

# Beyond Timber: balancing demands for tree resources between concessionaires and villagers

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## SUMMARY

Extensive areas of the Congo Basin forest are allocated to timber concessionaires. These forests also harbour and support village populations, including indigenous Baka people, who depend on forest foods obtained directly from trees (fruits, oils and caterpillars). Most food-producing tree species are harvested by concessionaires for timber. We documented the availability and abundance of three food tree species around four villages and in two neighboring timber concessions in Cameroon. Data was used to determine the importance of timber concessions as sources of food for local people to provide a foundation for governance arrangements that consider local needs for foods from timber trees. Discussions with concessionaires revealed that some of them have voluntarily refrained from extracting timber species of interest to villagers for their non-timber products. This is either to avoid conflict with villagers, or because regulations have been promulgated to safeguard these resources. The interplay between internal village dynamics, regulations and their implementation by forest guards, and the actions of timber concessions create a complex arena for addressing rights to forest resources. This paper provides information on the accessibility and availability of multiple use timber species as a foundation for negotiations and governance arrangements between concessionaires and local communities.

Keywords: timber concessions, forest communities, non-timber forest products, resource rights

## Au-delà du bois: équilibrer les demandes de ressources arboricoles entre concessionnaires et villageois

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De larges zones du Bassin du Congo sont allouées aux concessionnaires du bois. Ces forêts sont également résidence et sources de revenus pour des populations villageoises, ce qui inclut les Bakas, qui dépendent d'aliments forestiers provenant directement des arbres (fruits, huiles et chenilles). Le gros de ces espèces d'arbres particulières sont récoltées par les concessionnaires du bois. Nous avons documenté la disponibilité et l'abondance de trois espèces d'arbres produisant des aliments aux alentours de trois villages et dans deux concessions de coupe de bois avoisinantes au Cameroun. Les données ont été utilisées pour déterminer l'importance des concessions en tant que source alimentaire pour les populations locales et pour fournir une fondation pour des arrangements de gestion reconnaissant les besoins locaux d'aliments provenant d'arbres à coupe. Des dialogues avec les concessionnaires ont révélé que certains d'entre eux ont volontairement freiné l'extraction des espèces importantes pour les villageois, du fait de leurs produits autres que le bois. Cela s'est produit soit pour éviter un conflit avec les villageois, soit parce que des règlements ont été promulgués pour protéger ces ressources. Les échanges entre les dynamiques internes aux villages, les règlements et leur mise en pratique par les gardes forestiers, et les actions des concessions de bois créent une scène complexe où les droits aux ressources forestières peuvent être adressés. Par conséquent, ce papier fournit des informations importantes sur la disponibilité et l'accessibilité des espèces d'arbres à usages multiples, offrant ainsi une fondation pour aller vers des négociations et des arrangements de gestion satisfaisants entre concessionnaires et communautés locales.

## Más allá de la madera: cómo equilibrar las demandas por recursos arbóreos entre concesionarios y comunidades

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En la Cuenca del Congo se han asignado extensas áreas de bosque a concesionarios de la madera. Estos bosques albergan y sustentan también poblaciones rurales, como el pueblo indígena Baka, quienes dependen de los alimentos del bosque obtenidos directamente de los árboles (frutas, aceites y orugas). La mayoría de estas especies arbóreas son aprovechadas por concesionarios de la madera. Este estudio documenta la disponibilidad y abundancia de tres especies de árboles que proporcionan alimentos a cuatro aldeas en las cercanías de dos concesiones de madera vecinas en Camerún. Se utilizaron datos para determinar la importancia de las concesiones madereras como fuentes de alimento para la población local que pueden constituir la base para desarrollar estructuras de gobernanza que reconozcan las necesidades locales de alimentos procedentes de árboles maderables. Las conversaciones con los concesionarios mostraron que algunos de ellos se han abstenido voluntariamente de extraer especies madereras de interés para las comunidades, debido a los productos no maderables que ofrecen. Las razones han sido evitar conflictos con las comunidades, o porque se han promulgado regulaciones para salvaguardar estos recursos. La interacción entre la dinámica interna de las aldeas, las regulaciones y su implementación por los guardas forestales, y las acciones de los concesionarios de la madera, crean un espacio complejo para equilibrar los derechos a los recursos forestales. Por lo tanto, el artículo aporta información sobre la accesibilidad y la disponibilidad de especies maderables de uso múltiple como la base para negociaciones y estructuras de gobernanza entre concesionarios y comunidades locales.

## INTRODUCTION

In recent years, there has been an increased recognition of the impact of industrial logging activities on tropical forests and tree resources that are also of great importance to the livelihoods of forest-dependent populations (Rist *et al.* 2011, Yosi *et al.* 2011, Guariguata *et al.* 2010, 2008, Tieguhong and Ndoye 2007, Karsenty and Gourlet-Fleury 2006, Ndoye and Tieguhong 2004, Menton 2003, Laird 1995). This holds true for the forests of the Congo Basin forest, the second largest rainforest block in the world after the Amazonian forests. About 40 percent of the more than 200 million hectares of the Congo Basin forest are already allocated to commercial logging companies under concession arrangements (Gatti *et al.* 2015, Duveiller *et al.* 2008). The Congo Basin forest is a significant source of timber (Cerutti *et al.* 2008, Hall *et al.* 2003) and non-timber forest products (NTFPs) such as vegetables, fruits, oils, caterpillars, medicinal barks and bush meat (Lescuyer *et al.* 2012, Ingram and Schure, 2010, Tieguhong and Ndoye 2007, Ndoye and Tieguhong 2004). However, increasing pressures from logging, agriculture, population growth and mining are accelerating land-use change and forest degradation (Gatti *et al.* 2014, Maesano *et al.* 2013, Bayol *et al.* 2012), and threatening the livelihoods of over 50 million people whose shelter and well-being depend on these forests (Nasi *et al.* 2011). Given the large number of forest-dependent people living in or near the forests, the management of these forests by the logging companies has a direct impact on livelihoods (Arnold *et al.* 2012, Cronkleton *et al.* 2012, Rist *et al.*, 2012). Not only do forests provide food to the local populations (Fungo *et al.* 2015, Tieguhong *et al.* 2013, Debroux 2008) but they also act as buffers against environmental degradation due to disastrous weather changes (Chidumayo *et al.* 2011) and hunger in lean seasons and in times of crisis (Levang *et al.* 2015, Lescuyer *et al.* 2012, Tieguhong and Nkamgnia 2012, Tieguhong *et al.* 2009). Disruption of the supply of these products may have immediate and/or lasting consequences on the wellbeing of people (Duchelle *et al.* 2011, Laird *et al.* 2011, Nasi *et al.*

2011, Sunderland 2011, García-Fernández *et al.* 2008, Foley *et al.* 2007).

