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Prospects for Reduced Impact Logging in Central African logging concessions

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ABSTRACT

Reduced Impact Logging (RIL) has traditionally been described as a set of forest management practices that reduce logging impacts and improve productivity. In this paper, we review the evolution of the logging sector in the Congo basin since the early 20th century. We argue that logging in the Congo basin has been little influenced by RIL until the recent regional Forestry Law reforms that started in Cameroon in 1994. RIL has not been integrated into the logging sector of the region as an independent body of knowledge, but more as a complement of the new mandatory management plans. In spite of its proven environmental and economic advantages, the role of RIL in improving forest management has been poorly understood, and we identify some causes of this situation. Finally, based on a regional study of 30 concessions, we analyse the frequency of some RIL-related practices and their relation with markets and certification schemes. We conclude that a clear definition of what RIL techniques are embraced by the logging sector is needed if RIL is to fully benefit from the recent development of new market and logging schemes based on certification, improved logging efficiency and a more transparent chain of custody.

1. Introduction

West and Central Africa represents the second largest area of tropical forest in the world after the Amazon Basin (FAO, 2003). Its importance in global forest conservation as well as for biodiversity conservation (particularly in the eastern and coastal extremes of the region) has been widely acknowledged (Sayer et al., 1992; Alpert, 1993; Küper et al., 2004).

Central African tropical forest ecosystems have supported the livelihoods of millions of people for centuries (Vande weghe, 2003). They have indeed been the basis for the construction of a regional identity for a variety of cultures in balance through complementary trade (Vansina, 1990). They have also traditionally been one of the most important African timber producing regions. Early studies at the beginning of the 20th century by French foresters (Hédin, 1930; Versluys, 1927) already describe the economic potential, future expansion and industrialisation of the Central African logging sector: *"Dans un avenir prochain, l'exploitation des bois pénétrera aussi plus avant dans la fortêt, nécéssitant un apport plus considérable de capitaux et entraînant la généralisation de l'emploi de moyens techniques"* (Hédin, 1930, p. 209).

Expanded regional integration and increased social, economic and political stress have submitted the forests of the Congo basin to new challenges (CBFP, 2006). Industrial mining activities and agricultural crisis together with demographic pressure have dramatically increased the region's dependence upon forest resources (FAO, 2003). Regional Forestry Laws and economic reforms in synergy with a steady demand of tropical timber have catalysed a flourishing logging sector with steady timber market prices and increasing demand (Karsenty, 2006a). As a fresh wave of logging companies have resumed operations, forest research and management has been intensified and new conservation and market incentives towards sustainable forest management are being developed and implemented. This is particularly urgent since roughly 60% of tropical forests could be potentially logged in the newly pacified and dramatically poor Democratic Republic of Congo (DRC). This replicates a process that is taking place in other countries of the region, and what is generating new tensions and a wave of criticisms (WRM, 2003; Greenpeace, 2007).

International organisations have envisaged two general forest scenarios (FAO, 2003): 'business as usual', where logging concessions continue with their current practices; and 'improved management' through incremental steps from legalisation to certification and low impact logging. Under such scenarios, this paper reviews logging concession systems in Central Africa from the first records – based on early descriptions by French led research in West and Central Africa (CTFT, 1976) – to the most recent studies, drawing special attention on the regional forest

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sector reforms of the 1990s and the relevance of Reduced Impact Logging (RIL) practices – as the set of forest management technologies that reduce the impact of logging activities.

These techniques have been described as covering a variety of procedures although no standard definition has yet been adopted (Dupuy, 1998; Durrieu de Madron et al., 1998a,b; Sist et al., 1998). Within the scope of this paper, RIL techniques will be considered as: the delimitation of protected forests within concessions; the determination and use of minimum tree diameter at breast height (dbh); the development of a management plan and a logging inventory; minimising the width and density of the logging roads network; planning of logging roads; setting a maximum ceiling on the number of trees felled by hectare; use of directional felling; optimising timber transport roads network; and planning of timber yards (Durrieu de Madron et al., 1998a,b).

Building on a historical review of the integration process of RIL techniques within the Congo basin logging sector and data from 30 concessions in the region, the present paper will finally bring a critical discussion on the potential of RIL to lead and foster sustainable logging in the long term under the present forest sector conditions, and what management and market tools may converge with RIL techniques to face the forest management challenges ahead.

2. Logging until the Cameroonian Forestry Law reform

Western interests in Central African timber began in the 17th century as an economic activity of the European colonists' settlements in Cameroon and Gabon (Hédin, 1930). Production was limited to ebony (*Diospyros* sp.) and mahogany (*Khaya ivorensis* A. Chev.), which have become rare species. Progressive regional integration of inland areas brought interests in new species as forestry and timber technological research improved: iroko (*Milicia excelsa* (Welw.) C.C. Berg) in the beginning and okoumé in the late (*Aucoumea klaineana* Pierre) 19th century were integrated as part of the European demand for African tropical timbers (Versluys, 1927).

Records previous to 2nd World War show that logging was a marginal economic activity restrained to coastal areas due to the availability of timber and the lack of technical means and infrastructure to log in the continental interior (Videau, 1928). Nevertheless, heavy logging interests were already settled in coastal areas in 1930, pushing the Gabonese colonial government to introduce a bidding process for forest lots (Coquery-Vidrovitch, 1972).

The transfer of improved heavy transportation technology after the 2nd World War and the steady market demand upon few species already depleted from coastal areas, dragged logging progressively inland (Ezzine de Blas, 2007), fulfilling the predictions of earlier foresters (Hédin, 1930). Gabon, for example, transferred drastically in ten years okoumé logging areas from coastal – called the first zone, with 3 million ha allocated in 1960 and 0.2 million ha in 1968 to inland areas – called the second zone, with an allocated area migrating from 0.5 to 2.8 million ha in the same period (Pourtier, 1989). This continental interior expansion of logging concessions benefited from the historical structure built to facilitate the ivory and rubber colonial concessions, and served as a benchmark to test and a platform to launch large scale logging operations (Coquery-Vidrovitch, 1972).

Still, in general, logging remained a marginal economic sector for the newly constituted independent African countries (Karsenty, 2007). During the 1970s and 1980s, economic policies favoured high income producing activities like mining – oil in Gabon and Cameroon (Blandford et al., 1994), diamonds and minerals in Democratic Republic of Congo and Central Africa – and extensive cash crops like cotton, rubber or cocoa (Tosh, 1980). Forest pressure due to both rural livelihoods and industrial logging remained highly sensitive to success or failure of mining-based economies and urban-oriented planning, with high rent mining economies relying less on forest-based resources (Wunder, 2003).

