Southern African Training Academy

ORIGINAL ARTICLE

CHARCOAL CONSUMPTION AND DEFORESTATION IN THE HINTERLAND LUBUMBASHI CITY – DRC IN FRONT OF THE GLOBAL CLIMATE VARIABILITY OR CLIMATE CHANGE

Nge Okwe Augustin[1,2,3], Longo-Mbenza Benjamin[2,3,4,5], Paul Attibayéba[3], Ange Antoine Abena[3], Mokondjimobe Etienne[2,3], Mylor Shutcha[1], Philippe Lebailly[6], Jules NKULU[1], Manirakiza Diomede[7], Apalata Teke Ruphin[5], Kitenge Ndjibu Richard[1]

[1]University of Lubumbashi, Lubumbashi, DR Congo, [2]Lomo University of Research, Kinshasa, DR Congo, [3]University of MARIEN NGOUABI, Brazzaville, Republic of Cong, [4]Department of Internal Medicine, Cardiology and Physiopathology Service, University Clinics in Kinshasa, DR Congo, [5]Faculty of Health Sciences, Walter Sisulu University, Mthatha, Private Bag XI, Mthatha 5117, Eastern Cape, South Africa, [6]Liège University- Gembloux (AGRO BIO-TECH), [7]Burundi University

Corresponding Author: Longo-Mbenza Benjamin; E-mail: longombenza@gmail.com

Submitted: 12 March 2019, **Accepted:** 11 November 2019

ABSTRACT

Charcoal production for urban energy consumption is a main driver of forest degradation. The purpose of this project was to quantitatively evaluate the volume and flows of charcoal produced as well as to determine their effects on climate variability indicators in various areas of their production. A multitemporal dataset of very high-resolution remote sensing images and a quantitative systematic scoping of incoming flows put in place during 7 consecutive days, were used. Findings showed that major production and incoming flows were from Kinsevere (26%), followed by Kasenga (18%), Kasumbalesa (15%), Forest (8%), Plateau Karavia (8%), and road Kipopo (6%) at different moments. However, incoming quantities were obtained in accordance with different axis and procurement radius, hence the Kinsevere axis provides enormous quantitaties of charcoal with an average radius of procurement of about 59 km followed by others. In terms of travelled distance, the motorized vehicles (trucks, vans and trains) should reach 60 km while the bicycles should barely achieve 35 km. The quantities of incoming charcoal in the city of Lubumbashi are 375.530 tons/year, or 560.768 tons enter per year (equivalent to 0.55 kg/person/year). The three following axis have a considerable volume of incoming flows (>89% of the total volume): Kinsevere axis represents 41% of volume and 26% of in-flows, Kasenga 36% and 18% and Kasumbalesa 12% and 14%. It is also observed that the incoming flows are continuous, without interruption and unidirectional during the whole year. The only circulating product alongside those in-flows is the charcoal regulated only by the price (costs). The study highlights the importance of clear forest wood product collection on Miombo. Findings should be taken into account in the planning related to the management of Miambo wood resources.

Key words: Global climate change/climate variability, Flows of charcoal, procurement axis.

Access this article online
Website: http://www.satagroup.org
DOI: 10.18644/jiresh-biotech.0000078
E-ISSN: 2413-7669 (Online)

INTRODUCTION

In DRC, the charcoal is considered as an overriding energy source by households. It represents by itself 85% of energy balance of the country in the context of low rate of electrification (1). In Lubumbashi, more than 97% of

households resort to the charcoal as a source of energy for the cooking(2).

The rampant increase of urban and rural population is one of the causes that provoke a strong pressure on the forest resources and brings harmful socioeconomic and environmental impacts (3). To that is added the lack of steady income and the populations poverty that turn towards the available less expensive forms of energies like charcoal (4)

Given that increased tendency of exploitation of charcoal is far to be reversed, it is important to provide an accurate and material picture of quantities of wood used for the production of that so vital product for the households.

So, this study aims at determining quantitatively the volume and the flows of charcoal, identify areas of collection and unloading that will allow determining the importance of the collection of clear forest wood products of Miombo on deforestation.

METHODOLOGY

This is to evaluate quantitatively the incoming volume of charcoal and locate sites of collection. For that end, data collection sheets and survey questionnaires have been used.

