The informal sawn wood value chains in Uganda: structure and actors

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HIGHLIGHTS

- There is increased forestry sector informality in Uganda as small-scale operations expand.
- The shift from natural to planted forests as the primary wood source has led to sector fragmentation.
- Small volumes from predominantly individual players aggregate to an estimated production of up to 476,000 m^3 of sawn wood annually.
- Current regulations facilitate informality, being administratively burdensome for formal small-scale operations.
- Policies have succeeded in increasing planted forests but not yet in fostering effective and efficient utilization of the tree resources.

SUMMARY

With increasing scarcity and spatial dispersion of tree resources, Uganda's forest sector – similarly to several other countries in Sub-Saharan Africa – has experienced a shift from the large-scale concessionary model historically used to access and harvest forests, to more versatile models involving smaller-scale operators. The timber they produce is sold not only locally in producer countries but also across borders and beyond. Yet small-scale operators largely work outside established regulatory frameworks and as such remain invisible to national and international production and trade statistics, rendering these players voiceless during policy-reform processes. Uganda is no exception, and little is known about the nature of people involved in various small-scale forestry activities, the constraints they face in day-to-day operations, and the dynamics that influence these aspects. Through 452 interviews, of a random sample of actors engaged directly in the sawn wood value chain, conducted between 2016 and 2019, this paper describes sawn wood flows from production areas to markets in Uganda. It assesses the socio-economic characteristics of operators and the organisation of activities. Findings indicate that the majority of actors in the informal sawn wood value chain are adult males, belonging to a limited number of ethnic groups, exogenous to logging areas and generally deriving their income from the timber business. The sawn wood value chain shows a high degree of fragmentation, with low levels of organisation and lack of vertical and horizontal integration. We conservatively estimate the total volumes sold annually between 386,000 and 467,000 cubic meters of sawn wood. With the expected progressive shift from natural forests to plantations as the primary source of wood, it is key for the Government of Uganda to embrace a paradigm shift on the current policy framework, to ensure that it facilitates rather than constrains the sawn wood value chain, since most of the timber will be sourced from privately owned forests instead of State-owned forests. If most legal provisions remain based on the latter, it is likely that legality will remain the exception rather than the norm.

Keywords: Uganda, informal timber sector, timber value chain, illegal logging

La filière du bois d'œuvre informel en Ouganda: structure et acteurs

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Avec la raréfaction et la dispersion spatiale des ressources forestières, le secteur forestier ougandais – à l'instar de plusieurs autres pays d'Afrique subsaharienne – est passé du modèle concessionnaire à grande échelle utilisé historiquement pour accéder et exploiter les forêts, à des modèles plus polyvalents impliquant des opérateurs travaillant à une échelle plus petite. Le bois qu'ils produisent est vendu non seulement localement, mais aussi au-delà des frontières nationales. Ces opérateurs travaillent largement en dehors des cadres réglementaires établis et, en tant que tels, restent invisibles aux statistiques nationales et internationales de production et de commerce, ce qui les rend aussi sans voix lors des processus de réforme des politiques. L'Ouganda ne fait pas exception, et on connait mal la nature des personnes impliquées dans diverses

activités forestières à petite échelle, les contraintes auxquelles elles sont confrontées dans les opérations quotidiennes et la dynamique qui influence ces aspects. À travers 452 entretiens choisis dans un échantillon aléatoire d'acteurs impliqués directement dans la filière, menés entre 2016 et 2019, cet article décrit les flux de bois d'œuvre des zones de production vers les marchés en Ouganda. L'article évalue les caractéristiques socio-économiques des opérateurs et l'organisation des activités. Les résultats indiquent que la majorité des acteurs de la filière sont des hommes adultes, appartenant à un nombre limité de groupes ethniques, exogènes aux zones d'exploitation et tirant généralement leurs revenus du commerce du bois. La filière présente un degré élevé de fragmentation, avec de faibles niveaux d'organisation et un manque d'intégration tant verticale qu'horizontale. Nous estimons les volumes totaux vendus annuellement entre 386 000 et 467 000 mètres cubes de bois scié. Avec le passage progressif attendu, des forêts naturelles aux plantations comme principale source de bois en Ouganda, il est essentiel que le gouvernement ougandais adopte un changement de paradigme dans le cadre politique actuel, afin d'assurer des facilitations plutôt que des blocages pour le développement de la filière, puisque la plupart du bois proviendra de forêts privées au lieu de forêts appartenant à l'État. Si la plupart des dispositions légales restent fondées sur ces dernières, il est probable que la légalité restera l'exception plutôt que la norme.

Las cadenas de valor informales de la madera de aserrío en Uganda: estructura y actors

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Con la creciente escasez y dispersión espacial de los recursos arbóreos, el sector forestal de Uganda, al igual que varios otros países del África subsahariana, ha experimentado un cambio del modelo de concesión a gran escala utilizado históricamente para acceder a los bosques y aprovecharlos, a modelos más versátiles en los que participan operadores de menor escala. La madera que producen se vende no sólo a nivel local en los países productores, sino también al extranjero. Sin embargo, los pequeños operadores trabajan en gran medida al margen de los marcos normativos establecidos y, como tales, permanecen invisibles en las estadísticas nacionales e internacionales de producción y comercio, lo que hace que estos actores no tengan voz en los procesos de reforma de las políticas. Uganda no es una excepción, por lo que se sabe poco sobre la naturaleza de quienes participan en las diversas actividades forestales a pequeña escala, las limitaciones a las que se enfrentan en las operaciones diarias y las dinámicas que influyen en estos aspectos. Este documento describe los flujos de madera de aserrío desde las zonas de producción hasta los mercados en Uganda, como resultado de 452 entrevistas realizadas entre 2016 y 2019 a una muestra aleatoria de actores involucrados directamente en la cadena de valor de la madera de aserrío. En él se evalúan las características socioeconómicas de los operadores y la organización de las actividades. Los resultados indican que la mayoría de los actores de la cadena de valor informal de la madera de aserrío son hombres adultos, pertenecientes a un número limitado de grupos étnicos, exógenos a las zonas de tala y que generalmente obtienen sus ingresos del negocio de la madera. La cadena de valor de la madera de aserrío presenta un alto grado de fragmentación, con niveles de organización bajos y una falta de integración vertical y horizontal. En el artículo se estima, de forma conservadora, que los volúmenes totales vendidos anualmente de madera de aserrío están entre 386.000 y 467.000 metros cúbicos. Con el cambio progresivo que se espera de los bosques naturales a las plantaciones como fuente primaria de madera, es fundamental que el gobierno de Uganda adopte un cambio paradigmático en el marco político actual, para garantizar que se facilita, en lugar de limitar, la cadena de valor de la madera de aserrío, ya que la mayor parte de la madera procederá de bosques de propiedad privada, en lugar de bosques de propiedad estatal. Si la mayoría de las disposiciones legales siguen basándose en esto último, es probable que la legalidad siga siendo la excepción y no la norma.

INTRODUCTION

Domestic and regional demand for sawn wood in many tropical countries is increasing rapidly, due to demographic growth, urbanisation, improvement in economic conditions and standards of living (Cerutti *et al.* 2015, Hermans-Neumann *et al*. 2016, Schaafsma *et al.* 2014). In many countries and regions, including in East Africa and particularly Uganda, which is the focus of this paper, the growing demand for sawn wood is placing increasing pressure on available forest resources. This tends to result in unsustainable extraction rates that have led to overharvesting and degradation of existing forest reserves across the region, resulting in their continued decline (MWE 2016, Held *et al.* 2017, Ototo and Vlosky 2018). This has been amplified by illicit trade in sawn wood from forest-rich countries in the region such as Democratic Republic of the Congo (DRC) and South Sudan which increasingly transits through countries such as Uganda to other countries in the region (WWF 2012a, WWF 2012b).

With increasing spatial fragmentation and scarcity of forest resources, the large-scale concessionary model historically used to access and harvest forests has increasingly given way to alternative models involving smaller-scale operators. In sub-Saharan Africa and beyond, such operators have in recent years emerged as a dominant group across various nodes in the sawn wood value chain; ranging from harvesting and processing to sawn wood retailing and wholesaling (Putzel *et al.* 2014, Cerutti *et al.* 2014, Wit *et al.* 2010). Yet, while the legal frameworks of many countries acknowledge such operators, rules and regulations remain strongly biased in favour of large-scale concessions. Most small-scale operators consequently are forced to conduct their activities illegally or informally (Tacconi *et al.* 2016). This, in turn, often renders such operators invisible to national and international production and trade statistics (Cerutti *et al.* 2017), and smallholder interests are poorly represented within policy dialogues and reform processes (Cerutti *et al.* 2015).

