.zm/sites/default/files/documents/committee_reports/REPORT%20ON%20SUSTAINABLE%20FOREST%20MANAGEMENT.pdf
- GRZ (Government of the Republic of Zambia), 2018. Statutory instrument No. 11 on Forests and Community Forest management Regulations, 2018. Government Printers, Lusaka, Zambia. <http://extwpr-legs1.fao.org/docs/pdf/zam174187.pdf>
- GRZ (Government of the Republic of Zambia), 2007. The markets and bus station act. Ministry of Local Government and Housing, Lusaka, Zambia <http://www.wiego.org/sites/default/files/resources/files/Zambia-The-Markets-and-Bus-Station-Act-2007.pdf>
- Gumbo D. J., Moombe K. B., Kandulu M. M., Kabwe G., Ojanen M., Ndhlovu E., *et al.*, 2013. Dynamics of the Charcoal and Indigenous Timber Trade in Zambia: A Scoping Study in Eastern, Northern, and Northwestern Provinces. Bogor, Indonesia, CIFOR. https://www.cifor.org/publications/pdf_files/OccPapers/OP-86.pdf
- IEA, 2017. Energy Access Outlook 2017. From poverty to prosperity. OECD/IEA, 2017. <https://doi.org/10.1787/9789264285569-en>
- IEA, 2018. IEA Statistics by Country. <https://www.iea.org/classicstats/statisticssearch/>
- INS, 2008. Tendances, profil et déterminants de la pauvreté au Cameroun entre 2001 et 2007. Rapport de l'Enquête ECAM III, Yaoundé, Cameroun, 51 p. http://slmp-550-104.slc.westdc.net/~stat54/downloads/2016/Rapport_tendances_profil_determinants_pauvrete_2001_2014.pdf
- Kamweti D., Osiro D., Mwiturubani D., 2009. Nature and extent of environmental crime in Kenya. Institute for Security Studies, Report. <https://www.files.ethz.ch/isn/111770/M166FULL.pdf>

- Kendagor A. K., Prevost R. J., 2013. Energy Diversity and Development in Kenya. NDU press, 70 (3). <https://apps.dtic.mil/dtic/tr/fulltext/u2/a617053.pdf>
- Kenya Forest Service, 2013a. Analysis of The Charcoal Value Chain in Kenya. Ministry of Environment, Water and Natural Resources, Report, Nairobi, Kenya. <http://www.kenyaforestservice.org/documents/redd/Charcoal%20Value%20Chain%20Analysis.pdf> Accessed 11th May 2018
- Kenya Forest Service, 2013b. Miti Mingi Maisha Bora Programme – Support to Forest Sector Reform in Kenya, Implementation Phase (2009-2015). Ministry of Environment, Water and Natural Resources, Report, Nairobi, Kenya, 99 p. www.finland.or.ke/public/download.aspx?ID=133666&GUID={E56CC12B...
- Kuboka R. G., 2001. Planning for Rural Energy: The Woodfuel Problem in Central Kabras Location, Kakamega District, Kenya. Master's Thesis, The University of Nairobi.
- Leach G., Meams R., 1988. Beyond the Woodfuel Crisis: People, Land and Trees in Africa. Earthscan Publications Ltd, London, UK. <https://doi.org/10.4324/9781315066370>
- Madi A., 2012. Étude sur la situation de référence du bois-énergie dans la région de l'Extrême Nord, Cameroun. GIZ, ProPSFE, 120 p. https://www.researchgate.net/publication/260714809_Etude_de_l%27importance_economique_du_secteur_foret-faune_au_Cameroun
- Malimbwi R. E., Zahabu E. M., 2008. Research and development for sustainable management of semiarid miombo woodlands in East Africa Woodlands and the charcoal trade: the case of Dar es Salaam City. Working Papers of the Finnish Forest Research Institute, 98: 93-114. <http://www.metla.fi/julkaisut/workingpapers/2008/mwp098-12.pdf>
- Mbuthi P. N., 2009. Integrated Woodfuel Development Strategy for Kenya 2008-2012. GEF/RETAP Biomass Project. Final Report. Ministry of Energy. <http://kerea.org/wp-content/uploads/2012/12/Integrated-Woodfuel-Development-Strategy-Final-23-April-09.pdf>
- MECND, 2016. Arrêté Ministériel No 025/CAB/MIN/ECN-DD/CJ/00/RBM/2016 du 09 Fév. 2016 portant dispositions spécifiques relatives à la gestion et à l'exploitation de la concession forestière des communautés locales. Le Ministère de l'Environnement, Conservation de la Nature et Développement Durable.