The data required to better understand how to avoid this disruption is either partially available or completely lacking in most forest concession areas in the region. Data on the availability of important tree resources in forest concessions and surrounding village communities as well as their accessibility to the dependent populations is rare (but see Noutcheu *et al.* 2016, Maukonen *et al.* in press). This study sought to answer two key questions: what is the availability of these priority tree species in forest concessions and around villages? And how is the availability of these priority tree species affected by logging? Generating information about these patterns could guide policy makers in formulating policies and strategies to protect the tree resources that are beneficial to the forest-dependent populations (Rist *et al.* 2011, Endamana *et al.* 2010, Veloso de Freitas 2008, Assembe 2006, Garcia *et al.* 2001). The results presented in this paper try to fill this information gap for two forest concession areas in Cameroon, within the framework of a multi-partner project funded by the Congo Basin Forest Fund (CBFF) and the CGIAR Research Programme on Forests, Trees and Agroforestry (FTA).

## Conceptual framework

The central point discussed in this paper is how arrangements on access to forest foods from timber trees can be fairly articulated based on sound data on abundance, accessibility and availability around village communities and in neighbouring forest concessions. According to Wiersum *et al.* (2014), the rules, decision-making processes, institutional arrangements and measures that govern access to resources and markets are captured in the concept of governance. In the forestry sector, forest governance goes beyond specific products and services (e.g. timber, NTFPs, carbon) to address the multitude of institutional factors (across levels) that affect management of forest resources. However, with respect to this paper on the availability and accessibility of multiple use tree species, one can easily discern two inter-related governance concepts related to timber and non-timber forest

products (NTFP) respectively. Forest governance is defined as the multilevel and multi-stakeholder process of decision-making on, and the implementation of policies for, effective forest use and management (Arts and Visseren-Hamakers 2012). The purposes for which forests are managed and the conditions under which different stakeholders have access to decision-making and implementation processes are mostly linked to timber (Wiersum *et al.* 2014, Agrawal *et al.* 2008). Analogous to forest governance, NTFP governance is defined as the multi-stakeholder and multilevel process of interactive decision-making and creation of institutional frameworks for the allocation, use and trade of NTFPs (Ros-Tonen and Kusters 2011, Wiersum and Endalamaw 2013). By this definition, NTFP governance has some peculiarities because it is characterized by highly dispersed and seasonal products as well as community-wide involvement, featuring fewer barriers to entry and smaller or no capital investments. This may lead to more institutional complexity at the local level because of prevailing customary rules of access in addition to the statutory laws and institutions that typically prevail with regards to governing access to timber resources (Tieguhong *et al.* 2015, Wiersum *et al.* 2014, Ingram 2012, Colfer *et al.* 2011, Ros-Tonen and Kusters 2011). In this paper, the governance discourse is linked to the issues of accessibility and availability of multiple use trees that provide both NTFPs to local communities and timber to concessionaires. The information generated in our research and provided in this paper could form a foundation for negotiations between forest concessionaires and forest communities on the sustainability of access to multiple use tree species to ensure the fulfillment of corporate social responsibilities.

## METHODOLOGY

### Research sites and priority tree species

The results presented in this paper are from two study sites in Cameroon. The study sites are forest concession areas and adjoining village communities. The selection of the sites was based on a number of criteria including the existence of trees with timber and food values, easy access to sites for research teams, willingness of the concessionaire to collaborate in the study, existence of baseline information and management plans, and presence of human settlements (if possible of different ethnic groups) in the immediate environment of the concession. In addition, an attempt was made to select one concession that was managed by a national company and another that was managed by an international company. Using these criteria, all project partners participated in a workshop to select two forest concessions (SCTB and FIPCAM) in Cameroon (Figure 1). The main characteristics of the concessions and villages around them are as indicated in Table 1. In 2004 the population around the SCTB concession in the East Region numbered about 25,783 people who lived in 41 villages and hamlets and were mainly of the Kako, Pol, and Maka (Bantu) and Baka (pygmy) ethnic groups (Medinof 2004). The population around the FIPCAM concession in the South Region in 2009 was estimated at 79,353,

living in 29 villages and hamlets (Enviro Consulting 2009 in Levang *et al.* 2015), nearly all of them Bulu (Bantu) ethnic group. Population density around the concessions is low, with 7.1 inhabitants km<sup>-2</sup> in the East and 13.4 inhabitants km<sup>-2</sup> in the South (Levang *et al.* 2015). Sample villages were chosen based on several criteria: compact layout, proximity to the concession and their selection for parallel socioeconomic studies. Around SCTB concession, Nkolbikon (Nk) village is inhabited by Baka pygmies, who are highly dependent on forest resources although they are increasingly being accustomed to sedentary agricultural practices (Tieguhong and Ndoye 2007, Levang *et al.* 2015). The village is located inside a formally established community forest (APOBA) that is located less than 5 km from the concession's annual cutting area of 2012. Another sample village, Ndembo (Nd), inhabited by Kako and Pol people (Bantu), is located about 15 km from the concession. The other two sample villages near FIPCAM concession were Ngone (Ng) and Meyos (Me), inhabited by Bulu people of Bantu origin. Their principal activities are agriculture, hunting and informal timber production (Noumbissi 2012) (Figure 1).

The next activity was to select the focal timber tree species, which was done based on five criteria: the species is present in the selected concessions areas; has a nutritional non-timber forest product value to people in adjoining forest communities (these were included in parallel nutrition studies); has a significant timber value; and molecular markers are available, allowing for cost-effective parallel genetic studies regarding the effects of logging on the viability of populations and regeneration. Following these criteria, the selected tree species were moabi (*Baillonella toxisperma*), tali (*Erythrophloeum suaveolens*) and sapelli (*Entandrophragma cylindricum*). Moabi was selected because it produces edible fruits and oil-bearing seeds; tali and sapelli because they host edible caterpillars. All three important timber species were studied in Cameroon.

### Data collection

Data was gathered and analyzed on the accessibility (physical proximity) and availability (abundance) of selected food-providing timber tree species in two forest concessions and around four villages adjoining those concessions.