The latter is of particular concern, as the lack of policy consideration towards small-scale forestry operators in sub-Saharan Africa results in inadequately regulated and criminalised sectors that are widely associated with socio-economically

and environmentally detrimental practices, loss in government revenues and corruption. This buttresses poor governance and undermines national sustainable development objectives (Brack 2012, Pacheco *et al.* 2016). While this is often tackled by national policymakers as a domestic issue, part of the sawn wood produced by small-scale loggers is in fact traded across State borders, into regional and international markets (Lukumbuzya and Sianga 2017). This is particularly true of the East African region, where there is a pronounced and growing distinction between countries with significant wood resources available for harvesting in natural production forests (e.g. the Eastern Democratic Republic of Congo or South-Sudan) and net importers with few natural production forests left (e.g. Uganda and Kenya, Teucher *et al*. 2020).

Whereas Uganda and other countries in the Great Lakes region acknowledge the need to better regulate timber production and trade practices, there is paucity of critical information on value chain dynamics and governance due to its informal nature. Moreover, there are differences in the nature of logging operations across the region. In countries such as Democratic Republic of Congo, where large-scale logging concessionaires work alongside smaller operators, it is possible to explicitly identify and document operations of the latter. However, in other countries, such as Uganda, most of the sawn wood is produced by small-scale operators, mainly operating outside the purview of the State. Thus the distinction between formal and informal operations tend to get blurred, making it difficult to assess their real socio-economic impacts (Turyahabwe *et al*. 2015). This undermines the potential of the forest sector to contribute to the economic, social and environmental objectives of the country (MWE 2016). Generally, little is known about the range of actors involved, the functioning of the chain through which they operate, and the constraints they face in their day-to-day operations (e.g., with respect to corruption, efficiency and profitability).

Seeing how most actors engaged in small-scale logging, trading, and processing face structural barriers to formalization due to capacity and resource constraints, pervasive corruption, convoluted licensing procedures, and legal pluralism (Cerutti *et al.* 2015), a better understanding of such issues is pivotal to more effective forest policymaking. Even well-intended initiatives to address illegality could lead to extensive negative social impacts, such as marginalisation or exclusion of a significant proportion of the working force from economic sectors integrating to rural livelihoods. Effectively leveraging rising demand for sawn wood for sustainable and inclusive development purposes, requires that such initiatives expressly account for and respond to upgrading barriers confronting the sector.

This paper seeks to contribute to existing knowledge and to stimulate policy debate on informal sawn wood production and trade by examining the socio-economic characteristics of different actors across the Uganda sawn wood value chain, the types of activities they engage in, their organisational structures, and barriers they face. The findings are specific to Uganda. Yet, they are highly pertinent to ongoing local, regional and international policy processes that aim to formalize and reduce the deleterious effects of the sector. Findings are particularly relevant to current efforts to develop integrated and regionally coherent timber resource management policies in the EAC region, as well as internationally coordinated efforts to tackle illegal logging. Ultimately, findings help design interventions within the forest sector that safeguard and augment small-scale producers dependent on the sector, while also enabling improved forest management and more responsible and efficient use of forest resources.

The following sets of research questions were used to guide the analysis: (i) what are the socioeconomic characteristics of actors engaged in the informal sawn wood value chain in Uganda? How do socioeconomic attributes influence their positioning within the value chain? (ii) How are activities organised in the informal sawn wood value chain? What is the association between patterns of vertical and horizontal integration and primary activity in the sawn wood value chain? (iii) What constraints do different actors along the sawn wood value chain in Uganda face? How node-specific are these constraints?

METHODS

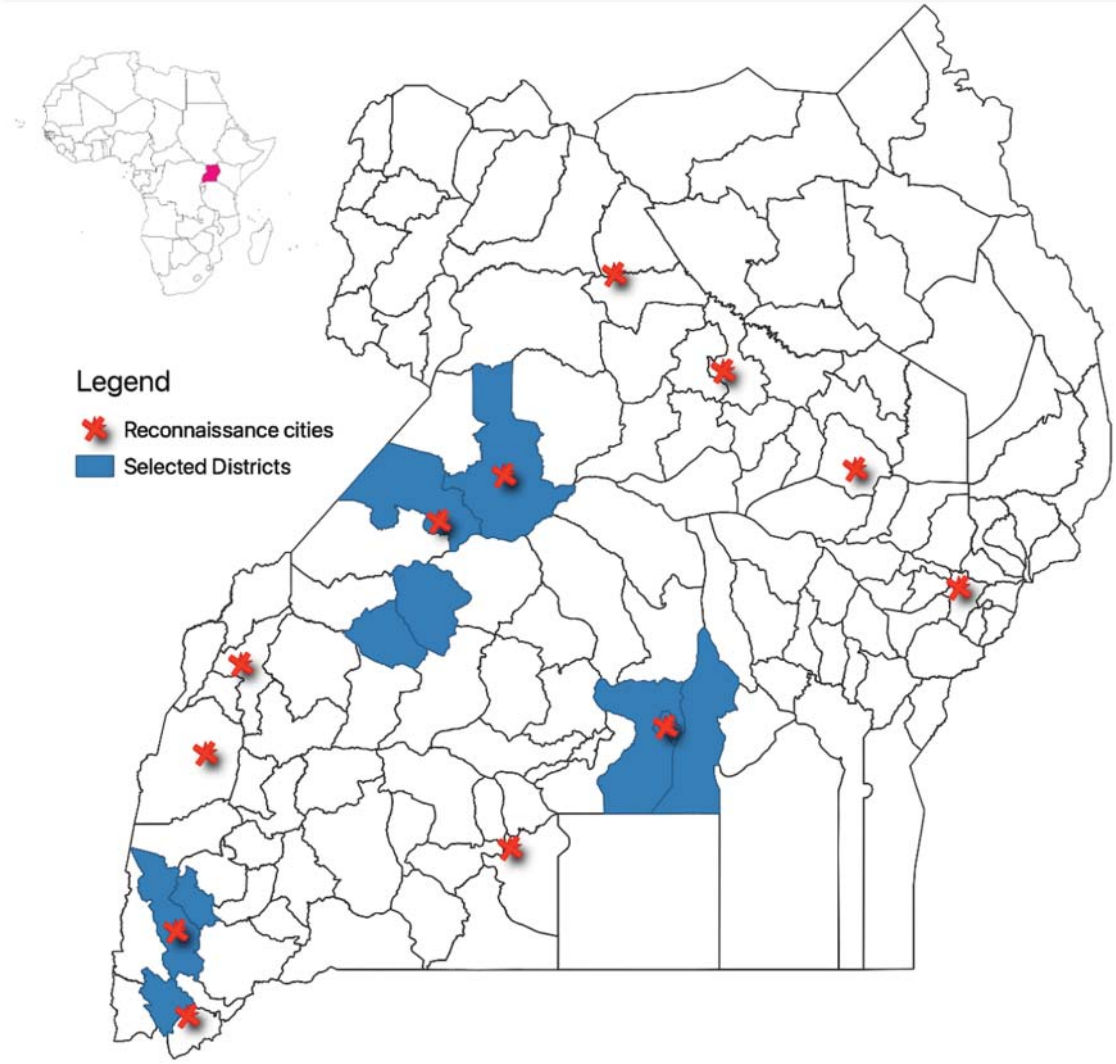
Study area

The study was conducted between mid-2016 and mid-2019. It commenced with a 1-month reconnaissance survey carried out across Uganda to identify patterns of sawn wood flows from production areas to end-markets. The reconnaissance survey interviewed 42 wholesalers/retailers across the country (Figure 1), identified through a snow-balling technique, with general questions about their activities in the sawn wood value chain, sawn wood sources origin and sawn wood destinations.

