

## Impact of forest transition on non-timber forest products in Central Africa

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### Abstract

The objective of the study is to evaluate the impact of deforestation on non-timber forest products (NTFPs) harvest in Central Africa. The most common vegetal NTFPs are fruits, barks and leaves used as complements to the staple food (cassava or plantain). Animal NTFPs such as caterpillars, worms and bush meat represent a major source of animal protein in the villagers' diet.

We analyzed the evolution of several parameters including NTFPs diversity, distance to the road, changes in land tenure rules, proportion in the alimentary bolus and in the villagers' incomes. The research is based on field surveys, participatory mapping and geolocation of activities held in 8 villages. Three study sites are located at different stages on Mather's forest transition curve (Mather, 1992). This curve shows the relationship between forest cover and population density. The sites represent the situations: (i) important cover of intact forest, (ii) forest partially degraded and under pressure of conversion to other land uses and (iii) small surfaces of degraded forest with a trend of plantation of useful trees on deforested land.

Results show a reduction in NTFPs diversity along with the increase of deforestation. The maximum distance of collection sites to the road increases between the first and the second study site, as a consequence of the decrease in the quantity of NTFPs available. This distance decreases significantly in the third study site due to the contraction of villagers' terroir. The diversity of bush meat decreases while the hunting bag evolves from big to small species along with the forest transition. Land tenure rules to access and extract NTFPs become stricter. As a consequence, the proportion of these products reduces in the alimentary bolus and in the family cash income.

This analysis establishes a strong link between Mather's forest transition curve and the decline of the importance of NTFPs in the village production and livelihoods systems.

*Keywords:* NTFP, Central Africa, Socio-ecological systems, forest transition curve

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### Introduction, scope and main objectives

Forests of the Congo Basin are among the best preserved areas of the globe. Currently, the erosion of biodiversity is low compared to other African areas and areas of Asia and tropical America (Sanderson *et al.* 2002). According to the projections of the impacts of global change on biodiversity proposed by Leadley *et al.* (2010) the conversion of large areas of forests to answer economic purposes outside the forestry sector in territories with a different assignment (such as mines or large scale plantations) is expected. The effects of this pressure on biodiversity and forest associated ecosystem services could be considerable.

The process of deforestation due to increasing demographic pressure has been described by Mather (1992) as the forest transition. The forest transition curve shows the relationship between forest cover

and time. Time can be replaced by the rise in population density or the economic development (Barbier *et al.* 2010). According to Angelsen (2008), the forest transition curve can be divided in three phases: initially, the area is characterized by a high percentage of forest cover with a low deforestation rate, the low population density involving a low impact on forest resources. Then the deforestation rate increases, the forest is partially degraded and under pressure of conversion to other land uses. Finally, only small surfaces of degraded forest remain once the transition is completed. Ultimate stage sees a trend of plantation of useful trees on deforested land, conducting to an increase in tree cover (Figure 1). This is the result of a joint development between economy, culture, technology, ecology and institutional development at different scales (Marten 2005). The forest transition participates in a complex phenomenon of change of a socio-ecological system (SES)<sup>1</sup>.

If a deterministic relationship between population trends and forest area is assumed, huge areas of native forests will disappear before the forest transition is completed and deforestation stopped. Nonetheless, as in many European cases, the forest transition might be completed relatively early, leading to the subsistence of large native forests areas linked with changes in resource perceptions and increasing rates of reforestation or afforestation in tropical countries (Mather and Needle 1998).

Despite the amount of study about forest transition (Barbier *et al.* 2010; Rudel *et al.* 2002; Rudel *et al.* 2005), functional aspects linked to this transition have not been treated. To understand the evolution of SES in the forest transition context, we evaluated the impact of deforestation on non-timber forests products (NTFPs) harvest in Central Africa. NTFP were defined by FAO in 1995 as "goods of biological origin other than wood, as well as services, derived from forests and allied land uses." In this study, we focused on NTFPs intended for human food. The most common vegetal NTFPs found in Central Africa are fruits, barks and leaves used as complements to the staple food (cassava or plantain). Animal NTFPs such as caterpillars, worms and bush meat represent a major source of animal protein in the villagers' diet.