- MECNT, 2013. Stratégie-Cadre Nationale REDD de la République démocratique du Congo. Fcpf and Un-Redd Kinshasa, MECNT. <https://www.forestcarbonpartnership.org/sites/fcpf/files/2015/March/Strategie-cadre%20nationale%20REDD%20de%20la%20RDC.pdf>
- MENR, 2018. Forest Resources Management and Logging Activities in Kenya. Taskforce to Inquire into Forest Resources Management and Logging Activities in Kenya. Ministry of Environment and Forestry, Report. <http://www.environment.go.ke/wp-content/uploads/2018/05/Task-Force-Report.pdf>
- MEWNR (Ministry of Environment, Water and Natural Resources), 2014. National Forest Policy, 2014. Government Printers, Nairobi, Kenya. [http://www.kenyaforestservice.org/documents/Forest%20Policy,%202014%20\(Revised%2020-2-2014\).pdf](http://www.kenyaforestservice.org/documents/Forest%20Policy,%202014%20(Revised%2020-2-2014).pdf)
- MINFOP-MINEPDED, 2017. Stratégie de modernisation de la chaîne de valeur bois-énergie dans la région de l'Extrême-Nord, Cameroun. Yaoundé, Cameroun.
- Ministry of Devolution and Planning, 2013. Second Medium Term Plan 2013-2017. Vision 2030. Government of the Republic of Kenya. <http://vision2030.go.ke/inc/uploads/2018/06/Second-Medium-Term-Plan-2013-2017.pdf>
- Ministère de l'Énergie et de l'Eau, 2008. Élaboration du diagnostic du secteur eau et énergie, Document 3: Diagnostic du sous-secteur des énergies renouvelables. Division des Études, de la Prospective et de la Coopération (DEPC), Cameroon, 33 p.
- Ministry of Energy and Petroleum, 2014. National Energy and Petroleum Policy - Final Draft - October 2014. Government Printers, Nairobi, Kenya. https://renewableenergy.go.ke/asset_uplds/files/National%20Energy%20and%20Petroleum%20Policy%20August%202015.pdf
- Mugo F., Gathui T., 2010. Biomass energy use in Kenya. A background paper prepared for the International Institute for Environment and Development (IIED) for an international ESPA workshop on biomass energy, 19-21 October 2010, Parliament House Hotel, Edinburgh. Practical Action, Nairobi, Kenya. <http://pubs.iied.org/pdfs/G02985.pdf>
- MoE (Ministry of Energy), 2012. National Energy Policy - Third Draft – May 11, 2012. Government Printers, Nairobi, Kenya. http://www.kplc.co.ke/img/full/bWxFzkyGyS97_National_Energy_Policy_-_Third_Draft_-_May_11_2012.pdf
- Mulenga B. P., Nkonde C., Ngoma H., 2015. Does Customary Land Tenure System Encourage Local Forestry Management in Zambia? A Focus on Wood Fuel. Working Paper n° 95, Indaba Agricultural Policy Research Institute (IAPRI), Zambia, 39 p. <https://ageconsearch.umn.edu/bitstream/207021/2/wp95.pdf>
- Maurer L., Pereira M., Rosenblatt J., 2005. Implementing Power Rationing in a Sensible Way: Lessons Learned and International Best Practices. Energy Sector Management Assistance Program (ESMAP), technical paper series ESM 305/05, Washington DC., World Bank, 216 p. <https://openknowledge.worldbank.org/handle/10986/18066>
- Mutumba S., Barasa M., 2005. Exploring the potential for a sustainable charcoal industry in Kenya. National Charcoal Survey: Energy for Sustainable Development Africa, Report, Nairobi 74 p.
