

*Full Length Research Paper*

# Trade of the most popular Indigenous fruits and nuts, threats and opportunities for their sustainable management around the Ivindo National Park (INP), Gabon

Christian Mikolo Yobo<sup>1,2\*</sup> and Kasumi Ito<sup>2</sup>

<sup>1</sup>Department of Bioengineering Science, Graduate School of Bioagricultural Sciences, Division of International Cooperation in Agricultural Science Laboratory of Project Development, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, 464-8601, Japan.

<sup>2</sup>International Cooperation Center for Agricultural Education, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, 464-8601, Japan.

Received 16 July 2014; Accepted 26 January, 2015

**Sustainable management of forest resources in and around national parks continues to be a growing challenge in Gabon. Rural people living close by national parks continue to depend on those forest resources to meet their various livelihoods needs despite strict governmental restriction on access and use of forest resources, especially inside of national parks. Hence, most of these resources are mismanaged and overexploited while innovative mechanisms that would assist parks' managers in sustainably managing these protected forests are lacking. A semi-structure interview was administrated to 79 sellers that were found in the three local markets located near the Ivindo National Park (INP), in the province of Ogooué Ivindo (Gabon). This survey aimed at clarifying the trade values of most of the popular indigenous fruits and nuts species and the sellers' perceptions on resource decline for an improved management of resources inside and outside of the Ivindo National Park. From both inside and outside of the park, *Coula edulis*, *Irvingia gabonensis* and *Dacryodes buettneri* tend to be among the most sold wild fruits and nuts according to 82.3, 73.4 and 31.6% of the respondents respectively. *I. gabonensis* fetches the highest sale price in FCFA and represents the most important income provider to sellers followed by *C. edulis* and *D. buettneri*. Since social status of sellers such as marital status and ethnicity appear to be the driving factors to people's entry to this trade, therefore they need all to be considered as key variables in regulating usages of these traded wild fruits and nuts. Despite the importance of indigenous fruits and nuts as source of income, resource decline have been acknowledged by almost all the sellers. Hence, sellers should be considered as key partners in identifying species in needs of conservation. Among the drivers of resource decline include the impacts of logging companies, climate change (unpredictability of rainfall), and unsustainable harvesting practices of the valued indigenous resources. Sustainable management of these valued indigenous forest resources call for a careful implementation of an innovative mechanism that would regulate demand and assist park managers in managing forest resources in a sustainable manner. Most critically, further studies need to look at the practical approach of setting up quotas based harvesting of these valued indigenous forest resources.**

**Key word:** Trade, indigenous fruits and nuts, threatened species, sustainable management, adaptive management, Ivindo National Park, Gabon.

---

## INTRODUCTION

Gabon, located in Central Africa, is endowed with a rich biodiversity including dense forest covering 25,767 000 ha, more than 80% of the total national territory (Caballé, 1978). This dense tropical forest supports the development of the forestry sector and the livelihoods of many local populations (Kaimowitz, 2003; Beauchamp and Ingram, 2011; Jamnadass et al., 2011; Ingram et al., 2012; Lescuyer et al., 2012; Tieguhong et al., 2012) including Non Timber Forest Products (NTFPs). NTFPs provide livelihoods to local people which include trees bearing fruits such as indigenous fruits and nuts. These forest products are one of the most important traditional resources and represent major sources of foods and income generation for people in the country (Walker and Sillans, 1961; Bouroubou-Bouroubou, 1994; Bouroubou-Bouroubou and Posso, 1995; Pineau, 1995; Corblin, 2006; Viano, 2005).

The Gabonese government has made tremendous efforts towards protecting the country's rich biodiversity and promoting its sustainable management through establishing a network of 13 national parks (covering nearly 11% of total national land area) throughout the country since 2002 (AFDB, 2011). This conservation effort has started since colonial period with Lopé reserve and the Ipassa Makokou Biosphere Reserve's establishment in 1946 and 1979 respectively. The establishment of national parks' represents therefore one of the traditional approach adopted by the Gabonese government for strict protection and sustainable management of its natural resources. However, one of the often mentioned constraints of this approach is that it negatively affects the livelihoods of local people living nearby those protected forests in terms of access and use of forest resources that get to be used by them to meet their various basic needs (Okouyi Okouyi, 2006; Lescuyer, 2006; Sassen and Wan, 2006; Corblin, 2006, Viano, 2005).

In addition, mechanism that could help resources managers to regulate usages and market demands over valued forest resources such as indigenous fruit trees and nuts in all core areas of national parks are new in most developing countries. In case such mechanisms are available they do not often contribute to improve the livelihoods of forest dependent people in most cases (Laird et al., 2010a). In developing countries such as Nepal, the importance of non timber forest products for rural communities has been overlooked and available governmental legislations have contributed to poorly regulate resources extraction, use, trade and marketing of these forest products leading therefore to resources decline and negative impacts on the livelihoods of resource users generally (Pandit et al., 2004; Subedi, 2010; Uprety et al., 2011).

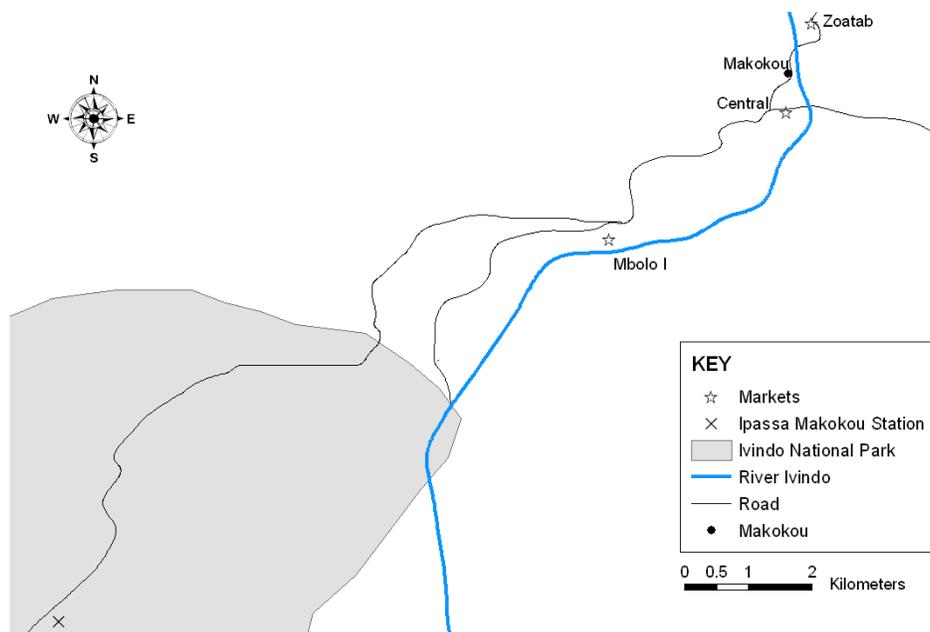
Scholars such as Laird et al. (2009) and Laird et al. (2010a) have pointed out factors that might contribute to undermine successful implementation of governmental forest policies including: (i) the contradicting nature of the forest policies with regards to forest tenure and property rights, (ii) the poor stakeholders' consultations regarding the implementation of projects that might affect their livelihoods, and (iii) the lack of depth analysis of the complexity of factors that might affect the sustainability and equity in resources access and use while designing forest resources management plans. Other driving factors stressed by Larsen et al. (2000), Chhetri (2009), Kunwar et al. (2009), Pokharel (2010), Uprety et al. (2011) and Patel et al. (2013) include: (i) the non recognition of legal traditional rights of collectors over harvest of the forest products, (ii) the lack of effective involvement of local people in forest resources management and policy elaboration process.

Since poor forest policy's implementation can indirectly lead to deforestation and unsustainable use of forest resources, therefore avoiding such issue and its negative impact on local people's livelihoods has led several scholars to suggest sustainable use of resources as a viable management's mechanism that would more likely reconcile biodiversity conservation (slowing deforestation) and enhancing local people's livelihoods (Arnold and Pérez, 2001; Ahenkan and Boon, 2010; Brussaard et al., 2010; Gondo et al., 2010; Laird et al., 2010a; Laird et al., 2010b; Powell et al., 2010; Rabbi et al., 2010; de la Torre et al., 2011), Laird et al., 2011; Mutenje et al., 2011).

In Gabon for example, policy and legislations regulating access and usages of forest resources are available for forests and national parks, as a part of natural resources management system of the country (Forest Code of 2001; the National Parks Law of 2007; decree on Customary Rights Law of 2004). Under such policy and legislations, access and use of forest resources is free in the transition area, regulated in the buffer zone, and strictly prohibited inside of all national parks of the country (Gabonese Republic, 2007). In addition, available studies country wide have poorly focused on assessing people's perceptions on access and use of wild traditional forest products including fruits and nuts that are gathered from indigenous trees on one hand and to determine their economic value on the other hand as an approach to regulate market demand and improve forest resources management in the country.

Moreover, the poor policy makers' knowledge on what are the most valued forest resources of the park also contributes to undermine the correct management of national parks, given that some of these forest resources

\*Corresponding author. E-mail: yobo.mikolo@g.mbox.nagoya-u.ac.jp. Tel: +81-52-789-4225. Fax: +81-52-789-4222.



**Figure 1.** Surveyed marketplaces around the commune of Makokou in the province of Ogooué Ivindo, north east Gabon.

(indigenous fruit and nuts) are pivotal to the livelihoods of the rural communities living near national parks in Gabon (Walker and Sillans, 1961; Bourobou-Bourobou, 1994; Bourobou-Bourobou and Posso, 1995; Pineau, 1995; Corblin, 2006; Viano, 2005; Okouyi Okouyi, 2006; Lescuyer, 2006; Sassen and Wan, 2006) and throughout Africa (Leakey *et al.*, 2005; Arnold *et al.*, 2011; Jamnadass *et al.*, 2011; Sunderland, 2011). Consequently, any attempt towards improving the management and conservation of forest resources of national parks including in the Ivindo National Park (INP), one of the newly established national parks, requires a clear understanding of the economic and social value of the most traded indigenous fruits and nuts products and the traders' perceptions on the current status of those traditional resources from the wild. Therefore, this study represents a most necessary starting point to inform policy makers' and raise their awareness on the decline of these forest resources, assisting park managers on pursuing a sustainable management of the parks' resources.