## Method

This research is based on participatory mapping and observations, interviews and group discussions that were conducted between June 2013 and May 2014 with more than 1000 villagers from 8 villages of Central Africa. The villages are located in three research sites in Cameroon and Gabon. The study sites were chosen according to their position on the forest transition curve (figure 1).

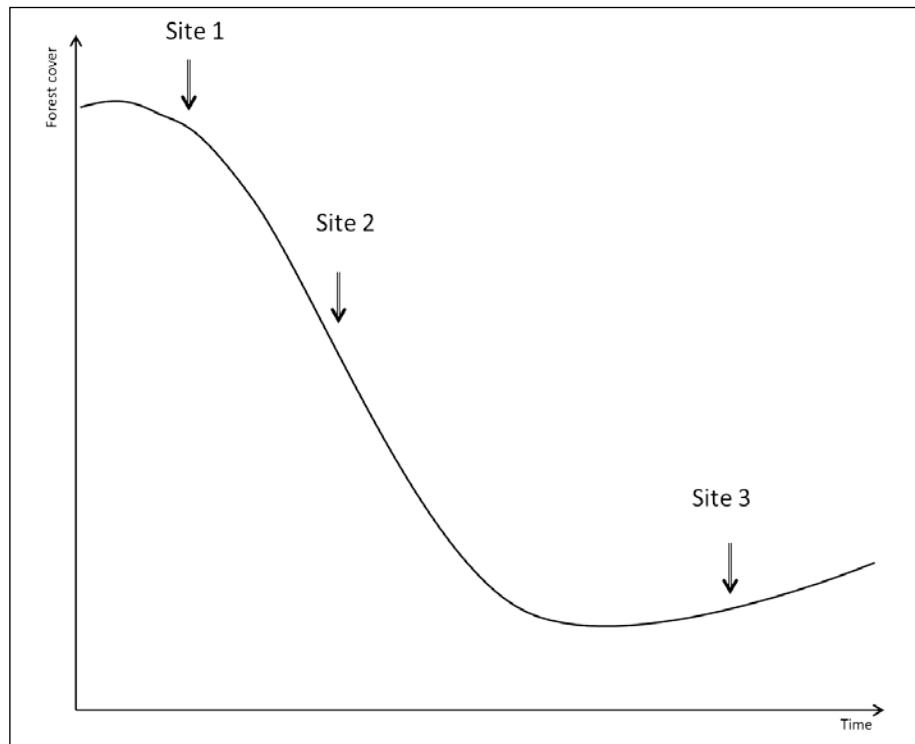
The first study site is located in north-east Gabon; it is characterized by a low population density (1.6 inhabitants/km<sup>2</sup>). The studied socio-ecological system is made of three surrounding villages in the influence sphere of Makokou (province capital city of less than 4000 inhabitants), inhabited mostly by natives of the ethnic group *Bakota*. Villagers' incomes are generated mostly from the exploitation of natural resources such as slash and burn agriculture, hunting, fishing and gathering. The low population density combined with a low agricultural impact explains the location of this site on the Mather's curve (figure 1).

The second study site consists of three villages located in the Eastern Province of Cameroon. The population density is about 6.3 inhabitants/km<sup>2</sup>, majoritarian ethnic groups are indigenous: *Badjoué* (33.5%), *Ndjem* (17.96%) and *Baka* pygmies (12.1%), the remaining population is made of ethnic groups from across the country. One of these villages hosts the base camp of a logging company. The income level is higher than in the first site and depends mostly on the salaries coming from the logging company. Slash and burn agriculture is mostly practiced to overcome family food needs. Forest cover located around the villages of this site is being degraded due to the rise in population density and the presence of the logging company which explains its intermediary position on the forest transition curve (figure 1).

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<sup>1</sup> The so called forested SES deals with a particular group of actors who have an impact on a particular lot of resources allocated to a particular set of institutions (Janssen *et al.* 2007).