- Mwitwa J., Makano A., 2012. Charcoal Demand, Production and Supply in the Eastern and Lusaka provinces. Ndola, Zambia, Mission Press.
- Nachmany M., Fankhauser S., Townshend T., Collins M., Landesman T., Matthews A., *et al.*, 2014. The GLOBE Climate Legislation Study: A Review of Climate Change Legislation in 66 Countries. Fourth Edition. London, UK, GLOBE International and the Grantham Research Institute, London School of Economics. <http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2014/03/Globe2014.pdf>
- Ndegwa G., Breuer T., Hamhaber J., 2011. Woodfuels in Kenya and Rwanda: powering and driving the economy of the rural areas. Rural 21 - 02/2011. <http://unf.mediapolis.com/binary-data/RESOURCE/file/000/000/117-1.pdf>
- Nlom J. H., 2018. Évaluation préliminaire du commerce bois-énergie dans la Région de l'Extrême-Nord du Cameroun. CIFOR, Yaoundé, 38 p.
- Njenga M., Karanja N., Munster C., Iiyama M., Neufeldt H., Kithinji J., *et al.*, 2013. Charcoal production and strategies to enhance its sustainability in Kenya, Development in Practice, 23 (3): 359-371. <https://doi.org/10.1080/09614524.2013.780529>
- Njenga M., Shrenk A., 2015. A burning issue: Woodfuel, public health, land degradation and conservation in Sub-Saharan Africa. Summary of the presentation given by Dr. Mary Njenga, and the subsequent discussions, at the BirdLife Africa Secretariat in Nairobi, Kenya. <https://www.birdlife.org/sites/default/files/attachments/making-woodfuel-sustainable-in-sub-saharan-africa.pdf>

- Nziramanga N. A., 2011. African industrialization and energy Opportunities for Integrating Energy in Development: Background paper Industrial Day: tackling energy poverty in Africa. UNIDO.
- Owen M., Van der Plas R., Sepp S., 2013. Can There Be Energy Policy in Sub-Saharan Africa without Biomass? *Energy for Sustainable Development*, 17: 146-152. <https://doi.org/10.1016/j.esd.2012.10.005>
- Paul C., Fraser I. M., 2014. Woodfuel plantation projects in Kinshasa province: potential contribution to the alleviation of pressure on natural forests. *International Forestry Review*, 16 (6): 507-523. <https://doi.org/10.1505/146554814814095366>
- RDC, 2015. Soumission de la contribution nationale prévue déterminée au niveau national au titre de la Convention des Nations unies sur les changements climatiques. Kinshasa, République démocratique du Congo. <https://www4.unfccc.int/sites/NDCStaging/Pages/Party.aspx?party=COD>
- RDC, FCPF, ONU-REDD, 2015. Stratégie Cadre Nationale REDD+ de la République Démocratique du Congo. Kinshasa, République démocratique du Congo. <https://www.forestcarbonpartnership.org/sites/fcp/files/2015/March/Strategie-cadre%20nationale%20REDD%20de%20la%20RDC.pdf>
- Sander K., Gros C., Peter C., 2014. Enabling reforms: Analyzing the political economy of the charcoal sector in Tanzania. *Energy for Sustainable Development*, 17: 116-126. <https://doi.org/10.1016/j.esd.2012.11.005>
- Schure J., Assembe-Mvondo S., Awono A., Ingram V., Lescuyer G., Sonwa D. J., *et al.*, 2010. L'état de l'art du bois énergie en RDC: Analyse institutionnelle et socio-économique de la filière bois énergie. Projet Makala. http://agritrop.cirad.fr/566698/1/document_566698.pdf
- Schure J., 2014. Woodfuel for urban markets in the Congo Basin: a livelihood perspective. Doctoral dissertation. Wageningen, University of Wageningen. https://www.researchgate.net/publication/261024549_Woodfuel_for_urban_markets_in_the_Congo_Basin_A_livelihood_perspective
- Schure J., Ingram V., Assembe-Mvondo S., Mvula-Mampasi E., Inzamba J., Levang P., 2013. La filière bois énergie des villes de Kinshasa et Kisangani. In: Marien J.-N., Dubiez E., Louppe D., Larzillière A (eds.), *Quand la ville mange la forêt: les défis du bois-énergie en Afrique centrale*. France, Éditions Quæ, 27-44.