## MATERIALS AND METHODS

### Study area

The study was conducted in three local marketplaces around the commune of Makokou, provincial city of the province of Ogooué-Ivindo (north-eastern of Gabon) that is located close by the Ivindo National Park (INP) with geographical coordinates of (0° 23'-0° 33'N, 0° 42'-12° 49'E) in Central African region (Figure 1). The region of Makokou is characterized by an equatorial climate, marked by high humidity, high rainfall of 1,700 mm and temperature averaging 24°C year round (IRET/CENAREST, 2003). The population of the region

estimated at about 15,000 people includes many ethnic groups such as the Bantus and the Baka pygmies. The Bantus break up into small groups including Fang, Kwélé, and Kota with Fang and Kota being the dominant ethnic groups in the area (Betti, 2013).

The forest of the region of Makokou belongs to the Guineo-congolian phyto-geographical type (Amalfi *et al.*, 2010; Yombiyeni *et al.*, 2011; Sonke *et al.*, 2012) with abundant fauna and floristic resources, including 1,200 floral species already inventoried. Among valuable timber and non-timber forest products commonly encountered around the study area include indigenous fruits and nuts trees. These forest products known as multiple uses trees species are considered by local people as major sources of timber (*Dacryodes buettneri*) and foods, income generation and healthcare (*Coula edulis* and *Irvingia gabonensis*) (Lescuyer, 2006; Sassen and Wan, 2006; Corblin, 2006; Viano, 2005).

The current Ivindo National Park (INP), one of the oldest protection areas in Gabon, is selected as a case study of typical national park of the country. The Ivindo National Park was formerly known as Ipassa Biosphere Reserve of 10,000 ha that was established in 1979 and composed of three main areas: a central core area of 10,000 hectare, a 2 km of wide band as buffer zone, and a 3.5 km of transition area (Gabonese Republic, 1971). The reserve area was extended to become the current Ivindo National Park covering an area of 300,000 ha today. Although, rules and regulations of the national parks exist under the Forest Code of 2001, the decree on Customary Rights Law of 2004 and the National Parks Law of 2007, however, access and use of resources are strictly prohibited, especially inside of all core areas of the national parks (Gabonese Republic, 2001, 2004, 2007). In addition, firewood is the only forest product allowed to be collected freely from the national parks to sustain the livelihoods of rural people while other forest products even non-timber forest products including nuts and fruits from indigenous trees are prohibited to be consumed in the core area, and their extraction is regulated in the buffer zone (Gabonese Republic, 2007).

The consumption, use and trade of indigenous fruit and nuts have been central component of the livelihoods of majority of rural communities throughout Africa (Akinnifesi *et al.*, 2006; Leakey *et*

al., 2005) including in Gabon, however, there is a scarcity of studies assessing the current economic value of the most popular indigenous fruits and nuts, and traders' perceptions on resource decline to regulate market demand and improve the management of national parks' resources. In addition, the observed mismanagement and the decline of the resources as to do with poor policy makers' knowledge on what are the valued forest resources gathered from the wild.

### Species selection and data collection

*C. edulis*, *D. buettneri* and *I. gabonensis* represent the three indigenous fruits and nuts that were selected for this study as a result of their popularity, their higher market price and their consumptive values that were evidenced during the previous household survey (Mikolo and Ito, 2014). The data were obtained through different techniques including; key informant interview and a semi-structure questionnaire that was administered to seventy nine sellers throughout the three local markets that were identified within the commune of Makokou as followed: Central market (n=31), Mbolob market (n=17) and Zoatab market (n=31). Questionnaire administration was based on a one hundred percent sampling strategy while participation of sellers in the interview was voluntary.

This work was constructed around the following four aspects: (1) the socio-economic profile of sellers and forest products outsourced, (2) the trade values of the most popular indigenous fruits and nuts, (3) the relationship between trade values of the most popular indigenous fruits and nuts and the socio-economic profile of sellers, (4) the cross tabulation relationships between sellers' awareness on resources decline, drivers of resource decline and opportunities for improving sustainable management of forest resources around the Ivindo National Park.

### Data analysis

Statistical analyses were conducted using SPSS, v17.0 to generate descriptive statistics such as means, frequency tables, and percentages and cross tabulations with regards to the above four aspects. Non-parametric statistics (Mann Whitney U tests and Kruskal Wallis tests) were performed to test differences between amounts of the resources sold, the economic value of the traded resources and the socio-economic profile of the sellers.

## RESULTS AND DISCUSSION

### Social status of sellers and forest products outsourced

In total, seventy nine sellers representing 77% of identified respondents have voluntarily participated in the market survey. Table 1 shows the social status of sellers and forest products outsourced in the study. Since 95% of the respondents were female respondents therefore the trade of most popular indigenous fruits and nuts tend to be highly gendered segmented as is the case in many regions of Central Africa. In Cameroon for example, the study of Perez et al. (2002) found that the traded forest product is gendered related and that gender differences found depends on business size, product specialization, market strategies involved as well as profit margins

generated. Other factors driving gender differences in the trade of forest products include the level of people's involvement in the segment of the value chain, availability or not of regulations measures on customary rules and legal regulatory norms guiding access and use of forest resources (Ingram et al., 2014). However, depending on the physical nature of the activity, female respondents tend to be less dominant in forest products related enterprises such as woodcrafts (Shackleton and Shackleton, 2003, 2004; Nkuna, 2004; Paumgarten, 2005; Mikolo Yobo, 2007; Christian et al., 2008). On the contrary, the higher involvement of female respondents in this trading activity has probably to do with their needs to supplement households' incomes.

The majority (96%) of people interviewed originated from Gabon compared to other nationalities probably because of their proximity to the resources added to the fact that they are probably more knowledgeable about where to find these valued forest products from the wild than foreign people. Almost sixty percent of the respondents are involved in the trade on a part time basis while the rest are full-time sellers. Thus, trading of forest resources on a part time basis may represent an important livelihood strategy sets in place by respondents since it allows them to carry multiple livelihoods activities for meeting other households' needs (Shackleton and Shackleton, 2003, 2004).

The collectors-sellers types of respondents tend to represent the majority (96%) of people encountered in the study compared to the sellers' type of respondents only (4%). It was found in the surveyed area that poorly educated people tended to dominate the trade of the most popular indigenous fruits and nuts since the majority (84%) of them have no education (8%) while 76% of respondents have reached primary education. Although, the net primary school enrolment's rate is relatively high (96%) in the country, however, this rate tends to drop while people reach secondary and university studies as a result of internal issues within the Gabonese education's system (World Bank, 2006). Thus, this poor education attainment may have driven sellers to enter such a trade as evidenced by Nkuna (2004) in the case of Hazyview area of the Mpumalanga Province (South Africa). He showed that people with no or poor education are more likely to get into the informal forest trading activities such as woodcrafts than in the formal trading sector. As a result, low education may have driven sellers' involvement into the trade of wild fruits and nuts given that people with poor education are less likely to get an employment in the formal sector in Gabon.

The trade of indigenous fruits and nuts is dominated by Kota ethnic group (58%), one of the major ethnic groups in the region, while others ethnic groups such as Mahongwé (19%), Fang (6%), Shamayé (6%), Kwélé (5%), Foreign (4%) and Sake (1%) have also managed to enter into this trade. In addition, the trade of the most popular indigenous fruits and nuts is dominated by non-married people

**Table 1.** Social status of sellers and forest products outsources (N=79).

Feature		Count	%	Mean	Min	Max
Gender	Female	75	94.9			
	Male	4	5.1			
Nationality	Gabonese	76	96.2			
	RD Congolese	1	1.3			
	Camerounese	1	1.3			
	Ghanean	1	1.3			
Sellers status	Collectors-sellers	76	96.2			
	Sellers only	3	3.8			
Sellers type	Part-time	47	59.5			
	Full-time	32	40.5			
Education level	None	6	7.6			
	Primary	60	75.9			
	Secondary	13	16.5			
Ethnicity	Kota	46	58.2			
	Mahongwe	15	19.0			
	Fang	5	6.3			
	Shamaye	5	6.3			
	Kwele	4	5.1			
	Sake	1	1.3			
	Foreign	3	3.8			
Marital status	Concubine	35	44.3			
	Married	16	20.3			
	Widow	15	19.0			
	Single	13	16.5			
Driving factors to the trade	Lack of employment	55	69.6			
	Additional income sources	22	27.8			
	Meeting consumers needs	2	2.5			
Working experience (Years)				11.41	0.2	25.0
Age (Years)				43.54	23.0	71.0
Household size				6.13	1.0	11.0
Forest products outsources	Inside of the park	0	0.0			
	Inside-Outside of the park	76	96.2			
	Outside of the park	3	3.8			

n, number of sellers who have exactly participate to the survey.

representing altogether almost (80%) of the respondents including concubine (44%), widow (19%), and single people (15%) while married people represent the rest.

Seventy percent of the respondents have mentioned entering the informal trade of indigenous fruits and nuts as a result of lack of employment while other respondents have stressed additional income sources (28%) and meeting consumers' needs (2%) as the driving factors to their entry to this trade. In the case of rural areas of South Africa for example, factors such as people's proximity to the location of the resources and the lack of

additional costs (except labor related one) involved in resources extraction have been cited as drivers of people's entry to the trade of marula (*Sclerocarya birrea*) beer (Shackleton and Shackleton, 2003, 2004). In Gabon, the state seems to fail to absorb the rising numbers of new entrants into the formal economy given the relatively higher level of unemployment rate 30% among the youth population with age ranging from 16 to 25 years old and poverty level estimated at 33% in the country as a results of the high income inequality among the Gabonese people (GDS, 2008; Mc Kinsey report,

**Table 2.** Trade value by species (N=79).

Species	No. of users	%	Selling amount/ season*			Income/ season*			Price/ Kg		
			Mean (Kg)	Min	Max	Mean (FCFA)	Min	Max	Mean	Min	Max
All species	79	100.0	301.2	24	610	174,949.4	14,400	377,500	536.1	461	699
<i>Coula edulis</i>	65	82.3	133.2	24	240	67,741.5	14,400	154,000	506.2	400	700
<i>Irvingia gabonensis</i>	58	73.4	231.9	33	400	152,919.0	19,800	280,000	660.3	600	800
<i>Dacryodes buettneri</i>	25	31.6	67.6	50	160	21,940.0	15,000	48,000	326.0	300	350

season\*=harvesting season; Currency: 1 euro=655.5 FCFA.

