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Impact Evaluation Study of Forest Management Systems on the Forest Cover in the Congo Basin

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Kenneth Houngbedji coordinated this study while working at AFD, and was then replaced by Pierre-Yves Durand

Cover page
Ivindo Makokou Rapids, Northwest Gabon

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Introduction

Given the extent of production forests, which is much larger than protected areas, sustainable logging, through timber concessions with forest management plans, can be a valuable tool for forest conservation, combining biodiversity conservation, economic production, and local development. To that end, several institutional players have been supporting the implementation of management plans in logging concessions in the Congo Basin for over twenty years. Indeed, more than half of the tropical rainforests of Cameroon, Gabon, Congo, and the Central African Republic (CAR) are devoted to industrial timber production and are allocated to logging concessions. Legally, since the new generation of forestry laws in these countries was enacted in the 1990s and 2000s, all the forest concessions must implement a forest management plan (FMP). In practice, roughly half of the forests allocated to active logging concessions were under a FMP by 2010, but the dynamic in terms of management plans in concessions is changing rapidly. The Forest Stewardship Council (FSC) certification is also very dynamic in the region, and, in 2010, approximately one third of managed forests were also certified.

Nevertheless, in spite of these positive developments, the effectiveness of forest management and certification to help avoid deforestation remains under debate, both within institutions and non-governmental organizations (NGOs) and within the scientific community. It is against this context that AFD, the French Facility for Global Environment (FFEM), whose secretariat is provided by AFD, and the French National Research Institute for Sustainable Development (IRD) have launched a research project that seeks to provide an empirical estimate of the average effect of FMP in timber concessions on deforestation in the Congo Basin. More precisely, this study aims at measuring the average effect of the approval of forest management plans in logging concessions on deforestation between 1990 and 2010 by adopting a quasi-experimental design using a counterfactual, i.e., comparing deforestation in managed concessions and in similar concessions without a management plan.

1. Setting Up the Study and an Independent Monitoring Committee

This study is a part of the "Évaluation d'impact des modes de gestion forestière sur le couvert forestier dans le bassin du Congo" [Impact Evaluation of Forest Management Systems on the Forest Cover in the Congo Basin] research project conducted jointly by the Evaluation and Learning Department at the Research, Innovation & Knowledge Direction at AFD, FFEM and the ESPACE-DEV research unit at the French National Research Institute for Sustainable Development (IRD). The study was carried out by Isabelle Tritsch and Benoît Mertens (IRD), as well as Jean-Sylvestre Makak (Geospatial Company – GEOCOM). It was guided by a reference group including members of AFD (Kenneth Houngbedji, Christophe Du Castel et Julien Calas) and FFEM (François-Xavier Duporge), as well as resource persons from CIRAD (Alain Karsenty), WWF (Jean Bakouma), ATIBT (Benoît Jobbe-Duval), WCS (Matthew Hatchwell), and Gembloux Agro-Bio Tech (Jean-Louis Doucet). This group was chaired by Pr. Pascal Combes Motel from CERDI, and met twice to review progress. A monitoring committee consisting of members of UCLouvain (Patrick Meyfroidt), CEE-M (Gwenolé Le Velly), and the engineering consultancy SIRS (Christophe Sannier) also met on a regular basis to discuss progress.

Box 1 – A Primer on Deforestation in the Congo Basin

Compared to the situation in other tropical forests, deforestation over the period covered by this study was relatively low in the four countries under consideration: Gabon, Congo, Cameroon, and CAR. National deforestation rates stood below 1% over 10 years in Congo and Gabon, somewhere between 1.5 and 2% in Cameroon, and between 2.5 and 3.5% in CAR. Moreover, deforestation has slowed down between 1990–2000 and 2000–2010 on a regional basis (the Democratic Republic of the Congo [DRC], and Equatorial Guinea excluded). Three quarters of forest loss occurred outside forest management units, and deforestation was particularly low in national parks and in logging concessions (less than 0.6% over 10 years). Broadly speaking, regionally, deforestation is mainly occurring at a small scale, the main direct cause being slash-and-burn agriculture, together with firewood collection, small-scale charcoal production, and small-scale lumbering operations (Desclée et al., 2013; Marquant et al., 2015; Tyukavina et al., 2018). Demographic pressure, both rural and urban, is thus the main underlying driver of deforestation in the Congo Basin (Defourny et al., 2011).

