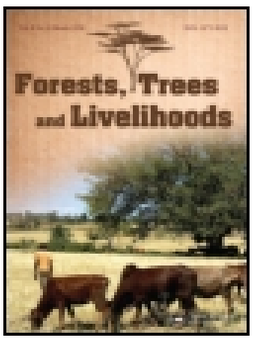

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The role of forest resources in income inequality in Cameroon

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ABSTRACT

The present study focuses on forest incomes of households around forest concessions in Cameroon. The contributions of forest income to the economy and well-being of households were measured and the explanatory factors for heterogeneity determined. We used the Gini index to evaluate the distribution of household forest incomes and their influence on well-being and income inequality amongst forest-dependent households. Three TOBIT econometric models with sample selection were estimated to identify factors that influence the level of each source of forest income. Results from our analysis show that forest contributes on average 38% of total annual household income with 19, 13 and 6% from illegal logging, hunting and non-timber forest products (NTFPs) of vegetal origin, respectively. Forest income overall contributes in increasing disparities among people by 3%. Income from illegal logging was found to be a major source of income inequality while other forest income sources such as NTFPs and hunting slightly reduced income inequality. Access to villages and the amount of agricultural income were the main factors that explained the differences in forest income.

KEYWORDS

Income; forest; inequality; dependence; gathering; hunting; illegal logging

1. Introduction

Populations living around forest concessions in developing countries derive a considerable share of their income from activities linked to the forest (Angelsen et al. 2014). For example, Cavendish (1999) estimated that 35% of total household income of rural communities in Zimbabwe comes from forest products. Fisher (2004) showed that 35% of total household income in rural areas of Malawi comes from the forest. Mamo et al. (2007) found that forest income contributes to 39% of average income of households in the Dendi district, south-west of Ethiopia. A large scale investigation on income carried out by the Centre for International Forestry Research (CIFOR) in 2011 on about 6000 households in the Congo basin confirmed that on average households living in and around forests derive between one-fifth and one-fourth of their incomes from forest-based sources (Wollenberg et al. 2011).

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For a population relying mainly on agriculture, income inequalities amongst households or individuals are most often due to inequalities in access to land, availability of labour and access to capital (Cavendish and Campbell 2008). Forest products, being for the most part in open access, ought to play a key role in reducing income inequality (free access, few entry barriers, immediate return activity, etc.). Cavendish (1999) in Zimbabwe and Fisher (2004) in the South of Malawi observed that income inequality increased, respectively, by 44 and 12% in Zimbabwe and Malawi when the inequality index was calculated without forest incomes.

In the forested part of Cameroon, households draw income from forest activities linked to hunting, gathering, artisanal logging and salaried employment in forest industries (Levang et al. 2015). But all households do not benefit at the same level from this natural patrimony. There are inherent factors that play a role in the amount of income drawn from forest activities. Gathering usually requires much labour and is thus more available to larger households (Tieguhong and Nkamgnia 2012), hunting requires technical know-how and stamina that are more readily available to the young men (Tieguhong and Zwolinski 2009), while artisanal logging demands greater capital and social relations (especially when logging is illegal) that are restricted to village elites and outsiders (Cerutti and Lescuyer 2011). Socio-demographic characteristics of households: age and sex of the household head, size of household, ethnicity, etc. have proved to be significant in Ethiopia (Asfaw et al. 2013), Nigeria (Inoni 2009), Malawi (Fisher 2004), and Kenya (Kabubo-Mariara 2013).

Others factors influencing the level of forest income are linked to the wider economic context. For instance, Kabubo-Mariara (2013) for Kenya, and Bwalya (2013) for Zambia showed that high prices of agricultural crops as well as the size of farmlands available to households are by nature greater incentives for households to focus more on agriculture rather than on activities bound to forests. Conversely, the proximity of households to the forest facilitates exploitation of forest products by reducing the cost of work and transport. As a rule, better access to forests and to markets accentuates forest extraction (Angelsen and Kaimowitz 1999).

Last but not least, the educational level of the household head is most often negatively correlated with forest dependence (Fisher 2004; Vedeld et al. 2007; Inoni 2009; Yemiru et al. 2010; Kabubo-Mariara 2013). A higher education usually provides alternative income earning opportunities that divert from forest resources extraction.

In other words, forest income seems to be essential to the poorer households which draw a greater share of their income from the exploitation of low value forest products compared to wealthier households that tend to focus on more profitable activities. This also means that when a household can diversify its income through other activities that could be agriculture or other professional occupation, it tends to be less dependent on forest products (Shackleton and Shackleton 2006; Bwalya 2013; Kabubo-Mariara 2013).