2014). Since a large proportion of the population remains poor (especially in rural areas) and that they find difficulty in finding proper employment therefore the informal trade of indigenous fruits and nuts may still continue to provide livelihood opportunities to these impoverished rural people and their families throughout the country.

The average number of years of experience of the sellers in this study is  $9\pm 7$  with minimum=0; maximum=25 years. Given that average age of sellers was estimated at  $43\pm 11$  with [minimum=23; maximum=71] years therefore these people are mostly adults who may represent a potential working force for the formal sector. Since average family size is estimated at  $6\pm 3$  with [minimum=1; maximum=11] therefore it represents a non-negligible labor force at the disposal of the sellers and their families, especially in time of resources outsources. As a result, family members plays a potential role in helping the main sellers in resources collection from the wild and their sale at marketplaces (Fu et al., 2009; Shackleton et al., 2011; Katel and Schmidt-Vogt, 2011; Asfaw et al., 2013).

Regarding resources outsourced, the majority (96%) of respondents has acknowledged collecting indigenous fruits and nuts from different trees that were found either inside or outside the park. As the collection of indigenous fruits and nuts depend on resources availability therefore the future management of these wild forest products has to be directed to either inside or outside of the park and or to both inside-outside of the park.

### Commercialization of the most popular indigenous fruits, nuts and sellers' livelihood dependence on valued resources

Table 2 shows variations in amounts of forest products sold, gross mean income generation and market price of the most popular indigenous fruits and nuts in the study. Although, all (100%) the respondents are involved in the sale of all the three most popular indigenous fruits and nuts, however variations exist with regards to mean amounts of resources sold, total gross mean income generated per season and total mean price per kg given range differences observed between minimum and maximum. The popularity of these forest products is also evidenced by the proportion of respondents engaged in

their sale. Since 82 and 73% of the respondents are engaged in the sale of *C. edulis* and *I. gabonensis* respectively therefore they can be considered as the most popular indigenous fruits and nuts while *Dacryodes buettneri* represents the least popular species given that (32%) of the respondents are involved in their sale.

For the less popular indigenous fruits and nuts namely *Dacryodes buettneri*, average total amounts of resources sold per season and gross mean income generated were relatively lower than of the two most popular indigenous fruits and nuts (*Coula edulis* and *Irvingia gabonensis*) in terms of average total amounts of resources sold per season and gross mean income generated. Out of the three wild indigenous fruits and nuts, *Irvingia gabonensis* (600 FCFA per Kg) is fetching the highest mean market price followed by *Coula edulis* (400 FCFA per kg) and *Dacryodes buettneri* (300 FCFA per Kg). Consequently, wild fruits and nuts that are fetching the highest market price are also those ones that are being sold and generate most gross mean income per season, especially *Irvingia gabonensis* and *Coula edulis*. In other words, sellers tend to depend more on wild fruits and nuts of a higher market prices.

Resource users' dependence on forest resources of higher economic values is not without any negative ecological impacts on resources base and on local people's livelihoods (Peres et al., 2003; Ticktin, 2004; Belcher and Schreckenber, 2007), especially absence of controlled resources management. However, its negative ecological impacts on resources tend to depend on trees parameters such as parts of the plants use, harvesting practices and intensity, inadequate management practices (Hall and Bawa, 1993; Ticktin, 2004; Uma Shaanker et al., 2004). In the case of this study, the trade of these valued wild fruits and nuts seems to have negative impacts on resources' availability since most of the sellers have acknowledged that these forest resources are declining from the wild. Thus, alleviating such negative ecological impacts on resources base has driven some scholars such as Syampungani et al. (2009), Hirsch et al. (2011), Lewis et al. (2011), and McShane et al. (2011) to suggest a win-win approach as a way to reduce biodiversity decline and enhance livelihoods of forest dependent people.

In the case of Gabon, such an initiative aiming at improving

biodiversity conservation and securing the livelihood local people (at the same time) is relatively recent. Indeed, the Gabonese government has made tremendous efforts in linking biodiversity conservation and livelihood security of local people by banning logs harvesting and commercial trade of five multiple (timber and non-timber forest products) uses plant species including *Poga oleosa* (Afo), *I. gabonensis* (Andock), *Tieghemella Africana* (Douka), *Baillonella toxisperma* (Moabi) and *D. buettneri* (Ozigo) until 2033 (Gabonese Republic, 2009). Among the list of the prohibited species include two of the target tree species of this study, especially *Irvingia gabonensis* and *Dacryodes buettneri*. The former represents the most sold indigenous nuts while the latter is the least sold indigenous fruits as a result certainly of consumers' wealth and price that they can afford for them.

Some of the drivers of households' consumption of forest resources such as wildlife include wealth and price of the goods (Wilkie and Godoy, 2001; Wilkie et al., 2005; Shackleton and Shackleton, 2006; Eniang et al., 2008; Fa et al., 2009; Godoy et al., 2010; Brashares et al., 2011; Foerster et al., 2012). Indeed, the consumption of such forest resources augments with rising of households' wealth and that while price of these forest products goes up its consumption diminishes. Thus, controlling the combined effects of such drivers on resources' consumption and its potential impact forests resources has led Wilkie et al. (2005) to suggest proper taxation coupled with better law enforcement as a valuable solution to overcome the issue of resources decline. According to East et al. (2005), understanding the in-depth causes driving demands of such wild forest products represents one of the starting point to solve the related effects of household wealth on consumption of forest resources.

In the case of this study, the high selling price of *I. gabonensis* and *C. edulis* (comparatively to *Dacryodes buettneri*) that were observed has certainly to do with the lower availability of these forest resources from the wild. Indeed, a recent ecological study carried out by Christian and Ito (2014) has shown that *I. gabonensis* and *C. edulis*, two of the most popular indigenous fruits and nuts, are in lower availability inside and outside of the park as a result of past anthropogenic pressures. Consequently, the scarcity of *Irvingia gabonensis* and *Coula edulis* from the wild may have contributed to increase their selling price at market. One of the direct consequences of the uncontrolled trade of wild forest products (especially those in lower availability) is its negative ecological impacts on species population (Ticktin, 2004) and on people's livelihoods (Eniang et al., 2008). Overcoming such negative impacts on forests and local people's livelihoods has led scholars such as Bennett et al. (2007), Sims (2010), Mukul et al. (2010), Duchelle et al. (2012) to suggest sustainable use and promotion of the commercial extraction of forest products as a viable solution to reconcile biodiversity conservation and livelihoods security of rural peoples in some cases

Regarding this study, viable solutions to regulate the trade of most popular indigenous fruits and nuts are suggested at the end of this paper.

### **Relationship between mean amounts of wild fruits and nuts sold, their gross mean income generation and socio-economic profile of sellers**

Tables 3 and 4 investigated the relationship between mean amounts of wild fruits and nuts sold and socio-economic profile of sellers on one hand and the relationship between gross mean income of these wild forest products and socio-economic profile of sellers on the other hand. The results of these analyses showed that no significant differences were found between each of the socio-economic profile of the respondents including gender, nationalities, sellers' types, job's type and education level and mean amounts of resources sold through Mann Whitney tests and Kruskal Wallis tests. In addition, no significant differences were also found between the previous socio-economic profile of the respondents and gross mean income generation. This may imply that gender, nationalities, sellers' types, job's type and education level of the respondents have no influence on the amounts of resources sold and income generated from their trade.

On the contrary, significant differences were found between ethnic groups and each of the following variables including mean amounts of resources sold ( $X^2 = 15.90$ ,  $p = 0.01$ ) and gross mean income generation ( $X^2 = 14.06$ ,  $p = 0.02$ ) through Kruskal Wallis tests (Tables 3 and 4). Indeed, Saké and Kwelé ethnic groups all together tend to sell significantly less mean amounts of wild fruits and nuts and generate also less gross mean income from not only all the three wild species but also for each of the wild forest products than other ethnic groups including Fang, Kota and Mahongwe. The above result stresses also that ethnicity in terms of social knowledge of the respondents represents a key driving factor to people involvement into the trade of wild fruits and nuts.

Since Kota, Mahongwe and Fang (the dominant ethnic groups) tend to be highly dependent on the wild forest products therefore resources management has to be based on ethnicity dominance in the area. Community organizations based on ethnic groups may represent a good example of informal institutions arrangement, especially with regards to their contribution to sustainable management of natural resources (Leach et al., 1999).

In such approach, successful resources management may require those informal bundles of rights in terms of property rights and resources ownership as well as the roles and responsibilities of resources users are clearly defined and that they are effectively devolved to local users groups by the state (Larson and Ribot, 2004; Hartter and Ryan, 2010; Lambini and Nguyen, 2014).