Limited reliable long-term statistics on timber production makes it difficult to obtain a detailed analysis of logging trends in the region (Ezzine de Blas et al., 2006). Only FAO statistics (FAOSTATS) present data from 1960 onwards, with most logging statistics starting in the 1990s (EUROSTATS, International Tropical Timber Organisation (ITTO) statistics). This data vacuum illustrates the weak monitoring of logging in Central African tropical humid forests until recent times (Westoby, 1987).

Old logging companies became established in a period between the 1950s and 1970s (Ruiz Pérez et al., 2004) benefiting from very low taxes and lacking the incentives to implement sustainable forest schemes (Gillis, 1988). A situation contrasting with the 2 million m^3 of logs yearly production reached by Cameroon and Republic of Congo in the late 1970s, or the average of nearly 1 million m^3/year being produced by Gabon, Central African Republic and Democratic Republic of Congo during the same period (FAOSTATS).

The cycle started at the end of the 2nd World War and especially since the early 1970s, has been described as a period of high deforestation rates in all tropical forests, although logging was not the direct cause of such net deforestation (defined as permanent loss of forest cover) (Minnemeyer et al., 2002; Vande weghe, 2003). Indeed, logging in Central African forests has traditionally been highly selective, with yields averaging 1 tree/ha and consequently with little impact over large tracks of the canopy (White, 1992; Durrieu de Madron et al., 2000; Van Gemerden et al., 2003). Human settlements and the opening of new agriculture fields – indirectly driven by the opening of logging roads (Ezzine de Blas, 2007) – have been, on the contrary, the main causes of such deforestation (Mertens and Lambin, 1997). The increasing international awareness of the role that logging and the international tropical timber market were indirectly playing in this process paved the basis for the International Tropical Timber Agreement in 1983 (ITTO, 2006a). Such agreement formed the basis for an international monitoring on timber market dynamics and enforcement of sustainable logging schemes through the International Tropical Timber Organisation created in 1986. Nevertheless, its African counterpart (*l'Organisation Africaine du Bois* (OAB)) was not created until 1993, illustrating again the weak presence of international initiatives in the Congo basin until the mid 1990s (Amsallem et al., 2004).

The present international concern can therefore be interpreted as a delayed response to the increasing stress suffered by forest ecosystems of the Congo basin due to demographic, industrial and political pressures. Poor governance, the fall of cash crop international prices, diminishing oil reserves, armed conflicts, and a sustained high demographic growth have put most of the countries of the region – with the exception of Gabon – in a prolonged economic crisis from the mid 1980s. This regional crisis has intensified the reoccupation of forests to maintain rural livelihoods and the use of forest resources for governments' financial reorganisation (Laurance, 1999; Blondel, 2003).

As an attempt to fight the economic crisis, governments of the region endorsed the Structural Adjustment Programs (SAP) to access International Monetary Fund lending, which was conditional to performing a number of reforms (Ekoko, 1997). The first country to adopt the SAP and accompanying reforms was Cameroon, with negotiations between the World Bank and the Cameroonian government to adjust the forest sector starting in 1990 (Brunner and Ekoko, 2000).

Table 1
Comparison of Forestry Laws in the Congo basin

Countries	Laws components							
	Management plan[a]	Higher surface taxes[b]	Processing threshold[c]	Log export ban[d]	Concession bidding[e]	Community concessions[f]	Surface ceiling[g]	Independent observer[h]
Gabon	•	•	•	•		•	•	
Congo	•	•	•	•				
DRC	•	•	•	•		•	•	
CAR	•	•	•	•				
Cameroon	•	•	•	•	•	•	•	•

[a] Management plan obligatory for logging concessions.
[b] Increase in surface taxes (per concession ha).
[c] Minimum log processing percentage threshold.
[d] Partial log export ban for some species.
[e] Concession open bidding.
[f] Existence of community concessions.
[g] Maximum concessions surface ceiling.
[h] Establishment of an independent forest observer.

3. The role of RIL within the regional process of concession system reform in the Congo basin

The concept of RIL was already present in forest management and logging research in the Congo basin since the 1970s. Concerns on how to minimise ecological impacts – soil and water conservation, silviculture and logging techniques – were included in the first widely diffused handbook for foresters, produced by the French Tropical Forest Centre (''*Centre Technique Forestier Tropical*'') (CTFT, 1976, p. 693 for Logging techniques, p. 995 for soil and water conservation). Therefore, prior to the Cameroonian forest reform of 1994, road planning, staff training, optimising log cutting dimensions, log tracking and directional felling – among other RIL techniques – were not new for forest industry in central Africa in the mid 1990s (i.e.: CEB or Rougier in Gabon, see Bayol and Rougier, 2004).

The year 1994 was of a special relevance as two reforms deeply affected the forest sector. The first was the devaluation of the CFA franc[2] to 50% of its value. The second was the official promulgation of the 1994 Cameroonian Forestry Law. Surprisingly few studies have dealt with the fostering effect that the devaluation of the CFA franc had on the logging sector (Crespi, 1994; Eba'a Atyi, 1998) and none with its timely coincidence with the launching of major forest reforms. In Cameroon, the devaluation of the CFA franc reduced logging costs leading to an increase in the number of logging companies (Eba'a Atyi, 1998). It also created the right financial environment for a more profitable business through a substantial drop in transportation costs in the short term (Karsenty, 1998). Companies operating in coastal impoverished forests found incentives to log a wider range of less valuable species, while at the same time the logging front was pushed inland in the search of the few most valuable timber species (Ezzine de Blas, 2007). These increasing logging activities preceded the application in the field of Cameroonian Forestry Law in the years following 1994 and were therefore poorly monitored (Bikié et al., 2000).

The Cameroonian Forestry Law reform process has been widely discussed (O'Halloran and Ferrer, 1997; Carret, 1998; IFIA, 1999). The five-year negotiations process implicated the World Bank, the Cameroonian Ministry of Forests and a wide number of less visible actors, including senators, influencing European governments, and NGOs. The final text was the compromising balance of multiple interests (Brunner and Ekoko, 2000), resulting in several concession management improvements (Fochivé, 2005; Karsenty et al., 2006) none of them directly referring to RIL techniques although implicitly included in the new mandatory management plans:

- Concession allocation was based on a bid over a surface tax per hectare.
- A national zoning differentiated between a Permanent Forest Domain (PFD) devoted to conservation and sustainable logging and a Non Permanent Forest Domain (NPFD).
- Management Plans were mandatory for all concessions in the PFD;
- Communities – in the NPFD – and municipal councils – in the PFD- had the possibility to develop commercial logging through Community and Communal Forests, respectively.
- The surface tax was to be redistributed between the central government (50%), the municipality (40%) and neighbouring communities to concessions (10%).