The third study site is 100 km north of Yaoundé (Cameroon capital city) at the interface between forest and savannah in a densely populated area (71 inhabitants/km<sup>2</sup>). The population is made exclusively of ethnic natives *Yambassa*. Agriculture is the main source of income; products are sold on local markets to traders of the capital city and to cocoa resellers. This area is characterized by a mosaic of agricultural land with small patches of remnant forest. Current landscape dynamics consist in an increase in the tree covers due to the expansion of cocoa agroforestry plantations in savannahs. This dynamic explains the position of this site at the last phase of the forest transition curve (figure 1).



**Figure 1. Forest transition curve and the position of the three study sites.**

To evaluate the impact of deforestation on NTFPs harvest in Central Africa, we focused on the diversity of NTFP harvested by local populations, NTFP quantity and diversity found in the alimentary bolus, the maximal distance perpendicular to the road at which NTFP are collected and the part of NTFP in villagers' income.

We observed and quantified the alimentary bolus during 21 days for each village; we studied the composition of the incomes for a sample of representative family units. We also performed a land tenure study according to the methodology developed by Le Roy *et al.* (1996). This study was published in Gillet *et al.* (2015).

The analysis of family income is based on in-depth interviews concerning the list of income-generating activities for the past year whether salaries, agricultural production, hunting, fishing or gathering. We then detailed this list by specifying the part self-consumed and sold and the selling prices of the different products. We interviewed 58 of 135 family units in Makokou (study site 1) (42.96 %), 97 of 691 family units in Mindourou (study site 2) (14.04%) and 55 of 450 family units in Guéfigué (study site 3) (12.09%) based on their representativeness in terms of ethnic groups and main activities. The hunting bag was established by interviewing hunters (16 in site 1; 27 in site 2; 15 in site 3) about the number of preys they collected for each season of the past years.

## Results

### Distance

Fixed non timber forests products (all NTFP except bush meat) can be spread all over the village territory. They can be found in the forest, along rivers, in fields and plantation or inside the village. In order to allow the comparison of accessibility for the three study sites, we considered the maximal distance perpendicular to the main road. We can see in the table 1 that this distance increases between site 1 and site 2 reflecting the additional effort required to collect NTFP when the pressure on the forest increases. In the third study site, this distance decreases drastically, related to the sharp contraction of the village territory caused by the high population density.

**Table 1. Maximal distance perpendicular to the road of fixed non-timber forest products in the three study sites**

	Population density (inhabitants/km <sup>2</sup> )	Maximal distance perpendicular to road (km)
Makokou (site 1)	1.6	8.7
Mindourou (site 2)	6.3	12.5
Guéfigué (site 3)	71	3.1

### Hunting bag

We can see in figure 2 the decrease in the diversity of bush meat and the evolution of the hunting bag from big to very small species along with the forest transition. The remaining bush meat in the third study site consists mainly of little rodents like rats and shrews due to the disappearance of forested shelter areas.