Establishment of flow counting devices

A systematic counting device has been put in place during one week.But before its establishment, meetings have been done with political-administrative officials, traditional and community leaders so as to identify all axes of entry of charcoal by road traffic (and rail). Those conversations have allowed us to chose the wise areas for counting points and determine schedules of surveys so as the two engaged teams for that target change shifts early in the morning (06H00) respectively in the beginning of the evening (18:00) for the axis with night traffic. A group of 4 beforehand trained investigators has then been put at every point.

When the location was judicious, the investigators were placed at the existing control barriers. A security support of authorities was sometimes necessary for night investigators. To avoid the fear of control by different actors that should make temporarily fall the traffic and distort the counting results, the concerned actors were forewarned (and their professional organizations, if applicable) before the startup of surveys, and to make them know that it is but a survey of "scientific" call but not a control aiming to make merchants pay taxes or punish fraudsters (eventually provide for an announcement by a local radio.)

The obtained weekly flows have been extrapolated on the whole year, taking into account identified traffic fluctuations during the surveys from the sectors' operators. The results of that extrapolation were compared to the annual energetic needs of Lubumbashi city (obtained on basis of estimations habitually admitted of urban households of domestic energy consumption).The periods of parties where the consumption of charcoal risked being atypical have been avoided in the choice of the week of the study. The incoming flows represented at the same time the households' consumption and that of merchants. The different points of entry have been represented on a map to facilitate the monitoring (Figure 1).

Census of deposits and outlets of charcoal in Lubumbashi

The census of deposits and outlets of charcoal in Lubumbashi has been done so as to:

- Identify all the deposits of charcoal;
- Locate all the secondary outlets of charcoal in town;
- Evaluate the stocks of charcoal in town ;
- To make a typology and weigh the principal packaging of charcoal (sacks of charcoal); and
- Evaluate the capacity of transportation means.
- Tools of data collection were of two types: counting sheets of observed flows and census sheets of outlets/storage.

Data processing

The data analysis was done in two stages:

a. **Data capture, processing, verification and correction of the data**
   The collected data on the field have been captured in Excel by the operators of capture. After the data capture, these ones were verified, corrected and washed. The qualitative interviews with stakeholders were registered on papers and after being captured in Excel and in Word. That data has undergone a changeover in SPSS 23.0.
b. **Data description**
   Individual data were presented under the form of tables, graphics depending on the nature of concerned variables and some characteristics were released to have a globalizing description of the results in the field. There are a certain number of ratios that was calculated.

Results were presented under the form:

- **Tables:** Tables of frequencies and cross-tabulations (with possibility of chi-square calculation)
- **Graphics:** Charts of discontinuous rectangles, charts of juxtaposed sticks, frequency histograms, charts of sectors, bars of errors, boxplots ad population pyramids.
- **Statistics :** central trend parameters (average or median) and of dispersion(standard deviation or standard error)

PRESENTATION OF RESULTS

It has been observed that day and night flows represented respectively 80% and 20% of entries. The most important

Figure 1: Map of entry points of charcoal in Lubumbashi (*Route=Road*)

procurement axis were respectively of Kinsevere (26%), Kasenga (18%), Kasumbalesa 4 houses (15%), Forest (8%), Karavia Plateau (8%), et Kipopo road (6%), without taking into account the entry moment (Figure 2).

As a whole, the flows were important in the morning hours between 6 am and 7am and during the night around 4 pm to bypass the taxes payment (Figure 3).

However, hours of arrival of different flows were related to transportation means used. It has been observed that the majority of vehicles arrived at the evening hours and sometimes in the morning. The motocycles came afternoon and the bicycles in the morning hours sometimes the evening. (Figure 4).

In the general manner, it has been observed that the most important flows arrived between 6 and 9 of the morning. That tendency is to qualify depending on the types of transportation used. So are released two groups of incoming flows that are; the am group made of incoming flows in the morning (am) and the group of evening made of incoming flows the evening and the night.