A shift towards sustainable logging, more efficient practices, increased fiscal pressure and decentralisation of forest management were therefore key objectives behind the 1994 Cameroonian Forestry Law – which was developed by the Decree 95/531 one year later (Karsenty, 2006b). It also established an independent international observer to monitor the application of the law and in particular the bidding process. Global Witness played that role from 1998 to 2003, being replaced by Resources Extraction Monitoring in 2004 (Cerutti and Assembe, 2005). Aside the irregular bidding process of 1997, the law has proved to be instrumental to enforce forest management in Cameroon (Fochivé, 2005; Karsenty et al., 2006). Nevertheless, illegal logging activities are still frequent and poor governance hinders the enforcement of sustainable forest management (Cerutti and Tacconi, 2006).

For neighbouring countries, the Cameroonian 1994 Forestry Law represented the first concrete legal output from the regional forest policy review process that had started a decade ago fostered by the Tropical Forest Action Plan and the design of the ''Country profiles'' for the Earth Summit in Rio 92. The specific and contextual social, economic and political conditions in Cameroon from 1986 and early 1990s may have facilitated a faster logging policy review and enforcement. Neighbouring countries followed closely after: Equatorial Guinea finished its review in 1997, Congo in 2000, CAR[3] and Gabon in 2001 and the DRC in 2002 (Karsenty, 2006b). Each country adopted a particular set of forest reforms but all converged in the main objectives (Table 1): sustainable logging

[2] *Franc pour la Coopération Financière en Afrique* – franc CFA – in French.

[3] CAR adopted only partial modification to its Forestry Law, which dates from 1990.

monitored by a mandatory management plan, an updated tax system that increased fiscal pressure and the decentralisation of forest resources management through community-based concessions.

Some measures that raised protests from the logging industry in Cameroon, like the bidding process for concessions' allocation and the presence of an independent observer, were not adopted by other countries (Karsenty, 2006b). The tax system, sensitive to different political realities, was also redesigned adjusting it to each national condition (Gray, 2002; Vincent et al., 2005). But overall, in less than 10 years, the incipient experience of the Cameroonian reform and the new Forestry Laws had consolidated a new regional forest management scheme that was already gaining progressive relevance in the region since the Rio Conference in 1992.

Improved techniques on line with RIL prescriptions that had previously been completely absent were now implicitly required by the new laws to comply with sustainable logging management plans. The lack of a clear and agreed definition of RIL techniques may have excluded its specific mention in the reformed Forestry Laws. RIL techniques included in Forestry Laws were only those associated with the mandatory management plans: i.e. pre-harvest planning of logging roads, determining dbh, or timber yards planning. Nevertheless, a number of RIL practices have been irregularly integrated by concessionaires and inconsistently implemented in the field depending on a variety of factors, as we shall discuss next.

4. Understanding how and who logs in the Congo basin

A good deal of experience on Sustainable Forest Management (SFM) has been built around different projects in the tropics during the last three decades (Bayol and Borie, 2004; Durrieu de Madron et al., 1998a,b; Nasi, 1998; Putz et al., 2000). Forest management plans have nowadays achieved a high level of accuracy in analysing forest structure, regeneration possibilities and sustainable logging cycles (Sist et al., 2003; Fargeot et al., 2004). Besides, sectorial and multidisciplinary studies have together brought a fresh new picture of forest and logging dynamics in the region, putting the sector in the front place for research and logging monitoring in tropical forests (Amsallem et al., 2004). These actions have failed, however, to formalise the link between SFM and the technical prescriptions of RIL (Applegate et al., 2004; García et al., 2007 in this issue; Kant, 2004).

Consequently, even if concessionaires have understood the need to better manage timber resources to attain a sustainable productivity and substantially increase the profitability (with better tracking, a company may avoid abandoning up to 30% of felled logs in the forest, with a relevant boost of productivity), RIL techniques are still far from being implemented on a large scale (Cassagne et al., 2004). In the highly diverse Congo basin logging sector, the lack of a formal link between SFM and RIL may indeed have weakened the process of adoption of RIL techniques despite such benefits.

What was assumed to be a relatively homogeneous activity has on the contrary been described as a very dynamic sector adapting to new business environments (Ruiz Pérez and Ezzine de Blas, 2006). Concession typologies respond to type of capital, size of the concession, distance to port of export and principal destination market. A balance of forest resource richness and infrastructure availability configure regions of more or less dynamic logging embedded in the particular legal and socio-political framework of each country. Most active concessions are in southeastern Cameroon, Congo and Gabon; less active but with great potential is the forest sector in the DRC. The general picture that arises is of an asymmetric industry: Congo and Gabon present the highest and most dynamic logging sector, while CAR and Cameroon seem to present a dwindling production (Ruiz Pérez et al., 2005). In the case of the CAR, lower production figures since 2002 are also explained by the increasing adoption of the management plan procedure by all forest companies, channelling production through planed volumes, with lower quantities than prior non regulated logging. At the same time, the special logging permits – "permis spéciaux de coupe" – were banned, that removed around 10% of the productive surface (Yalibanda and Ezzine de Blas, 2006). The DRC with more than half of the tropical forests of the region but with the lowest timber production appears to be the next expanding frontier (Table 2). In all countries, informal logging still represents a high volume of the total tropical timber harvested (over 40% in Cameroon; Pinta and Fomete, 2004).

In Cameroon, measures to enforce log processing have been more successful, being at the moment the only country where exports of sawn timber exceed those of logs (Table 2) (ITTO, 2006b). High oil prices and the subsequent increase in transportation costs have contributed to the recent expansion of local processing. In spite of the efforts to diversify the number of species produced, industrial logging is still targeting a few high valuable species. Only two – sapelli and okoumé – account for more than 50% of the production and six account for around 85%, even if the number of secondary species is rapidly increasing, especially from the most modern European companies, and from Asian ones. (Fochivé, 2005; Ruiz Pérez et al., 2005).

The rise of Asian (especially Chinese but also Indian) demand has had a crucial impact for the logging sector in the region (White et al., 2006), keeping prices high over some species (especially okoumé) (Karsenty, 2006a; ITTO, 2007). While Asian market oriented concessions tend to present lower transformation rates and are more reluctant to develop management plans (Ruiz Pérez et al., 2005), development of new market niches and the need to adapt to more enforced forest legislation are pushing Asian companies to invest in processing and sustainable management (ITTO, 2005). Besides, if converted to equivalent m^3 in logs, the European market accounts for more than 60% of total exports of the region, with China following behind (ITTO, 2006b).