This study has three specific research objectives: (i) to measure the absolute and relative contribution of forest incomes to the economy of households; (ii) to assess the impact of forest income on income inequalities; and (iii) to identify the factors determining the level of the household's forest income.

2. Conceptual framework

In Cameroon, rural households' income from forest resources can be grouped around three main activities: gathering, hunting and artisanal logging. This is indicated with more details

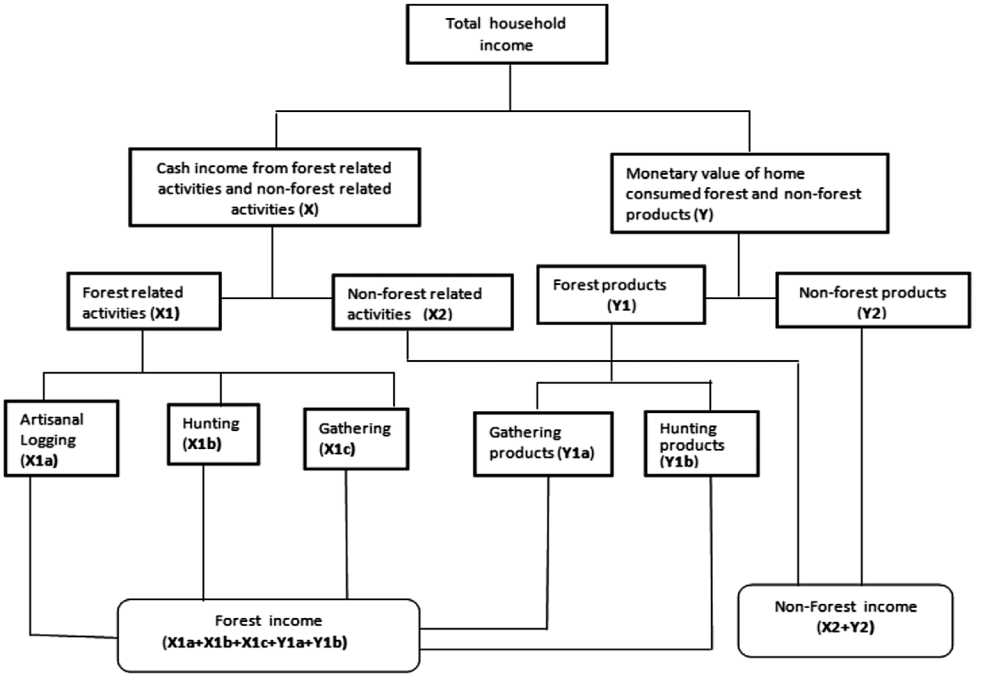

Figure 1. Conceptual framework on splitting total household forest income in sample villages.

in Figure 1 which is an adapted conceptual framework[1] from Tieguhong and Nkamgnia (2012).

- *Gathering*: This activity does not generally need legal or customary permission. Land tenure is generally based on customary recognition rather than on legally established land tenure rights (the latter being very rare in forested areas). Products that are most often subjected to gathering are non-timber forest products of vegetal origin. They might include insects, snails and other hand-picked animals.
- *Hunting*: This activity is principally conducted using traps and guns, generally with no prior customary or legal authorization. Hunting for personal consumption is not forbidden since bushmeat is an important component for food security in forest areas. However, it becomes problematic when hunting is oriented towards commercial ends. In fact, over-hunting generally for commercial use constitutes an important threat for the survival of fauna and according to some scholars it is a threat to the preservation of the ecosystem. Despite the restrictions made by the law, hunting remains a very important income generating activity for populations living in and around forests (Wilkie and Carpenter 1999; De Merode et al. 2004; Tieguhong and Zwolinski 2009; Nielsen et al. 2012).
- *Artisanal logging*: this activity is registered in what is commonly called 'domestic timber sector' in contrast to the industrial sector. Many actors, generally village dwellers, are involved in this activity most often carried out illegally. The income they generate depends on their hierarchical position in the value chain, which is itself intimately correlated with the level of investment, and also at times to the monetary value of the

timber and to the bargaining power of those involved. Actors include: *supervisors,* who are in charge of the management of activities; *prospectors,* who identify trees in the forest or on agricultural fields; *timber sellers* who sell the timber; *sawyers,* who fell trees and cross-cut them into smaller portable pieces; *dockers,* who transport the cross-cut pieces from the forest to the road; and *loaders,* who load the pieces into the trucks. Local populations might draw important income from this activity (Cerutti and Lescuyer 2011).

3. Data collection and methodology

To meet our objectives, we used the ratios of household forest income over total income, computed the Gini index, decomposed the index into household income sources, and applied a Tobit model to identify factors correlated with inequality in household incomes.