### Resource availability study in concessions

To answer the question, 'How is the availability of the selected food-providing tree species affected by logging?' two studies were carried out: one based on harvest inventories and one based on field sampling. In some areas, logging has taken place over a very long period, under the auspices of several different companies. It cannot be assumed that the conditions in most concessions represent an "unlogged" condition; we can only compare the current status of the forest before and after current logging. Field work was carried out from January to May 2013 in Cameroon by a team of researchers including experts from Bioversity International, national research institutes and university students. In each

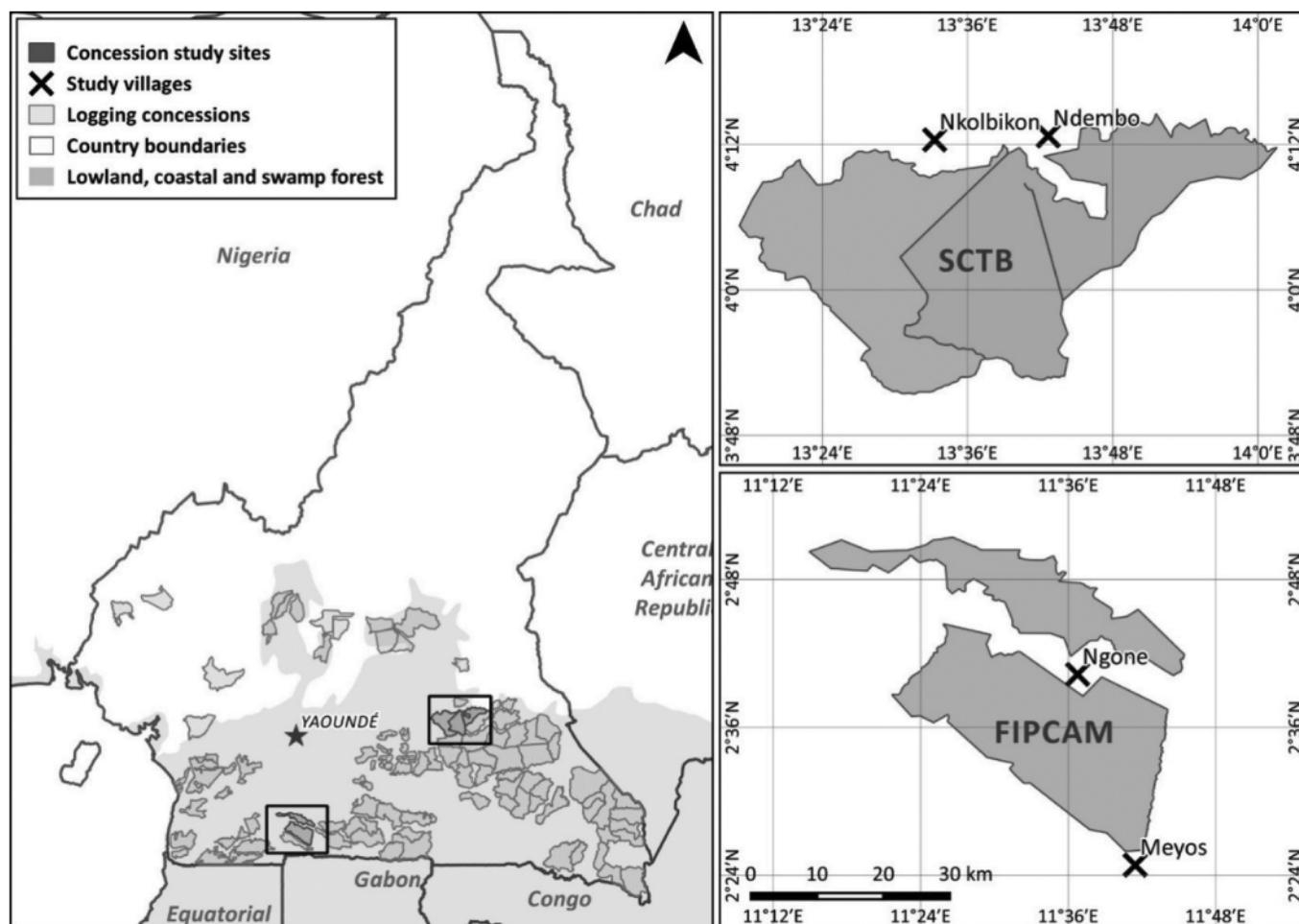
FIGURE 1 Location of SCTB and FIPCAM concessions and associated sample villages in Cameroon (Noutcheu *et al.* 2016)

TABLE 1 Characteristics of the selected concessions in Cameroon

Characteristics	Concession	
	SCTB	FIPCAM
Size (ha) of concession*	169,180	99,459
Status of management plan	Approved	Approved
Certification status	Uncertified	Uncertified
Origin of main holders	Cameroonian	European
Number of villages around concessions*	41	29

\*Lescuyer *et al.* 2015.

forest concession, plot-based sampling was conducted in a recently exploited forest unit. Twenty 5-ha plots were established in the 2012 cutting area in each concession to quantify the density of trees of moabi, tali and sapelli remaining after harvest, including those below exploitable size. Exploitation inventory maps were provided by the concessionaires. These maps were used to identify the 2012 cutting area and the 25 ha inventory plots (logging units) by their numbers. In Cameroon, annual cutting units totaled about 5000 ha, 200 inventory plots of 25 ha. In each of the four quadrants (North,

South, East and West) of the 2012 cutting area, five of the 25 ha inventory plots were selected at random. Within each randomly selected inventory plot, a subplot of 100 m by 500 m (5 ha) was established to give a 0.5% sample area. All individuals of priority tree species (moabi, tali and sapelli)  $\geq 20$  cm dbh within the sample plot were identified and their diameters at breast height (dbh) measured. When trees had buttresses, diameters were measured at 50 cm above the buttresses in addition, recent stumps were identified and measured (Noutcheu *et al.* 2016).



### Availability and accessibility of tree resources around villages

In order to quantify the availability of food trees at different distances from the village, sample plots were stratified by distance from the village towards the concession. The sample area was a half circle surrounding the villages, an area of 157 km<sup>2</sup> (15,700 ha). To achieve a 0.5% sampling intensity, 21 plots of 5 ha were established around each of four villages. Plots were laid out along three transects outward from the village centre toward the forest concession to a maximum distance of 10 km. The central transect (“B”) was oriented toward the forest concession and transects “A” and “C” were laid out on bearings 45 degrees on each side of it. Transects were laid out using compasses and GPS (to measure distance) and cleared by machetes to facilitate access. Sample plots were located within four different distance bands from the village along the transects. Numbers of plots per distance band were proportional to the area sampled in each band, which increased with distance from the village (Noutcheu *et al.* 2016). Sample plots were 5 ha in size, 100 m along transects and 500 m extending to one side or the other (alternating) of the directional transect. Within each plot, all individuals  $\geq 20$  cm diameter of tali, sapelli and moabi were identified and their diameters measured. All stumps were also identified and measured; stumps of moabi, tali or sapelli were measured based on the diameter of the circular stem within any buttresses.