The sector's heterogeneity is an expression of specific factors with a differentiated influence on logging companies that face management problems related to the changing logging environment. ITTO regional research identified key problems like financial bottlenecks, technical and human capacities and policy imple-

Table 2
Production, exports and trends by country

	1993–1997		1998–2002		2003–2006		Trends	
	Prod.	Exp.	Prod.	Exp.	Prod.	Exp.	Prod.	Exp.
Cameroon								
Logs	14.915	6.111	12.320	3.929	7.210	1.072	▼	▼
Sawnwood	3.683	1.682	4.445	3.818	3.273	2.840	=	▼
DRC								
Logs	1.368	428	727	202	378	243	▼	▼
Sawnwood	519	229	293	94	71	63	▼	▼
Congo								
Logs	2.832	1.637	5.686	2.063	5.770	3.352	▲	▲
Sawnwood	495	337	730	557	999	743	▲	▲
CAR								
Logs	1.421	346	3.200	1.165	2.318	870	▲	▲
Sawnwood	359	174	530	357	402	196	=	=
Gabon								
Logs	10.982	10.009	17.580	11.128	16.188	6.768	▲	=
Sawnwood	1.109	566	1.542	1.118	1.702	1.431	▲	▲

Source: ITTO statistics. All values are in 1000 m^3.

Table 3
Certification chronological evolution

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Withdrawn
Congolèse Industrielle des Bois	*Pre FSC*					Keurhout		SGS		*FSC*	Kerhout
Leroy Gabon	*FSC*							Keurhout ISO 14001			FSC
CEB-Thanry					*Pre FSC*	Keurhout			ISO 14001		
Rougier Gabon								Keurhout	ISO 14001		
Wijma									*Pre FSC OLB*	*FSC*	
Pallisco										*Pre FSC OLB*	
Transformation Reef Cameroon										*Pre FSC OLB*	
Decolvenaere										*Pre FSC*	
CBC (Vicwood Thanry)										SGS	

Vandehaute and Heuse (2006).

mentation as perceived by logging concessionaires (Sarre, 2006). Very large concessions tended to identify fewer constraints than smaller ones, while foreign capital timber companies recorded fewer management problems (Ruiz Pérez et al., 2006).

Improved understanding by the international community of the links between the factors influencing the forest sector in the Congo basin and a change in tropical timber demand has paved the road for a synergy between international NGOs and concessionaires (Ruiz Pérez et al., 2006). A number of timber companies are now targeting the FSC market (Transformation Reef Cameroon, Congolèse Industrielle de Bois, Pallisco) with the help of international NGOs (WWF-International, World Conservation Society) that bring technical support (WWFI, 2005). Given the fact that certification standards make use of key RIL techniques (directional felling, planning of logging roads, use of the diameter at breast height, etc.) it could therefore be assumed that the recent successful development of certified concessions would foster its implementation on a broad scale in Central African forests. The lack of a standard definition of RIL techniques may again reduce the potential support that certification and SFM schemes could bring to support its implementation in those aspects that apply to market certified labels. We will discuss later, based on a regional study of 30 concessions, the critical importance of this link.

Nevertheless, as we have already discussed, a variety of trends characterise the logging sector in the region. On one hand, European-oriented concessions are more sensitive to green markets than Asian-oriented while on the other hand medium concessions are not being able to cope with increasingly tightened international standards (Debroux and Karsenty, 1997; Buttoud et al., 2005; Ruiz Pérez et al., 2006). Even though in order to support those medium concessions, several specific initiatives are on going through a mixed public/private approach (i.e. Parpaf project in the Central African Republic; *Projet appui aux petits permis au Gabon* both funded by the French Development Agency), there is a fear that such tension coupled with the competition from illegal timber markets may put at risk on the medium term the few promising forest management initiatives (Canby, 2006).

5. Markets incentives and governance

Concessionaires perceive certification as being linked to pressure groups (Ruiz Pérez et al., 2006) having been adopted as a realistic market incentive towards sustainable logging (Sayer et al., 2005). As a response to this new demand, a wide variety of certification methodologies are currently available: *Origine Légale du Bois* (OLB) implemented by BVQI-Eurocertifor; SGS certification; ISO 14001; Pan African Forest Certification (PAFC) implemented by the International Forest Industries Association (IFIA); Keurhout certification developed by Dutch timber importers and the Forest Stewardship Council (FSC) endorsed by international NGO's (Table 3). The internationally supported certifications (FSC and Kerhout) have been extended only to specific concessions or production quotas. Some conservation pressure groups are arguing that such certification, even if trying to reach high ecological and social standards, is too partial (Lescuyer, 2006).

Nevertheless, few certification schemes have had a real impact on changing management practices (Vandehaute and Heuse, 2006). OLB and SGS certifications mainly assess compliance with legal standards and are self-evaluated certificates by commercial companies, whereas ISO 14001 – an international quality certification applied to other activities – follow the same philosophy with environmental standards. These three certification schemes rely more on internal procedures and traceability methodologies developed by the logging enterprise.

FSC, Keurhout and PAFC are market oriented green labels. ITTO' Principles, Criteria and Indicators have been the basis of the PAFC certification standard endorsed by the industrial logging sector (IFIA, 2000). In spite of the initial endorsement of the Keurhout label, recent internal arrangements have left it with virtually no influence. FSC is the only certification endorsed by environmental NGOs and is now winning some support among the Congo basin logging industry. International NGOs supporting this scheme are offering technical guidance in the field (WWF-International guiding Pallisco in the East Cameroon, WCS guiding CIB in the North of Congo) while orienting demand in western countries (WWF-International Global Forest Trade Network (GFTN) program, Rain Forest Alliance Smartwood program). However, FSC recent adjustments towards more flexible standards have raised wide criticism (Carrere, 2006; Vandehaute and Heuse, 2006).

In any case, it is now evident for the logging sector that some enterprises have understood the need to adopt 'chain of custody' and tracking procedures prior to the certification process. Tracking means logging companies having the possibility to be aware of the exact state and position of all its timber products (logs and sawn timber) as well as an increase in the operations efficiency (Vandehaute and Heuse, 2006). Regarding these tracking systems, two categories may be considered: (a) internal tracking by the industry to reduce costs and improve productivity; and (b) tracking piloted by the government, in order to secure the accountability of woods exported and to define logging and export taxes on a clear basis. This is the case in CAR with a rather successful pre-shipment inspection self-financed scheme, contracted between Veritas and the Government. On a national basis, different strategies based upon code-bars and radio-tracking have been considered in Cameroon. In particular, code-bar based tracking has been successfully tested by a number of logging companies in Cameroon but lack of government institutional support has prevented this method to expand nationwide. Governments of Congo and the CAR are considering implementing this system (Vandehaute and Heuse, 2006).