3.1. Data collection

Data was collected over a period of one year between March 2012 and February 2013 under the framework of the 'Beyond Timber project' coordinated by Bioversity International in partnership with CIFOR, IRAD (Cameroon), IRET (Gabon) and the University of Kisangani (DRC). The project involved three countries in the Congo basin: Cameroon, Gabon and the Democratic Republic of Congo (DRC), but in this paper we only consider the data collected in Cameroon. Data were collected in 12 villages located around or within three forest concessions in the South (5 villages) and East (7 villages) regions of Cameroon.

These three concessions are located in the bimodal forest agro-ecological zone, of which natural ecosystem is tropical rainforest. The climate of these areas is equatorial with two distinct rainy seasons and rainfall ranging from 1500 to 2000 mm/year. The annual average temperature is 25 °C. The different ethnic groups found over there are Maka, Bakoum, Pol, Kako, Mezimé and Baka in the East, and Bulu in the South. Economically, the major activities are agriculture, livestock raising, bushmeat hunting, gathering, artisanal logging and small businesses. People are generally poor. Land tenure is that of customary law.

In each village, 20% of resident households were selected randomly. A total of 124 households have been surveyed throughout the entire study period. Two main methods were used to collect data, namely focus group discussions (FGD) during the first visit, and later on interview of resource persons and household heads using structured questionnaires. In addition, during the first visit, a specific questionnaire was administered to document the socio-demographic characteristics of households. Four quarterly follow-up surveys were carried out over a period of one year over the same sample. These surveys permitted data collection at regular intervals on the quantity of products and natural resources collected. Activities taken into account were agriculture, gathering of NTFPs, hunting, logging and other income generating activities. During each survey, the interviewers recorded the quantities of forest and non-forest products collected or produced during the three preceding months, making a distinction between the proportion sold and the proportion reserved for home consumption or gifts to friends and neighbours. The data were collected from all the members of the household who participated in the different activities. This included the household head (mostly the husband), his wife and also very often the children. The information was then aggregated at the household level. Tables A1 and A2 (see supplemental

file) provide a list of the main NTFPs and animals obtained from forests and declared by our respondents. For any of the NTFPs and bushmeat, a part was consumed in the household and another part was sold. For most NTFPs, agricultural crops and bushmeat, there was a local market where households or traders sold them, thus we referred to the local market price to value the home consumed part. Although this method is quite reliable for marketable products, many other minor products such as medicinal plants, barks and wild fruits that are collected and directly consumed by children were not recorded. This could lead to an underestimation of the total value of household income from gathered forest products. Table A3 (see supplemental file) provides a list of the major timber species that households declared having exploited. In our sample all harvested timbers were sold. All valuations were recorded in the local currency, CFA franc (XAF), and then converted into Euros (CFA Franc has a fixed exchange rate with Euro. 1 Euro = 655.96 XAF)

3.2. Measurement of inequalities

The methods applied to measure inequalities are based on the Gini index ratio. The detailed methodology is presented in Appendix (see supplemental file).

4. Results

4.1. General characteristics of households

Overall, 40% of households in our survey were located in the South region while 60% were located in the East region. Ninety-two per cent of the households were headed by men with just 8% headed by women. The education level was found to be low in all study sites, with 11, 50 and 39% of household heads having no formal education, primary and secondary education, respectively. With regard to equipment and location, 24% possess a generator and only 2% a chain saw whereas 86% were located in villages with relative good access. With regard to quantitative variables, household size was between 1 and 24 with an average of seven people. Household heads were aged between 19 and 73 with an average age of 45 years.

All households are involved in agriculture and derive income from farming, but only 58% of households are involved in logging while 81 and 98% are involved in hunting and gathering activities, respectively (Table 1).

Households on average make a higher annual income from agriculture than from other sources. While incomes from logging, agriculture and other cash income sources are subject to many disparities, incomes from hunting and gathering are relatively evenly spread.

Tables 2–4 show how the incomes drawn from the different activities are linked to some household covariates (level of education, age and accessibility of the village).

Table 2 shows that the higher the household head's level of education, the higher the income from logging, agriculture and other activities. Incomes from gathering and hunting seem not to be correlated to the level of education.

Households with older heads (45 years and above) earn more income from agriculture and gathering compared to households with younger heads. Income from gathering is less variable than other incomes. Households with younger heads (less than 45 years old) draw

Table 1. Households' involvement in activities, average annual income per income source (in Euros) and average income shares of the different income sources.*

Activity	Households involved (%)	Average income	Standard deviation	Minimum	Maximum	Share** (%)
Hunting	81	511	889	5	6591	13
Agriculture	100	1574	1342	54	8030	50
Gathering	98	187	175	2	827	6
Logging	58	1003	4251	11	34878	19
Others	69	538	852	3	4493	12
Overall		3127				

*Average and standard deviation for each activity are calculated only for the subset of households involved in the activity.
**The shares are calculated integrating the probabilities for a household to be involved in the activity.