The reconnaissance survey helped identify key trade routes, as well as nationally significant production and consumption areas. Basing on this, the mid-western and south-western regions of Uganda were selected as timber supply source areas, while the more urbanized central region was identified as the primary end markets. Specifically, we interviewed actors from the timber producing districts of Rukungiri, Mitooma and Rubanda in south-western Uganda and the districts of Kakumiro, Kibaale, Hoima and Masindi in mid-western Uganda. All these districts are located in the Albertine region of Uganda, which is the country's leading biodiversity hotspot (Plumptre *et al*. 2007). While production is highly concentrated, the reconnaissance survey shows that sawn wood retail and wholesale markets are scattered across the country. Nevertheless, the vast majority of sawn wood is in the central region, particularly Kampala and nearby towns located in adjoining Wakiso and Mukono districts, with an estimated population of 5.3 million people (UBOS 2020). Thus, actors sampled from sawn wood demand destinations were selected from these locations (Figure 1).

In mid-western Uganda, timber largely originates from tropical natural forests and a few scattered small-scale plantations of exotic species such as eucalyptus and pine.

FIGURE 1 *A map of districts of Uganda showing location of study area*



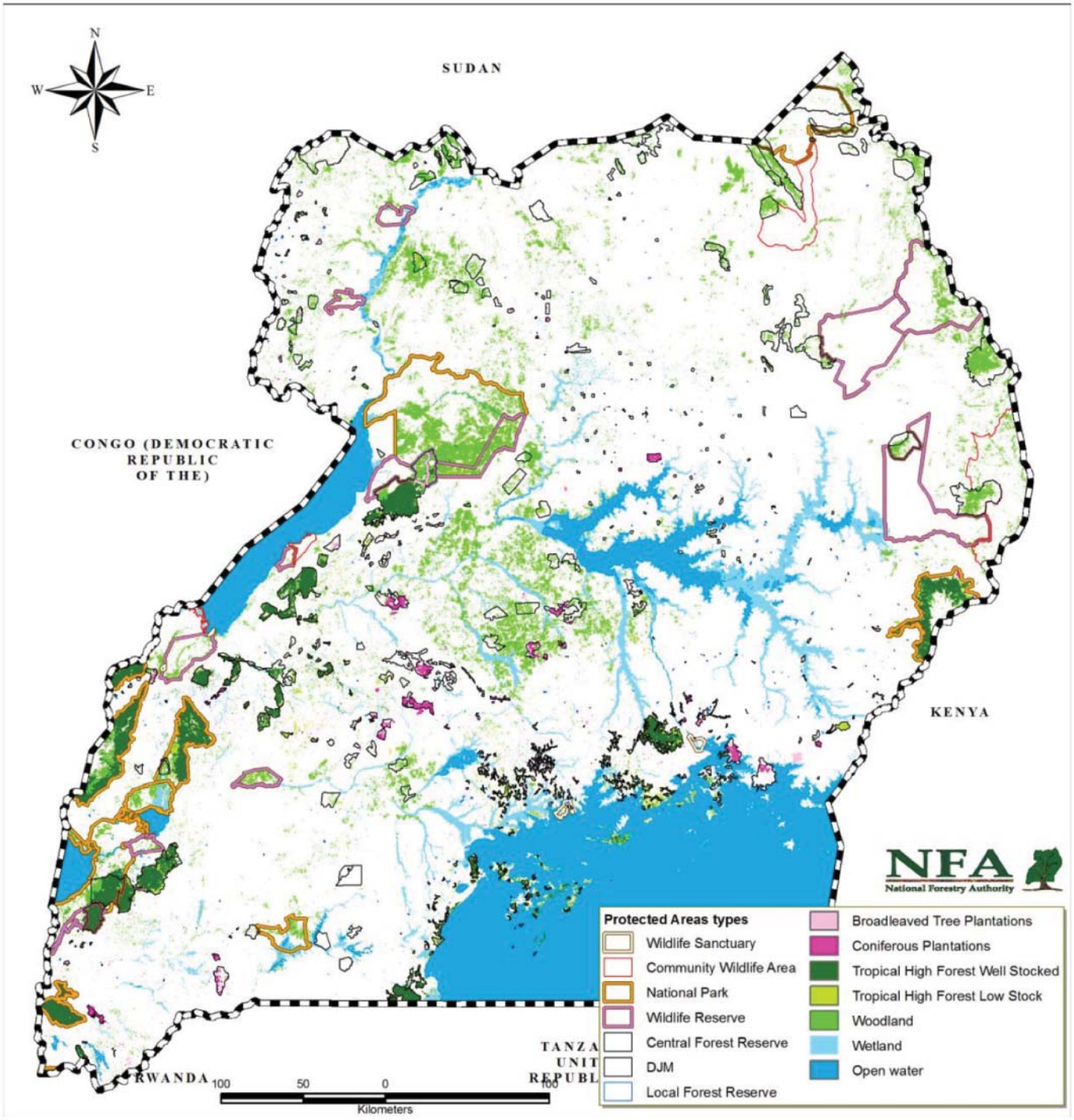
Timber is generally sourced from private land with absent landlords, government public land and communally owned land. In accordance with historical traditions and legacies of gendered customary rights, women barely own land but have rights of access and use to land and to trees and forests, although mainly for domestic purposes. Timber is mostly harvested from natural forests on private land, scattered trees on farmlands and illegally from government managed Central Forest Reserves. Kampala, the capital city of Uganda, and adjacent districts of Wakiso and Mukono, form the main market for sawn wood produced in the area. Only a small part of the harvested timber is also consumed locally and in the surrounding districts.

Land in the selected districts in south-western Uganda largely comprises private freeholds that are acquired through inheritance or commercial land markets. Plot size has steadily reduced over time due to land fragmentation, currently standing at an average of ¼ acre per household. Hence, most people do not have enough land to integrate agroforestry systems into the same plot. Most of the forest resources in sampled areas are planted and contained within these freeholds by – typically better resourced – farmers that transitioned out of crop farming. Government does however retain rights over trees within these plantations, as those contained with the districts' natural forest managed as central and local forest reserves. While the lion's share of timber is sourced from private plantations, some timber is sourced from government plantations and high-value species illegally from government natural forests. As is the case for the mid-western region, Kampala city is the main market, with a small proportion retaining locally for local consumption.

Data collection

While our analysis in the next section of annual domestic sawn wood consumption is an important feature of this research, our research methods were mainly concerned with the socio-economic characteristics of operators and tracing the dynamics along the value chain. Consumption information collected by the two independent teams (reconnaissance and follow-up surveys) from different retailers in different markets and cities, also provides new insights into the national economic significance of the sector. Among other questions, the reconnaissance survey asked retailers about the number of

FIGURE 2 *Forest cover and protected areas in Uganda (National Forestry Authority, Ministry of Water and Environment, 2015)*



sawn products (e.g. planks, beams, with their individual dimensions and price) they would sell in an average week or month, while the in-depth surveys asked retailers about the sawn products sold over a four month period (two previous months from interview date for easier recollection as well as the best and worst month within the previous year). Reconciling and extrapolating these results enables us to provide data-informed estimations.

For all categories of operators (Table 1) along the value chain who had been provisionally categorised, for purposes of sampling, as producers, transporters, intermediaries, traders and wholesalers/retailers, a node-specific structured questionnaire was tested, validated, and administered.

In total, 410 interviews were held to characterise each operator type, the activities they engage in, the organisation of these activities and the constraints they face (Table 2).

In production areas, specific locations with active and ongoing sawn wood production operations were obtained from the District Forestry Officers of each study district, while local leaders helped identify producers. Within markets, operators were identified using market leaders. From each category of actors, respondents were randomly selected and interviewed.