In order to determine where local populations obtained priority tree products, a participatory mapping exercise with GPS was carried out in two villages associated with each of the two selected timber concessions in Cameroon, a total of four villages. Villages were selected based on their accessibility and proximity to the concessions. Only spatially contiguous villages were selected, not those that consisted of multiple hamlets. Data from recent socioeconomic and nutrition studies were also used in selecting the villages (Noumbissi 2012). Male and female collectors of moabi fruits/seeds and caterpillars that use sapelli and tali trees were interviewed and accompanied by a researcher (female when the informant was female; male where the informant was male) to the trees where they collected these resources. Each team was also accompanied by a local guide to translate and clear footpaths, when necessary. The male and female researchers accompanied different informants each day for a period of 5 days, making a total sample size of 5 women and 5 men from each village. Each informant showed the researcher the moabi, sapelli and tali trees from which he/she collected either fruits or caterpillars and answered a questionnaire about the availability and collection of the resource. Each team was equipped with a Garmin Dakota 20 GPS device, a diameter measuring tape, field data sheets, a questionnaire and lunch. Trees from which resources were collected were mapped by the researcher using GPS coordinates (Maukonen *et al.* in press). A map of the collection trees of the priority species was developed for each village.

### Data analyses

Primary statistics were used to analyze the abundance, densities and diameter distributions of priority tree species around villages and in concessions. Analysis of variance (ANOVA) was used to understand whether the densities of the priority species varied significantly among villages and concessions and Games Howell post hoc analysis was employed to better show the dispersion of the distribution of size classes of selected trees around villages.

## RESULTS

Three levels of analysis were carried out to determine the abundance of priority tree species in sampled areas within concessions and around four village communities surrounding those concessions.

### Resource availability around villages

The availability of priority trees around villages varied significantly (Moabi  $p=5.517e-06$ ; Sapelli  $p=4.771e-07$ ; Tali  $p=0.00258$ ) among the four villages (abbreviated Me=Meyos, Nd=Ndembo, Ng=Ngone and Nk=Nkolbikon). Trees measured included individuals with diameters up to 300 cm; on average they measured 77.8 cm (STD= 51.2 cm). Moabi trees reached 300 cm, with a mean of 52.4 cm (STD=58.7 cm); sapelli reached 282 cm with a mean of 65.0 cm (STD=52.4 cm) and tali reached 263 cm with a mean of 98.2 cm (STD=37.1.0 cm). On the 420 ha of sample plots around the four villages, a total of 537 trees of the three priority tree species were counted, equivalent to approximately 128 on 100 ha (density of 1.28 trees/ha), with tali dominating in absolute numbers (Table 2). Overall there were larger trees of tali than the other two priority species, which could reflect different logging histories and pressures on the three species. Densities of trees around the different villages varied greatly ( $p=0.0476$ ), with many more moabi trees around Me than around the other villages. Nd and Nk had a higher density of sapelli trees and Nk had the highest density of tali trees (Figure 2). There were fewer moabi trees than the other two species in all diameter classes. Stumps of the selected species were observed in the sampled forest areas around the villages (Noutcheu *et al.* 2016), and about 30% of the priority trees were larger than the 100 cm minimum exploitable diameter for moabi and sapelli or 50 cm for tali (Figure 3). Moabi and sapelli trees were most abundant in the smallest diameter class (20–39.9 cm), although their density would only translate to about 1 in every 5 ha.

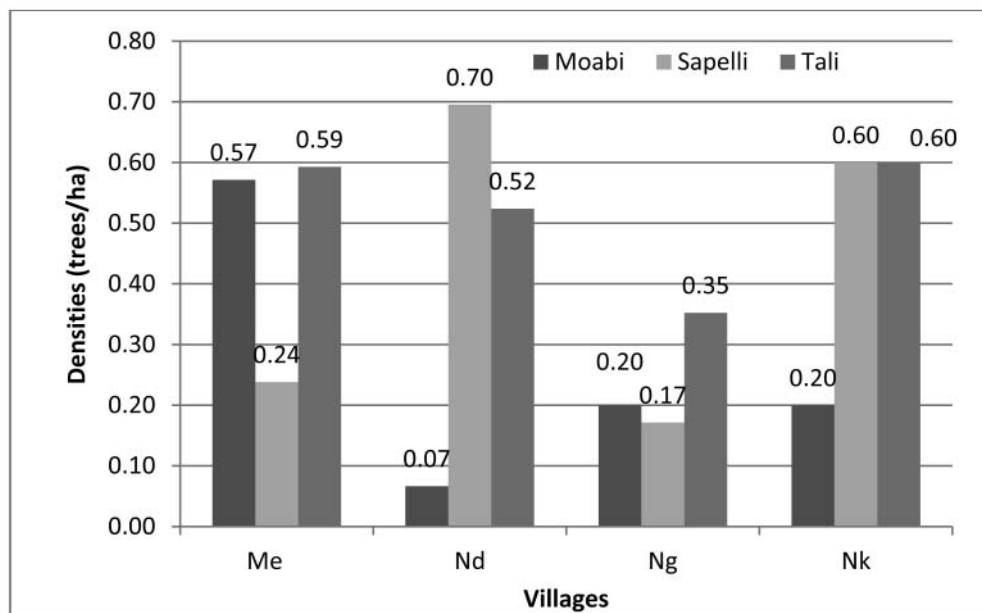
### Resource availability in concessions

On the 200 ha of sample plots inventoried in the two forest concessions, a total of 275 trees  $\geq 20$  cm of the three priority species were counted: 6.5% were moabi, 39.3% were sapelli and 54.2% were tali; of these 5.8% were stumps of sapelli (1.4%) or tali (4.4%). There were no moabi stumps in either

TABLE 2 Characteristics of diameters of priority tree species  $\geq 20$  cm dbh on a total of 105 ha of sample plots per village on transects extending to 10 km from each of four villages (abbreviated Me, Nd, Ng and Nk)