Table 2. Distribution of average income (in Euros) by source according to level of education.*

	Number of respondents involved	No education	Primary	Secondary (1st level)	Secondary (2nd level)
Logging	72	160	352	743	8920
Gathering	122	187	185	183	212
Agriculture	124	1104	1458	1930	1608
Hunting	72	490	630	289	613
Other income	86	124	230	599	1707

*Average incomes are calculated only for the subset of households involved in the activity.

Table 3. Distribution of average income (in Euros) by source according to age bracket.*

	Number of respondents	<35	(35–45)	(45–60)	60 and above
Logging	72	721	1886	758	195
Gathering	122	166	173	196	228
Agriculture	124	1281	1042	1882	1719
Hunting	72	695	591	333	333
Other income	86	710	477	484	486

*Average incomes are calculated only for the subset of households involved in the activity.

Table 4. Distribution of average income (in Euros) by source according to village access.*

	Number of respondents	Difficult	Moderate	Satisfactory	Good
Logging	72	46	766	1125	451
Gathering	122	110	224	206	111
Agriculture	124	215	1406	1655	1684
Hunting	72	987	417	514	419
Other income	86	312	164	638	442

*Average incomes are calculated only for the subset of households involved in the activity.

more income from hunting, while income from logging peaks for the age group 35–45 years old.

Agricultural income increases with better village accessibility, while the contrary is true for hunting income. This could be explained by less game and more police controls against poaching in more accessible villages. Logging income is much higher in villages with moderate or satisfactory access than in villages hardly or easily accessible.

4.2. Economic dependence on forest resources

Forest resources play an important role in the well-being of households both in terms of cash income and of self-consumption. In the study area, forest resources are drawn from three main activities: gathering, hunting and logging.

On average, forest income represents 38% of the households' total income, with 9.4% in self-consumption and 28.6% in cash income. The Relative Kuznets Ratio is 0.9 (less than 1), which means that the share of forest income is higher for low income households than for high income households. Forest income varies between the two regions of the survey. Households in the East depend on 40% from forest resources while this ratio drops to 36% in the South Region (Table 5).

However, in absolute terms, households from the South earn more from forest activities than those of the East region.

4.2.1. Cash contribution

Figure 2 shows the quarterly and annual contributions of the different sources of cash income.

Cash income from forest resources comes second after agriculture. Among forest resources, cash income from logging comes first, followed by hunting and gathering in that order. This is explained by the fact that timber and bushmeat have a higher exchange value

Table 5. Annual average income (in Euros) from different sources in the two study areas.*

	East			South		
Income sources	Households involved (%)	Average	Share(%)	Households involved (%)	Average	Share (%)
Agriculture	100	1154	51	100	2216	50
Hunting	83	637	22	84	330	6
Gathering	96	163	7	100	223	5
Logging	65	379	11	47	2332	25
Others	64	309	9	76	835	14
Total		2264	100		4447	100

*Average for each activity is calculated only for the subset of households involved in the activity, but average total income is calculated over all households.

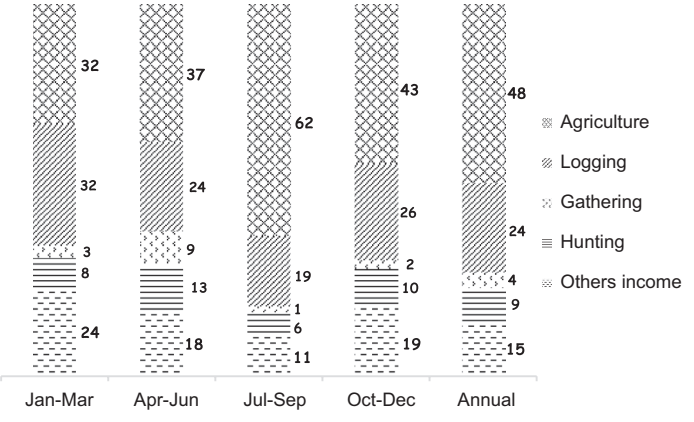

Figure 2. Annual and quarterly contributions of different sources of cash income (%).

Table 6. Quarterly and annual contribution to home consumption by activities concerned.

Activities	Period of the year				
	January–March (%)	April–June (%)	July–September (%)	October–December (%)	Annual (%)
Gathering	17	20	6	10	12
Hunting	46	26	26	19	28
Agriculture	38	54	68	71	60

on the market than gathered products. However, gathering is practised by almost all households while logging and bushmeat hunting are practised by a smaller proportion of households.