TABLE 1 *Categories of operators*

Operators	Description of main activity
Producers	Engage directly in the conversion of standing trees to sawn wood
Brokers	Search out and/or organise sawn wood supply for other people in the value chain
Transporters	Engage in movement of sawn wood between locations
Traders	Buy and sell sawn wood but do not sell directly to final consumers
Retailers	Buy and sell sawn wood directly to final consumers

TABLE 2 *Distribution of respondents by primary activity and region*

Primary actor	Number (percentage) of actors by region			
	Central	South-western	Mid-western	Total
Producer	22 (17.5)	57 (45.2)	47 (37.3)	**126 (30.7)**
Broker	27 (64.3)	09 (21.4)	06 (14.3)	**42 (10.2)**
Transporter	30 (55.6)	06 (11.1)	18 (33.3)	**54 (13.2)**
Trader	19 (35.2)	11 (20.4)	24 (44.4)	**54 (13.2)**
Retailer	86 (64.2)	24 (17.9)	24 (17.9)	**134 (32.7)**
Total	**184 (44.9)**	**107 (26.1)**	**119 (29.0)**	**410 (100)**

Surveys were operator-centric and not set up to identify larger societal impacts. To capture these, focus group discussions (FGDs) with men, women and mixed youth groups (<35) were held in the targeted production districts. A total of 54 FGDs were held. The FGDs were structured around general questions on changes and trends in the availability and management of timber and other forest resources, socioeconomic benefits associated with timber production, as well as potential negative social and environmental impacts. Facilitators were trained to specifically probe for potential socially differentiated perceptions and impacts.

As is generally the case when studying activities deemed informal and/or illegal by authorities, particular care was taken with requesting consent from interviewees and protecting their identifies. This involved ensuring that (i) responses would be anonymous and delinked from names and locations; (ii) interview could be stopped at any time with any need for justification; (iii) no detailed data would be published by aggregating results at the group level.

Data analysis

The analysis consists of three components, namely the socioeconomic characterisation, the organisation, and constraints of actors in the informal sawn wood value chain. In relation to the socioeconomic characterisation, data were summarised using percentages, and a multinomial logistic regression analysis used to examine whether socioeconomic variables influenced the types of activities actors are engaged in. The most relevant results derived from this analysis are integrated in the following section (Results and Discussion). Interested readers can see the detailed analysis in Appendix I, which explains the technical analysis in more details. Analysis of actor organisation is largely based on descriptive statistics on patterns of vertical and horizontal integration. Analysis of vertical integration involved grouping actors into four clusters, including sole activity players who engage in a single activity, 'upstream actors', 'downstream actors', and 'integrated actors'. Upstream actors integrate activities in the upstream to midstream end of the value chain from production to trade, but do not engage in downstream activities such as retail; downstream actors integrate activities in the mid- to downstream end of the value chain from retail back to transportation but do not engage in production; the integrated category includes those who span the whole value chain from production to selling of sawn wood to the final consumers. Analysis of horizontal integration involved assessing extent of involvement in collective action schemes such as associations and cooperatives at node level. Cross-tabulation and Chi-Square tests were used to examine if there was significant association between patterns of business organisation and the relative importance of specific activities to the overall sawn wood enterprise. Constraints faced by actors were categorised into groups, and cross tabulation as well as Chi-square tests were used to explore whether these constraints were associated with the primary focus of the sawn wood enterprise.

RESULTS AND DISCUSSION

Who is involved in the informal sawn wood sector in Uganda?

In this section, a description of the socioeconomic characteristics of the actors is provided to paint the picture of a typical actor engaged in the informal sawn wood value chain in

Uganda. Operators were characterised based on gender, ethnicity, education, experience (number of years in primary activity), sawn wood dependence (what percentage of their income was derived from sawn wood), residence status, social burden (how many dependant family members were in the family i.e. below 18 years and above 65 years of age) and wealth endowment (how much wealth a family had using indicators such as nature of houses and land ownership) (Table 3).

Among interviewees, men represent the majority, while 'mature' respondents predominate (as opposed to youths and the elderly). However, while the percentage of actors in the mature category is similar among women and men, the odds of elderly women to young women (1 to 15) is much lower than the odds of elderly men to youths (1 to 5). With respect to education of actors engaged in informal sawn wood value chains, about 88% of the respondents had not gone beyond the secondary level. The study identified few women participating in timber harvesting. While some younger women in the south-western region reported occasionally carrying logs in the absence of alternative livelihood options, female involvement in the value chain is mainly concentrated in trading and – to a limited but potentially increasing extent – brokering.

TABLE 3 *Socioeconomic characteristics of actors (n = 410)*

Characteristic		Category	Percentage
Gender	Men (79%)	Youths (18–30 years)	15.1
		Mature (31–59 years)	81.8
		Elderly (≥ 60 years)	3.1
	Women (21%)	Youths (18–30 years)	17.6
		Mature (31–59 years)	81.2
		Elderly (≥ 60 years)	1.2
Ethnicity		Baganda	19.0
		Bakiga	33.2
		Banyankole	14.1
		Banyoro	19.8
		Others*	13.9
Education		Primary or below	46.6
		Secondary	41.2
		Tertiary or above	12.3
Experience (years)		< 5	16.0
		5–<10	44.1
		10–<20	33.7
		≥ 20	6.2
Residence**		Locals	6.5
		Residents	37.3
		Outsiders	56.2
Dependence		Average	72.0
		Light	18.6
Social Burden		Medium	78.2
		Heavy	3.2
Wealth Endowment		Low	42.0
		Medium	17.3
		Affluent	40.7

* Includes Bafumbira, Batooro, Lugbara, and Bakonjo.
** Locals work and reside in districts of birth; residents stay in district where they work but not born there; outsiders were neither born nor stay in district of work

A total of 14 ethnic groups participating in the sawn wood value chain were identified, with the Bakiga representing the majority, corroborating previous research (Jagger *et al.* 2011). This may be because the first commercial timber plantations in Uganda were established in Kigezi region which is the cradle of this ethnic group (Byakagaba and Muhiirwe 2017). Thus, they acquired the knowledge and skills for sawn wood production earlier than other ethnic groups in Uganda, and have so far been able to maintain experiential advantages to engage in timber trade beyond their areas of origin, as is also suggested by the majority (56%) of operators being 'outsiders', i.e. operating in districts where they were not born and do not reside.

This has relevant social consequences in terms of local livelihoods, the distribution of wealth across various districts, and the attachment (or lack thereof) that individuals have to the geography where they work. Research by Jagger *et al.* (2011) indicates that labourers come from outside logging areas due to lack of expertise by locals to do the work, while the local population in areas where timber is harvested does not directly benefit from the value chain, except for money that is spent locally by workers (e.g. on food). This is in line with findings in other countries (e.g. see Bickel and Cerutti 2017, Phuc and Sikor 2006). Lack of local benefit capture could produce conflicts between the local and resident population and external value chain actors, especially when both sectors and practices are extractive. This demands careful consideration by local and national policy makers attempting to reduce inequities and prevent conflicts along the value chain.

The largest share (44%) of respondents indicated that they have been engaged in the timber business for between 5 to less than 10 years, though a relatively large number (34%) have also been engaged for up to 20 years. This – when also related to other findings – bears very relevant information for policy makers with ramifications extending well-beyond the forest sector. For example, professional education programmes may graduate skilled young operators who will clash with the reality on the ground as long-established operators largely from one ethnic group may constitute a heavy barrier to entry for prospective new entrants. Hence for policies to result in equitable, effective and positive social impacts, such details need consideration and should aim at integration through ad-hoc incentives.

On average, actors in the value chain derive most (72%) of their income from their sawn wood businesses, indicating that the sector is a major source of local livelihoods. Notably, about 15% of respondents indicated that they have no alternative income sources, having identified sawn wood as their

sole income generating activity. This is a common feature in many timber producing countries (Hansen *et al.* 2015, Tumusiime *et al.* 2011, Mukul *et al.* 2014), and – we argue – one of the most important determinants when it comes to successful policies. Indeed, it needs careful consideration. For example, policymakers seeking to better regulate the sector because of global environmental concerns – as it is the case in most Nationally Determined Contributions to the Paris Agreement – should first and foremost assess whether valid alternative options are available for people risking loss of livelihood as a result of overly stringent and technocratic regulation or being forced into further illegality/criminality.

In terms of the potential social impacts of environmentally inspired policies, analysis sought to check how dependence on sawn wood varies between social burden categories. Results indicate that operators with heavy or medium household labour burden (family size of at least seven, at least 3 dependents, household head, and married or widowed) experienced greater dependency on the sector (73–79%) compared to those with a lower burden (69%). On the other hand, actors in the high wealth endowment category (houses have walls of burnt bricks, roofed with coloured corrugated iron sheets and tiled floors, plus substantial rural land holding) had a higher dependence (79%) compared to the other categories.