**Table 3.** Economic value and amounts of traded forest products by sellers social status in the study area.

Social status	Species	#	%	Mean amount/ season*			
				Kg	Min	Max	
Gender	Male	All species	4	5.1	292.5	130.0	440.0
		<i>Irvingia gabonensis</i>	4	5.1	197.5	130.0	240.0
		<i>Coula edulis</i>	2	2.5	120.0	120.0	120.0
		<i>Dacriodes buettneri</i>	2	2.5	70.0	60.0	80.0
	Female	All species	75	94.9	301.7	24.0	610.0
		<i>Irvingia gabonensis</i>	54	68.4	234.4	33.0	400.0
		<i>Coula edulis</i>	63	79.7	133.6	24.0	240.0
		<i>Dacriodes buettneri</i>	23	29.1	67.3	50.0	160.0
Nationality	Gabonese	All species	76	96.2	302.7	24.0	610.0
		<i>Irvingia gabonensis</i>	55	69.6	234.8	33.0	400.0
		<i>Coula edulis</i>	64	81.0	132.5	24.0	240.0
		<i>Dacriodes buettneri</i>	24	30.4	67.1	50.0	160.0
	Others	All species	3	3.8	263.3	130.0	480.0
		<i>Irvingia gabonensis</i>	3	3.8	176.6	130.0	220.0
		<i>Coula edulis</i>	1	1.3	180.0	180.0	180.0
		<i>Dacriodes buettneri</i>	1	1.3	80.0	80.0	80.0
Sellers' type	Collectors-sellers	All species	76	96.2	302.7	24.0	610.0
		<i>Irvingia gabonensis</i>	55	69.6	234.8	33.0	400.0
		<i>Coula edulis</i>	64	81.0	132.5	24.0	240.0
		<i>Dacriodes buettneri</i>	24	30.4	67.1	50.0	160.0
	Sellers only	All species	3	3.8	263.3	130.0	480.0
		<i>Irvingia gabonensis</i>	3	3.8	176.6	130.0	220.0
		<i>Coula edulis</i>	1	1.3	180.0	180.0	180.0
		<i>Dacriodes buettneri</i>	1	1.3	80.0	80.0	80.0
Seller job's type	Full-time	All species	32	40.5	312.5	50.0	570.0
		<i>Irvingia gabonensis</i>	26	32.9	247.3	110.0	360.0
		<i>Coula edulis</i>	27	34.2	117.8	50.0	240.0
		<i>Dacriodes buettneri</i>	6	7.6	65.0	50.0	80.0
	Part-time	All species	47	59.5	293.5	24.0	610.0
		<i>Irvingia gabonensis</i>	32	40.5	219.3	33.0	400.0
		<i>Coula edulis</i>	38	48.1	144.1	24.0	240.0
		<i>Dacriodes buettneri</i>	19	24.1	68.4	50.0	160.0
Education levels	None	All species	6	7.6	243.3	80.0	520.0
		<i>Irvingia gabonensis</i>	3	3.8	216.6	150.0	260.0
		<i>Coula edulis</i>	4	5.1	142.5	80.0	200.0
		<i>Dacriodes buettneri</i>	2	2.5	120.0	80.0	160.0
	Primary	All species	60	75.9	316.1	24.0	610.0
		<i>Irvingia gabonensis</i>	46	58.2	236.1	33.0	400.0
		<i>Coula edulis</i>	50	63.3	135.2	24.0	240.0
		<i>Dacriodes buettneri</i>	21	26.6	63.8	50.0	80.0
Secondary	All species	13	16.5	259.6	65.0	570.0	
	<i>Irvingia gabonensis</i>	9	11.4	215.0	65.0	340.0	
	<i>Coula edulis</i>	11	13.9	120.9	70.0	180.0	
	<i>Dacriodes buettneri</i>	2	2.5	55.0	50.0	60.0	
Ethnicity	Kota	All species	46	58.2	288.7	33.0	520.0
		<i>Irvingia gabonensis</i>	33	41.8	230.1	33.0	360.0
		<i>Coula edulis</i>	38	48.1	131.3	50.0	240.0
		<i>Dacriodes buettneri</i>	9	11.4	77.7	50.0	160.0
	Mahongwe	All species	15	19.0	425.6	60.0	610.0
		<i>Irvingia gabonensis</i>	14	17.7	250.3	65.0	400.0

Table 3. Contd.

		<i>Coula edulis</i>	14	17.7	153.5	60.0	220.0
		<i>Dacriodes buettneri</i>	12	15.2	60.8	50.0	80.0
		All species	5	6.3	310.0	160.0	440.0
	Fang	<i>Irvingia gabonensis</i>	3	3.8	260.0	240.0	300.0
		<i>Coula edulis</i>	5	6.3	138.0	80.0	240.0
		<i>Dacriodes buettneri</i>	1	1.3	80.0	80.0	80.0
		All species	5	6.3	219.6	24.0	570.0
	Shamaye	<i>Irvingia gabonensis</i>	3	3.8	216.6	110.0	340.0
		<i>Coula edulis</i>	3	3.8	116.0	24.0	180.0
		<i>Dacriodes buettneri</i>	2	2.5	50.0	50.0	50.0
		All species	4	5.1	150.5	32.0	340.0
	Kwele	<i>Irvingia gabonensis</i>	2	2.5	195.0	150.0	240.0
		<i>Coula edulis</i>	3	3.8	70.6	32.0	100.0
		<i>Dacriodes buettneri</i>	0	0	0	0	0
		All species	1	1.3	90.0	90.0	90.0
	Sake	<i>Irvingia gabonensis</i>	0	0	0	0	0
		<i>Coula edulis</i>	1	1.3	90.0	90.0	90.0
		<i>Dacriodes buettneri</i>	0	0	0	0	0
		All species	3	3.8	263.3	130.0	480.0
	Foreign	<i>Irvingia gabonensis</i>	3	3.8	176.6	130.0	220.0
		<i>Coula edulis</i>	1	1.3	180.0	180.0	180.0
		<i>Dacriodes buettneri</i>	1	1.3	80.0	80.0	80.0
		All species	35	44.3	248.6	24.0	520.0
	Concubine	<i>Irvingia gabonensis</i>	21	26.6	199.2	33.0	280.0
		<i>Coula edulis</i>	28	35.4	141.0	24.0	240.0
		<i>Dacriodes buettneri</i>	7	8.9	81.4	50.0	160.0
		All species	13	16.5	305.7	65.0	570.0
	Single	<i>Irvingia gabonensis</i>	12	15.2	208.8	65.0	340.0
		<i>Coula edulis</i>	10	12.7	120.0	70.0	180.0
		<i>Dacriodes buettneri</i>	4	5.1	67.5	50.0	80.0
Marital status		All species	16	20.3	405.0	50.0	610.0
	Married	<i>Irvingia gabonensis</i>	13	16.5	264.6	200.0	400.0
		<i>Coula edulis</i>	14	17.7	161.4	60.0	220.0
		<i>Dacriodes buettneri</i>	13	16.5	60.0	50.0	80.0
		All species	15	19.0	309.4	80.0	470.0
	Widow	<i>Irvingia gabonensis</i>	12	15.2	276.6	120.0	360.0
		<i>Coula edulis</i>	13	16.5	96.3	50.0	160.0
		<i>Dacriodes buettneri</i>	1	1.3	70.0	70.0	70.0
		All species	55	69.6	289.6	24.0	570.0
	Lack of employment	<i>Irvingia gabonensis</i>	42	53.2	230.5	33.0	360.0
		<i>Coula edulis</i>	45	57.0	122.4	24.0	240.0
		<i>Dacriodes buettneri</i>	11	13.9	67.2	50.0	80.0
Reasons for entering the trade		All species	22	27.8	340.7	32.0	610.0
	Additional income sources	<i>Irvingia gabonensis</i>	15	19.0	241.0	65.0	400.0
		<i>Coula edulis</i>	19	24.1	154.3	32.0	240.0
		<i>Dacriodes buettneri</i>	14	17.7	67.8	50.0	160.0
		All species	2	2.5	185.0	150.0	220.0
	Meeting consumers needs	<i>Irvingia gabonensis</i>	1	1.3	150.0	150.0	150.0
		<i>Coula edulis</i>	1	1.3	220.0	220.0	220.0
		<i>Dacriodes buettneri</i>	0	0	0	0	0
Total			79				

Table 3. Contd.

Statistical analysis		Mean income/season*			Statistical analysis	
Chi-Square	P-Value	FCFA	Min	Max	Chi-Square	P-Value
147.00	0.96	169,750.0	78,000.0	273,000.0	150.00	1.00
		130,500.0	78,000.0	192,000.0		
		54,000.0	48,000.0	60,000.0		
		24,500.0	21,000.0	28,000.0		
		175,226.7	14,400.0	377,500.0		
		154,579.6	19,800.0	280,000.0		
		68,177.8	14,400.0	154,000.0		
		21,717.4	15,000.0	48,000.0		
23.00	0.62	176,065.8	14,400.0	377,500.0	24.00	0.65
		155,078.1	19,800.0	280,000.0		
		67,675.0	14,400.0	154,000.0		
		21,687.5	15,000.0	48,000.0		
		146,666.6	78,000.0	254,000.0		
		113,333.3	78,000.0	154,000.0		
		72,000.0	72,000.0	72,000.0		
		28,000.0	28,000.0	28,000.0		
102.00	0.78	176,065.7	14,400.0	377,500.0	98.00	0.71
		155,078.1	19,800.0	280,000.0		
		67,675.0	14,400.0	154,000.0		
		21,687.5	15,000.0	48,000.0		
		146,666.6	78,000.0	254,000.0		
		113,333.3	78,000.0	154,000.0		
		72,000.0	72,000.0	72,000.0		
		28,000.0	28,000.0	28,000.0		
717.00	0.73	180,850.0	15,000.0	291,000.0	722.00	0.76
		158,692.3	66,000.0	238,000.0		
		56,933.3	25,000.0	120,000.0		
		20,666.6	15,000.0	28,000.0		
		170,931.9	14,400.0	377,500.0		
		148,228.1	19,800.0	280,000.0		
		75,421.0	14,400.0	154,000.0		
		22,342.1	17,500.0	48,000.0		
2.21	0.33	147,166.6	40,000.0	340,000.0		0.38
		154,666.6	90,000.0	192,000.0		
		85,750.0	40,000.0	120,000.0		
		38,000.0	28,000.0	48,000.0		
		183,295.0	14,400.0	377,500.0		
		154,821.7	19,800.0	280,000.0		
		68,788.0	14,400.0	154,000.0		
		20,785.7	15,000.0	28,000.0		

Table 3. Contd.

		149,253.8	40,000.0	291,000.0		
		142,611.1	45,500.0	204,000.0		
		56,436.3	28,000.0	90,000.0		
		18,000.0	15,000.0	21,000.0		
		171,467.4	19,800.0	347,500.0		
		154,266.6	19,800.0	238,000.0		
		67,742.1	25,000.0	154,000.0		
		24,722.2	17,500.0	48,000.0		
		240,633.3	30,000.0	377,500.0		
		163,678.5	45,500.0	280,000.0		
		77,000.0	28,000.0	140,000.0		
		20,000.0	17,500.0	28,000.0		
		172,200.0	96,000.0	225,000.0		
		156,000.0	144,000.0	180,000.0		
		73,000.0	32,000.0	144,000.0		
		28,000.0	28,000.0	28,000.0		
		119,000.0	14,400.0	291,000.0		
15.90	0.01**	140,333.3	77,000.0	204,000.0	14.06	0.02*
		48,000.0	14,400.0	72,000.0		
		15,000.0	15,000.0	15,000.0		
		93,500.0	16,000.0	228,000.0		
		129,000.0	90,000.0	168,000.0		
		38,666.6	16,000.0	60,000.0		
		0	0	0		
		54,000.0	54,000.0	54,000.0		
		0	0	0		
		54,000.0	54,000.0	54,000.0		
		0	0	0		
		146,666.6	78,000.0	254,000.0		
		113,333.3	78,000.0	154,000.0		
		72,000.0	72,000.0	72,000.0		
		28,000.0	28,000.0	28,000.0		
		146,208.5	14,400.0	347,500.0		
		133,323.8	19,800.0	196,000.0		
		76,178.5	14,400.0	154,000.0		
		26,357.1	17,500.0	48,000.0		
9.19	0.01**	179,115.3	40,000.0	291,000.0	7.58	0.02*
		141,458.3	45,500.0	208,000.0		
		54,300.0	28,000.0	84,000.0		
		22,000.0	15,000.0	28,000.0		
		225,937.5	15,000.0	377,500.0		
		170,769.2	120,000.0	280,000.0		

Table 3. Contd.