Other related international measures seeking improved transparency in the sector are the Forestry Law Enforcement Govern-

ance and Trade (FLEGT) adopted by the European Commission in 2003 and the African Forestry Law Enforcement and Governance (AFLEG) with support of the European Commission and the World Bank. FLEGT is intended to stop illegal timber imports into EU member countries through voluntary bilateral agreements. So far, FLEGT achievements have not been very visible, the absence of clear results has been highlighted by the European Parliament (European Union Bulletin, 2005). The AFLEG targets political governance but so far it has also seen little success (Forest Monitor, 2003). A collateral expected outcome is the future convergence of forest policies in the region through the Convergence Plan – *Le Plan de Convergence* (COMIFAC, 2003).

Governance has been the key topic of a number of current studies (Cerutti and Tacconi, 2006; Labrousse and Verschave, 2003) as the cornerstone without which current advanced research on sustainable management techniques and planning strategies would remain highly ineffective. The current debate over logging in the DRC is a clear example (CBFP, 2006; Greenpeace, 2007; Nasi et al., 2006). Under the current scenario of poor governance conditions, the chances of failing to implement RIL and sustainable logging are high (Debroux et al., 2007). At the same time, the potential benefits in terms of timber productivity and forest sustainable management are huge.

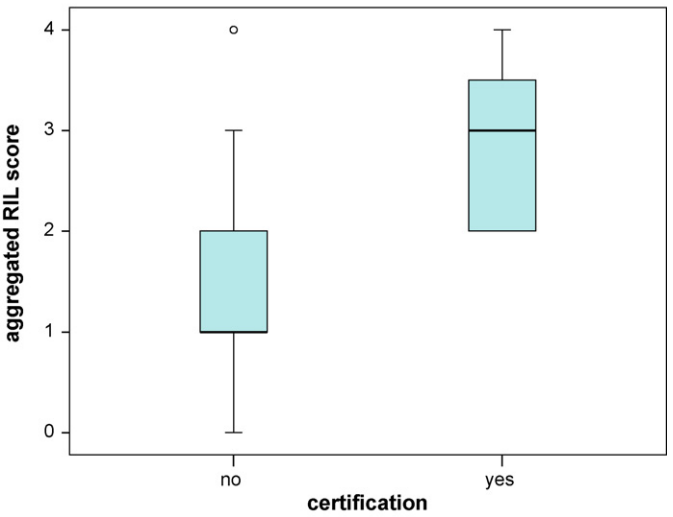

Fig. 2. Boxplot of aggregated RIL-related logging practices score for concessions without certification plans versus concessions that have applied or have already obtained a certification.

6. Linking RIL with initiatives to improve forest management

The above mentioned improved forest management schemes within the Congo Basin show a number of common points with RIL. These change according to the type of scheme and the way they are being implemented locally. For example, certification requires a management plan, proper design of logging tracks, training of workers and, in general, improved management conditions.

In our study based on a sample of 30 concessions in the Congo Basin (see Ruiz Pérez et al., 2005 for a detailed description of the methodology and characteristics of the sample), we gathered information about four logging practices that directly relate to RIL prescriptions: existence of an approved and functional management plan, directional felling, demarcation of logging tracks, and training of skidder drivers. The latter is the least frequent, being practiced only by 1/3 of the concessions interviewed, whereas the planning of logging tracks is the most frequent, being conducted by 79% of the concessions (Fig. 1).

We composed a simple aggregation index with the four activities that was used to test for possible differences between types of concessions. While logging companies owned by foreign capital tend to have similar aggregated scores compared to companies owned by national capital (2.0 and 1.9 mean score, respectively), those aiming at the European market tend to present higher mean scores (2.2) compared to those selling in the national (1.7) or Asian markets (1.4), although the difference does not reach the level of statistical significance.

For 29 concessions in the sample we had valid information related to their plans to join a certification scheme. Of those, 21 did not have any plan at the time of the interview, 6 had on going plans at different level of development, while 2 had already achieved an internationally backed certificate. Fig. 2 presents the difference in aggregate RIL related practices score between concessions without certification plans (mean score 1.6) versus those which are on the way or have already obtained a certificate (mean score 2.9). The difference is statistically significant ($F = 7.752$; $p = 0.010$).

Our results support the above mentioned relationship between certification and RIL, with foreign companies selling in the European market, the ones that tend to score higher in the aggregated index, also leading the certification process in the region.

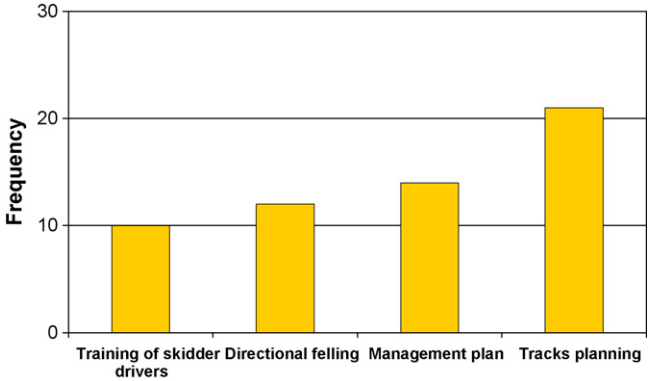

Fig. 1. Frequency of RIL-related logging practices.

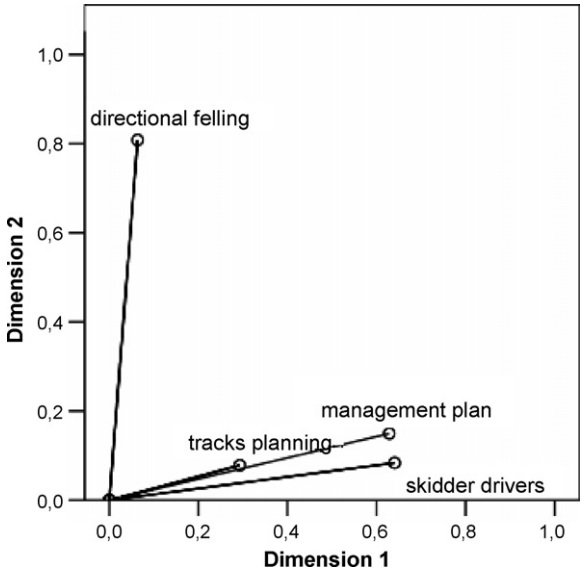

Fig. 3. Association trends between RIL-related practices using multiple correspondence analysis.