All in all, the analysis of patterns of involvement along the value chain indicates that downstream activities (e.g., retailing and wholesaling) are dominated by more youthful individuals that are new entrants in the sawn wood chain, who do not entirely depend on sawn wood as a source of income, and are residents in their areas of operation. This can be attributed to the fact that brokering as well as retail can be carried out with limited financial resources, but require adequate social networks, thereby privileging players with stronger local roots. On the other hand, transporting of timber in Uganda has several formal and informal costs that one has to pay upfront, and this may make it less attractive.

How much timber is potentially sold?

National statistics are wanting when it comes to the official estimates of timber production and consumption. In 2012, the quantity of timber produced domestically (i.e., excluding imports from neighbouring Democratic Republic of Congo or South-Sudan) was estimated at about 360,000 cubic meters of sawn wood, or about 1.4 million cubic meters roundwood-equivalent with a processing rate of about 25% (WWF 2012a). The authors clearly indicated that their findings were "*informed estimates*" (WWF 2012a, p.6). FAOSTAT production data report the same value from 2015 to 2019, at 440,000 cubic meters for sawn wood and about 1.7 million cubic meters of round wood (based on imputation methodology, http://www.fao.org/faostat/en/#data/FO).

This assessment focussed more on the socio-economic dynamics along the timber value chain, than with a detailed quantification of produced and sold volumes. We believe regulatory improvements to the forestry sector in Uganda could stem more from a better understanding – and indeed acknowledgement – by policy makers about who does what and for what reasons, than from an exact quantification of traded volumes. That notwithstanding, collected data do allow us to provide informed estimates about timber volumes sold on the market, which seem to indicate a growing trend as compared to previous estimates.

Overall, surveyed retailers provided length, width, and height of about 2 million pieces sold from 34 species, of which about 50% eucalyptus (*Eucalyptus spp.*), and about 21% pine (*Pinus spp.*). The vast majority of pieces can be categorised as planks, with a general length of 2.5 meters, width of 10–15 centimetres, and height 5 centimetres. The average volume of such piece is about 0.02 cubic meters. Findings indicate that most *Pinus spp.* and *Eucalyptus spp.* Are sourced from private and government plantations located in South Western Uganda in the districts of Rukungiri, Mitooma and Rubanda. Less than 30% of the timber was made of high value traditional hardwoods (mainly *Milicia excelsa* and various species sold as mahogany), low value hardwoods (mainly *Antiaris toxicaria*, *Polyscovia fulva* and *Canarium schweinfurthii*) and medium value hardwoods (including *Lovoa trichiliodes*, *Maesopsis eminii*, *Piptadeniastrum africana*, *Warburgia ugandanensis*, *Pynanthus angolensis*, *Funtumia africana*, *Markhamia lutea*, *Blighia unijugata* and *Albizia Coriaria*). These timbers were sourced mainly from natural forests on private land, government forest reserves and scattered trees on farm in mid-western Uganda in the districts of Kakumiro, Kibaale, Hoima and Masindi.

Interviewed retailers during the reconnaissance survey indicated an average of about 1,800 planks sold per month, or about 31 cubic meters. The in-depth survey resulted in an average of about 38 cubic meters per month. The reconnaissance survey across the 13 cities and surrounding areas indicated a total number of about 1,700 sheds, of which more than 1,000 found in Kampala and neighbouring areas (e.g., Wakiso). Results also show that about 80% of all recorded sales are destined to these markets (Kampala and Wakiso in particular), while about 97% of the volumes sourced by sheds in Kampala and Wakiso are coming from other districts (in particular Kabale, Kalangala, Rubanda, Rukungiri, Masaka, and Masindi).

The above considerations are important because double-counting when estimating national consumption can be an issue. For example, a plank can be recorded as 'sold' from one shed in, say, Kabale, then bought by one shed in Kampala, and then recorded again as 'sold' by the latter to the final user of the plank. Hence, for this assessment we consider that volumes sold and recorded in Kampala and neighbouring areas can be used as a good proxy for the total volumes sold on the national territory. All in all, the total volumes sold annually in these areas vary from between 386,000 and 467,000 cubic meters. This is based on extrapolating average quantities sold by market in these areas to the total number of sheds per market. We account for seasonality, by taking the average of the total volume sold during the rainy/low season and the total volume sold during the dry/high season. This is very likely a gross underestimate since our analysis does not

capture direct sales (e.g., sales bypassing timber markets), indicating – if need be – that consumption has grown in recent years and that a clear policy decision should be taken as soon as possible to monitor at least the basic trends in production and consumption across the country.

How do informal sawn wood trade operators do business?

The majority (75%) of sampled actors engage in a sole activity, with mid-stream activities (brokerage and transport) almost entirely engaged in by single activity actors (Table 4).

This means that at least one in four sampled operators engage in some form of vertical integration. This seems to be a distinctive feature of the Ugandan informal timber sector as compared to the formal one, where vertical integration is a common practice owing to the advantages it offers such as improving procurement security and capturing profit margin along the chain (Held *et al.* 2010). This can be attributed to challenges inherent to small-scale operations. The upstream integration pattern (e.g., production and trading) is relatively more frequent than the other integration patterns while the downstream integration pattern is the least common. Interestingly, those that are more fully integrated are rarely involved in trading and transportation, indicating that this category may be dominated by producers who sell directly to consumers within the locality of production.

Integrated strategies are adopted almost exclusively by men. Despite reportedly higher profits associated with such models, women traders report preferring procuring and selling timber at the market in order to avoid risky and time-consuming activities associated with timber production. In the mid-western cluster, female traders often work with their spouse. In some instances, this is reported to allowing male-spouses to focus on production activities while female-spouses manage sales. Overall, female traders were observed to operate with smaller sawn wood stocks and often relying on male associates when dealing with law enforcement agents.

Overall, the informal timber business is fragmented, with low levels of vertical integration. This can be attributed to the lack of process and product standards demanded downstream, as well as to the informal and criminalized nature of the sector, which in turn hampers the discussion and adoption of streamlined and coherent regulations providing incentives and opportunities for a coordinated approach to production, processing and selling. Rather, the chain, as expected, resembles traditional market governance, characterized by an absence of standards and high levels of fragmentation both up- and downstream. Horizontal coordination with other operators in the value chain is uncommon with only 25% of respondents indicating that they had any form of collaboration with actors engaged in similar activities as theirs. When it does exist, coordination relates to both core and non-core activities. The former include activities that are specific to the sawn wood value chain such as tree planting, harvesting, transportation, processing, and marketing of sawn wood. This type of coordination includes joint performance of activities and labour pooling in order to capitalize on scale efficiencies. The latter include activities such as joint savings or social support for private activities not directly related to the sawn wood value chain (e.g., see Chevallier and du Preez 2012).

The reasons for weak horizontal coordination include limited opportunities due to lack of groups (e.g., cooperatives, associations) to join, the mobile nature of the business, or the excessive membership fees when groups do exist, but also negative perceptions – notably among traders – such as lack of interest, mistrust, and ethnic divisions. While indeed there were barriers to collective action initiatives, the limited number of people participating in any form of cooperation may have also been exacerbated by the fact that most of the trade is informal and criminalised by mainstream government law enforcement practices. Collective action initiatives are triggered by the existence of incentives from government for grouping of enterprises (Guillen 2000), and the current environment in Uganda is not conducive to this.

Yet, we argue, a more proactive stance is needed on both sides – government and operators – to start discussions aimed at improving the current situation. Incentivising coordination may bring social benefits to operators (e.g., job security, bargaining power), financial benefits (e.g., more sustainable profits and increased revenues), and environmental benefits to all (e.g. better planning of harvesting operations and replanting schemes), in addition to decreasing the number of operations and operators working outside the law by spreading legal compliance costs. Importantly, given for instance women's lesser engagement in vertical integration as well as their dependence on male relatives and associates for dealing with authorities, such efforts must seriously consider various social, economic and cultural constraints in order to avoid further marginalizing less connected and competitive value chain actors (see e.g., Ribot 1998 and Smith *et al*. 2018).