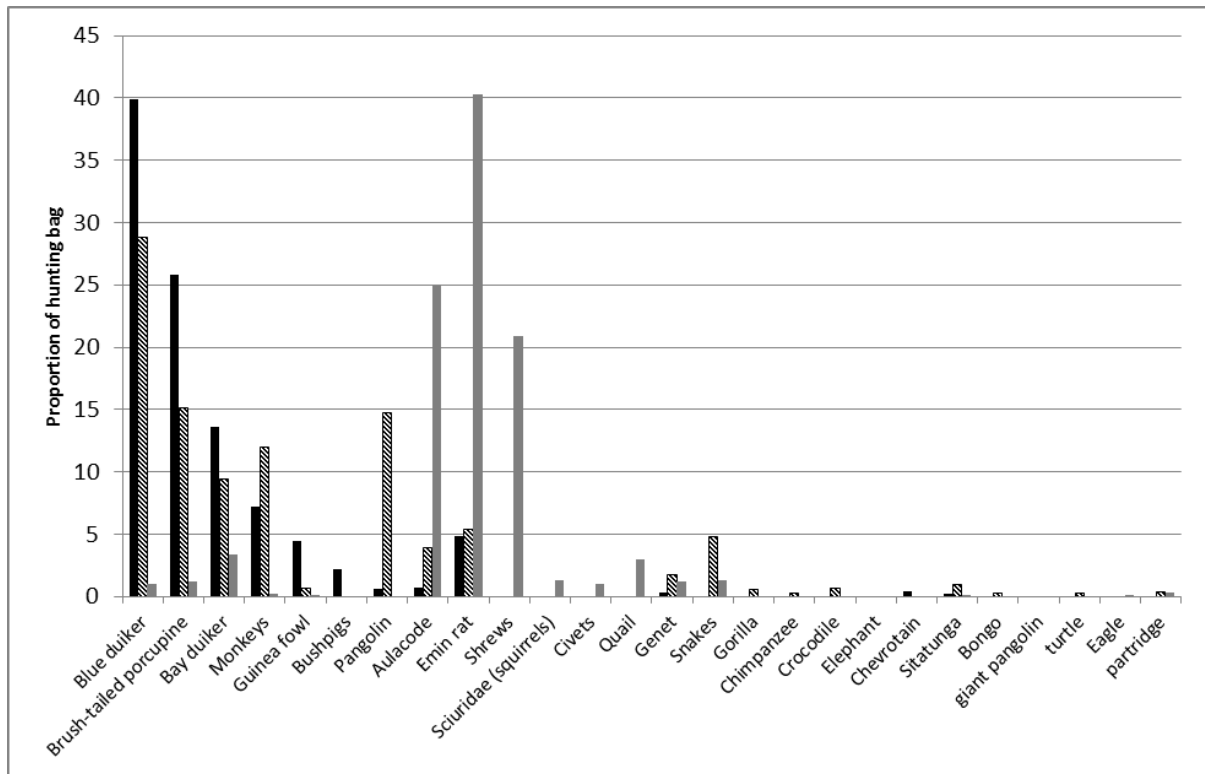


Figure 2. Proportion of the hunting bag for the main bush meat species in each study site. (black: site 1; hatched: site 2; grey: site 3)

### Family incomes

Table 2 shows that incomes generated by gathering decrease when progressing on forest transition curve. The presence of the logging company in the second study site results in an increase in purchasing power leading to the increase in demand for bush meat consumption.

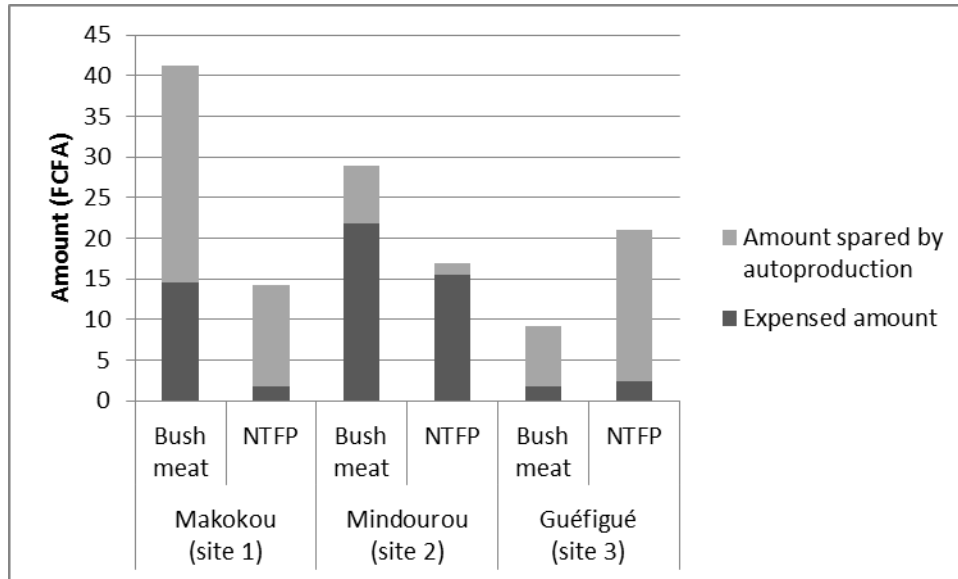
Table 2. Part of incomes due to NTFP extraction and bush meat.