Species and villages	N	Max dbh (cm)	Mean dbh (cm)	STD (cm)
<b>Moabi (sum)</b>	<b>109</b>	<b>300</b>	<b>52.4</b>	<b>58.7</b>
Me	60	236	54.0	56.9
Nd	7	83	36.3	21.5
Ng	21	150	38.7	33.9
Nk	21	300	67.2	85.0
<b>Sapelli (sum)</b>	<b>179</b>	<b>282</b>	<b>65.0</b>	<b>52.4</b>
Me	25	264	115.1	64.4
Nd	73	160	42.5	33.6
Ng	18	215	61.2	49.8
Nk	63	282	72.3	51.1
<b>Tali (sum)</b>	<b>249</b>	<b>263</b>	<b>98.2</b>	<b>37.1</b>
Me	55	263	124.5	36.0
Nd	37	155	83.1	35.3
Ng	63	212	100.9	40.5
Nk	94	164	86.9	26.4

FIGURE 2 Densities (trees/ha) of priority tree species of all diameter classes on 105 ha of sample plots around four sample villages

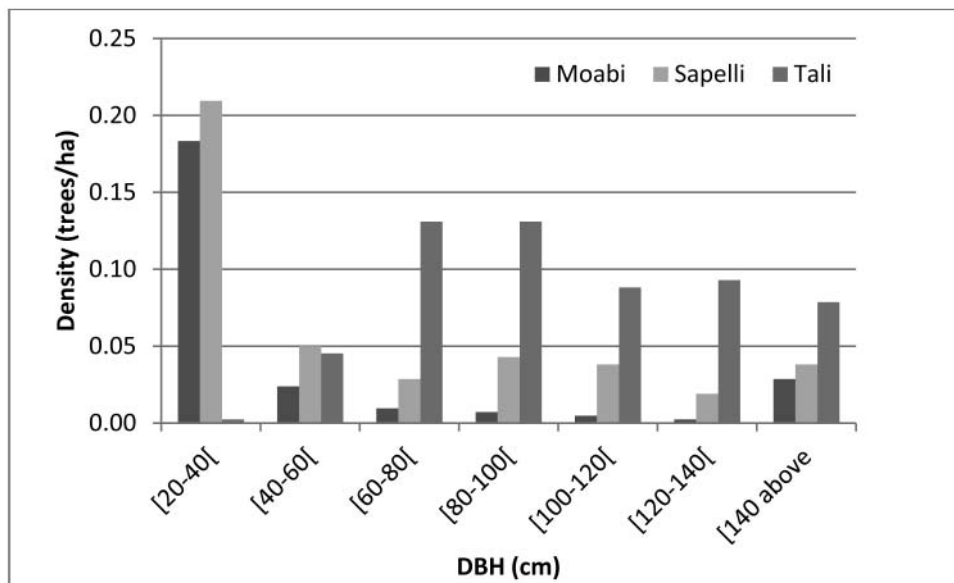


of the concession areas sampled. The two concessions did not have the same densities of the three targeted tree species: 69% of the individuals were found in one concession (Table 3).

The availability and diameter distribution of priority tree species varied by species ( $p=0.00002$ ) and by concession (Table 3, Figure 4). Moabi trees occurred at very low abundances in both forest concessions. The densities of moabi were 0.09 trees/ha for both SCTB and FIPCAM, 0.23 for sapelli in FIPCAM and 0.85 in SCTB, and 0.53 trees/ha for

tali in FIPCAM and 0.96 in SCTB. On the FIPCAM concession, diameters reached 180.5 cm with a mean of 76.8 cm (STD=41.8 cm). On the SCTB concession, trees reached a similar maximum, 182.4 cm dbh, with a mean of 66.0 cm (STD=37.4 cm). DBH varied among the species, with tali reaching the largest diameters (Figure 4). More than 61% of the 275 priority trees sampled were less than 80 cm in diameter; only 22% were greater than 100 cm. Only two moabi trees out of 18 were above 60 cm in diameter (Figure 4). On

FIGURE 3 Densities of priority tree species by diameter class around four sample villages

TABLE 3 Abundance of trees and stumps, and maximum and average diameters of priority tree species  $\geq 20$  cm dbh by concession and species on 100 ha of sample plots in each concession

Concession	Tree species	Number of trees	Stumps	Max dbh(cm)	Mean dbh(cm)	STD dbh(cm)
FIPCAM		85	4	180.5	76.8	41.8
	Moabi	9	0	45.4	31.7	7.2
	Sapelli	23	1	101.9	37.7	22.8
	Tali	53	3	180.5	101.5	30.9
SCTB		190	12	182.4	66.0	37.4
	Moabi	9	0	182.4	61.7	63.7
	Sapelli	85	3	134.5	52.4	33.2
	Tali	96	9	169	78.4	33.8

the FIPCAM concession, all moabi trees sampled were  $<40$  cm dbh. Sapelli trees were most frequent in the lowest diameter class (20 cm – 39.9 cm), although their density would translate to only about 1 in every 3ha.

#### Resource accessibility around villages

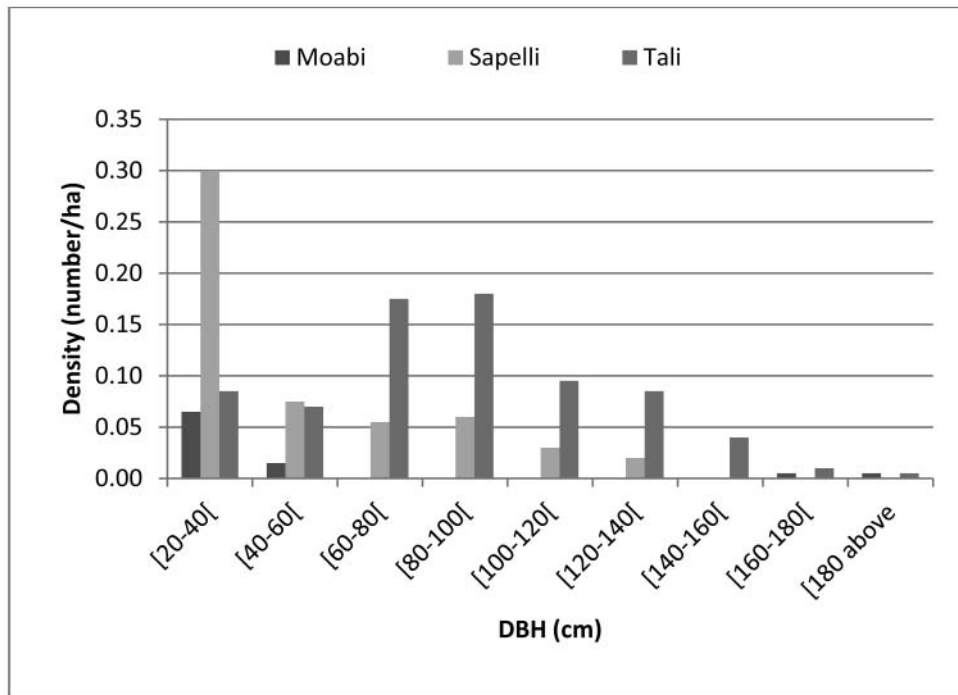
The accessibility of the priority trees to local people was assessed not only from their distribution around the villages but also using participatory mapping with GPS to document the distances local people traveled to collect these food resources from trees. Interviews revealed the diameter classes at which priority trees produced food products of interest. The minimum and maximum diameters of moabi trees described as sources of fruits and seeds for the production of oil were 62.8 cm and 355 cm, respectively, with an average of 139.7 cm (STD=58 cm). Caterpillars were gathered from sapelli of 51.2 cm dbh to 340.6 cm, with an average of 178.9 cm (STD=65.2 cm); caterpillars were collected from