Box 2 – A Primer on Forest Concessions

Given how much forest they cover, logging concessions are predominant in the management of tropical rainforests of the Congo Basin and form the basis of the forest industry sector. Under a concession system, forests remain under state ownership, and logging permits are awarded to private logging companies for extended periods of time (of up to 100 years), granting them exclusive rights over forest resources in return for compliance with certain standards and the payment of fees (Karsenty, 2005; Cerutti et al., 2017). Logging companies are required by law to implement forest management plans (FMPs) based on national standards and under the supervision of forest administrations. In a context where the rule of law is weak, beyond management plans, logging companies can undertake FSC forest certification, which provides a guarantee by an independent third party that relevant laws and regulations are complied with, that FMPs are properly implemented, and that measures specific to FSC are applied (Blackman et al., 2018).

Implementing a FMP in a concession implies addressing a series of environmental, social, and economic issues, including the conservation of the forest's ecological conditions, local development, and reinforcing the economic benefits of logging. FMPs proceed based on inventories of forest resources, which, associated with ecological and social studies, enable concession-holders to divide their concessions into "management series," which are tracts of forest differentiated according to the use of the timber resource.

"Production series" are assigned to logging operations, while "conservation series" are apportioned to ensure the preservation of seed trees and protect the most vulnerable areas, and, when villages are included within concessions, "community management series" focused on community or agroforestry development, which acknowledge their use rights and the coexistence of various uses for forestry resources. Production series are subdivided into "annual allowable cuts" (AAC), for which the FMP presents a detailed plan for selective logging over a specific time period. This plan must allow for an optimal use of the timber supply, all the while enabling forest species to replenish, thereby ensuring the viability of the next logging cycle after a specified period of time (the usual rotation time is 25–30 years).

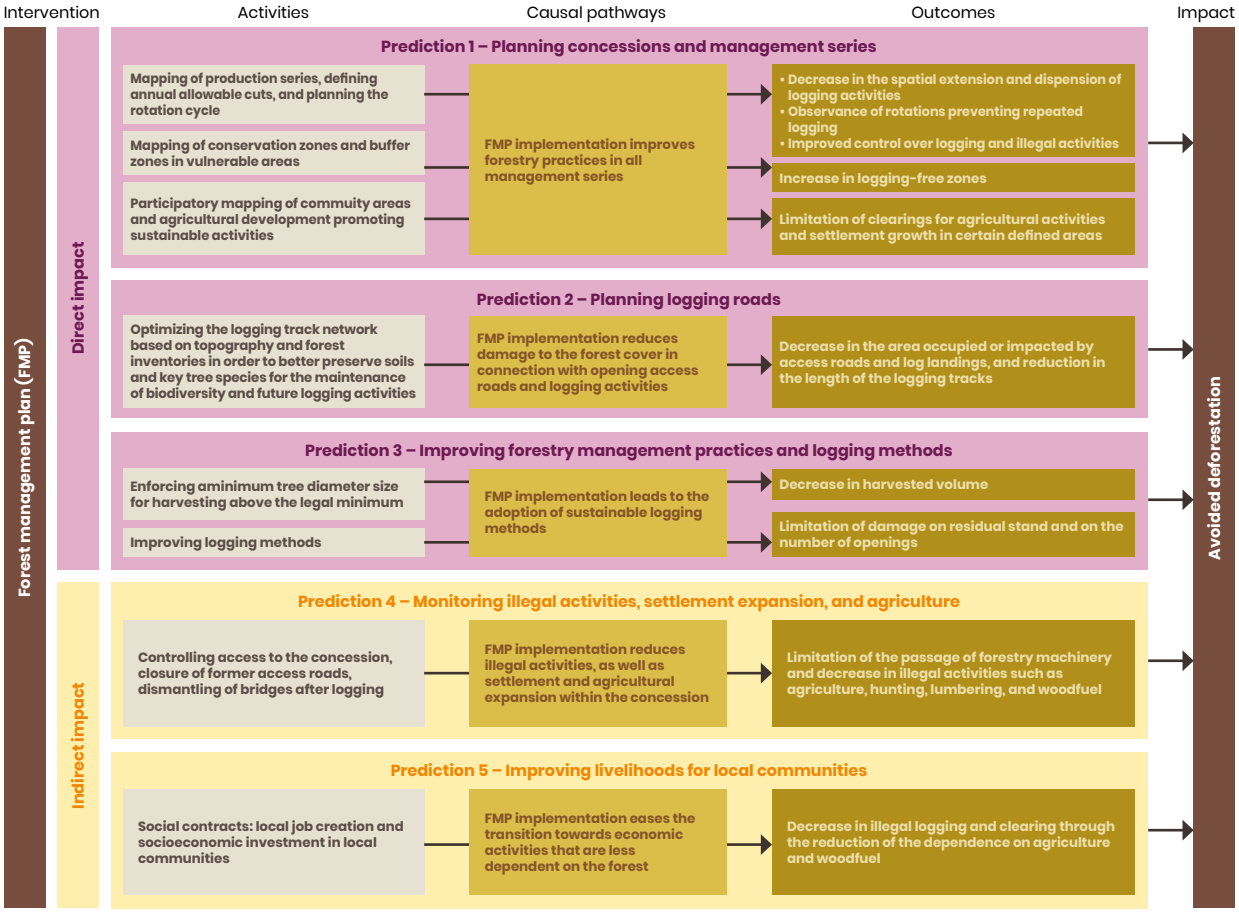
2. How Can Forest Management and FSC Certification Help Avoid Deforestation?