Finally, we apply a multiple correspondence analysis for the presence of each of these four practices in the sample of concessions in order to assess the degree of commonality and interrelationship between the four RIL-related practices being studied. The first two dimensions represent 69% of the variability (41% and 28% for dimension 1 and dimension 2, respectively). The analysis (Fig. 3) shows a close association between the existence of a management plan, planning of tracks and training of skidder drivers while directional felling stands in a different dimension, suggesting the separation between the planning and infrastructure development phase (including workers training) on one hand and the field-oriented activities on the other.

7. Conclusion

Implicitly included in the new wave of forest codes developed in the Congo basin through mandatory management plans, RIL techniques are now embedded to different degrees in a forest logging sector under diverse market driving forces and concession typologies. However, its real integration at a regional scale remains elusive due to technical, economical and political bottlenecks.

The first attempts to identify what techniques would fall within RIL (CTFT, 1976) provided the theoretical grounds and the practical guidance to face the new challenges and requirements of the Congo basin forest sector to achieve a sustainable logging scheme. Some RIL-related practices have been fulfilling this role without an explicit recognition, and even frequently without the direct knowledge of RIL prescriptions by those who are implementing the new logging approaches. Indeed, the fact that RIL has remained mostly unrecognised in Central Africa as a concept has precluded the development of those techniques which would be most efficient to implement, and would obtain the strongest support by forestry partners.

This reality should lead to the definition of RIL and its potential contribution to sustainable management in the new scenarios for the forests of the Congo basin. Partly because of timber resources scarcity and partly due to new market demands and incentives, a number of companies are moving to more sustainable forest management techniques. Traceability, certification and improved governance are currently the driving forces of these new scenarios. Our work has showed the close association between certification and a group of RIL-related practices that suggests a promising potential opportunity for RIL development and implementation in the region as the new forestry driving forces advance.

But huge challenges lay ahead, especially the heterogeneous behaviour of the logging industry and its expectations towards the remaining forests of the region. Much of RIL's future developments will depend on its synergies with current initiatives and the innovation capacity of institutions and researchers to keep both consumers and producers interested in sustainable forest management.

References

Alpert, P., 1993. Conserving Biodiversity in Cameroon. Ambio 22, 44–49.

Amsallem, I., Koné, P.D., Wilkie, M.L., Ngandji, M., 2004. Gestion forestière en Afrique centrale: à la recherche de l'excellence. Bois et Forêts des Tropiques 281, 5–18.

Applegate, G., Putz, F.E., Snook, L., 2004. Who Pays for and who Benefits from Improved Timber Harvesting Practices in the Tropics? Lessons Learned and Information Gaps. CIFOR, Bogor.

Bayol, N., Borie, J.M., 2004. Itinéraires techniques d'aménagement des forêts de production d'Afrique centrale. Bois et Forêts des Tropiques 281, 35–49.

Bayol, N., Rougier, F., 2004. La mutation des concessionnaires forestiers en gestionnaires d'écosystèmes: le cas de Rougier Gabon. Bois et Forêts des Tropiques 281, 61–70.

Bikié, H., Collomb, J.G., Djomo, L., Minnemeyer, S., Ngoufo, R., Nguiffo, S., 2000. Logging in Cameroon. Global Forest Watch and World Resources Institute, Washington, DC.

Blandford, D., Friedman, D., Lynch, S., Mukherjee, N., Sahn, D.E., 1994. Oil boom and bust: the harsh realities of adjustment in Cameroon. CIFOR Occasional Paper No. 27. CIFOR, Bogor.

Blondel, A., 2003. Dérive Criminelle de l'Économie du Bois. Le Monde Diplomatique December 2003. Le Monde Diplomatique, Paris.

Brunner, J., Ekoko, F., 2000. Cameroon. In: Seymour, J.F., Dubash, N.K. (Eds.), The Right Conditions: the World Bank, Structural Adjustment, and Forest Policy Reform. World Resources Institute, Washington, DC, pp. 59–82.

Buttoud, G., Karsenty, A., Memvie, B., Tissari, J., Sollo, J.W., 2005. Mission Technique de Diagnostic de la Gestion Durable des Forêts en vue d'atteindre l'Objectif 2000 de l'OIBT en appui au Gouvernement de la République Gabonaise. ITTO, Yokohama.

Canby, K., 2006. Investing in natural tropical forest industries. ITTO Tropical Forest Update 16 (2), 4–8.

Carrere, R., 2006. Greenwash. Critical Analysis of FSC Certification of Industrial Tree Monocultures in Uruguay. World Rainforest Movement, Montevideo.

Carret, J.C., 1998. La Réforme de la Fiscalité Forestière au Cameroun: Contexte, Bilan et Questions Ouvertes. CERNA, Paris.

Cassagne, B., Bayol, N., Rougier, F., 2004. From concession holders to forest ecosystem managers: the example of Rougier Gabon. Bois et Forêts des Tropiques 281, 61–70.

Centre Technique Forestier Tropical, 1976. Mémento du forestier: techniques rurales en Afrique. Ministry of Foreign Affairs, Paris.

Cerutti, P., Assembe, S., 2005. Cameroon forest sector, independent observer. Global Witness end of contract project review. Unpublished report. DFID, London.

Cerutti, P., Tacconi, L., 2006. Illegal Logging and Livelihoods. CIFOR Working Paper 35, CIFOR, Bogor.

Coquery-Vidrovitch, C., 1972. Le Congo au temps des grandes compagnies concessionnaires 1898–1930. Mouton, Paris.

Conférence des Ministres des Forêts d'Afrique Centrale (COMIFAC), 2003. Plan de Convergence. Actions prioritaires 2003–2005. COMIFAC, http://www.pefac.net/pdf/plan_convergence.pdf.

Congo basin Forest Partnership (CBFP), 2006. Les Forêts du Bassin du Congo. État des Forêts 2006. USAID, http://www.cbfp.org/thematiques/index.htm.

Crespi, J.M., 1994. The Effect of a CFA Devaluation on Tropical Hardwood Harvesting in Equatorial Africa. Colorado State University, Fort Collins.

Debroux, A., Karsenty, A., 1997. L'implantation des sociétés asiatiques en Afrique centrale: Rimbunan Hijau au Cameroun. Bois et Forêts des Tropiques 254, 80–85.

Debroux, L., Hart, T., Kaimowitz, D., Karsenty, A., Topa, G., 2007. Forests in Post-Conflict Democratic Republic of Congo: Analysis of a Priority Agenda. World Bank and CIFOR, Bogor.

Dupuy, B., 1998. Bases pour une sylviculture en forêt dense tropicale humide africaine. Série FORAFRI, CIRAD, Montpellier.