tali trees of a minimum of 53.5 cm and a maximum of 230 cm dbh, with an average of 114.1 cm dbh (STD=35.6 cm). Among the four study villages, a total of 65 moabi trees, 89 sapelli trees and 188 tali trees were described as sources for the collection of these food products.

The spatial distribution of these trees was ascertained and paths to reach them mapped for the four villages. Overlaying these maps on the concession maps revealed that in only two cases out of the four were villagers penetrating concession areas to collect fruits from moabi trees and caterpillars from sapelli and tali trees during one-day collection trips (Figure 5).

Out of the 342 trees to which sampled informants from the four villages led researchers, food products were collected from 86% of moabi trees, 65% of sapelli trees and only 18% of tali trees. This reflected fluctuations in yields from year to year of both moabi fruits and caterpillars. The analysis of the distances to collect either moabi fruits or caterpillars from the priority trees showed significant variation among villages, but

FIGURE 4 Densities of priority tree species by diameter class (cm) on 200 ha of sample plots in two concessions



not among the products collected. For instance, the average distances travelled to collect moabi fruits or caterpillars from sapelli and tali trees were 2.5 km (STD=1.3 km), 3.0 km (STD=1.6 km) and 3.0 km (STD=1.3 km), respectively. The maximum distance never exceeded 6.5 km while the minimum was less than one third of a kilometer.

## DISCUSSION

### Comparing densities between concessions and villages

The density of trees of interest on 100 ha of sample plots was compared among the four villages and the two concessions (Table 4). The variation among villages was high ( $p=0.0476$ ), particularly with regards to the density of moabi; but on the lands around three of the villages, the total (interpolated) abundance of moabi trees on 100 ha of sample plots was almost three times higher than the density of moabi trees on 100 ha of sample plots on concession lands. Differences in abundances of sapelli and tali trees on 100 ha of sample plots in concessions and villages seems to reflect internal differences between concessions or among villages rather than differences between concession forests and forests around villages. However, these preliminary observations seem to reveal that three out of four sampled villages have chosen to protect and retain moabi trees, presumably because of their importance as food and a source of oil.

### Distance to resources matters

It is noteworthy that villagers collecting food resources from forest trees during day-long forays typically do not go further

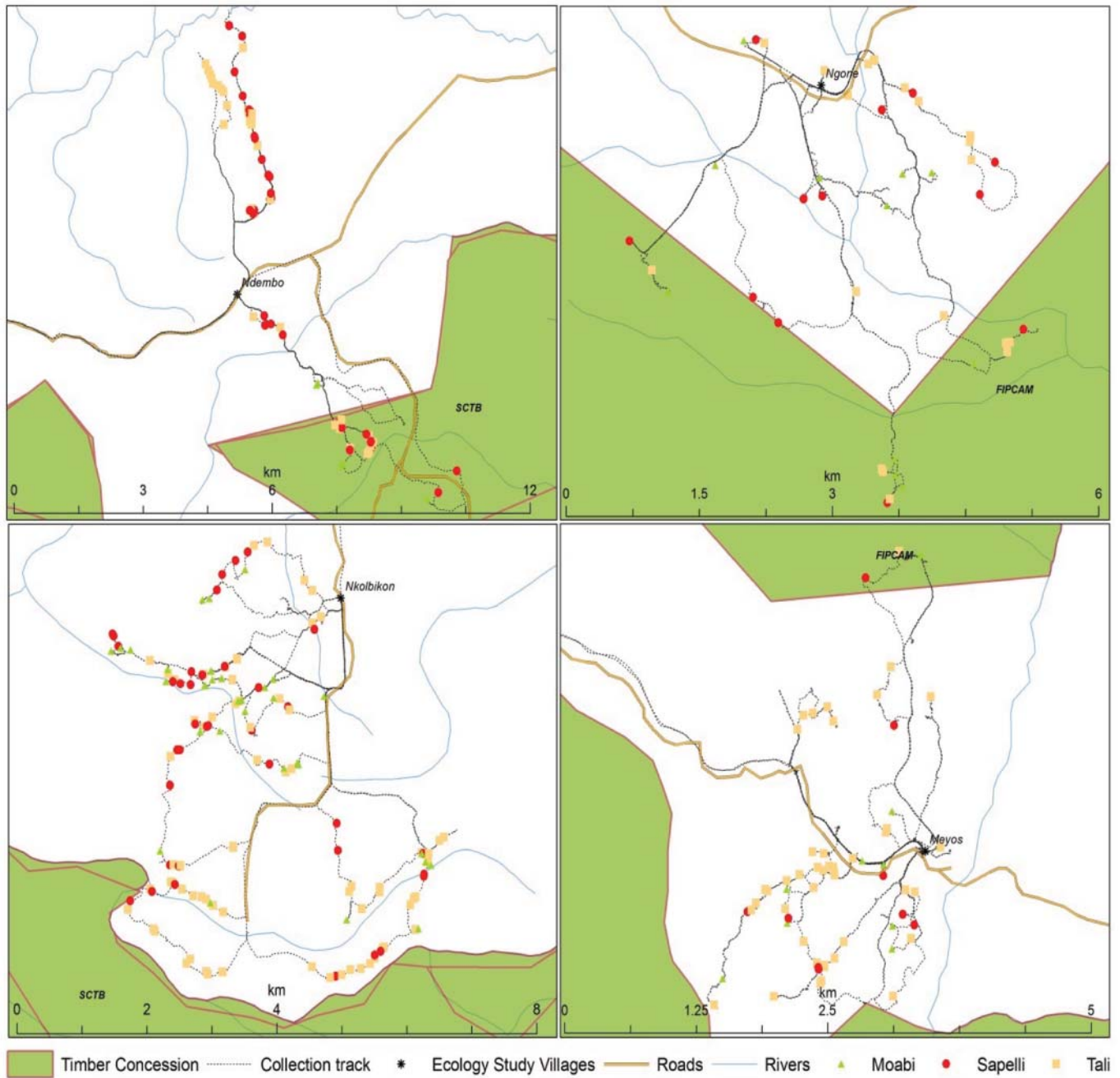
than about 6.5 km to do so. Some groups also make overnight trips to collect resources further away, but these trips were not documented. Given that their average collection radius is  $< 4$  km, it seems that villagers in the sampled villages most often collect these products within the forests around their villages, not far into the concessions. However, two villages did obtain resources from nearby forest concessions. It will be important to calculate the distances between villages and concessions to determine what proportion of villages use concession forests to obtain their resources, and what proportion of their resources they obtain there.