Table 1 summarizes the theory of change through which we hypothesize that FMP and FSC certification could help avoid deforestation in logging concessions. It hinges on five predictions, three of which are under the direct control of logging companies, and two of which are indirect, depending on external agents.

As for the FSC certification, it is assumed to be impacting deforestation through the same hypotheses and causal pathways. In addition to these five predictions, however, FSC certification leads to greater control of the logging operations by third parties.

In a context of weak governance and rule of law, such third-party verification can lead to improved compliance and improved performance regarding each of the detailed pathways. FSC certification is therefore expected to have an additional effect on reducing deforestation.

Table 1. Theory of Change

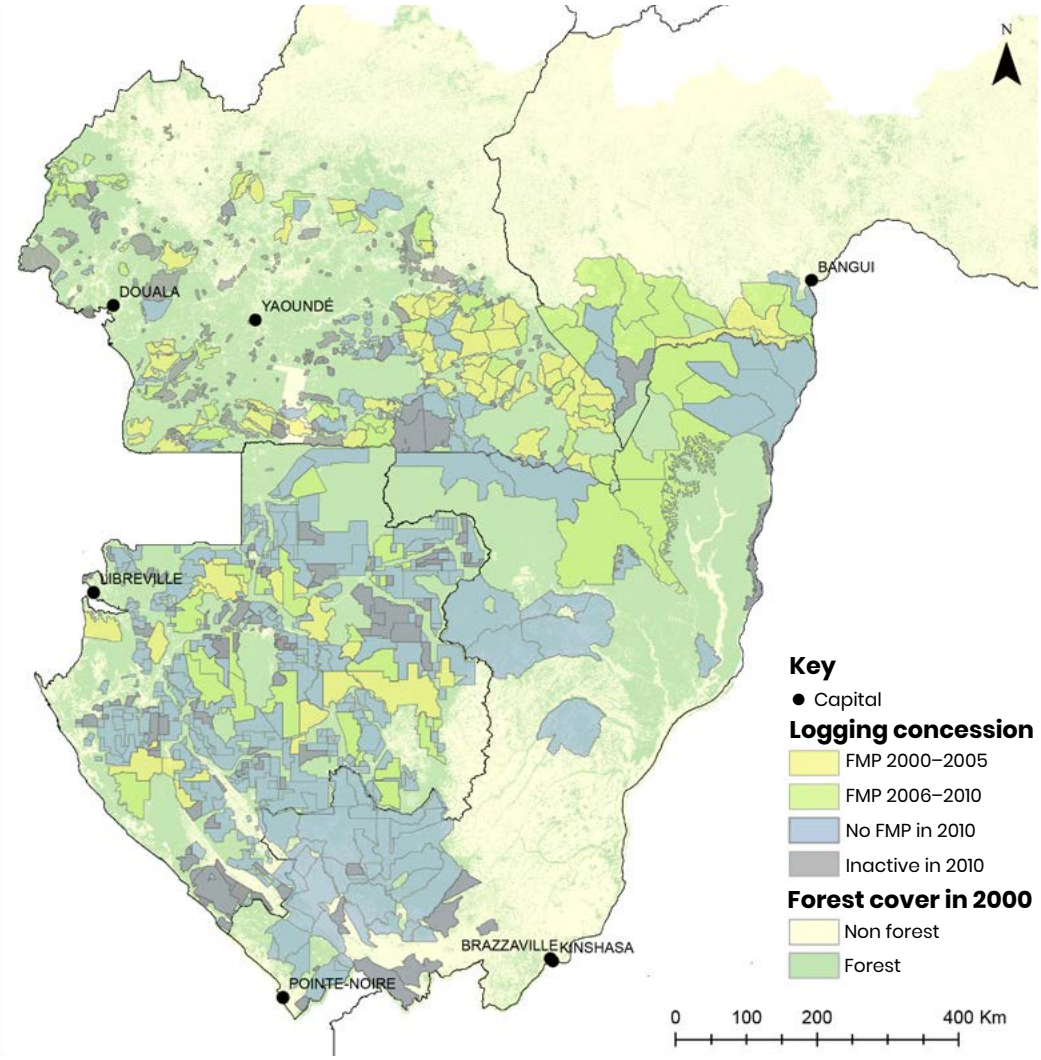


Source: Author's work, based on a review of logical frameworks of forest management plans. See Tritsch et al. (2020) for further details.

3.
Data Employed

The map data used comes from the national forest monitoring data generated under the REDD+ (Reducing Emissions from Deforestation and Forest Degradation) framework and by the national forest monitoring systems. Several international programs supported this data generation.

Map 1. Forest Cover and Forest Management in the Study Area



Source: Prepared by the authors based on national forest monitoring maps, WRI atlases, as well as OFAC data.

4. Impact Evaluation Method

The study uses an empirical approach that draws on the literature on impact evaluations of forestry conservation policies (Baylis et al., 2016; Blackman, 2013; Börner et al., 2016; Miteva et al., 2012). Deforestation in concessions with an approved FMP (or FMP concession in the remainder) is compared with deforestation in active concessions with no approved FMP. Over the study period, FMP concessions display, on average, different characteristics than concessions with no FMP (see box 3). Yet, these characteristics