Incoming flows depending on procurement distance

It has been observed that the charcoal brought in the consumption center came from an average distance of 36±15km with, a procurement radius arriving at 153 km. The latter depended on the transportation means used and the availability of the products at the place of production. Moreover, vehicles went till to an average distance of 60 km and the bicycles till 35 km. The axis Kasumbalesa 4 houses and Tujenge were the furthest with an average distance of 74 km. The axis Likasi-Kinsevere

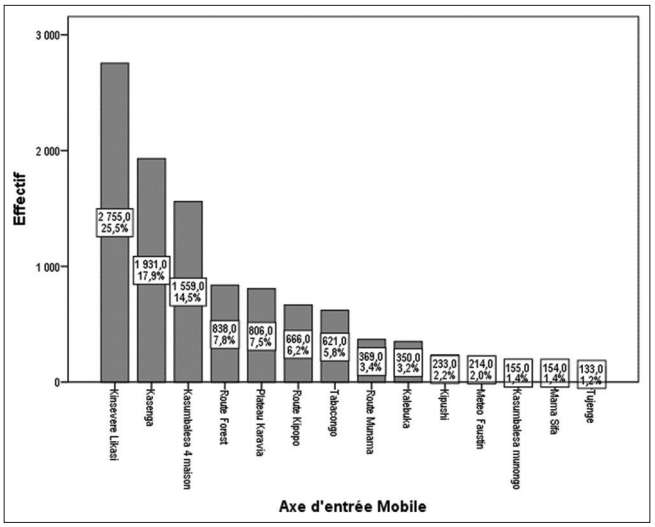

Figure 2: Different procurement axis (*Effectif =Number, Axe d'entrée mobile: Mobile entry axis*)

had an average distance of 58km,Karavia plateau of 53km and the rest with 32km (Figure 5).

.

Flow according to the mode of transport used

During the study, three commonly used modes of transport were observed. These are bikes (81%), trucks (9%) and Hiaces (9%), respectively (Figure 6).

Quantification of incoming flow

The study found that the total weight of charcoal entering the city was estimated at 375,530 tonnes / year (7,510,600 50kg bags). This annual tonnage is equivalent to 2,628,710 tonnes or 3,627,620 m3 of wood and an annual flow of 560,768

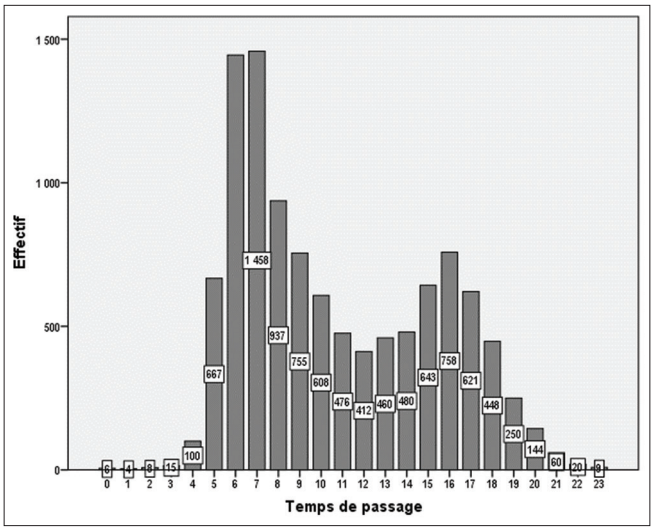

Figure 3: Peaks and nadirs of entries (Effectif=Number, Temps de passage= Transit time)

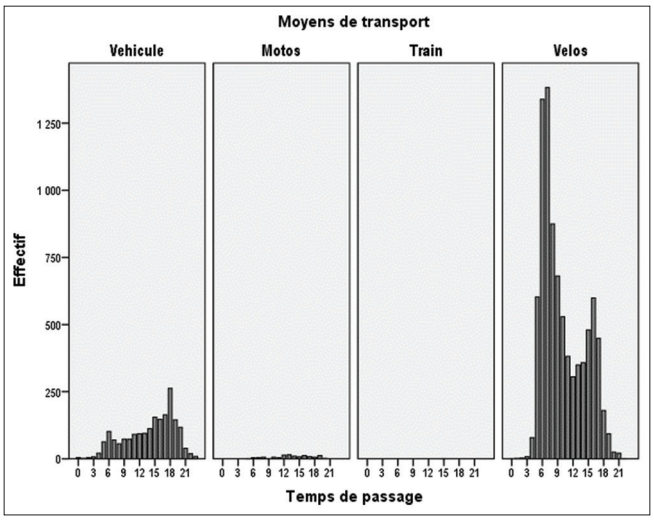

Figure 4: Arrival hours depending on the transportation means used (*Vehicule=Vehicle, Motos =Motocycles, Train= Train, Vélos= Bicycles, Effectif= Number, Temps de passage = Transit time, Moyen de transport= Transportation modes*)

incoming mobiles, representing a turnover of 81,750,000 dollars (USD) (Table 1).