Dependence on forest cash income varies over the year. Dependence on forest resources is more pronounced in the months of January to March and from April to June, with forest resources representing 44 and 46%, respectively, of the total cash income. This dependence drops to 26% from July to September. The higher dependence on forest resources during the first half of the year is due to the major dry season (January–March) and the cropping season (April–June). Agricultural harvests start by mid-June until September.

4.2.2. Self-consumption

Households do not sell the totality of the forest resources they collect. A part of the products from hunting and gathering activities are self-consumed or shared out to neighbours and friends. Although relatively lower compared to agricultural products, a non-negligible part of forest products is self-consumed by households. A little more than a quarter of the bushmeat hunted annually is self-consumed, thus considerably contributing to food security and protein supply. NTFPs of vegetal origin are often seasonal. Most of them are collected from June to July. They do not fetch high market values and therefore are collected in limited quantities for self-consumption.

Table 6 shows quarterly and annual contributions of livelihood activities to self-consumption within households.

Depending on the period of the year the self-consumed portion of forest resources varies greatly. During the first quarter of the year, products from hunting are consumed more than others, this period being suitable for the activity (dry season). It is also a festive period with Christmas and New Year during which families come together to feast. Moreover, during the dry season, little or nothing is harvested from agricultural fields and gathering of forest products is quite high compared to the two last quarters of the year.

4.3. Forest income and inequalities

All households do not benefit from forest resources and incomes at the same level. Income from forest resources contribute to inequalities in income distribution among households.

4.3.1. Influence of forest incomes on income inequalities

Figure 3 presents the Lorenz curves both for total income and forest income.

The Gini index calculated over the total income of all households is 0.46, but is down to 0.43 when forest income is excluded from the total income. This means that overall, forest

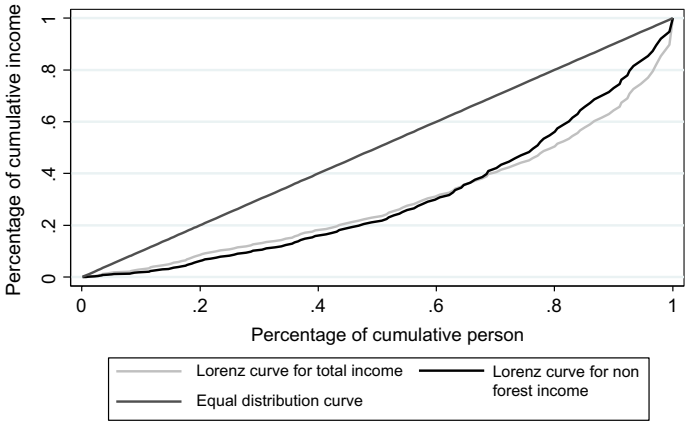

Figure 3. Distribution of income with and without forest incomes.

incomes contribute to increase income inequalities amongst households by 3%. At the regional level, in the East the Gini index for total income is 0.43 and 0.44 when excluding forest incomes, while in the South, those indicators are, respectively, 0.47 and 0.35 meaning that forest income does not significantly reduce income inequalities in the East region (reduction of 1%) but in the South it is rather generating inequalities (increase of 12%). This result for the South is explained by the fact that in this region, artisanal logging generates a huge income for a limited number of households, while other income sources are less heterogeneous.

Table 7 and Table A4 (see supplemental file), that, respectively, give the decomposition of the total income Gini index by income sources for the whole sample first and then per region, show that income from logging is the most unequally distributed (Gini index 0.92).

Income from hunting and other sources also show great inequalities (Gini index of 0.72 and 0.77, respectively). On the contrary, incomes from agriculture and gathering (Gini index of 0.45 and 0.55, respectively) are relatively evenly distributed and thus less subject to inequalities. These two activities concern the majority of villagers. Figure 4 presents the Lorenz's curves for the different income sources.

Differences in total income among households are mainly explained by differences in agricultural income (40.7%) and logging income (31.5%). The relative marginal effects for each source of income given in column (9) of Table 7, show that a 1% increase in hunting, gathering and logging income, results in a 0.6% and a 2.1% decrease, and a 12.8% increase, respectively, in overall income inequality. Thus, hunting and gathering have an equalizing effect on the distribution of total income whereas logging has an opposite effect.

The decomposition of the Gini index for total income by income source and by region (Table A4, see supplemental file) shows that in the East region, overall total income inequality is mainly due to inequalities in hunting (33.7%) and agricultural incomes (44.4%), while in the South region it is mostly due to logging (50%) and agricultural income (30%).

4.3.2. Forest income inequalities decomposed into income sources

Some components contribute more than others to accentuate or to reduce inequalities in incomes. Table A5 (see supplemental file) summarizes the contributions of the various components.