	81,428.5	30,000.0	140,000.0	
	19,615.3	15,000.0	28,000.0	
	184,013.3	40,000.0	267,000.0	
	179,333.3	84,000.0	238,000.0	
	45,169.2	25,000.0	64,000.0	
	21,000.0	21,000.0	21,000.0	
	170,245.4	14,400.0	347,500.0	
	152,638.1	19,800.0	238,000.0	
	60,293.3	14,400.0	154,000.0	
	21,772.7	15,000.0	28,000.0	
	193,522.7	16,000.0	377,500.0	
Test cannot be performed	157,900.0	45,500.0	280,000.0	Test cannot be performed
	83,157.8	16,000.0	144,000.0	
	22,071.4	17,500.0	48,000.0	
	100,000.0	90,000.0	110,000.0	
	90,000.0	90,000.0	90,000.0	
	110,000.0	110,000.0	110,000.0	
	0	0	0	

Season\* corresponds to harvesting season. Mann Whitney U tests were performed for variables related to Gender, Nationality, trader types and job opportunities types. Kruskal Wallis tests were performed for variables related to educational levels, ethnicity, marital status and reasons for entering the trade.

Table 4. Sellers' awareness and rational for resources decline and suggested solutions for successful use and management of the resources.

Species	Awareness on resource decline			Rational of resource decline			Suggested solutions to overturn resource decline		
	Response	Count	%	Response	Key word count	%	Response	Key word count	%
<i>Irvingia gabonensis</i>	Aware	56	96.6	Climate change	21	37.5	Better climate	21	37.5
				Logging companies	19	33.9	Deforestation reduction	19	33.9
				Unsustainable use	16	28.6	Sustainable use	16	28.6
	Unaware	2	3.4						
Total		58	100.0		56	100.0		56	100.0
<i>Coula edulis</i>	Aware	61	93.8	Climate change	26	42.6	Better climate	26	42.6
				Logging companies	18	29.5	Deforestation reduction	18	29.5
				Unsustainable use	17	27.9	Sustainable use	17	27.9
	Unaware	4	6.2						
Total		65	100.0		61	100.0		61	100.0
<i>Dacriodes buettneri</i>	Aware	23	92.0	Climate change	9	39.1	Better climate	9	39.1
				Logging companies	7	30.4	Deforestation reduction	7	30.4
				Unsustainable use	7	30.4	Sustainable use	7	30.4
	Unaware	2	8.0						
Total		25	100.0		23	100.0		23	100.0

**Table 5.** Recommendations on potential regulation of commercial resources of the park.

Regulation by		Inside	Buffer zone	Outside
Quotas (Amounts)		P to P	R to A	A to A
Socio-economic status		P to P	R to A	A to A
Other options	Restocking and cultivation	P to A	R to A	A to A
	Alternative income source	P to P	P to R	A to A
	Reducing disturbances	A to A	A to A	A to A

P=Prohibit; R=regulate; A=allow.

Indeed, the effective devolution of policy tenure, power and responsibilities to local resource users has to contribute to yield collective action and equity in resources management and stakeholders' involvement in decision making over forest resources (Larson and Ribot, 2004). In Gabon, community participation in forest and national parks resources management has been acknowledged by both the Forest Code of 2001 and the National Parks of 2007; however, the transfer of rights to local groups of users appears not to be effective on the grounds. As a result, capacity building of institutions is needed to strengthen their roles in resources management.

Significant differences were also found between marital status and each of the following variables including mean amounts of wild fruits and nuts sold ( $X^2 = 9.19$ ,  $p = 0.01$ ) and gross mean income generation ( $X^2 = 7.58$ ,  $p = 0.02$ ) using Kruskal Wallis tests (Tables 3 and 4). This may imply that widow respondents tend to sell and generate significantly less income from wild fruits and nuts from *C. edulis* and *D. buettneri* than others marital statuses of respondents in the study. Since marital status is driving sellers' dependency on the trade of wild fruits and nuts therefore it needs to be taken into account in the future design of forest resources management in the area.

In the case of this study, limiting access to members of the same household alone or excluding other potential users may contribute to undermine the successful management of forest resources unless well-defined and clear rules directed to regulate resources use are set among community members (Ostrom et al., 1999; Poteete and Welch, 2004). Consequently, in that process, social costs and conflicts caused by such exclusionary approach have to be avoided (Lele et al., 2010). Avoiding such pitfalls while improving resources management has led scholars such as Ostrom (1999), Charnley and Poe (2007) and Lele et al. (2010) to take into account policy based on resources tenure and property rights changes.

In Gabon, the effective devolution of some responsibility and authority to the local community is less likely to happen given that the Gabonese government has retained the exclusive property rights and ownership over forests and land. Indeed, the ownership rights over forests have never been granted to the local communities by the Gabonese government in the country except a user fruits rights (Gabonese Republic, 2001, 2007). One

of the often mentioned concerns with regards to the lack of ownership over forest resources is that local communities become more vulnerable and exposed to issues of state's land grabbing (Wily, 2011). Avoiding such issue has led Mudekwe (2007) to suggest the need for forest policy changes so that it reflects the current level of local people's dependence on forest resources upon which they depend on for years in Zimbabwe. In Gabon, the government has not yet embarked on such forest policy changes yet.

#### **Awareness on resources decline, rational and suggested solutions to overturn such issue**

Table 5 shows the relationships between sellers' awareness on resources decline, rational of their decline and suggested solutions to successful overturn such issue. Regarding respondents' awareness level, almost all sellers were aware of the decline of *I. gabonensis*, *C. edulis* and *D. buettneri* according to 97, 94 and 92% of the respondents respectively. Since sellers have a high level of awareness or ecological knowledge on the decline of these fruits and nuts species from the wild therefore they need to be considered as key partners in identifying species in need of conservation and their sustainable management (Gunatilake et al., 2012) at local level. At state level, the issue of resources decline is well known from the Gabonese forest's administration and the state given that a policy initiative aiming at sustainably managing forest resources has led to the ban of harvesting and commercial trade of the five multiple use species such as *Poga oleosa* (Afo), *Irvingia gabonensis* (Andock), *Tieghemella Africana* (Douka), *Baillonella toxisperma* (Moabi) and *Dacryodes buettneri* (Ozigo) (Gabonese government, 2009). Among those species include also two of the valued wild fruits and nuts of this study, especially *I. gabonensis* and *D. buettneri*.

In the case of this study, the drivers of resources decline are multiple. Among mentioned drivers include climate changes (seasonality changes, unpredicted rainfall) according to 38-43% of the respondents followed by logging companies' activities (selective and uncontrolled harvesting) according to 30-34% of the interviewees then unsustainable harvesting (no norms of harvesting) as acknowledged by 28-30% of the people

interviewed (Table 5). Past and current anthropogenic pressures including land clearing for agricultural fields' establishment based on slash and burns and logging companies through selective logging operations and uncontrolled illegal logging have all certainly contributed to the decline of these multiple use timber and non timber forest products from the wild (Lescuyer, 2006, Sassen and Wan, 2006, Corblin, 2006, Viano, 2005). Indeed, locations of forests that are actually found inside and outside of the Ivindo National Park have been granted to logging operations by the forest department until 2004 and that local people get to use forest resources in those locations even before the park was gazette in 2002 (Lescuyer, 2006).

Around the Miombo woodlands in Mwekera area (Zambia), the study of et al. (2009) has contributed to highlight drivers of resources decline including the absence of rules or norms guiding harvesting of wild fruits species, deforestation caused by charcoal extraction and expansion of land for agriculture purposes. Consequently, the loss of certain species of trees from the forest may have serious livelihoods implications for rural people who depend on those forest resources. In other words, fewer trees may mean less forest products upon which local people would derive foods and income from for household livelihoods maintenance. The issue of loss of forest and its negative impacts on local people livelihoods is even more enhance in absence of domestication initiatives and alternatives livelihoods provision by the state to those people (Kalaba et al., 2009).

In this study, some of the solutions to overcome the issues of resources decline have been suggested by the respondents themselves and are among the following "Better climate", "Deforestation reduction" and "Sustainable use" according to 38-43, 30-34 and 28-30% of the respondents respectively (Table 5). Indeed, improving the management of forest resources inside and outside of the park through a "Better climate" driven by the unpredictability of rainfall might be a less plausible solution to achieve on the ground due to difficulty in predicting rainfall. According to Dale et al. (2001), climate change can have an impact on forests structure and composition on one hand while it influences also the severity and magnitude of forest disturbances through rainfall shift on the other hand.

Regarding the others two suggested solutions to overcome the issue of resource decline including, the "reduction of deforestation" through the ban of logging activities inside of the park might contribute certainly to lower the impact of past anthropogenic pressures on the population of species. However, this suggested solution could not contribute to stop people from accessing and using illegally these forest resources in the long term as a result of several issues including the lack of: (i) resources ownership granted to local people by the state, (ii) domestication initiatives to alleviate household dependence on resources base, and (iii) alternative livelihood

provision to the households in the area.

Regarding the last suggested solution and knowing that one of the key concerns of local people and parks' managers is the increasing scarcity of valued forest resources including fruits and nuts species from the wild therefore "Sustainable use" may represent a viable solution to overcome the observed issue of resources decline. In Gabon for example, since the country has turned towards the diversification of its economy through the development of Non Timber Forest Products based enterprises it is therefore crucial for the Gabonese government to take into consideration such sustainable use mechanism as a part of the country innovative approach to regulate and overturn issue of resource decline for both livelihoods sustainability and biodiversity conservation.