change the extent and risks of deforestation. Simply comparing concessions with and without FMPs, it is therefore not possible to tell whether a difference in deforestation has to do more with differences in observable characteristics or with a FMP being approved. In order to control for this selection bias, we compared the concessions with FMPs with concessions with no FMPs sharing otherwise similar observable characteristics correlated with deforestation. Practically speaking, we used propensity score matching (PSM), which consists of the following: (1) computing the propensity score that makes it possible to identify the combination of observable characteristics differentiating concessions with an approved FMP, then (2) identifying concessions with no FMP that have identical scores to concessions with FMPs, and finally (3) comparing the concessions with and without FMPs having the same propensity score.

We performed statistical analysis at the concession level.

The main outcome of interest is the total deforested surface area in the concessions during each ten-year period (1990–2000 and 2000–2010) and between both periods, expressed in hectares. Given that the potential effects of FMPs on deforestation are more likely to appear in the medium to long range, deforestation between 2000 and 2010 is probably lower in concessions that have had their FMP approved over a longer period of time. With this in mind, we have differentiated concessions that have had their FMP approved before 2005 (2000–2005 FMP treatment) and concessions that have had their FMP approved between 2006 and 2010 (2006–2010 FMP treatment). As deforestation was measured between 2000 and 2010, the 2006–2010 FMP treatment reflects the immediate and very short-term impacts of FMP approval, these treated concessions having had their FMP approved for less than four years. In contrast, the 2000–2005 FMP treatment includes concessions with FMPs approved for at least five years and therefore allows us to measure the short-term and mid-term impacts of FMP approval.