The latter point is particularly important as results indicate that, when it comes to the legality of traded products, the most common modus operandi in the sector is 'don't ask, don't

TABLE 4 *Patterns of vertical integration in the sawn wood value chain*

Activity pattern	Frequency (percentages) by primary activity					
	Produce	**Broker**	**Transport**	**Trade**	**Retail**	**Total**
Sole activity	82 (65.1)	41 (97.6)	53 (98.1)	28 (51.9)	102 (76.2)	**306 (74.6)**
Upstream	25 (19.8)	-	1 (1.9)	18 (33.3)	-	**44 (10.7)**
Downstream	-	1 (2.4)	-	8 (14.8)	16 (11.9)	**25 (6.1)**
Integrated	19 (15.1)	-	-	-	16 (11.9)	**35 (8.5)**
Overall	**126 (30.7)**	**42 (10.2)**	**54 (13.2)**	**54 (13.2)**	**134 (32.7)**	**410**

tell'. On average, sampled operators reported that most of the sawn wood (60%) that they dealt with in their businesses is legal (i.e., it conforms to established rules and regulations), with producers indicating the lowest proportion (54%). Obviously, producers are key here. If the timber is accessed and harvested illegally, it can then be sold down the chain without other operators knowing, hence dealing with it as if it were a legal product. This is further reinforced by the finding that on average 15% of sampled operators (with the lowest value at 10% for wholesalers/retailers) report customers demanding for legal sawn wood or paperwork attesting to the legality of the product traded or bought.

While these results are based on estimations of actors about the volumes of legal sawn wood through their businesses as opposed to hard assessment of paperwork, they still clearly indicate not only that there are serious problems with the legality of the timber value chain in Uganda, but also that such problems are persistent throughout the years, as research conducted almost a decade ago indicated that most sawn wood marketed in Uganda was illegal as official procedures and regulations were rarely followed (WWF 2012a, 2012b).

What constraints do different actors along the sawn wood value chain face?

The key challenges faced by sawn wood value chain actors include the high cost of doing business, poor road infrastructure, timber scarcity and poor quality of timber, as well as business environment risks. Key issues identified under high cost of doing business include expensive licenses and high taxes, the high cost of transportation, and high cost of borrowed capital. Poor road infrastructure relates to impassable roads in rural areas, particularly during the rain seasons. The issues identified under resource waste, scarcity and poor quality include harvesting of immature trees which yields poor quality timber, reduced availability of trees (hence timber) and under-sizing of the timber.

Business environment risks and weaknesses faced by timber producers include bad debts and delayed payments arising from credit customers, high competition for the few customers, corruption, theft, unreliable workers, fire hazards and the unregistered brokers. Regulatory challenges include harsh enforcement personnel, unclear requirements, bureaucracy necessary to formally harvest trees even from privately owned plantations, and illegality of chainsaw use.

The regulatory framework governing the production and trade in forest produce includes the Uganda National Forest Policy (2001), the National Forestry and Tree Planting Act (2003), the Statutory instrument No.16 (forest produce fees and license order) 2000, the Ministerial Notice (2004) banning chain saw use in sawn wood processing, the legal timber trade guidelines (2014), Value Added Tax Act Cap 349 (1996) as Amended, PPDA Act-2003, the National Forestry and Tree Planting Regulations (2016), and Chain of Custody Procedures (UNBS 2019). The many restrictive provisions in these regulatory instruments, while well-intentioned, do provide the ground for non-compliance as the administrative burden required for their observance is overarching for both, the regulators and the regulated.

Consequently, most of the timber on the market is produced in contravention of these legal instruments and as such is classified as informal and/or illegal. According to WWF (2012), the reasons explaining why over 80% of sawn wood in Uganda is produced and traded illegally include inconsistent regulation, inadequate law enforcement, dysfunctional systems of tracking of timber, tax evasions and uncoordinated institutional responses. Yet, little has changed on the policy side over the past decade. This can partly explain why most of the harvesting and trade is still done either in legally grey areas (e.g., it remains illegal to use chainsaws to harvest trees but not to process timber), or tout-court illegally, with operators complaining almost unanimously about regulatory procedures which are too expensive, too complex, and enforced through aggressive and militaristic approaches, with no efforts paid towards improving rules and regulations applied to their operations.

Given the high level of fragmentation both up and downstream and the potential benefits of more explicit coordination, more emphasis should be placed on improving collective organization; for example, by promoting and incentivizing cooperative enterprises. This will furthermore enable policymakers and regulators to reduce transaction costs associated with enforcing formal rules and enable small-scale producer interests to be more equitable represented in policy dialogues and reforms.

CONCLUSION

This paper addressed several knowledge gaps on the formal-informal continuum found along the sawn wood value chain in Uganda. Results point to a very fragmented value chain, where neither vertical nor horizontal integration are mainstream. Yet urbanisation and demographic growth have pushed demand up over the years, and while the scale of single operations remains generally small, their growing number is currently able to satisfy a very conservative annual consumption of between 386,000 and 467,000 cubic meters of sawn wood.

Overall, we argue the current policy framework is neither adapted nor ready for the value chain to become an engine of growth in terms of socially fair and environmentally sustainable local livelihoods, green businesses, and State revenues. This is possibly the result of long-term neglect and criminalisation by the Government of Uganda, and poor consideration to social dynamics, which also contribute to maintain a large number of production and trade operations in the informal or tout-court illegal realm.

As Uganda has in recent years started putting on the market timber sourced from its industrial plantations, it is of the utmost importance to adopt improved and 'do-no-harm' policies vis-à-vis the large number of currently informal operators and their families described in this paper. This does not mean that policy reforms are a panacea to the challenge of informal sawn wood production and trade, as any sector reform process will create new winners and losers. Yet they remain a very important step indicating that the sector is acknowledged, discussed and legislated by the Government

of Uganda, instead of brushed under the carpet of a ban which remains, as we have shown, largely unenforced.

The expected progressive shift from natural forests to plantations as the primary source of wood, has policy implications with regard to privately grown plantations requiring lengthy regulatory procedures to be formally harvested. This points to the need for a paradigm shift on the regulatory framework to ensure that it facilitates rather than constrains the sawn wood value chain, since most of the timber is expected to be sourced from privately owned forests instead of State-owned forests. In fact, if most legal provisions remain based on the latter, there is not much hope that legality in the forestry sector will become the norm instead of the exception. In addition, findings also indicate that potential trade-offs between the expansion of plantations and local food production and security must be considered carefully.

Although addressing all these issues at once might seem complex, maintaining the status-quo – as it has been for decades on the banned use of chainsaws – is not a good option either. Policy discussions including concerned and relevant operators should start in earnest, as demand and consumption will continue to rise in the coming years.

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REFERENCES

BRACK, D. 2012. Excluding illegal timber and improving forest governance: The European Union's forest law enforcement, governance and trade initiative. In: LUJALA, P., and RUSTAD, S.A. (Eds): High-value natural resources and peacebuilding, 211–220. Earthscan, London, UK

BICKEL, A., and CERUTTI, O.P. 2017. Liberia: Domestic timber value chain analysis. Extractive overview report.

BYAKAGABA, P., and MUHIIRWE, R. 2017. Industrial forest plantations in Uganda: Local adjacent community perspectives, *Journal of Sustainable Forestry* **36**(4): 375–387. DOI: 10.1080/10549811.2017.1310048

CERUTTI, P.O., EBA'A ATYI, R., MENDOULA, E.E., GUMBO, D., LESCUYER, G., MOOMBE, K., TSANGA, R., and WALKER, J. 2017. Sub-Saharan Africa's invisible timber markets. *ITTO Tropical Forest Update* **26**(1): 3–5.

CERUTTI, P.O., LESCUYER, G., ATYI, E.A., ESSIANE, M.E., NGUIEBOURI, J., and ONDOUA, J.P. 2010. Opportunities and challenges of chainsaw milling in the Congo Basin. Paper presented at "Small scale forestry in a changing world: opportunities and challenges and the role of extension and technology transfer. IUFRO Conference, Bled, Slovenia, 06–12 June 2010".

CERUTTI, P.O., PUTZEL, L., PACHECO, P., and BAXTER, J. 2015. Tackling illegal logging in the tropics: From good intentions to smart policies. *BIORES* **9**(4): 8–11.

CERUTTI, P.O., TACCONI, L., LESCUYER, G., and NASI, R. 2013. Cameroon's hidden harvest: commercial chainsaw logging, corruption and livelihoods. *Society & Natural Resources* **26**(5): 539–553.