Until such a mechanism is in place, several trials and errors experiments are still needed to be carried out before it being widely used throughout the country as a magic solution. Achieving that would more likely ensure future access of forest resources for local people while pursuing at the same time government conservation's efforts as suggested by Mudekwe (2007) in Zimbabwe. Others options falling within sustainable use management of these valuable wild fruits and nuts species may include setting up quotas over harvesting of valued forest resources, restocking of wild species coupled with the implementation of domestication initiatives (local planting) of these forest products in the fields (Maghembe et al., 1998; Leakey et al., 1994; Akinnifesi et al., 2006). Among others valuable solutions to lower local people's dependence and pressure on the wild forest products may also include provision of alternative income sources to local people through proper incentive (DeFries et al., 2007; Davidar et al., 2010). Above all, this study has come up with the following mechanism (author suggestions) as a way to regulate sustainably the trade of the three valued wild fruits and nuts species gathered from different locations of the Ivindo National Park as shown (Table 5).

## Conclusion and recommendations

The contribution of wild indigenous fruits and nuts gathered from different locations of the Ivindo National Park in sustaining the livelihoods of sellers has been clearly shown in this study since these forest products represent an integral part of the livelihoods of rural sellers as source of income generation. *Coula edulis* and *Irvingia gabonensis* appear to be the most popular traded wild fruits and nuts with regards to the proportion of people involved in the trade, mean amounts of resources sold, gross mean income and their marketed price while *Dacryodes buettneri* is acknowledged as the least popular fruits species.

Since *I. gabonensis* fruits species is fetching a higher market price followed by *C. edulis* and *D. buettneri* therefore it can be stressed that traders depend most on

forest resources of higher market value in the study. This study also contributes to show that traders' dependency on forest resources of higher market value is not without any consequence on outsourced resources from the wild. Furthermore, since marital status (social) and ethnicity (affinity with forest resources) of sellers seems to drive people's involvement into the trade of wild indigenous fruits and nuts for income generation therefore these key variables need to be considered in regulating such commercial trade of forest products in the study.

Despite the importance of wild indigenous fruits and nuts as source of income, resources decline have been acknowledged by almost all the sellers. Drivers of resources decline include the impacts of logging companies (selective logging), climate change (unpredictability of rainfall) and unsustainable harvesting practices of these wild indigenous fruits and nuts' species. In addition, achieving conservation and sustained livelihoods of rural sellers call for a careful implementation of the mechanism suggested to regulate market demands of these valued wild resources in the study area. Moreover, further studies should aim at looking on the practical approach of setting up quotas based harvesting of these wild indigenous fruits and nuts for resources management purposes.

## ACKNOWLEDGEMENTS

This study was carried out on the basis of the financial assistance from Japanese International Cooperation Association (JICA) for which I am highly thankful. I am also grateful to the Directors of the Tropical Ecology Research Institute (IRET) of the National Centre of Research in Science and Technology (CENAREST), for providing necessary facilities and guidance. I also thank the staff at the Ipassa Makokou's station for their friendly assistance, tolerance and helpfulness throughout the study period and introducing me to the local administration, village chiefs, and local people. I would like to express my thanks to researchers and friends for their continuous help. I am particularly grateful to Dr. Donald Midoko Iponga and numerous anonymous reviewers for their advice and valuable comments to improve the quality of this manuscript. I am also particularly thankful to my parents and family for their unstoppable support through the course of this study.

## Conflict of interests

The authors did not declare any conflict of interest.

## REFERENCES

African Development Bank Group (AFDB) (2011). Republic of Gabon. Country Strategy Paper 2011-2015. Operations Department Centre Region – ORCE. January 2014. Online accessed 25th September

2014. [www.afdb.org/Documents/Operations/Gabon.pdf](http://www.afdb.org/Documents/Operations/Gabon.pdf).
- Ahenkan A, Boon E (2010). Assessing the impact of forest policies and strategies on promoting the development of non-timber forest products in Ghana. *J. Biodiv.*, 1(2): 85-102.
- Akinnifesi FK, Kwesiga FR, Mhango J, Chilanga T, Mkonda A, Kadu CAC, Kadzere MD, Saka JDK, Sileshi G, Ramadhani T, Dhlwayo P (2006). Towards the development of miombo fruit trees as commercial tree crops in southern Africa. *Forests, Trees and Livelihoods* 16: 103-121. <http://dx.doi.org/10.1080/14728028.2006.9752548>
- Amalfi M, Yombiyeni P, Decock C (2010). Fomitiporia in sub-Saharan Africa: morphology and multigene phylogenetic analysis support three new species from the Guineo-Congolian rainforest. *Mycologia*, 102(6), 1303-1317. <http://dx.doi.org/10.3852/09-083>
- Arnold J, Pérez MR (2001). Can non-timber forest products match tropical forest conservation and development objectives?. *Ecol. econ.*, 39(3): 437-447.
- Arnold M, Powell B, Shanley P, Sunderland TCH (2011). Editorial: Forests, biodiversity and food security. *Int. Forestry Rev.*, 13(3): 259-264. <http://dx.doi.org/10.1505/146554811798293962>
- Asfaw A, Lemenih M, Kassa H, Ewnetu Z (2013). Importance, determinants and gender dimensions of forest income in eastern highlands of Ethiopia: The case of communities around Jelo Afromontane forest. *Forest Policy and Economics*, 28: 1-7. <http://dx.doi.org/10.1016/j.forpol.2013.01.005>
- Brashares JS, Golden CD, Weinbaum KZ, Barrett CB, Okello GV (2011). Economic and geographic drivers of wildlife consumption in rural Africa. *Proceedings of the National Academy of Sciences*, 108(34): 13931-13936. <http://dx.doi.org/10.1073/pnas.1011526108>
- Beauchamp E, Ingram V (2011). Impacts of community forests on livelihoods in Cameroon: Lessons from two case studies. *Int. Forestry Rev.*, 13(4): 389-403. <http://dx.doi.org/10.1505/146554811798811371>
- Belcher B, Schreckenber K (2007). Commercialisation of Non-timber Forest Products: A Reality Check. *Development Policy Rev.*, 25(3): 355-377. <http://dx.doi.org/10.1111/j.1467-7679.2007.00374.x>
- Bennett EL, Blencowe E, Brandon K, Brown D, Burn RW, Cowlshaw G, Wilkie DS (2007). Hunting for consensus: reconciling bushmeat harvest, conservation, and development policy in West and Central Africa. *Conservation Biology*, 21(3): 884-887. <http://dx.doi.org/10.1111/j.1523-1739.2006.00595.x>
- Betti JL, Iponga DM, Yongo OD, Mbomio DO, Mikolo Yobo C, Ngoye A (2013). Ethnobotanical study of medicinal plants of the Ipassa-Makokou Biosphere Reserve, Gabon: Plants used for treating malaria. *Journal of Medicinal Plants Research*, 7(31), 2300-2318.
- Bouroubou-Bouroubou HP (1994). Biology and domestication of some wild fruits trees of Gabon. Doctoral dissertation. Montpellier University II. France.
- Bouroubou-Bouroubou HP, Posso P (1995). Overview of the importance of some wild fruits trees in the North-East of Gabon. *Nature and Fauna*, 11(3): 42-48.
- Brussaard L, Caron P, Campbell B, Lipper L, Mainka S, Rabbinge R, Pulleman M (2010). Reconciling biodiversity conservation and food security: scientific challenges for a new agriculture. *Current Opinion in Environmental Sustainability*, 2(1), 34-42. <http://dx.doi.org/10.1016/j.cosust.2010.03.007>
- Caballé G (1978). Essay on forest's geography of Gabon. *Adansonia* 17:425-440.
- Charnley S and Poe MR (2007). Community Forestry in Theory and Practice: Where Are We Now?. *Annual Rev. Anthropology*, 36(1): 301. <http://dx.doi.org/10.1146/annurev.anthro.35.081705.123143>
- Chhetri RB (2009). From protection to poverty reduction: A review of forestry policies and practices in Nepal. *J. Forest and Livelihood*, 5(1): 66-77. <http://dx.doi.org/10.3126/jfl.v5i1.1982>
- Christian MY, Chirwa PW, Ham C (2008). The influence of tourism on the woodcarving trade around Cape Town and implications for forest resources in southern Africa. *Development Southern Africa*, 25(5): 577-588. <http://dx.doi.org/10.1080/03768350802447800>
- Christian MY, Ito K (2014). Availability and size class distribution of the most popular indigenous fruits trees and implications for sustainable harvest around the Ivindo National Park, Gabon. *Int. J. Biodiv. Conserv.* 6 (11): 777-789.
- Corblin A (2006). Economy and perceptions of villagers' practices in the