A third test considers that FMP concessions certified by FSC as at 2010 are part of the "treated" group. Due to the recent timeframe, this test also lacks data, but it is nevertheless interesting, in part because most concessions certified as at 2010 had had their FMP validated for a number of years, but also because FSC concessions have benefited from an audit of their practices and the implementation of their FMP by a third-party body. For these three tests, the control concessions were both active and without a FMP by 2010.

Box 3 – Correcting Selection Biases: Differences in Characteristics between FMP Concessions and No-FMP Concessions in 2010

Analyzing the location of the concessions in relation to covariates describing accessibility, population density, and environmental variables reveals that FMP concessions are less accessible and more isolated than concessions with no FMP, and that they are located in less populated areas.

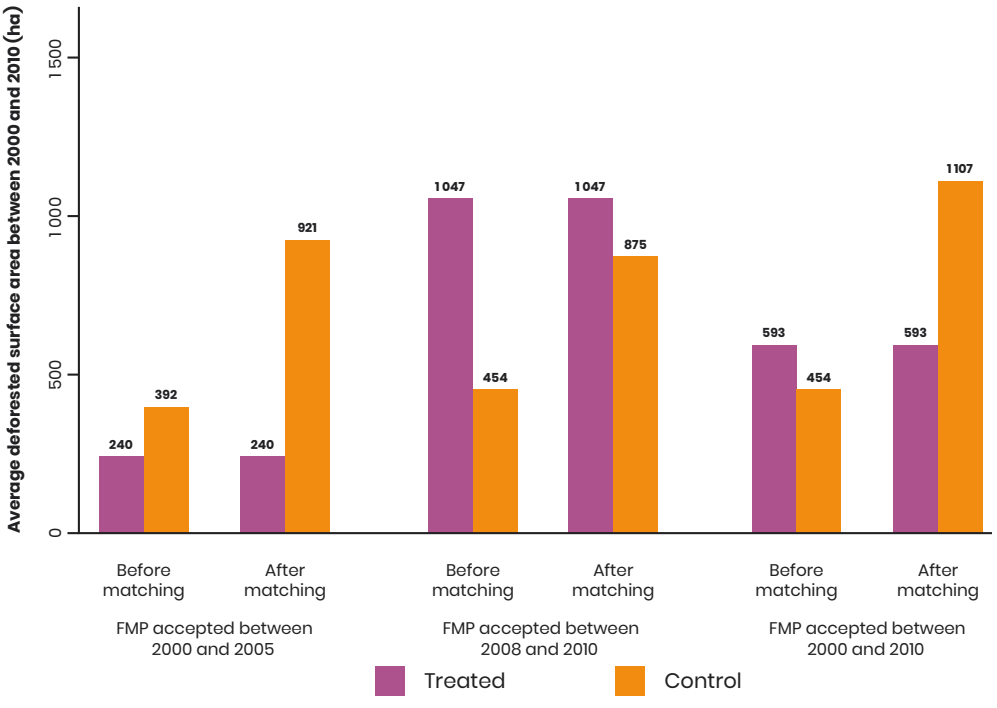
Moreover, they are located in areas with more forest biomass. In terms of topography, FMP concessions are located in areas where the average altitude is higher but where average slopes are gentler than in areas where non-FMP concessions are located. Finally, the presence of a temporal gradient can be noted: the concessions which had their FMPs accepted first (before 2005) are more isolated than those that had their FMPs accepted later (between 2006 and 2010) for all the variables included.

5. Results

Results show that, after matching, deforestation is statistically lower in concessions with FMPs of more than five years, when compared to similar concessions (having the same propensity score) with no FMP (see figure 1). In the medium term, implementing a FMP has resulted in preventing 681 ha of forest loss (see figure 2), which represents a 74% fall in deforestation compared to control concessions. However, in the short term (low hindsight) no statistically significant impact of FMPs was observed: concessions that have had their FMP approved between 2006 and 2010 have the same deforestation levels in the 2000–2010 period than similar concessions with no FMP. Finally, after matching, we note that deforestation between 2000 and 2010 is, on average, 514 ha lower in FMP concessions than in control concessions with no FMP. This amounts to a 48% decrease in deforestation compared to no-FMP control concessions.