Table 7. Results of the decomposition of total income Gini index by income source.

Income source (1)	m_f (2)	W_f (3)	G_f (4)	C_f (5)	W_f *C_f (6)	$g_f = C_f/G$ (7)	W_f * g_f (8)	RME (9) = (8)−(3)
Logging	81.4	0.187	0.92	0.783	0.146	1.686	0.315	0.128
Agriculture	220.1	0.505	0.44	0.375	0.189	0.807	0.407	−0.097
Hunting	57.6	0.132	0.72	0.445	0.059	0.958	0.127	−0.006
Gathering	25.6	0.059	0.55	0.299	0.018	0.643	0.038	−0.021
Others	51.5	0.118	0.77	0.450	0.053	0.968	0.114	−0.004
Total income	436.2	1.000	0.465	0.465	0.465	1.000	1.00	

Notes: m_f stands for the average income per capita (in Euros) for each income source. W_f represents the weight of the income source *f* in total income. G_f represents the Gini coefficient of each of the income component. C_f measures the factorial component in Gini's total income of each income source. g_f stands for the relative concentration ratio. RME measures the relative marginal effect on Gini of total income and reflects the impact of a percentage change in respective income source on overall inequality measure.

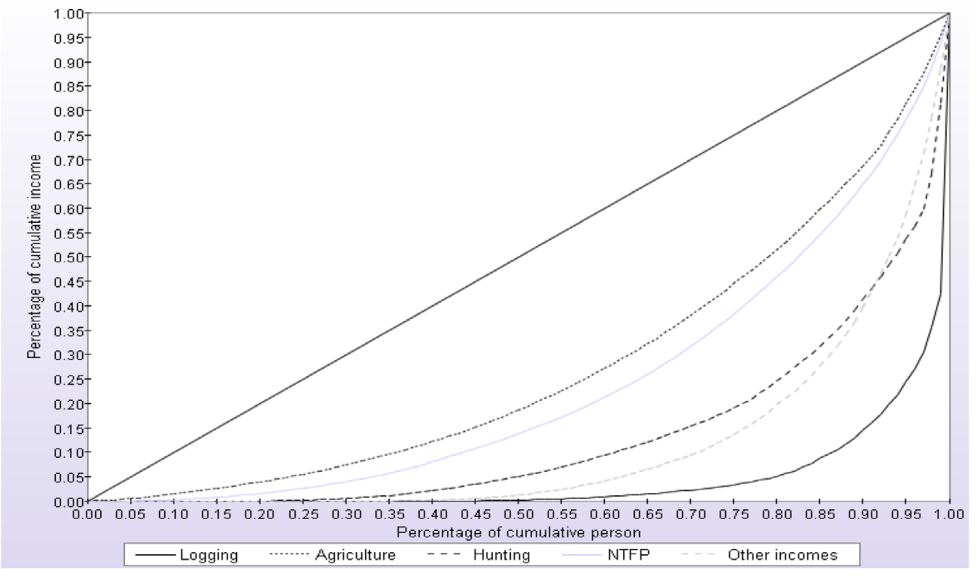

Figure 4. Lorenz curves for the different income sources.

The Gini index for total forest income is *0.71*, which is relatively high compared to the maximum level of 1. It is even higher than the Gini index for total income, a consequence of the high disparity in forest income among households. These differences in total forest income are mainly explained by differences in logging (60.6%) and hunting income (30.7%). Income from gathering contributes very little to inequalities in forest income (9%). This can be explained by the fact that almost all households participate in the collection of NTFPs. On the contrary, only 58% of households participate in logging. When we look at the relative concentration ratios, it becomes clearer that income from illegal logging is about 122% more of a source of accentuation in inequalities (concentration ratio equal to 1.225 times) than other forest incomes (hunting and gathering) which on the contrary are sources of reducing income inequality (concentration ratios inferior to 1).

Table 8. Parameter estimates of the Tobit models with sample selection for each source of forest income (the results of the Probit selection model are given below).