The next three axes represented more than 89% of incoming tonnage; the Kin severe Likasi axis predominated with 41%, Kasenga 37% and Kasumbalesa 4 houses 12% (Figure 7).

DISCUSSION

The purpose of this study was to assess the volume and flow of charcoal entering the city of Lubumbashi in order to estimate the rate of degradation of the Miombo open forest related to charcoal production. The determination of flow and volume of charcoal was carried out through an installation of the metering device and a typology of means of transport and bags.

Thus, the study demonstrated that certain sites targeted during the surveys had significant flows compared to others following their short supply distances, unlike those which had to travel long distances (102 km) (5). This amounts to saying that in a given environment, the supply distance is proportional to the rate of disappearance of forest species. It follows from this study that the supply basin is in the form of a starfish, translated by roaming in the choice of carbonization sites and the choice of species for carbonization. A similar situation was observed in Bukavu where the average supply distances are 100 km (2) while in Kisangani, these distances are equivalent to 25 km for firewood and 37 km for charcoal (5). This is proof enough that the city of Bukavu was already experiencing intense deforestation due to high consumption of charcoal (6).

Trefon et al. (2) cited by Münkner (6) also revealed in their observations that the railway was less used for the transport of charcoal. This situation suggests that the train, more often used for goods moving at much greater distances than any vehicle used to transport charcoal, was not predisposed to the distribution of this goods since 'This is first of all a type of production that develops in the outskirts of a city such as Lubumbashi in the specific case. Guidal et al. (7) in their study on the wood energy sector and the "charcoal" value chain in Bukavu claimed that the most dominant means of transport is the truck and that its range can reach 100 km. Indeed, large vehicles are the most popular because of their ease of access to the production site and also because of the large quantities of charcoal they can transport.

The study showed that the overall annual tonnage of charcoal was estimated at 375,000, or 0.5 kg per day per individual. This figure is close to that found in Münkner (6), but higher than that found by Trefon (8), ie 0.39 kg. This difference in the estimates would be linked to the different methodological approaches used. Indeed, in this study the estimate was made on the basis of a quantification of flows including households and small industries as a whole. On the other hand, that of Trefon (8) was carried out on the basis of interrogations carried out on a reduced sample of households.

The transport of goods on motor vehicles, most often in an irregular situation, is generally done at night to avoid meeting the services of the State, in particular law enforcement officials. On the one hand, charcoal transporters must regularly pay taxes at the commune and parking lot level at the ACCO (Association des Chauffeurs du Congo). On the other hand, some Charcoal depots report regular visits by the National Security Service (ANR) with the mission of making it obvious to the goods entering the urban markets.