	Part of fixed NTFP in family incomes (%)	Part of bush meat in family incomes (%)
Makokou (site 1)	2.15	11.71
Mindourou (site 2)	0.24	11.87
Guéfigué (Site 3)	0.1	0.4

### Alimentary bolus

We tried to summarize the different budget allocated for NTFP and bush meat in the three study sites. In figure 3, the different charts represent the part of the family budget effectively spent to buy NTFPs

and bush meat and the part spared by consuming gathering and hunting products. The part of bush meat in the alimentation decreases with forest transition, we can also see that the presence of the logging company in the second study site results in an increase in purchasing power leading to the increase in bush meat consumption and in the prices for bush meat and NTFP. The drastic reduction of game in the third site explains the low value dedicated on the purchase of bush meat at this place.



**Figure 3. Budget allocated for food in the three study sites. The different charts represent the amount of the family budget effectively spent to buy food and the amount spared by gathering and hunting performed in the family.**

#### Land tenure

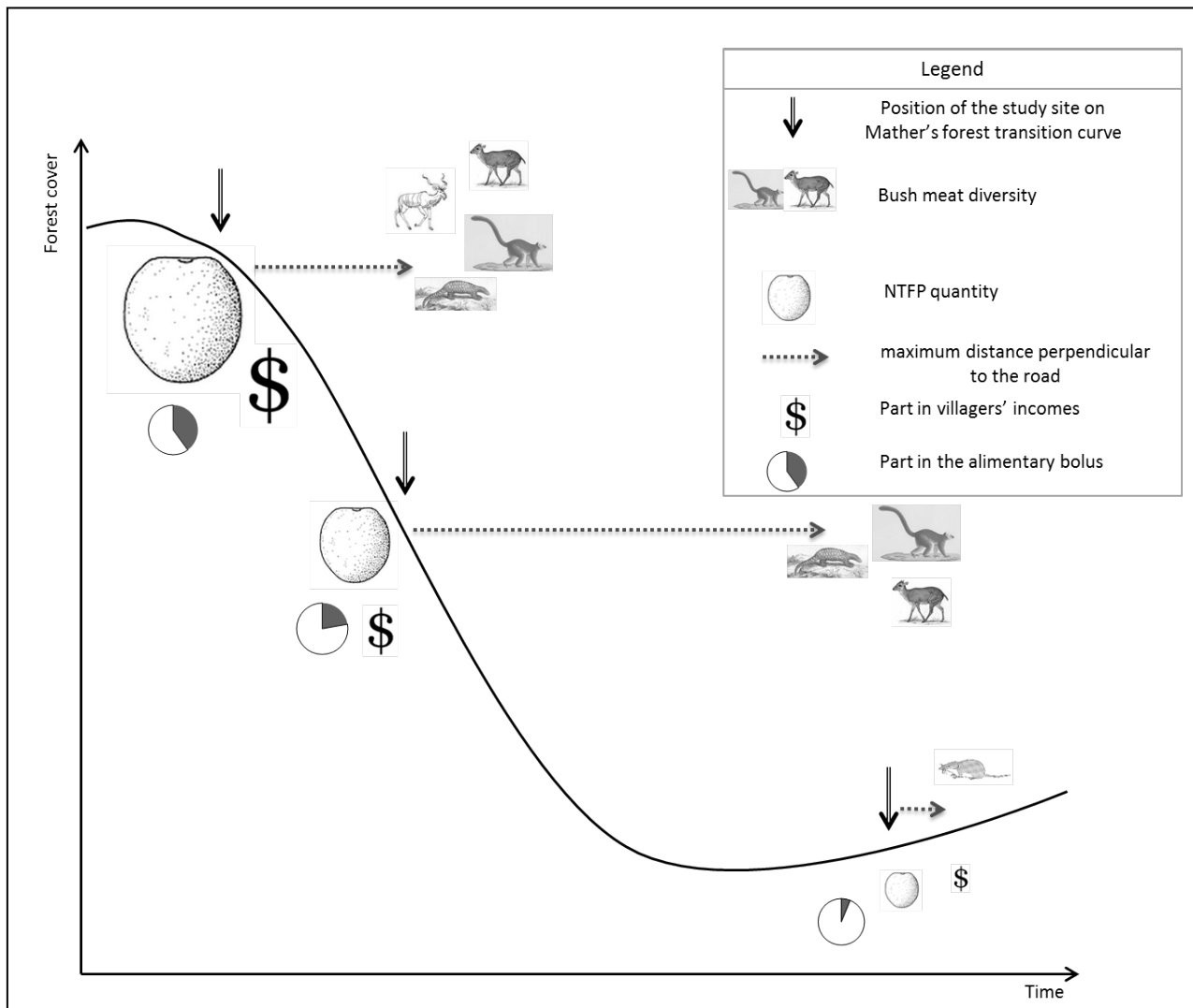
Land tenure linked to population density can be used as an indicator of deforestation rate (Gillet *et al.* 2015). We can see in table 3 the evolution of land tenure objects linked to hunting and NTFP in the land tenure table (represented by charts). The majority of these land tenure objects (represented by the circle) evolve from loose land control with undefined management unit in the first study site (black arrow) to privatization and the ability to dispose of resources in the third study site with highly degraded forest cover (grey arrow).