- National Park Ivindo (Gabon). Master Thesis; Ecology Engineering and Biodiversity management, University of Montpellier II, France.
- Davidar P, Sahoo S, Mammen PC, Acharya P, Puyravaud JP, Arjunan M, Roessingh K (2010). Assessing the extent and causes of forest degradation in India: Where do we stand?. *Biological Conservation*, 143(12):2937-2944. <http://dx.doi.org/10.1016/j.biocon.2010.04.032>
- Dale VH, Joyce LA, McNulty S, Neilson RP, Ayres MP, Flannigan MD, Michael Wotton B (2001). Climate Change and Forest Disturbances: Climate change can affect forests by altering the frequency, intensity, duration, and timing of fire, drought, introduced species, insect and pathogen outbreaks, hurricanes, windstorms, ice storms, or landslides. *BioScience*, 51(9): 723-734. [http://dx.doi.org/10.1641/0006-3568\(2001\)051\[0723:CCAFD\]2.0.CO;2](http://dx.doi.org/10.1641/0006-3568(2001)051[0723:CCAFD]2.0.CO;2)
- DeFries R, Hansen A, Turner BL, Reid R, Liu J (2007). Land use change around protected areas: management to balance human needs and ecological function. *Ecological Applications*, 17(4):1031-1038. <http://dx.doi.org/10.1890/05-1111>
- de la Torre L, Valencia R, Altamirano C, Ravnborg HM (2011). Legal and administrative regulation of palms and other NTFPs in Colombia, Ecuador, Peru and Bolivia. *The Botanical Review*, 77(4): 327-369. <http://dx.doi.org/10.1007/s12229-011-9066-z>
- Duchelle AE, Guariguata MR, Less G, Albornoz MA, Chavez A, Melo T (2012). Evaluating the opportunities and limitations to multiple use of Brazil nuts and timber in Western Amazonia. *Forest Ecology and Management*, 268,39-48. <http://dx.doi.org/10.1016/j.foreco.2011.05.023>
- East T, Kumpel NF, Milner-Gulland EJ, Rowcliffe JM (2005). Determinants of urban bushmeat consumption in Rio Muni, Equatorial Guinea. *Biol. Conserv.*, 126(2):206-215. <http://dx.doi.org/10.1016/j.biocon.2005.05.012>
- Eniang EA, Eniang ME, Akpan CE (2008). Bush meat trading in the Oban Hills region of south-eastern Nigeria: implications for sustainable livelihoods and conservation. *Ethiopian J. Environ. Studies Management*, 1(1): 70-83.
- Fa JE, Albrechtsen L, Johnson PJ, Macdonald DW (2009). Linkages between household wealth, bushmeat and other animal protein consumption are not invariant: evidence from Rio Muni, Equatorial Guinea. *Animal Conservation*, 12(6), 599-610. <http://dx.doi.org/10.1111/j.1469-1795.2009.00289.x>
- Foerster S, Wilkie DS, Morelli GA, Demmer J, Starkey M, Telfer P, Lewbel A (2012). Correlates of bushmeat hunting among remote rural households in Gabon, Central Africa. *Conservation Biol.*, 26(2):335-344. <http://dx.doi.org/10.1111/j.1523-1739.2011.01802.x>
- Fu Y, Chen J, Guo H, Hu H, Chen A, Cui J (2009). Rain forest dwellers' livelihoods: income generation, household wealth and NTFP sales, a case study from Xishuangbanna, SW China. *Int. J. Sustainable Development and World Ecology*, 16(5): 332-338. <http://dx.doi.org/10.1080/13504500903198805>
- Gabonese Republic (1971). Decree N° 837/PR/MEF du 02/10/1971 related to the classification of the Natural Integral Reserve of Ipassa Upland.
- Gabonese Republic (2002). Forest Code Law No 16/01 of the 31st of December 2001.
- Gabonese Republic (2007). Law N0 003/2007 of the 27th August on National Parcs.
- Gabonese Republic (2009). Decree N0 137/PR/MEFEPA of the 04th February 2009 on prohibition of five timber forest products throughout the Gabonese forest.
- Gabonese Republic (2001). Law No. Law N0 16/01 of 31st December 2001 on the Forestry Code in the Gabonese Republic.
- Gabonese Republic (2004). Decree N0 000692 /PR/MEFEPEPN setting up the conditions for exercising customary use rights on forest, wildlife, hunting and fishing livelihoods activities.
- Gabonese Republic (2007). Law N0 003/2007 related to National Parks based on the Forest Code in the Gabonese Republic.
- General Directorate of Statistics (GDS) (2008). Gabon Statistics Yearbook of 2004-2008. Gabonese Republic, pp 29. Accessed on 25th December 2014.
- Godoy R, Undurraga EA, Wilkie D, Reyes-García V, Huanca T, Leonard WR, Vadez V (2010). The effect of wealth and real income on wildlife consumption among native Amazonians in Bolivia: estimates of annual trends with longitudinal household data (2002–2006). *Ani. Conserv.*, 13(3): 265-274. <http://dx.doi.org/10.1111/j.1469-1795.2009.00330.x>
- Gondo T, Frost P, Kozanayi W, Stack J, Mushongahande M (2010). Linking knowledge and practice: Assessing options for sustainable use of mopane worms (*Imbrasia belina*) in southern Zimbabwe. *J. Sustainable Development in Africa*, 12(4): 127-145.
- Gunatilake HM, Wickramasinghe WAR, Abeygunawardena P (2012). Time preference and natural resource use by local communities: the case of Sinharaja Forest in Sri Lanka. *Sri Lankan J. Agric. Econ.*, 10, 31-60.
- Hall P, Bawa K (1993). Methods to assess the impact of extraction of non-timber tropical forest products on plant populations. *Economic botany*, 47(3):234-247. <http://dx.doi.org/10.1007/BF02862289>
- Harterter J and Ryan SJ (2010). Top-down or bottom-up? Decentralization, natural resource management, and usufruct rights in the forests and wetlands of western Uganda. *Land Use Policy*, 27(3):815-826. <http://dx.doi.org/10.1016/j.landusepol.2009.11.001>
- Hirsch PD, Adams WM, Brosius JP, Zia A, Bariola N, Dammert JL (2011). Acknowledging conservation trade-offs and embracing complexity. *Conserv.Biol.*, 25(2):259-264.
- Ingram V, Ndumbe LN, Ewane ME (2012). Small scale, high value: *Gnetum africanum* and *buchholzianum* value chains in Cameroon. *Small-Scale Forestry*, 11(4): 539-556. <http://dx.doi.org/10.1007/s11842-012-9200-8>
- IRET-CENAREST (2003). Draft: Research Station Ipassa, Makokou, Gabon. Presentation and Publications (1962-2003). IRET/CENAREST, Libreville, Gabon.
- Jamnadass RH, Dawson IK, Franzel S, Leakey RRB, Mithöfer D, Akinnifesi FK, Tchoundjeu, Z (2011). Improving livelihoods and nutrition in sub-Saharan Africa through the promotion of indigenous and exotic fruit production in smallholders' agroforestry systems: a review. *Int. Forestry Rev.*, 13(3):338-354. <http://dx.doi.org/10.1505/146554811798293836>
- Kaimowitz D (2003). Not by bread alone... forests and rural livelihoods in sub-Saharan Africa. In *Forests in poverty reduction strategies: capturing the potential*. EFI Proceedings (No. 47, pp. 45-63).
- Kalaba FK, Chirwa PW, Prozesky H (2009). The contribution of indigenous fruit trees in sustaining rural livelihoods and conservation of natural resources. *J. Horticult. Forestry*, 1(1):1-6.
- Katel ON, Schmidt-Vogt D (2011). Use of Forest Resources by Residents of Jigme Singye Wangchuck National Park, Bhutan: Practices and Perceptions in a Context of Constraints. *Mountain Research and Development*, 31(4):325-333. <http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00077.1>
- Kunwar SC, Ansari AS, Luintel H (2009). Non-timber forest products enterprise development: Regulatory challenges in the Koshi hills of Nepal. *Journal of Forest and Livelihood*, 8(2):39-50. <http://dx.doi.org/10.3126/jfl.v8i2.2307>
- Laird SA, Wynberg R, McLain RJ (2009). Wild products governance: laws and policies for sustainable and equitable non-timber forest product use. Policy brief. United Nations University, Darwin, Australia, Centre for International Forestry Research, Bogor, Indonesia, People and Plants International, Bristol, Vermont, Environmental Evaluation Unit, University of Cape Town, Cape Town, Institute for Culture and Ecology.
- Laird SA, McLain RJ, Wynberg R (eds.) (2010b). Wild product governance: finding policies that work for non-timber forest products. Earthscan.
- Laird SA, Ingram V, Awono A, Ndoye O, Sunderland T, Fotabong EL, Nkuinkeu R (2010a). Integrating customary and statutory systems: the struggle to develop a legal and policy framework for NTFPs in Cameroon In: Laird SA, McLain RJ, Wynberg R (eds.) (2010). Wild product governance: finding policies that work for non-timber forest products. London: Earthscan, 53-70.
- Laird SA, Wynberg R, McLain RJ (2011). Regulating complexity: policies for the governance of non-timber forest products. In: *Non-timber forest products in the global context* (pp. 227-253). Springer Berlin Heidelberg. [http://dx.doi.org/10.1007/978-3-642-17983-9\\_11](http://dx.doi.org/10.1007/978-3-642-17983-9_11)
- Lambini CK and Nguyen TT (2014). A comparative analysis of the effects of institutional property rights on forest livelihoods and forest conditions: Evidence from Ghana and Vietnam. *Forest Policy and*