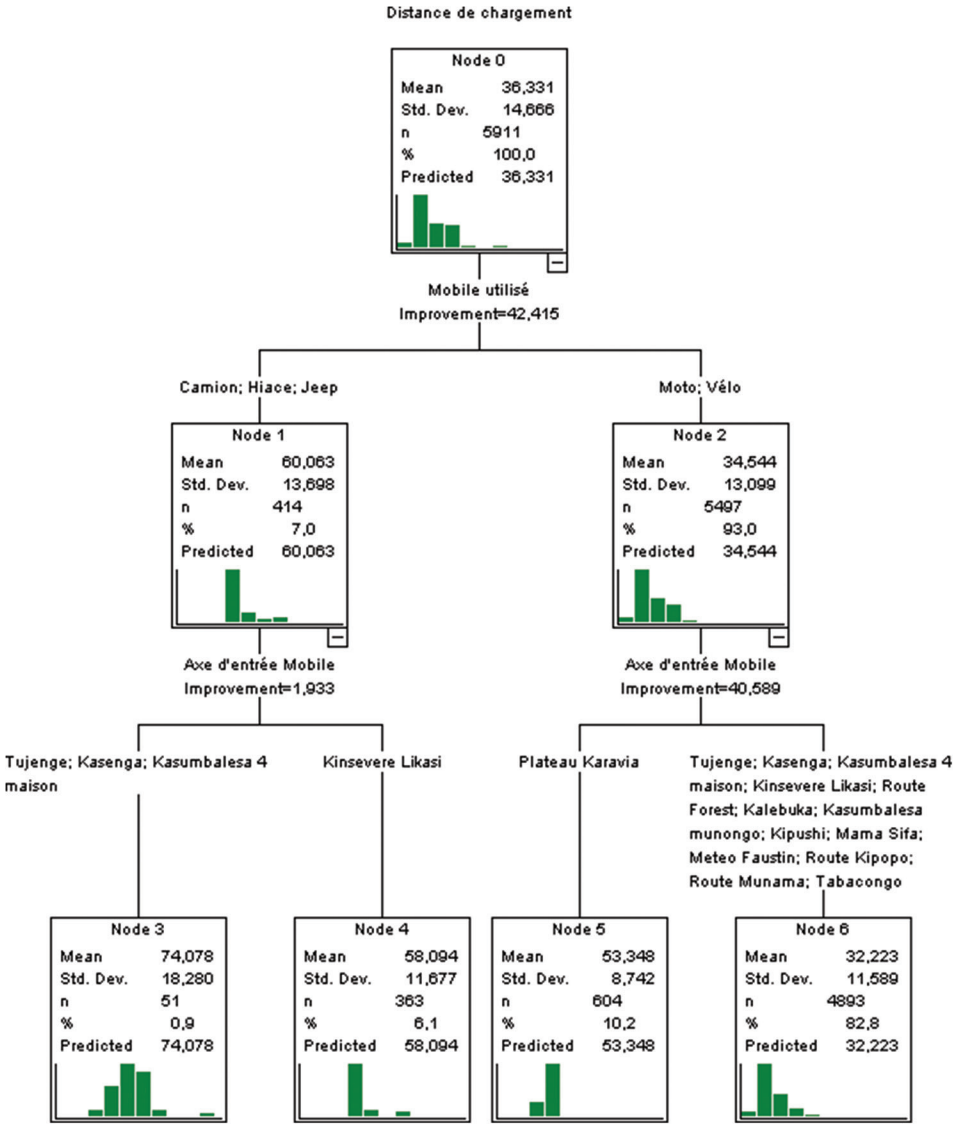

Figure 5: Flows segmentation depending on axis, distance and transportation means used(*Distance de chargement= loading distance, Mobile utilisé=used mobile, Route=Road*).

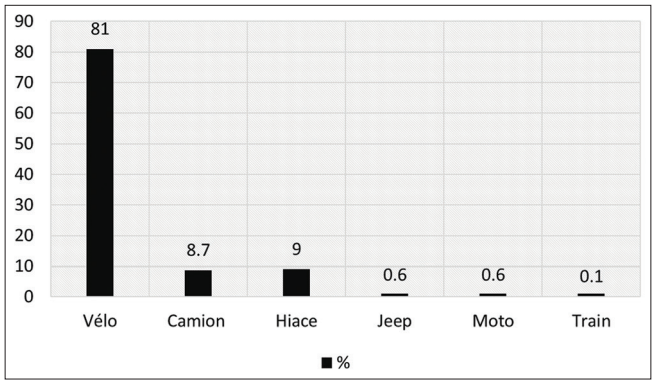

Figure 6: Modes of transport used

However, the study also showed that the large quantity of charcoal entering the city of Lubumbashi came mainly from two ecogeographic axes most frequented by their accessibility (Kasumbalesa and Kasenga). They alone accounted for more than 89% of incoming quantities and almost 60% of charcoal flows. And even if the data of this observation are lower than that of the city Kinshasa (135km) and its axes (Bandundu, Bas-Congo and Ecuador) where the quantities and distances are much greater (7), this situation confirms that the accessibility of the sites is proportionally linked to their degradation. Which would translate a landscape structure into a corridor. This is observed in all the main consumption centers (7); (9).