CERUTTI, P.O., ARTATI, Y., DERMAWAN, A., KELLY, A., LESCUYER, G., MEJÍA, E., OBIDZINSKI, K., PACHECO, P., PUTZEL, L., TSANGA, R., and WARDELL, A. 2014. Policy options for improved integration of domestic timber markets under the voluntary partnership agreement (VPA) regime. Synthesis from lessons learned in Cameroon, the Democratic Republic of the Congo, Ecuador, Gabon and Indonesia. Infobrief. Bogor, Indonesia: Center for International Forestry Research (CIFOR).

CHEVALLIER, R., and DU PREEZ, M.-L. 2012. Timber trade in Africa's Great Lakes: The road from Beni, DRC to Kampala, Uganda. South African Institute of International Affairs (SAIIA), Johannesburg, South Africa.

GUILLEN, M.F. 2000. Business groups in emerging economies: A resource-based view. *academy of Management Journal* **43**(3): 362–380.

HANSEN, C.P., POULIOT, M., MARFO, E., OBIRI, B.D., and TREUE, T. 2015. Forests, timber and rural livelihoods: Implications for social safeguards in the Ghana-EU voluntary partnership agreement. *Small-Scale Forestry* **14**(4): 401–422.

HELD, C., JACOVELLI, P., TECHEL, G., NUTTO, L., WATHUM, G., and WITTMANN, N. 2017. Tanzanian Wood Product Market Study. Forestry Development Trust.

HELD, C., TECHEL, G., and WINDHORST, K. 2010. Timber market study. Kampala, Uganda, UNIQUE and Sawlog Production Grant Scheme (SPGS).

HERMANS-NEUMANN, K., GERSTNER, K., GEIJZENDORFFER, I.R., HEROLD, M., SEPPELT, R., and WUNDER, S. 2016. Why do forest products become less available? A pan-tropical comparison of drivers of forest-resource degradation. *Environmental Research Letters* **11**(12): 125010.

JAGGER, P.A., SHIVELY, G., and ARINAITWE, A. 2011. Circular migration, small-scale logging, and household livelihoods in Uganda. *Population and Environment*. DOI: 10.1007/s11111-011-0155-z

LESCUYER, G., and CERUTTI, P. 2013. Sustainable forest management policies in Central Africa: Taking the informal sector into account. Perspective-policy-brief, CIRAD.

LESCUYER, G., CERUTTI, P.O., MENDOULA, E.E., EBA'A ATYI, R., and NASI, R. 2012. An appraisal of chainsaw milling in the Congo Basin. In: deWasseige *et al*. (eds). The forests of the Congo Basin – State of forests 2010. Publications office of the European Union, Luxembourg.

LESCUYER, G., CERUTTI, P.O., and ROBIGLIO, V. 2013. Artisanal chainsaw milling to support decentralized management of timber in Central Africa? An analysis through the theory of access. *Forest Policy and Economics* **32**: 68–77.

LESCUYER, G., CERUTTI, P.O., TSHIMPANGA, P., BILOKO, F., ADEBU-ABDALA, B., TSANGA, R., YEMBE YEMBE, R.I., and ESSIANE-MENDOULA, E. 2014. The domestic market for small-scale chainsaw milling in the Democratic Republic of Congo: Present situation, opportunities and challenges. Occasional Paper 112, CIFOR, Bogor, Indonesia.

LUKUMBUZYA, K., and SIANGA, C. 2017. Overview of the Timber Trade in East and Southern Africa: National Perspectives and Regional Trade Linkages. Cambridge, UK: TRAFFIC and WWF.

MWE [Ministry of Water and Environment]. 2016. State of Uganda's forestry – 2016. Government of Uganda, Kampala, Uganda.

MUKUL, S.A., HERBOHN, J., RASHID, A.Z.M.M., and UDDIN, M.B. 2014. Comparing the effectiveness of forest law enforcement and economic incentives to prevent illegal logging in Bangladesh. *International Forestry Review* **16**(3): 363–375.

OTOTO, G., and VLOSKY, R.P. 2018. Overview of the forest sector in Kenya. *Forest Products Journal* **68**(1): 6–14. DOI: 10.13073/0015-7473.68.1.4

PACHECO, P., CERUTTI, P.O., EDWARDS, D.P., LESCUYER, G., MEJÍA, E., NAVARRO, G., OBIDZINSKI, K., POKORNY, B., and SIST, P. 2016. Multiple and intertwined impacts of illegal forest activities. In: KLEINSCHMIT, D., MANSOURIAN, S., WILDBURGER, C., and PURRET, A. (Editors). Illegal Logging and Related Timber Trade – Dimensions, Drivers, Impacts and Responses: A Global Scientific Rapid Response Assessment Report. IUFRO World Series, Volume 35.

PHUC, T.X., and SIKOR, T. 2006, June. Illegal timber logging in Vietnam: Who profits from forest privatization connected with a logging ban? In *Survival of the Commons: Mounting Challenges and New Realities. In Proceedings of the Eleventh Conference of the International Association for the Study of Common Proverty, Bali, Indonesia* (pp. 19–23).

PLUMPTRE, A.J., DAVENPORT, T.R., BEHANGANA, M., KITYO, R., EILU, G., SSEGAWA, P., and PETERHANS, J.K. 2007. The biodiversity of the Albertine Rift. *Biological Conservation* **134**(2): 178–194.

PUTZEL, L., KELLY, A., CERUTTI, P., and ARTATI, Y. 2014. Formalization of natural resource access and trade: Insights from land tenure, mining, fisheries, and non-timber forest products. CIFOR, Bogor, Indonesia.

REBOREDO, F. 2013. Socio-economic, environmental, and governance impacts of illegal logging. *Environment Systems and Decisions* **33**(2): 295–304.

RIBOT, J.C. 1998. Theorizing access: forest profits along Senegal's charcoal commodity chain. *Development and change* **29**(2): 307–341.

RICHARDS, M., WELLS, A., DEL GATTO, F., CONTRERAS-HERMOSILLA, A., and POMMIER, D. 2003. Impacts of illegality and barriers to legality: a diagnostic analysis of illegal logging in Honduras and Nicaragua. *International Forestry Review* **5**(3): 282–292.

SCHAAFSMA, M., BURGESS, N.D., SWETNAM, R.D., NGAGA, Y.M., TURNER, R.K., and TREUE, T. 2014. Market signals of unsustainable and inequitable forest extraction: assessing the value of illegal timber trade in the Eastern Arc Mountains of Tanzania. *World Development* **62**: 155–168.

SMITH, H., LING, S., BARNEY, K., and KANOWSKI, P. 2018. Value Chain Assessment: Interim Summary Report – Teak plantations in Northern Laos. Technical Report. DOI: 10.13140/RG.2.2.33508.19845

TACCONI, L., CERUTTI, P.O., LEIPOLD, S., RODRIGUES, R.J., SAVARESI, A., TO, P., and WENG, X. 2016. Defining Illegal Forest Activities and Illegal Logging. In: KLEINSCHMIT, D., MANSOURIAN, S., WILDBURGER, C., and PURRET, A. (eds.) Illegal Logging and Related Timber Trade – Dimensions, Drivers, Impacts and Responses. A Global Scientific Rapid Response Assessment Report. Vienna: International Union of Forest Research Organizations (IUFRO), World Series Volume 35.

TEUCHER, M., SCHMITT, C.B., WIESE, A., APFELBECK, B., MAGHENDA, M., PELLIKKA, P., LENS, L., and HABEL, J.C. 2020. Behind the fog: Forest degradation despite logging bans in an East African cloud forest. *Global Ecology and Conservation* **22**: e01024.

TURYAHABWE, N., KAKURU, W., ASIIMWE, M., and BYAKAGABA, P. 2015. Proximate and underlying causes of illegal timber trade in Uganda. In: Miodrag Zlatic (Ed). Precious Forests, Precious Earth. https://doi.org/10.5772/61015

TUMUSIIME, D.M., VEDELD, P., and GOMBYA-SSEMBAJJWE, W. 2011. Breaking the law? Illegal livelihoods from a Protected Area in Uganda. *Forest policy and economics* **13**(4): 273–283.

UGANDA BUREAU OF STATISTICS [UBOS]. 2020. 2020 Statistical Abstract. Accessed from: https://www.ubos.org/wp-content/uploads

UGANDA NATIONAL BUREAU OF STANDARDS [UNBS]. 2019. Chain of custody procedures for timber and other wood-based products. Draft Uganda Standard, WDUS 2162.