Explanatory variables	Model for logging	Model for hunting	Model for gathering
Age	−0.047 (0.142)	0.035 (0.062)	0.031 (0.051)
Age square	0.001 (0.002)	−0.001 (0.001)	0 (0.001)
Size of household	0.02 (0.096)	0.029 (0.039)	−0.024 (0.031)
Household head education (Default: No school education)			
Primary	0.568 (0.871)	−0.442 (0.705)	−0.06 (0.349)
Secondary (1st level)	2.434 (1.51)	−0.911 (0.832)	−0.305 (0.365)
Secondary (2nd level)	2.939 (2.017)	−0.844 (1.555)	0.14 (0.471)
Access to village (Default: Hardly accessible)			
Moderate	−1.266 (3.399)	−1.349 (1.028)	0.634 (0.617)
Satisfactory	−2.324 (3.59)	−1.809** (0.934)	0.218 (0.559)
Good	−1.477 (2.507)	−2.664* (1.236)	−0.777 (0.623)
Other income	0.033 (0.057)	−0.027 (0.025)	−0.004 (0.02)
Agriculture income	0.323 (0.399)	0.388** (0.224)	0.261* (0.126)
Constant	10.196 (5.758)	8.731 (2.231)	7.076 (1.801)
Results of Probit model			
Age	0.024 (0.064)	−0.042 (0.075)	0.311 (0.209)
Age square	0 (0.001)	0 (0.001)	−0.003 (0.002)
Size of household	−0.035 (0.036)	−0.027 (0.042)	−0.148 (0.092)
Household head education (Default: No school education)			
Primary	−0.042 (0.438)	−5.7 (2109.39)	−5.776 (.)
Secondary (1st level)	−0.764 (0.473)	−5.858 (2109.39)	5.316 (.)
Secondary (2nd level)	−0.977 (0.594)	−6.73 (2109.39)	−1.066 (.)
Access to village (Default: Difficult)			
Moderate	1.452081** (0.829)	−5.519 (2109.391)	−1.662 (.)
Satisfactory	1.638908* (0.756)	−5.424 (2109.391)	−6.61 (10.283)
Good	0.618 (0.814)	−5.991 (2109.391)	−8.657 (11.089)
Other income	−0.012 (0.026)	−0.023 (0.03)	0.099 (0.108)
Agriculture income	−0.033 (0.177)	0.252 (0.17)	0.651 (0.585)
Possession of a generator	−0.099 (0.344)	–	–
Possession of a chain saw	6.216 (.)	–	–
Constant	−0.129 (2.587)	10.465 (.)	0.16 (.)
Rho	−1.000	0.461	0.351
Observations	124	124	124
Left-censored observations	52	24	3
P-value	0.7049	0.0658**	0.0043*

Notes: * and ** denote statistical significance at 5 and 10% respectively. Figures in parentheses are standard errors.

4.4. Determinants of forest income

The Tobit models help to determine which factors are responsible for forest income disparities. Table 8 summarizes the estimates of the parameters of the Tobit models with sample selection for each of the forest income source.

4.4.1. Gathering

Even though the model for gathering was globally statistically significant, only agricultural income proved significant in explaining the variability of gathering income. According to the parameter estimates of the Tobit model, a 1% increase in agricultural income results in a 26.1% increase in gathering income. No other explanatory variable was statistically significant to explain the participation of households to this activity. This can be explained by the fact that this activity is practised by almost all households. Moreover, gathering income

being evenly distributed over the sample explains why almost no explanatory variables had a significant impact.

4.4.2. Hunting

Concerning hunting income, the only significant variables were the level of accessibility of the village and the amount of agricultural income. Hunting tends to be lower when village accessibility is better. In villages relatively easy to access, households earn 1.8–2.7 times less income from hunting than in villages hardly accessible. The reason for this is probably a combination of less game and more police controls against poaching in the more accessible villages.

4.4.3. Artisanal logging

Even though the global significance of the model related to artisanal logging was not relevant, the results suggest that only the level of accessibility to the village is statistically significant to explain the participation of households to this activity. Households living in villages with moderate or satisfactory access are, respectively, 1.45 and 1.64 more likely to participate in logging than in hardly accessible villages. This can easily be explained by the necessity for good quality tracks to ship the timber out of the forest to urban markets. In our survey area artisanal logging is mostly illegal. Loggers depend on small trucks and are not in position to open skidding tracks in remote forests.

5. Discussion

Results from the present study on households' dependence on forest resources are in accordance with the findings of previous studies and reiterate that forest income plays a great role in the livelihoods of households. The study confirms that populations living in and around forests are largely dependent on forest resources for their livelihoods. The share of forest income (36–40%) in the two study areas is quite similar to the results obtained from similar studies in other parts of the world (Gutierrez-Rodriguez et al. 2009; Hogarth et al. 2012; Angelsen et al. 2014; Wunder et al. 2014) or in Africa (Fisher 2004; Mamo et al. 2007; Babulo et al. 2009; Yemiru et al. 2010; Asfaw et al. 2013; Bwalya 2013). In Cameroon, previous studies on similar issues around the Lobeke National Park estimated household forest dependency at 44.4% (Tieguhong and Nkamgnia 2012).

While the share of forest income is quite similar in forested areas across the world, the respective contribution of forest resources to cash income and self-subsistence is more variable. Self-subsistence generally prevails in the remotest areas as can be seen in Cameroon (Tieguhong and Nkamgnia 2012; Levang et al. 2015).