Durrieu de Madron, L., Forni, E., Karsenty, A., Loffeier, E., Pierre, J.M., 1998a. Le projet d'aménagement Pilote Intégré de Dimako (Cameroun). Série FORAFRI, CIRAD, Montpellier.

Durrieu de Madron, L., Fontez, B., Dipapounji, B., 2000. Dégâts d'exploitation et de débardage en fonction de l'intensité d'exploitation en forêt dense humide d'Afrique Centrale. Bois et Forêts des Tropiques 264, 57–60.

Durrieu de Madron, L., Forni, E., Mekok, M., 1998b. Les techniques d'exploitation à faible impact en forêt dense humide camerounaise. Série FORAFRI. CIRAD, Montpellier.

Eba'a Atyi, R., 1998. Cameroon's Logging Industry: Structure, Economic Importance and Effects of Devaluation. Tropenbos Cameroon program and CIFOR, Bogor.

Ekoko, F., 1997. The Political Economy of the 1994 Cameroon Forest Law. Working Paper 3, CIFOR, Bogor.

European Union. Bulletin EU 7/8-2005, 2005. Development cooperation. Sustainable development. Environment and tropical forests. European Parliament resolution on speeding up implementation of the EU action plan on Forestry Law enforcement, governance and trade (FLEGT). European Commission, Brussels.

Ezzine de Blas, D., 2007. El Corazón de Madera de África: Dinámicas de Concesiones Forestales en la Cuenca del Congo. Unpublished PhD, Autonomous University of Madrid, Madrid.

Ezzine de Blas, D., Mertens, B., Ruiz Pérez, M., Cerrutti, P.O., N'Gono, G., 2006. L'exploitation forestière au Cameroun: des paradigmes internationaux au pragmatisme du terrain. In: Nasi, R., N'guinguiri, J.C., Ezzine de Blas, D. (Eds.), Exploitation en gestion durable des forêts en Afrique Centrale. L'Harmattan, Paris, pp. 123–152.

FAO, 2003. Forests, a view to 2020. Forest outlook study for Africa. FAO, Rome.

Fargeot, C., Forni, E., Nasi, R., 2004. Réflexions sur l'aménagement des forêts de production dans le bassin du Congo. Bois et Forêts des Tropiques 281, 19–34.

Fochivé, E., 2005. Évolution du secteur forestier sur la période 1998–2004 (opérateurs économiques, investissements, emplois). World Bank, Yaounde.

Forest Monitor, 2003. Forest Management Transparency, Governance and the Law: Case studies from the Congo basin. http://new.forestsmonitor.org/en/reports/549560.

García, C., Ruiz-Pérez, M., Wunder, S., 2007. Multiple-use forest management widely implementable in the tropics? Forest Ecology and Management, in this Special Issue on Reduced Impact Logging in the tropics.

Gillis, M., 1988. West Africa: resource management policies and the tropical forest. In: Repetto, R., Gilli, M. (Eds.), Public Policies and the Misuse of Forest Resources. WRI, Washington, DC, pp. 299–351.