- Schure J., Pinta F., Cerutti P. O., Kasereka-Muvatsi L. K., 2019. Efficiency of charcoal production in Sub-Saharan Africa. *Solutions beyond the kiln*. *Bois et Forêts des Tropiques*, 340 (2): x-y.
- SEI, 2002. Charcoal Potential in Southern Africa (CHAPOSA): Final Report. Stockholm, Inco-Dev..
- Sola P., Cerutti P. O., Zhou W., Gautier D., Iiyama M., Schure J., *et al.*, 2017. The environmental, socioeconomic, and health impacts of woodfuel value chains in Sub-Saharan Africa: a systematic map. *Environmental Evidence*, 6 (1): 4. <https://doi.org/10.1186/s13750-017-0082-2>
- Sola P., Gumbo D. J., 2014. Women and charcoal value chain in East and Southern Africa, presentation, IUFRO 2014 World Congress, 5-11 October 2014, Salt Lake City, Utah, USA. <https://www.slide-share.net/CIFOR/sola-iufro-presentation2014>
- Sustainable Energy for All, République démocratique du Congo, PNUD, 2013. Rapport national énergie durable pour tous à l'horizon 2030. Programme National et Stratégie. http://www.cd.undp.org/content/dam/dem_rep_congo/docs/eenv/UNDP-CD-RAPPORT-ENERGIE-DURBALE-POUR-TOUS-HORIZON-2030.pdf
- Tembo S. T., Mulenga B. P., Sitkon N., 2015. Cooking fuel choice in urban Zambia: implications on forest cover. Working Paper No. 94. Indaba Agricultural Policy Research Institute (IAPRI), Lusaka Zambia. <https://ageconsearch.umn.edu/bitstream/202883/2/wp94.pdf>
- Trossero M. A., 2002. Wood energy: the way ahead. *Unasylva*, 211 (53). <http://www.fao.org/docrep/pdf/005/y4450e/y4450e02.pdf>
- World Bank, 2001. Sustainable Woodfuel Supplies from the Dry Tropical Woodlands. Energy Sector Management Assistance Programme (ESMAP), technical paper series n° 13, Washington DC., World Bank, 108 p. <https://openknowledge.worldbank.org/handle/10986/20294>
- World Bank, 2011. Wood-Based Biomass Energy Development for sub-Saharan Africa Issues and Approaches. Africa Renewable Energy Access Program (AFREA). Washington, World Bank, 64. https://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1266613906108/BiomassEnergyPaper_WEB_Zoomed75.pdf
- World Bank, 2018. World Bank Open Data. <https://data.worldbank.org/>
- Ziba V., Grouwels S., 2017. Greening Zambia's charcoal business for improved livelihoods and forest management through strong producer groups. Forests Farm Facility, Food and Agriculture Organization of the United Nations, Rome, Italy. <http://www.fao.org/3/a-i7238e.pdf>

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