Nevertheless, the continuous and unidirectional nature of the flows entering Lubumbashi as noted in this study reflects on the one hand the strong dependence of the city on charcoal as the main fuel source and on the other hand, the strong pressure

Table 1: Measurement of incoming flows

Supply axes	Modes	Entry hours	Mean of supply radius (km)	Annual weight in tonnes	%	Incoming flows
Tujenge	Vehicle	13	88	3 846	1,15	1 060
	Motorbike	17	67	4		53
	Bike	12	58	469		5 936
Kalebuka	Vehicle	14	68	22	0,52	159
	Motorbike	14	58	14		265
	Train	15	200	29		53
	Bike	12	54	1 896		18 073
Kasenga	Vehicle	14	70	132 411	37,1	42 559
	Motorbike	14	60	164		1 325
	Bike	8	62	6 868		58 459
Kasumbalesa 4 maisons	Vehicle	14	70	35 000	11,8	11 819
	Motorbike	10	64	9 388		70 808
Kasumbalesa munongo	Motorbike	10	52	7	0,29	106
	Bike	9	49	1 085		8 109
Kinsevere likasi	Vehicle	14	59	146 560	41,9	44 255
	Motorbike	14	57	338		3 392
	Bike	10	56	10 565		98 368
Kipushi	Véhicle	17	102	46	0,49	53
	Bike	6	68	1 809		12 296
Maman sifa	Bike	12	55	1 043	0,27	8 162
Meteo faustin	Vehicle	13	62	3 324	1,2	1 431
	Motorbike	10	60	3		53
	Bike	10	62	1 204		9 858
Plateau karavia	Motorbike	11	66	3	1,9	53
	Bike	10	79	7 488		42 665
Forest	Vehicle	17	66	221	1,2	159
	Motorbike	12	64	83		742
	Bike	12	57	4 547		43 513
Kipopo	Bike	8	49	6 237	1,6	35 298
Munama	Bike	12	31	2 114	0,56	19 557
Tabacongo	Vehicle	15	45	1 538	1,5	530
	Bike	12	37	4 407		32 383
Total		In the morning then in the evening	± 36km overall, ± 60km for the vehicle and ± 35km for the bicycle	375.530 tonnes / year (7.510.600 50kg bags)	100	560 768

exerted on wood resources. A study conducted by GTCR / RDC, (7) joins this study by confirming that in all the major consumption centers, the incoming flow had the same character.

Lubumbashi generates on average 81,750,000 USD in turnover per year, distributed along the entire value chain, while Kinshasa is approaching double this amount with 143,000,000 USD (7); Schure et al., (5). Far behind, Kisangani presents himself with only 2,500,000 USD (10). It has therefore been proven that the charcoal value chain in Lubumbashi generates a considerable average annual turnover, which translates into a significant contribution to the national economy, despite its informal nature. It was observed during the study that on average 7,222 tonnes of charcoal represented the quantities per week entering the city. These results are similar to those found by Münkner

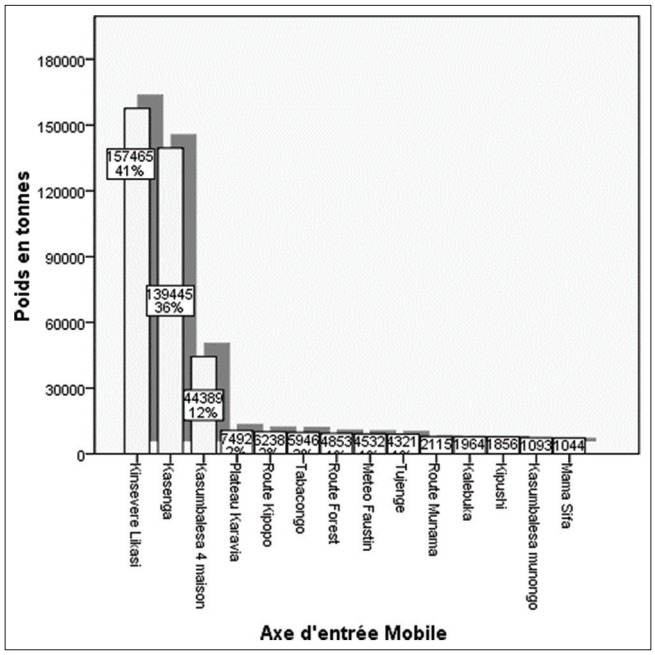

Figure 7: Representation of supply axes according to tonnage (Poids en tonnes= Weight in tonnes, route= road, Axe d'entrée mobile= Movable input axis)