### Conflicts over the use of trees occur among multiple users

Interviews revealed that there is competition among village residents between those who focus on timber and those who prioritize other production values. A community forest known as APOBA covering 4900 ha had been legally established in the vicinity of six villages including one of our sample villages (Nkolbikon), occupied by Baka people who depend on hunting and gathering, but their rights to obtain NTFPs have been superseded by the Bantu villagers' rights to harvest timber. The Baka, who prefer gathering the fruits of moabi trees and caterpillars from tali and sapelli trees find themselves in conflict with the Bantu villagers interested in the timber from the same trees to furnish increasing demand for wood by merchants from the northern parts of Cameroon and beyond. Several authors have noted that the way the forests and their products are governed can have far reaching resource - related outcomes (e.g. perpetuating rural poverty, enriching a few members of the community, degrading the



FIGURE 5 Spatial distribution of priority trees accessible to villagers. Shaded areas correspond to forest concessions. Villages shown top left and top right show overlaps with neighboring timber concessions; villages at bottom left and right show no overlap



resource base) on the sustainability of livelihoods in the short and long terms, depending on who governs, why, and the rights and rules in place (Ingram 2014, Laird *et al.* 2009, Mayers and Vermeulen 2002). This phenomenon was anticipated by Karsenty *et al.* (1997) with the conclusion that the privatisation of some portion of forests through the establishment of community forests might be more harmful for indigenous people (Baka pygmies in this case) than the industrial concessions. Many studies have shown that the benefits from exploiting trees for timber in community forests mostly go to

individuals or specific groups rather than the whole community (Ezzine de Blas *et al.* 2011, Ofoulhast-Othamot 2014). Even when trees are near the village, outside a concession or a community forest, there may be conflicts among villagers as to the best use of the tree, whether to sell it as timber, often the preference of men, or to retain it for its yield of NTFPs, as typically preferred by women (Snook *et al.* 2015, Noutcheu *et al.* 2016). The losses experienced by the Baka are shared by both Bantu and Baka women that are also primarily interested in the NTFPs (e.g. moabi seeds from the moabi tree for

TABLE 4 Comparison of the total density of trees of priority species found on 100 ha of sample plots on concessions as compared to their interpolated density on 100 ha of sample plots on land surrounding four villages near the concessions (abbreviated Me, Nd, Ng and Nk).

Concession or Village	Density equivalent on 100 ha, trees $\geq$ 20 cm dbh		
	Moabi	Sapelli	Tali
FIPCAM	9	23	53
SCTB	9	85	96
Me	57	24	53
Nd	7	70	35
Ng	20	17	60
Nk	20	60	90

oil) for income and household food items (Snook *et al.* 2015). According to the Baka, logging the trees that provide NTFPs meant that they had to go further than previously to obtain non-timber forest products. Similarly, some villagers complained that forest guards working for the Ministry of Forestry sometimes confiscated the products they had gathered, if the quantities were large enough to sell, on the grounds that the rights of villagers to harvest non-timber forest products for subsistence excluded their harvesting more than they could consume (Foundjem-Tita *et al.* 2013, 2012, Wiersum *et al.* 2014).

### Diameter matters

Logging operations in the Congo Basin are governed by selective harvesting norms (Bayol *et al.* 2012, Cerruti *et al.* 2008) with defined minimum cutting diameters ranging from 30–100 cm depending on the species and the country; and logging cycles of 25–30 years, depending on the country (Gatti *et al.* 2014, Maesano *et al.* 2013). Minimum diameters related to the production of fruit or caterpillars are typically lower than minimum cutting diameters (Noutcheu *et al.* 2016, Paluku *et al.* in prep). There is no conflict over the uses of precommercial sizes of timber trees, meaning that options for sharing resources between concessionaires and villagers could be negotiated. During the participatory GPS mapping exercise, villagers indicated that they collected these resources from trees with the following minimum diameters: 63 cm for moabi, 51 cm for sapelli and 54 cm for tali (Maukonen *et al.*, in press). Smaller diameter trees were not of interest to villagers. According to MINFOF (2010), timber concessionaires cut only those individuals that are larger than the minimum cutting diameter defined by law (100 cm for moabi, 100 cm for sapelli and 50 cm for tali). For concessionaires, trees in the pre-commercial classes are also considered important as potential future sources of timber. Only in the case of tali is there a complete overlap in size classes between individuals that produce caterpillars and those that can be legally harvested for timber. In the case of moabi and sapelli, even if the

concessionaires harvested trees of commercial size, they would leave trees of sufficient size to produce caterpillars (though clearly, their harvests would reduce the numbers of trees overall). Moreover, the production of caterpillars by sapelli trees has been shown to increase with tree diameters (Paluku *et al.* in prep.). To sustain trees in these size classes, it is important for both villagers and timber concessionaires to protect trees in smaller size classes that will grow into those size classes.