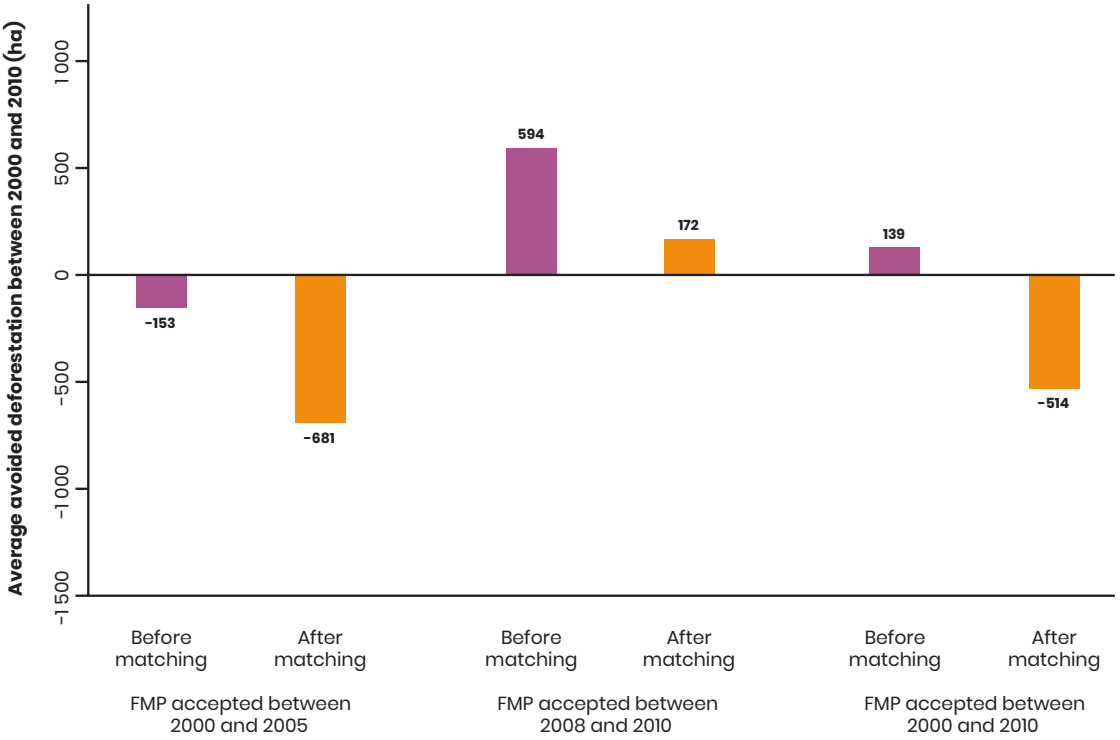
In order to test the robustness of these results, the analysis was replicated using data on forest cover loss between 2000 and 2010 from the Global Forest Change (GFC) dataset (Hansen et al., 2013). Both analyses produced similar results. The analysis on deforestation trends between 1990–2000 and 2000–2010 (through a difference-in-difference approach) show that the deforested surface area decreases more in FMP or certified concessions than in control no-FMP concessions, whatever the considered treatment, although the difference isn't statistically significant in the case of the 2000–2005 FMP treatment. Nevertheless, few concessions were attributed to forest companies during the 1990–2000 period, and it is arguable that deforestation over that period was not driven by the activities of the forest companies. This limits our ability to draw conclusions from the results provided by a difference-in-difference approach .

Figure 1. Summary of Outcomes for the Three Treatments Considered: Average Deforested Surface Area between 2000 and 2010 before and after Matching, and Avoided Deforestation



Source: Authors' calculations, based on national forest monitoring maps, WRI atlases, as well as OFAC data. See Tritsch et al. (2020) for more details.

Figure 2. Summary of Outcomes for the Three Treatments Considered: Average Avoided Deforestation between 2000 and 2010 before and after Matching, and Avoided Deforestation



Source: Authors' calculations, based on national forest monitoring maps, WRI atlases, as well as OFAC data. See Tritsch et al. (2020) for more details.