Gray, J.A., 2002. Forest Concession Policies and Revenues Systems. World Bank Technical Paper 522, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2002/07/09/000094946_02062204051575/Rendered/PDF/multi0page.pdf.
Greenpeace, 2007. Carving up the Congo. Greenpeace, http://www.greenpeace.org/international/press/reports.
Hédin, L., 1930. Étude sur la forêt et les bois du Cameroun sous mandat français. Commissariat du Cameroun. Librairie Larose, Paris.
Interafrican Forest Industries Association (IFIA), 1999. European Foundation for the Preservation of African Forest Resources. IFIA, Paris.
Interafrican Forest Industries Association (IFIA), 2000. Etablissement d'une Certification Panafricaine (PAFC). IFIA, Paris.
ITTO, 2005. Chinese seek certified tropical wood. Tropical Timber Market Report 1–15 October, 4–5.
ITTO, 2006a. A Brief History. ITTO, Yokohama.
ITTO, 2006b. Annual Review and Assessment of the World Timber Situation 2005. ITTO, Yokohama.
ITTO, 2007. Report from Central-West Africa. Unabated demand from Asia drives log prices up. Tropical Timber Market Report 12, 2.
Kant, S., 2004. Economics of sustainable forest management. Forest Policy and Economics 6, 197–203.
Karsenty, A., 1998. La filière bois d'oeuvre dans les pays de la zone Franc à la lumière de la crise asiatique. Caisse Française de Développement Trésor Public, Paris.
Karsenty, A., 2006a. Enjeux méconnus de l'économie du bois. Le Monde Diplomatique July, Special issue.
Karsenty, A., 2006b. L'impact des reformes forestières dans le secteur forestier en Afrique Centrale. In: Nasi, R., N'guinguiri, J.C., Ezzine de Blas, D. (Eds.), Exploitation et gestion durable des forêts en Afrique Centrale. L'Harmattan, Paris, pp. 25–60.
Karsenty, A., 2007. Overview of Industrial Forest Concessions and Concession-Based Industry: Contributions to Social and Economic Development in Central and West Africa. Rights and Resources and CIRAD, Washington, DC.
Karsenty, A., Roda, J.M., Milol, A., Fochivé, E., 2006. Audit économique et financier du secteur forestier au Cameroun. Ministère des Forêts et de la Faune, Yaounde.
Küper, W., Sommer, J.H., Lovett, J.C., Mutke, J., Linder, H.P., Beentje, H.J., Van Rompaey, R.S., Chatelain, C., Sosef, M., Barthlott, W., 2004. Africa's hotspots of biodiversity redefined. Annals of the Missouri Botanical Garden 91 (4), 525–535.
Labrousse, A., Verschave, F., 2003. Les Pillards de la forêt. Exploitations criminelles en Afrique. Agone, Marseille.
Laurance, W.F., 1999. Reflections on the tropical deforestation crisis. Conservation Biology 91 (2–3), 109–117.
Lescuyer, G., 2006. In: Nasi, R., N'guinguiri, J.C., Ezzine de Blas, D. (Eds.), Exploitation et gestion durable des forêts en Afrique Centrale. L'Harmattan, Paris, pp. 369–388.
Mertens, B., Lambin, E.F., 1997. Spatial modelling of deforestation in southern Cameroon: spatial disaggregation of diverse deforestation processes. Applied Geography 17 (2), 143–162.
Minnemeyer, S., Walker, T., Collomb, J.G., Cotton, L., Bryant, D., 2002. An Analysis on Access into Central Africa's Rainforests. Global Forest Watch and World Resources Institute, Washington, DC.
Nasi, R., 1998. Gérer des populations d'arbres? Résultats d'études sur l'okoumé et le moabi. Canopée 11, http://www.ecofac.org/Canopee/N11/N1107_Populations/PopulationArbre.htm.
Nasi, R., N'guinguiri, J.C., Ezzine de Blas, D., 2006. Progrès accomplis et défis pour le proche futur. In: Nasi, R., N'guinguiri, J.C., Ezzine de Blas, D. (Eds.), Exploitation en gestion durable des forêts en Afrique Centrale. L'Harmattan, Paris, pp. 389–397.
O'Halloran, E., Ferrer, V., 1997. The Evolution of Cameroon's New Forest Legal, Regulatory and Taxation System. The World Bank, Washington, DC.
Pinta, F., Fomete, T., 2004. Filière bois au Cameroun: vers une gestion durable des forêts et une transformation industrielle performante? Bois et Forêts des Tropiques 281, 71–86.
Pourtier, R., 1989. Le Gabon. Tome 2: État et développement. L'Harmattan, Paris.
Putz, F., Dykstra, D., Heinrich, R., 2000. Why poor logging practices persist in the tropics? Conservation Biology 14 (4), 951–958.
Ruiz Pérez, M., Ezzine de Blas, D., Nasi, R., Sayer, J., Sassen, M., Angoué, C., Gami, N., Ndoye, O., Ngono, G., Nguinguiri, J.C., Nzala, D., Toirambe, B., Yalibanda, Y., 2005. Logging in the Congo bas a multi-country characterization of timber companies. Forest Ecology Management 214 (1–3), 221–236.
Ruiz Pérez, M., Ezzine de Blas, D., 2006. Qui exploite les bois des forêts du bassin du Congo ? Une analyse régionale. In: Nasi, R., N'guinguiri, J.C., Ezzine de Blas, D. (Eds.), Exploitation et gestion durable des forêts en Afrique Centrale. L'Harmattan, Paris, pp. 99–122.
Ruiz Pérez, M., Ezzine de Blas, D., Nasi, R., Sayer, J., Sassen, M., Angoué, C., Gami, N., Ndoye, O., Ngono, G., Nguinguiri, J.C., Nzala, D., Toirambe, B., Yalibanda, Y., 2006. Socioeconomic constraints, environmental impacts and drivers of change in the Congo basin as perceived by logging companies. Environmental Conservation 33 (4), 1–9.
Ruiz Pérez, M., Ezzine de Blas, D., Nasi, R., Sayer, J., Sassen, M., Angoué, C., Gami, N., Ndoye, O., Ngono, G., Nguinguiri, J.C., Nzala, D., Toirambe, B., Yalibanda, 2004. Pilot Study on the Social, Environmental and Economic Sustainability of Industrial Concessions in the Congo basin. International Tropical Timber Organisation, http://www.itto.or.jp/live/PageDisplayHandler?pageId=161&id=804.
Sarre, A., 2006. How deep does your cash flow? ITTO Tropical Forest Update 16, 1–2.
Sayer, J.A., Harcourt, C.S., Collins, M., 1992. The Conservation Atlas of Tropical Forests. IUCN, Africa Gland.
Sayer, J.A., Ndikumagenge, C., Campbell, B., Usongo, L., 2005. Wildlife, loggers and livelihoods in the Congo basin. In: Sayer, J.A., Maginnis, S. (Eds.), Forests in Landscapes; Ecosystem Approaches to Sustainability. Earthscan, London, pp. 115–127.
Sist, P., Dykstra, D., Fimbel, R., 1998. Reduced impact logging guidelines for lowland and hill dipterocarp forests in Indonesia. In: Bulungan Research Report Series 1, CIFOR, Bogor.
Sist, P., Picard, N., Gourlet-Fleury, S., 2003. Sustainable cutting cycle and yields in a lowland mixed dipterocarp forest of Borneo. Annals of Forest Science 60, 803–814.
Tosh, J., 1980. The cash-crop revolution in tropical Africa: an agricultural reappraisal. African Affairs 79 (3–4), 79–94.
Vansina, J., 1990. Paths in the Rainforests. Toward a History of Political Tradition in Equatorial Africa. James Currey, London.
Vande weghe, J.P., 2003. Les Forêts d'Afrique Centrale: la Nature et l'Homme. Lanoo, Tielt.
Vandehaute, M., Heuse, E., 2006. Aménagement forestier, Traçabilité du bois et Certification. Etat des lieux des progrès enregistrés au Cameroun. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Yaounde.
Van Gemerden, B.S., Shu, G.N., Olff, H., 2003. Recovery of conservation values in Central African rain forest after logging and shifting cultivation. Biodiversity Conservation 12 (8), 1553–1570.
Versluys, J., 1927. De l'utilisation rationnelle des forêts du Congo. Le matériel colonial. Organe de l'association pour le perfectionnement du matériel colonial. Archives Coloniaux, Aix-en-provence.
Videau, G., 1928. Rapport sur les transports maritimes et ferroviaires des bois coloniaux. Rapport du Congrès National de Bois et dérivés. Archives Coloniaux, Aix-en-provence.
Vincent, J.R., Gibson, C.C., Boscolo, M., 2005. The Politics and Eonomics of Timber Reforms in Cameroon. The World Bank Institute, The World Bank, Washington, DC.
Westoby, J., 1987. The Purpose of Forests: The Follies of Development. Basil Blackwell, Oxford.
White, A., Sun, X., Canby, K., Xu, J., Barr, C., Katsigris, E., Bull, G., Cossalter, C., Nilsson, S., 2006. China and the Global Market for Forest Products. Transforming Trade to Benefit Forests and Livelihoods. Forest Trends, Washington, DC.
White, L.J.T., 1992. Vegetation history and logging disturbance. Effects on rain forest mammals in the Lopé Reserve, Gabon. Unpublished Ph.D. thesis.
World Rainforest Movement, 2003. Bulletin 73, http://www.wrm.org.uy/bulletin/73/Congo.html.
World Wild Fund International, 2005. Des exploitants s'engagent pour une gestion forestière responsable au Cameroun. WWF-International, http://www.panda.org/about_wwf/what_we_do/forests/news/index.cfm?uNewsID=18253&uLangID=3.
Wunder, S., 2003. Oil Wealth and the Fate of the Forest. A Comparative Study of Eight Tropical Countries. Routledge, London.
Yalibanda, Y., Ezzine de Blas, D., 2006. L'exploitation forestière au coeur de l'Afrique: la République Centrafricaine. In: Nasi, R., N'guinguiri, J.C., Ezzine de Blas, D. (Eds.), Exploitation en gestion durable des forêts en Afrique Centrale. L'Harmattan, Paris, pp. 195–216.