(6) in the city of Lubumbashi during the study initiated by GIZ (11). These figures are, however, different from those obtained in Kinshasa and Kisangani by Schure (5). However, they clearly demonstrate the growing importance of the anthropisation of forest ecosystems throughout the Republic. Inbound flows have also been shown to be continuous, uninterrupted and unidirectional throughout the year. This situation corroborates that of the GTCR (12), illustrating that throughout the Democratic Republic of the Congo, inflows were regular every seven days of the week. Price, as the study demonstrates, is a predictor of charcoal flow and volume. This observation is different from that of UNEP (9), which reports that in Haiti, 82% of those questioned indicated that there was no interference between the price or demand for coal and the volume entering the country. wood energy.

CONCLUSION

This study will have made it possible to quantitatively determine the volume and flows of charcoal and to identify the areas of removal and unloading, which has made it possible to determine the importance of removal of wood products from the Miombo open forest. The quantities of charcoal brought into the city are greater than the demand because this resource constitutes an energy opportunity for consumers (households and businesses) in a context of local energy crisis. It also constitutes a potential source of income for the various players in the sector and therefore its exploitation is inevitable.

But this exploitation is not sustainable, the forest resources in peri-urban areas of the city suffer. It is therefore urgently necessary to establish a regular control system and a tax system which will allow the proper functioning and viability of this sector of activity, but also initiate popularization campaigns for the management and conservation of forest resources in large-scale reforestation programs.

BIBLIOGRAPHIE

1. Shalufa A.N., Malombo T. B., Kavira K. P., Kambale K. J., Etat de lieux de charbon de bois dans la ville de Kisangani. Université de Kisangani, Kisangani, RDC. *Centre de Surveillance de la Biodiversité*. 2016; 1-8
2. Trefon T., Hendriks N., Manuella B., & Ngoy, *L'économie politique de la filière du charbon de bois à Kinshasa et à Lubumbashi.* IOB Working Paper, University Antwerpen, Institut de politique et de gestion du développement (IOB). 2010; 1-111.
3. FAO., Aperçu général de la situation du bois de feu dans les pays en développement. Rome. 2015; 1-66.
4. Rossier G., Micuta W., Le charbon de bois est-il incombustible satisfaisant ?. Redi, Renewable Energy Development Institute. Genève. 2005; 1-7.
5. Schure J. et De wasseige C., Contribution du bois énergie à la satisfaction énergétique des populations d'Afrique centrale : perceptives pour une gestion durable de ressource disponible, université de florence, CIRAD, FAO. 2011; 1-14.
6. Münkner C.A., Analyse des chaines de valeurs ajoutée en bois énergie et bois d'œuvre de la ville de Lubumbashi dans la province du Katanga, PBF, GFA, GIZ. 2015; 1-21.
7. Guidal A., Proposition de schéma d'approvisionnement durable en bois-énergie pour la ville de Bukavu (Sud-Kivu). PBF, GFA, GIZ. 2014 ; 1-27.
8. Trefon T., Hendriks T, Kabuyaya N, Ngoy B., L'économie politique de la filière du charbon de bois à Kinshasa et à Lubumbashi. Résultats de la recherche faite dans le cadre du projet RDC-appui stratégique à la politique de reconstruction post-conflit en RDC-Volet gouvernance environnementale. 2009; 1-182.
9. PNUE., Les Energies Renouvelables en République Démocratique du Congo. Kinshasa, RDC. 2011; 1-51.
10. Louppe D., Schure J., Analyse de la filière bois énergie de villes de Kisangani et Kinshasa, CIRAD, CIFOR. 2010; 1-16.
11. GIZ/PBF. La Filière Bois Energie dans le bassin d'approvisionnement de la ville de Bukavu (Sud Kivu), PBF, GFA, MECNT. 2013; 1-4
12. GTCR**.,** Etude sur les moteurs de la déforestation : Etape de validation rapport du traitement des données de terrain. Groupe de travail climat REDD, RDC. 2012; 1-13.