### Concessionaires are conscious

In the 90s and the 2000s, conflicts between villagers and companies regarding moabi trees were raised in the international arena by Friends of the Earth. A lot of attention from concessionaires resulted from these campaigns, especially those companies that are owned by Europeans (WRM 2001, Les Amis de la Terre 2005). Nowadays, sampled timber companies seemed to respect the priority species defined in their annual production plans as described in their management plans (MINFOF 2012). For example, no moabi stumps were found in the 2012 annual cutting area on either of the two concessions sampled. This reflects an agreement by those concessionaires not to fell moabi trees because of their value to local villagers. Discussions with concessionaires revealed that some of them (SCTB, FIPCAM, CEB) have voluntarily refrained from extracting timber species of interest to villagers for their non-timber products, notably moabi (*Baillonella toxisperma*), the source of an edible fruit with seeds used to produce edible oil. This is either to avoid conflict with villagers (Les Amis de la Terre, 2005) as was observed with the SCTB concession, or because the concessionaires aspire to become certified, as was observed with the ‘Congolese Industrielle du Bois’ (CIB) concession in the northern Republic of Congo, where all caterpillar-supporting trees were marked by communities and left behind during logging operations for the benefits of indigenous Mbendjele pygmies (Hopkin 2007). This is logical because according to Hopkin (2007), a single sapelli tree might yield five 50 kg bags (sacks) of caterpillars per year, potentially fetching US\$ 500 at the local market, but the timber from the same tree could bring in a one-time profit of US\$ 1500 to the logging company. This holds true for a moabi tree of one meter in diameter that if logged will produce about 9 m<sup>3</sup> of timber worth 1350 Euros to the company but if left standing can support the production of 150 litres of oil worth 270 Euros every three years, equivalent to the timber value in just 15 years for a tree that can live for up to 600 years (Schneemann 1995). Of course, not felling the trees involves a tradeoff from the logging company’s point of view but they have still pledged not to cut down trees deemed by the Mbendjele pygmies to be of value and they are able to respect those trees without harming their profit margins (Hopkins 2007). According to Capron (2010), this is a pertinent aspect of respecting social responsibilities with local communities. Moreover, concessionaires could leave useful trees to local communities because regulations have been promulgated to safeguard these resources, as was the case in Gabon with a decree that banned the logging of five

multiple use tree species (*Baillonella toxisperma*, moabi; *Dacryodes buettnerii*, ozigo; *Poga oleosa*, afo; *Tieghemella africana*, douka and *Irvingia gabonensis*, andok) that are of importance for the provision of NTFPs to local communities (Republic of Gabon 2009). NTFP access is also safeguarded through respecting the law and regulations (German 2010, Assembe-Mvondo 2009, 2006) that stipulate the minimum density of each timber tree species, below which no logging is permitted (Cerutti 2008).

## CONCLUSIONS AND RECOMMENDATIONS

A number of studies have pointed out that managing forests for multiple uses and for multiple stakeholders is a potential way of increasing the monetary value that local communities, managers and owners may obtain from the forest resource (Lescuyer *et al.* 2015, Sabogal *et al.* 2013, Clawson 1974). Logging activities and the collection of NTFPs influence forest conservation and management in the Congo Basin (Rist *et al.* 2012). The results presented in this paper are preliminary and the sample villages and concessions in Cameroon only represent about 1/3 of the concessions and villages where this study was conducted in the Congo Basin. Local people in these villages depend on a number of food products gathered from the wild. However, our observations reveal that our initial hypothesis that timber harvesting by concessionaires was reducing the access by communities to food resources from those species may be a simplification of a more complex and nuanced set of interactions.

Resource accessibility and availability in concessions and village communities is defined by both legal (*de jure*) and customary practices (*de facto*), as well as by the interpretation and implementation of the laws and regulations by the Ministry of Forestry. Other factors such as attitudes and logging histories around the villages and in the concessions that were not addressed by this study may also affect the accessibility and availability of resources to villagers. Aside from the strict interpretation of rights, concessionaires also respond to other management and social considerations such as avoiding conflicts by deliberately leaving certain trees identified to be of nutritional importance to local populations (Karsenty 2010, Capron 2010). Multiple additional factors influence the availability of these products to villagers, including distance between the concession and the village, the interests of different groups of villagers in forest resources in the vicinity of the village, and the diameter classes of different species that are important for timber production or production of foods. This implies that there are grounds for negotiation, both within villages and between villagers and concessionaires that can safeguard people's present and future access to important food resources. For instance, some concessionaires such as CIB in northern Congo go a long way to recognise and map out village management areas ('terroir' in French), in some cases areas overlapping with concession boundaries, to facilitate access to potentially disputed forest resources (Karsenty and Assembe-Mvondo 2011). This is now used as a precedent by other concessionaires seeking certification of their forests.

Studies have shown that some multiple use tree species, such as the Moabi, are more valuable for oil in the long term to local communities than the short-term profit gained by logging the same tree for its timber. According to Snook *et al.* (2015) and Noutcheu *et al.* (2016) the production of timber and NTFPs can be sustained from the same concessions, for different stakeholders, with appropriate practices and arrangements (concessionaires and populations discuss and reach agreements).

Generally, where non-timber products are obtained outside concessions or from trees that are below commercial size, or where commercial sized trees are not felled, there is no conflict between industrial timber harvesting and gathering of NTFPs. Collaborative arrangements that consider the uses of NTFPs from timber species by resident villagers can also forestall conflicts, either through agreements not to harvest those species (as agreed voluntarily by the concessionaires in Cameroon with regards to moabi and mapping out of trees used by communities as in northern Republic of Congo), or by regulation (as imposed by the government of Gabon with regards to five aforementioned multiple use tree species). However, over the long term, the availability of these resources, both timber and NTFPs, will depend on successful regeneration with management practices taking into account the genetic aspects of sustainability (Snook *et al.* 2015, Karsenty and Gourlet-Fleury 2006). The issues of: who has the access and the rights to benefit from the trees in the short or long term? What are the trade-offs? Who are the appropriate mediators for dialogue and negotiations? Who or what mechanism provides the level playing field? are pertinent questions that deserve special attention for the Congo Basin forests that are managed for timber production from dozens of species with over 60% of them also producing important NTFPs to local communities.

## ACKNOWLEDGEMENTS

This study was carried out under the Beyond Timber project, funded by a grant from the Congo Basin Forest Fund to Bioversity International; and by the donors to CGIAR Research Programme on Forests, Trees and Agroforestry. The authors are grateful to all participants in the surveys, including colleagues from national research systems. Our most sincere gratitude goes to the forest concessionaires that allowed our entry into their forest concessions, the villagers that patiently sacrificed their time in responding to lengthy questionnaires and the Ministry of Forestry for their collaboration.

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