**Table 3. Land tenure table of the hunting and gathering activities in the three study sites. Charts represent the number of land tenure objects in the three study sites (black: study site 1; hatched: study site 2 and grey: study site 3). The circles represent the majority of land tenure object for each study site (black: study site 1; hatched: study site 2 and grey: study site 3). The hatched lines and the arrows stand for Mather's deforestation curve and the location of each study sites on this curve.**

	<i>Undifferentiated (Access)</i>	<i>Priority (Access and extraction)</i>	<i>Specialised (Access, extraction and Management)</i>	<i>Exclusive (Access, extraction, management and Exclusion)</i>	<i>Absolute (Right to use and dispose thus alienate)</i>
Public					
Common to some groups					
Common to 2 groups					
Common to 1 group					
Common to 1 lineage					
Common to 1 family unit					

## Discussion

All the results are summarized in figure 4.



**Figure 4. Evolution of quantity, maximum distance to the road, bush meat diversity, part in villager's income and in the alimentary bolus in three study sites along Mather's forest transition curve**

Results show a reduction in the NTFPs availability along with the forest transition. The maximum distance of collection sites to the road increases between the first and the second study site, in consequence of the decrease in the quantity of NTFPs available. This distance decreases significantly in the third study site due to the contraction of villages' terroir. The diversity of bush meat decreases while the hunting bag evolves from big to small species along with the forest transition. Land tenure rules to access and extract NTFPs become stricter. As a consequence, the proportion of these products reduces in the alimentary bolus and in the family cash income and are replaced by agricultural products (Feintrenie *et al.* 2015) and breeding animal proteins.

This analysis establishes a link between Mather's forest transition curve and the decline of the importance of NTFPs in the village production and livelihoods systems.

Many authors have underlined the importance of NTFP (Fankap *et al.* 2001; Vermeulen and Fankap 2001; Lescuyer 2010; Moupela *et al.* 2011), many public policies and donors proposed projects focusing on NTFPs in Central Africa. However, our results show that their importance for local population decreases with deforestation, particularly linked to population growth (expected in several



countries in Central Africa). Policies need to be adapted accordingly: two options are emerging; either abandoning this theme in deforested areas, or turning to programs oriented towards domestication and reforestation in NTFP within the framework of high efficiency agroforestry systems.

## Conclusion

This study showed that the forest transition curve can be linked to the reduction in NTFP availability, in bush meat diversity and in the land tenure rules. It conducts to the reduction of the part of these products in family incomes and in the alimentary bolus, replaced by agricultural and breeding products. As many public policies propose projects focusing on NTFPs in Central Africa, they should be oriented towards domestication and reforestation in NTFP within the framework of high efficiency agroforestry systems.

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