- Economics, 38: 178-190. <http://dx.doi.org/10.1016/j.forpol.2013.09.006>
- Larsen HO, Olsen CS, Boon TE (2000). The non-timber forest policy process in Nepal: actors, objectives and power. *Forest Policy and Economics*, 1(3): 267-281. [http://dx.doi.org/10.1016/S1389-9341\(00\)00013-7](http://dx.doi.org/10.1016/S1389-9341(00)00013-7)
- Larson A, Ribot J (2004). Democratic decentralisation through a natural resource lens: an introduction. *Euro. J. Development Res.*, 16(1): 1-25. <http://dx.doi.org/10.1080/09578810410001688707>
- Leakey RRB (1994). Les arbres au bois dormant. *Agroforestry Today* ICRAF, Nairobi, Kenya. 6(2):3-4.
- Leakey RR, Tchoundjeu Z, Schreckenber K, Shackleton SE, Shackleton CM (2005). Agroforestry tree products (AFTPs): targeting poverty reduction and enhanced livelihoods. *Int. J. Agric. Sustainability*, 3(1): 1-23. <http://dx.doi.org/10.1080/14735903.2005.9684741>
- Lele S, Wilshusen P, Brockington D, Seidler R, Bawa K (2010). Beyond exclusion: alternative approaches to biodiversity conservation in the developing tropics. *Current Opinion in Environmental Sustainability*, 2(1): 1-10.
- Lescuyer G (2006). Economic evaluation of the Ivindo National Park of Gabon: an estimation of benefits expected from nature conservation in Central Africa. CIRAD paper and CIFOR, Montpellier, France.
- Lescuyer G, Mvondo SA, Essoungou JN, Toison V, Trébuchon JF, Fauvel N (2012). Logging concessions and local livelihoods in Cameroon: from indifference to alliance?. *Ecology and Society*, 17(1): 7. <http://dx.doi.org/10.5751/ES-04507-170107>
- Lewis D, Bell SD, Fay J, Bothi KL, Gatere L, Kabila M, Travis AJ (2011). Community Markets for Conservation (COMACO) links biodiversity conservation with sustainable improvements in livelihoods and food production. *Proceedings of the National Academy of Sciences*, 108(34):13957-13962. <http://dx.doi.org/10.1073/pnas.1011538108>
- Maghembe JA, Simons AJ, Kwesiga F, Rarieya M (1998). Selecting indigenous fruit trees for domestication in southern Africa: Priority setting with farmers in Malawi, Tanzania, Zambia and Zimbabwe. *International Centre for Research in Agroforestry, Nairobi, Kenya*. p. 94
- Mc Kinsey report (2014). The state of poverty in Gabon. Gabonese republic, pp 50. Accessed on 10th December 2014.
- McShane TO, Hirsch PD, Trung TC, Songorwa AN, Kinzig A, Monteferri B, O'Connor S (2011). Hard choices: Making trade-offs between biodiversity conservation and human well-being. *Biological Conservation*, 144(3):966-972. <http://dx.doi.org/10.1016/j.biocon.2010.04.038>
- Mikolo Yobo C (2007). Livelihood and income generation from the woodcarving trade in the Cape Town area of the Western Cape Province, South Africa. Master thesis, Stellenbosch: University of Stellenbosch, Western Cape Province
- Mudekwe J (2007). The impact of subsistence use of forest products and the dynamics of harvested woody species populations in a protected forest reserve in western Zimbabwe. Doctoral dissertation, Stellenbosch: University of Stellenbosch, Western Cape Province.
- Mukul SA, Uddin MB, Manzoor Rashid AZM, Fox J (2010). Integrating livelihoods and conservation in protected areas: understanding the role and stakeholder views on prospects for non-timber forest products, a Bangladesh case study. *Int. J. Sustainable Development World Ecology*, 17(2), 180-188. <http://dx.doi.org/10.1080/13504500903549676>
- Mutenje MJ, Ortmann GF, Ferrer SR D (2011). Management of non-timber forestry products extraction: Local institutions, ecological knowledge and market structure in South-Eastern Zimbabwe. *Ecological Economics*, 70(3): 454-461. <http://dx.doi.org/10.1016/j.ecolecon.2010.09.036>
- Nkuna I (2004). Trade in woodcrafts in the Hazyview area, Mpumalanga province as a source of income for informal traders. MSc thesis, University of KwaZulu-Natal, Durban.
- Okouyi- Okouyi J (2006). Local knowledge and modern cynegetic tools: commercial value chain development of wild meat in Makokou (Gabon). Doctoral dissertation, Orléans University, France.
- Ostrom E (1999). Coping with tragedies of the commons. *Annual review of political science*, 2(1): 493-535. <http://dx.doi.org/10.1146/annurev.polisci.2.1.493>
- Pandit BH, Thapa GB (2004). Poverty and resource degradation under different common forest resource management systems in the mountains of Nepal. *Society and Natural Resources*, 17(1):1-16. <http://dx.doi.org/10.1080/08941920490247209>
- Patel T, Dhialuhaq A, Gritten D, Yasmi Y, De Bruyn T, Paudel NS, Suzuki R (2013). Predicting future conflict under REDD+ implementation. *Forests*, 4(2):343-363. <http://dx.doi.org/10.3390/f4020343>
- Paumgarten F (2005). The role of non-timber forest products as safety-nets: a review of evidence with a focus on South Africa. *Geo Journal*, 64(3):189-197. <http://dx.doi.org/10.1007/s10708-005-5647-x>
- Peres CA, Baider C, Zuidema PA, Wadt LH, Kainer KA, Gomes-Silva DA, Freckleton RP (2003). Demographic threats to the sustainability of Brazil nut exploitation. *Science*, 302(5653): 2112-2114. <http://dx.doi.org/10.1126/science.1091698>
- Perez MR, Ndoye O, Eyebe A, Ngono DL (2002). A gender analysis of forest product markets in Cameroon. *Africa today*, 49(3):97-126. <http://dx.doi.org/10.1353/at.2003.0029>
- Pineau W (1995). Reflexion on medicinal plants from fangs, Bakotas and Bakwélés of Makokou region in North-East of Gabon: future perspectives. End cycle draft dissertation. OSTOM International Institut in Agrodevelopment, Cergy-Pontoise, France. PRONATURA, IRET: 79pp.
- Pokharel BK (2010). A critical reflection on the sustainable livelihoods approach and its application to Nepal's community forestry. *Livelihood Insecurity and Social Conflict in Nepal*, 183.
- Poteete AR, Welch D (2004). Institutional development in the face of complexity: developing rules for managing forest resources. *Human Ecology*, 32(3):279-311. <http://dx.doi.org/10.1023/B:HUEC.0000028083.29437.ac>
- Powell B, Watts JD, Asaha S, Boucard A, Feintrenie L, Lyimo E, Urech ZL (2010). The role of wild species in the governance of tropical forested landscapes. *Collaborative governance of tropical landscapes*, 157.
- Rabbi F, Bauer S, Idalinya J (2010). Contribution of forests to rural inequality reduction: present scope and future options for rural development and sustainable use of forests. *Int. J. Sustainable Development and World Ecology*, 17(1):4-14. <http://dx.doi.org/10.1080/13504500903488271>
- Sassen M, Wan M (2006). Biodiversity and local priorities in a community near the Ivindo National Park Makokou, Gabon. Project IRET/CENAREST and CIFOR. Makokou/Ipasa, Gabon.
- Sims KR (2010). Conservation and development: Evidence from Thai protected areas. *J. Environ. Econs. Mgt.*, 60 (2),94-114. <http://dx.doi.org/10.1016/j.jeem.2010.05.003>
- Shackleton C, Shackleton S (2003). Value of non-timber forest products and rural safety nets in South Africa. In: *International Conference on Rural Livelihoods, Forests and Biodiversity* (pp. 19-23).
- Shackleton C, Shackleton S (2004). The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African J. Sci.*, 100 (11 and 12): 658.
- Shackleton, CM, Shackleton SE (2006). Household wealth status and natural resource use in the Kat River valley, South Africa. *Ecological Economics*, 57(2):306-317. <http://dx.doi.org/10.1016/j.ecolecon.2005.04.011>
- Shackleton S, Paumgarten F, Kassa H, Husselman M, Zida M (2011). Opportunities for enhancing poor women's socioeconomic empowerment in the value chains of three African non-timber forest products (NTFPs). *Int. Forestry Rev.*, 13(2):136-151. <http://dx.doi.org/10.1505/146554811797406642>
- Sonke B, Taedoung H, Robbrecht E (2012). A reconsideration of the Lower Guinean species of *Sericanthe* (Rubiaceae, Coffeaeae), with four new species from Cameroon and Gabon. *Botanical J. Linnean Society*, 169(3): 530-554. <http://dx.doi.org/10.1111/j.1095-8339.2012.01254.x>
- Subedi M (2010). Aromatic Plant Trade and Livelihood Strategies in Rural Nepal: A Case of Wintergreen in Dolakha District. *Occasional Papers in Sociology and Anthropology*, 11: 84-103.
- Sunderland TCH (2011). Food security: why is biodiversity important? *Int. Forestry Rev.*, 13(3): 265-274. <http://dx.doi.org/10.1505/146554811798293908>
- Syampungani S, Chirwa PW, Akinnifesi FK, Sileshi G, Ajayi OC (2009). The miombo woodlands at the cross roads: Potential threats,

- sustainable livelihoods, policy gaps and challenges. In *Natural Resources Forum*, 33(2): 150-159. <http://dx.doi.org/10.1111/j.1477-8947.2009.01218.x>
- Tieguhong JC, Ndoye O, Grouwels S, Mala WA, Betti JL (2012). Rural enterprise development for poverty alleviation based on non-wood forest products in Central Africa. *Int. Forestry Rev.*, 14(3): 363-379. <http://dx.doi.org/10.1505/146554812802646701>
- Ticktin T (2004). The ecological implications of harvesting non-timber forest products. *J. Appl. Ecol.*, 41(1): 11-21. <http://dx.doi.org/10.1111/j.1365-2664.2004.00859.x>
- Uma Shaanker R, Ganeshiah KN, Krishnan S, Ramya R, Meera C, Aravind NA, Chinnappa Reddy BV (2004). Livelihood gains and ecological costs of non-timber forest product dependence: Assessing the roles of dependence ecological knowledge and market structure in three contrasting human and ecological settings in South India. *Environmental Conservation*, 31(3): 242-253. <http://dx.doi.org/10.1017/S0376892904001596>
- Uprety Y, Poudel RC, Asselin H, Boon EK, Shrestha KK (2011). Stakeholder perspectives on use, trade, and conservation of medicinal plants in the Rasuwa District of Central Nepal. *J. Mountain Sci.*, 8(1): 75-86. <http://dx.doi.org/10.1007/s11629-011-1035-6>
- Viano M (2005). Characterisation of activities of Makokou's population in the Ivindo National Park (province of Ogooué Ivindo, Gabon). DEES dissertation, Gembloux University Belgium.
- Walker AR, Sillans R (1961). *The useful plants of Gabon*. Lechevalier, Paris, p. 614.
- Wilkie DS, Godoy RA (2001). Income and price elasticities of bushmeat demand in lowland Amerindian societies. *Conservation Biology*, 15(3): 761-769. <http://dx.doi.org/10.1046/j.1523-1739.2001.015003761.x>
- Wilkie DS, Starkey M, Abernethy K, Effa EN, Telfer P, Godoy R (2005). Role of prices and wealth in consumer demand for bushmeat in Gabon, Central Africa. *Conserv. Biol.*, 19(1), 268-274. <http://dx.doi.org/10.1111/j.1523-1739.2005.00372.x>
- Wily LA (2011). The Law is to Blame: The Vulnerable Status of Common Property Rights in Sub-Saharan Africa. *Development and Change*, 42: 733-757. <http://dx.doi.org/10.1111/j.1467-7660.2011.01712.x>
- Yombiyeni P, Douanla-Meli C, Amalfi M, Decock C (2011). Poroid Hymenochaetaceae from Guineo-Congolian rainforest: *Phellinus gabonensis* sp. nov. from Gabon—taxonomy and phylogenetic relationships. *Mycological Progress*, 10(3):351-362. <http://dx.doi.org/10.1007/s11557-010-0708-z>