WELLS, J., and WALL, D. 2005. Sustainability of sawn timber supply in Tanzania. *International Forestry Review* **7**(4): 332–341.

WIT, M., VAN DAM, J., CERUTTI, P.O., LESCUYER, G., KERRETT, R., and PARKER, M.J. 2010. Chainsaw milling: supplier to local markets – A synthesis. ETFRN News 52.

WWF. 2012a. National timber trade and FLEGT solutions for Uganda. World Wildlife Fund (WWF), Kampala, Uganda.

WWF. 2012b. Timber movement and trade in Eastern Democratic Republic of Congo and destination markets in the region. Kampala, Uganda, World Wildlife Fund (WWF).

WYNBERG, R., LAIRD, S., VAN NIEKERK, J., and KOZANAYI, W. 2015. Formalization of the natural product trade in southern Africa: unintended consequences and policy blurring in biotrade and bioprospecting. *Society & Natural Resources: An International Journal* **28**(5): 559–574. DOI: 10.1080/08941920.2015.1014604.

APPENDIX I

A multinomial logistic regression analysis (Equation 1) was used to examine whether socioeconomic variables influenced primary activity engaged in.
(Equation 1)

$$Ln\left(\frac{p(\pi_j)}{p(\pi_q)}\right) = \beta_{jo} + \sum_{i=1}^{k} \beta_{ji} x_i \text{ for } j = 1,\ldots,q\text{-}1 \qquad (1)$$

Where p denotes probability, π_j are the categories of the dependent variable (π_q being the reference category), β_{ji} are logistic constants (β_{jo} being intercepts), x_i are the explanatory variables (numbering k), Ln is the natural logarithm. Primary activity engaged-in was the dependent variable (categories: 'produce', 'broker', 'transport', 'trade' and 'retail' with 'produce' as the reference category) while socioeconomic variables were the independent variables. For all categorical independent variables the dominant category was used as the reference group.

Relationship between primary activity and socioeconomic characteristics

Unsurprisingly, analysis of patterns of involvement along the value chain indicates that majority of actors sampled were engaged in the sawn wood business as producers or wholesalers/retailers, which are the upstream and downstream ends of the sawn wood value chain respectively (Table 4).

The multinomial logistic regression model makes adequate prediction compared to the null model (X^2 = 329, df = 64, p =0.00) and explains about 59% of observed variations in the data. With exception of sex of respondents, all socioeconomic variables included in the model have significant influence on the primary activity engaged-in by actors in the informal sawn wood value chain (Table 4). Overall, the model correctly classifies 58% of actors; with exception of traders (12%), all categories are fairly correctly classified (44%–74%).

The insignificance of sex as a determinant of primary activity engaged-in can be attributed to the dominance of men over women in all nodes of the chain ranging between 74% and 90% except for the retail node where women represent 33% of actors sampled. This is the only node where sex influences the odds of participation compared to the production node.

Similarly, dependence influences participation in the transport node while education influences participation in the retail node. The odds of being a transporter compared to a producer decrease with increased dependence on sawn wood for income, indicating that actors who derive a high proportion of their income from sawn wood are less likely to engage in transport as a primary activity compared to production. Similarly, having a secondary level of education increases the odds of participation in the retail node compared to production, indicating that actors with a secondary level of

TABLE 5 *Patterns of involvement in various stages of the sawn wood value chain*

Activity Rank	Frequency (percentage) by activity				
	Production	**Brokerage**	**Transport**	**Trade**	**Retail**
Primary	131 (81.4)	42 (68.9)	54 (84.4)	53 (58.2)	130 (82.3)
Secondary	28 (17.4)	19 (31.1)	6 (9.4)	36 (39.6)	26 (16.5)
Tertiary	2 (1.2)	-	4 (6.2)	2 (2.2)	2 (1.2)
Overall	**161**	**60**	**64**	**91**	**158**

TABLE 6 *Likelihood ratio tests for independent variables*

Effect	-2 log likelihood	X^2	df	p
Intercept	854.2	0	0	-
Timber income dependence	864.8	10.6	4	0.03
Years in primary activity	887.6	33.4	4	0.00
Age	888.3	34.2	4	0.00
Sex	862.4	8.2	4	0.08
Ethnic group	892.8	38.6	16	0.00
Social burden	887.5	33.3	8	0.00
Wealth endowment	879.2	25.0	8	0.00
Residence category	903.5	49.4	8	0.00
Education level	880.3	26.1	8	0.00

education (compared to primary and below) are more likely to participate in the retail link than in the production link.

Experience reduces the odds of participation in intermediation, transport and the retail nodes as a primary activities compared to production, indicating that actors participating in those nodes have less experience in the sawn wood commodity chain than those who are primarily producers.

Similarly, age reduces the odds of participation in intermediation and the transport node as a primary activities compared to production, indicating that compared to producers, brokers and transporters are more likely to be younger. On the other hand, facing a light (compared to medium) social burden increase the odds of doing intermediation and participation in the retail nodes as a primary activities compared to production, indicating that actors facing a light burden are more likely to engage in intermediation or retail than in production.

Residence status (local or resident compared to outsiders) increase the odds of doing intermediation, and participation in the transport and retail nodes as a primary activities compared to production. Thus compared to producers, brokers as well as wholesalers/retailers are less likely to be outsiders. Similarly, ethnicity influences participation in all nodes of the informal sawn wood commodity chain, except the role of intermediation, increasing or decreasing the odds of participation depending on node and ethnicity. Compared to the production node, belonging to the Banyoro ethnic group increases odds of participation in the transport and wholesale nodes. On the other hand, belonging to the Banyankole or 'others' ethnic groups reduces the odds of participation in the trade node compared to the production node. This can be attributed to an above average participation of the Bakiga and below average participation of the Banyoro, Banyankole and 'others' ethnic groups in these nodes. At 39% and 48% in the production and trade nodes respectively, participation of the Bakiga ethnic group in these nodes is higher than their overall participation in the chain at 33%.

Apparently, there is overlap between the production and trade node or the actors who engage in production and trade as primary activities have relatively similar socioeconomic characteristics. A cross-tabulation between these activities indicates that 25% of actors who are primarily producers also engage in trade while 33% of actors who are primarily traders also engage in production. Both nodes are dominated by the Bakiga ethnic group at participation levels above their overall average in the chain.

TABLE 7 *Extract of parameter estimates for significant effects in the model*

Activity*	Variable	β	SE	Wald	df	Sig.	Exp(β)
Intermediation	Intercept	5.23	1.58	10.96	1	0.01	-
	Experience	-0.23	0.07	12.02	1	0.00	0.79
	Age	-0.14	0.04	16.25	1	0.00	0.87
	Burden (Light)	2.96	1.34	4.91	1	0.03	19.35
	Residence (Locals)	2.77	1.22	5.15	1	0.02	16.01
	Residence (Residents)	2.90	0.74	15.42	1	0.00	18.20
Transport	Intercept	3.58	1.52	5.56	1	0.02	-
	Dependence	-0.02	0.01	5.08	1	0.02	0.98
	Experience	-0.25	0.06	19.53	1	0.00	0.78
	Age	-0.07	0.03	5.10	1	0.02	0.93
	Ethnicity (Banyoro)	1.54	0.57	7.33	1	0.01	4.67
	Residence (residents)	2.62	0.66	15.72	1	0.00	13.78
Trade	Ethnicity (Others)	-1.23	0.61	4.13	1	0.04	0.29
	Ethnicity (Banyankole)	-1.24	0.63	3.89	1	0.05	0.29
Wholesale/Retail	Experience	-0.08	0.03	7.22	1	0.01	0.93
	Sex (Women)	1.06	0.47	5.25	1	0.02	2.89
	Ethnicity (Others)	-1.25	0.57	4.88	1	0.03	0.29
	Ethnicity (Banyoro)	1.03	0.44	5.51	1	0.02	2.80
	Education (Secondary)	0.86	0.34	6.51	1	0.01	2.37
	Residence (Residents)	2.33	0.50	21.41	1	0.00	10.30
	Social Burden (Light)	1.80	0.53	11.33	1	0.01	6.03

* Primary activity (reference category = Produce)