6. Which Pathways Explain the Reduced Deforestation?

In order to investigate the causal pathways of reduced deforestation, the spatial heterogeneity of the impact was analyzed through pixel-level sampling within the concessions. Three predictions were tested, studying the change in the probability of deforestation within the concessions according to the distance to past deforestation, distance to the closest local settlements, and distance to main roads (see table 2).

Approval of a FMP prior to 2005 is associated with a significantly lower deforestation in areas close to human settlements, close to previously deforested areas, and close to a main road.

At equal distance to a village, a road, or a previously deforested area (cleared between 1990 and 2000), we observe that the pixels located in concessions with FMPs that were approved before 2005 have a lower probability of being deforested than those located in concessions with no approved management plan. Moreover, the measured impact in areas close to villages or past deforestation is higher than the average impact measured in concessions as a whole. These analyses may be indicating the effectiveness of certain FMP pathways in reducing deforestation: *(i)* the effectiveness

of planning concessions with defined rotation cycles for the annual cutting areas and the community development series including agricultural activities; *(ii)* the effectiveness of the control and monitoring of concessions by closing former logging tracks and by monitoring the expansion of settlements and cultivated land; and *(iii)* the effectiveness of the monitoring of human incursions into the concessions from public roads. For further information, Tritsch et al. (2020) detail the methodology and the results of the study on the potential effect of the approval of FMPs and FSC certification on the loss of forest cover in the Congo Basin.

Table 2. Predictions of the Main Causal Pathways Informing the Analysis

Prediction	Variables tested in the heretogeneity analysis	Pathway tested	Expected impact
1	*Distance to past deforestation*	Effectiveness of concession planning, especially the mapping of production series	Less deforestation close to previous deforestation due to rotation and ACA planning, avoiding the reharvesting previously logged areas
		Effectiveness of concession monitoring, especially control of access by closing former logging tracks	Less deforestation close to previous deforestation due to the reduction in illegal activities along former logging tracks
2	*Distance to local settlements*	Effectiveness of concession planning, especially the definition of areas for community and agriculture development	Less deforestation close to populated areas due to the promotion of sustainable activities and better monitoring of the extension of settlements and cropland
		Effectiveness of the "social contracts" of concessions	
3	*Distance to main roads*	Effectiveness of concession monitoring, especially control of access	Less deforestation close to main transport networks due to control of concession borders from from public roads

7. What about Other Forest Management Systems?

In order to analyze these results in light of other forest management systems that exist in the Congo Basin, a comparative analysis of forest management systems was also conducted. The same empirical methodology was used, comparing management approaches against one another, when it is possible to find a control group that is similar to the treated group and therefore obtain satisfactory matching.

The results show that, after matching, deforestation is statistically lower in protected areas compared to concessions, a result that stands whether the protected areas are national parks, other types of protected areas, or protected areas as a whole, as well as logging concessions as a whole or only concessions that were active in 2010. Depending on the specifics, deforestation is 73 to 77% lower.

This result is further confirmed when we compare concessions with FMPs dating back more than five years with control areas located in protected areas: deforestation is then higher in logging concessions than in protected areas.

Box 4 – And What about the Decentralization Modalities for Forest Management?

In Cameroon, the most advanced country in terms of decentralization, other forest management systems exist: community forests [1] and communal forests, which empower rural communities and *communes* (municipalities) in order to foster sustainable forest management. Community forests are unique in that they fall within the jurisdiction of the Ministry of Forestry, though they form part of the non-Permanent Forest Estate. In other terms, they are currently forested areas but, unlike the Permanent Forest Estate, they are zoned as areas that may be converted to other land uses. In the case of community forests, they are decentralized from the state to a community, but remain state property (Cuny, 2011). In contrast, in the case of communal forests, there is a transfer of land ownership from the state to the *commune*. The effect of these two forest management systems on deforestation is measured compared with logging concessions. Our results suggest that, compared with control areas located in logging concessions in Cameroon, there is no statistically significant difference of deforestation over 2000-2010 in communal and community forests.

8. Discussion and Concluding Remarks

Curbing tropical deforestation is arguably a major environmental challenge. It is therefore particularly important to evaluate the effectiveness of policies implemented to that end and to understand the underlying pathways for their successes and failures.