Similarly to the findings of Angelsen et al. (2014), the value of the Relative Kuznets Ratio indicates that forest income contributes more to the livelihoods of the poorest households. Our study estimates that forest income increases inequalities by 3%, which contradicts the decreases of 15.5% observed by Yemiru et al. (2010) in Ethiopia and of 16.4% by Fonta and Ayuk (2013) in Nigeria. However, this contradicting result is due in our study to the artisanal logging practised by a small number of households especially in the South region. The decomposition of forest income into more detailed income sources shows clearly that gathering and hunting help reducing inequality among households, while income from logging strongly contributes to increasing inequality. About 58% of the households in our sample

earned an income from artisanal logging, an activity mostly illegal in the area. Most households involved got wages for sawing, carrying and loading. However, the organizers of the traffic – in a much smaller number- collected far higher incomes than from any other activity, thus increasing disparities in income amongst households.

Considering the determinants of the variation in forest income, most studies include the sex of the household head as a major factor (Inoni 2009; Yemiru et al. 2010; Bwalya 2013; Kabubo-Mariara 2013), even though in most cases this factor did not prove to be significant. As 92% of the household heads in our study were men, it was judged irrelevant to consider this factor. Instead, the accessibility of the villages proved to be a much more relevant factor with a highly significant impact on the distribution of forest income.

An ANOVA test at 5% level of significance confirmed that neither the ethnic group of the people nor their village of origin were important factors influencing the level of income derived from forests.

Even though a large number of theoretical and empirical works (Fisher 2004; Mamo et al. 2007; Inoni 2009) have shown that the size of households is a major determinant of the household's forest income our study showed the opposite. Our results are in accordance with those of Hogarth et al. (2012) and Tieguhong and Nkamgnia (2012), especially for activities that do not necessarily require all the members of the household to be involved. A vivid example is hunting whereby only one or two members of the household are generally involved. On the contrary, gathering is an activity with no special skill requirement that involves most members of the households. However, household size was found to be positively correlated to agricultural income at 1% level of significance (P-value = 0.006 < 0.01), which makes sense. This result suggests that larger households focus more on agricultural activities than on forest activities.

Looking at the age of the household head and its possible influence on forest income, Hogarth et al. (2012) showed that age was a significant determinant. Our results showed the contrary, in line with those of Mamo et al. (2007) and Tieguhong and Nkamgnia (2012). Education of the household head was not significant; this is probably due to the relative remoteness of the survey areas with a quasi-absence of salaried jobs requiring a higher education.

6. Conclusion

In this paper, we quantified the contribution of forest resources to households' incomes and their participation in reducing or increasing inequality in Cameroon by using inequality decomposition techniques. Moreover, we analysed the determinants of each of the forest income sources (gathering, hunting and logging) using Tobit models with sample selection to correct the effects of selection bias. Results show that 38% of household income comes from the exploitation of forest resources, indicating a high level of dependence on forests for households' livelihoods. Furthermore, forest income overall contributes to increasing income inequalities by 3%. This is due to logging which is mostly illegal in our survey areas and strongly increases income inequalities. Income from gathering and hunting on the contrary contributes to reducing inequalities. Forest income appears more important during agricultural slack periods. As such forest income contributes to maintaining a financial equilibrium over the year. Our findings confirm that forest income constitutes a safety net that can be used to fill deficits resulting from poor yields of agricultural crops, agriculture being the major livelihood activity of most households.

Among all factors tested to explain the heterogeneity of total forest income, only two factors appeared to be significant: the accessibility level of the villages and the amount of agricultural income. In villages with bad accessibility, hunting and gathering are the main activities, agriculture is devoted to self-consumption and artisanal logging is limited, transportation costs being too expensive; household incomes show little inequalities. In moderate accessible villages, agriculture is more developed, hunting and gathering contribute to the households' income and diet; however, illegal logging contributes to increasing inequalities among villagers. In villages with good accessibility, agriculture is the main activity, the access to the forest is reduced and as such gathering, hunting and logging are limited; income from forest resources is reduced and agricultural income is the cause of income inequalities among households.

Gathering and hunting obviously play a major role as a safety-net and as a factor reducing income inequality among households. However, their role in poverty alleviation appears more limited. Households with the highest incomes in our sample are the ones organizing illegal logging in their villages. Hunters come second, especially those involved in large-scale poaching. Unfortunately, the most profitable forest activities – illegal logging and poaching – are far from being sustainable.

Note

1. Income from non-forest related activities include income from agriculture, non-forest wages, remittances, trade or business, fishing/aquaculture, etc. Agricultural products used for self-consumption are recorded as non-forest products.

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Disclosure statement

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