This paper contributes to this effort, revealing that the surface area that was deforested between 2000 and 2010 is lower in the logging concessions of the Congo Basin that have had their FMP approved for at least five years by 2005, as well as in concessions that obtained an FSC certification before 2010. However, we find no statistically significant difference in terms of deforested surface area between concessions that had their FMP approved during the second half of the observation period compared with similar concessions that were active but with no FMP. This result draws attention to the importance of the time frame of the study: the effect of FMP is likely to build up and vary over time. Interventions aiming to foster FMP implementation and forest certification should therefore be evaluated over long time frames.

Evidence from concession-level analysis suggests that FMPs have allowed logging companies to improve the planning of their logging activities, thereby avoiding re-harvesting previously logged areas. Our results also suggest that FMP concessions are more likely to better control access into their perimeter, and to have a better ability to curb deforestation around village communities located within or nearby the concession. This is in line with the theory of change that articulates how adopting a FMP can help reduce deforestation and confirms the value of investigating the spatial heterogeneity of intervention impacts in terms of policy and management (Bruggeman et al., 2018). Further research would nevertheless be warranted to improve the identification of these pathways and the conditions under which they have an effective and sustained influence on deforestation. It would also be useful to investigate the effects of FMP production and approval policies on forest degradation given that several impact pathways in the theory of change are likely to result in greater effects in terms of the reduction of forest degradation than in terms of deforestation.

Our work covered the period between 1990 and 2010, during which few concessions implemented forest management plans in the Congo Basin. It would therefore be important to extend the analysis and investigate whether a decrease in deforestation was experienced between 2005 and 2015 in the concessions that had their FMP approved between 2005 and 2010. It would also be worthwhile examining whether the area of avoided deforestation increases further when forest management plans are assessed over even longer time periods. We can indeed wonder how deforestation unfolded over longer periods of observation in concessions that had their FMP approved between 2000 and 2005.

Answering the above questions is a natural extension of our work here, and will help improve our understanding of the best policy responses to develop and protect forest resources. This would also help us determine whether organizing concessions with FMP production and approval policies is effective in preventing deforestation in logging concessions.

Likewise, the adoption of forest management plans and certifications is also expected to bring benefits other than reduced deforestation, notably improving biodiversity and wildlife conservation, decreasing forest degradation, and improving living standards for local communities. Future work should therefore address other potential FMP impacts in the Congo Basin, and reveal whether lower deforestation has come at the expense of other dimensions of development and conservation.

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List of Acronyms and Abbreviations

ACA	Annual cutting area
AFD	Agence française de développement (French Development Agency, or the Agency)
AGEOS	Agence gabonaise d'études et d'observations spatiales (Gabonese Studies and Space Observations Agency)
ATIBT	Association technique internationale des bois tropicaux (International Tropical Timber Technical Association)
CAR	Central African Republic
CEE-M	Centre d'économie de l'environnement – Montpellier (Center for Economic Economics – Montpellier)
CERDI	Centre d'études et de recherches en développement international (Center for Studies and Research on International Development)
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (Agricultural Research Center for International Development)
DRC	Democratic Republic of the Congo
EVA	Evaluation and Knowledge Capitalization Department (AFD)
FMP	Forest management plan
FFEM	Fonds français pour l'environnement mondial (French Facility for Global Environment)
FSC	Forest Stewardship Council
GEOCOM	Geospatial Company (Gabon)
GFC	Global Forest Change
ha	Hectare(s)
IRD	Institut de recherche pour le développement (French National Research Institute for Sustainable Development)
IRS	Research, Innovation & Knowledge Department (AFD)
OFAC	Observatoire des forêts d'Afrique centrale (Observatory of Central African Forests)
NGO	Nongovernmental organization
PSM	Propensity score matching
REDD	Reducing Emissions from Deforestation and Forest Degradation
SIRS	Systèmes d'information à référence spatiale (an engineering consultancy)
UMR	Unité mixte de recherche (Mixed Research Center, a type of research laboratory in France)
WCS	Wildlife Conservation Society
WRI	World Resources Institute
WWF	World Wildlife Fund

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What is AFD?

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