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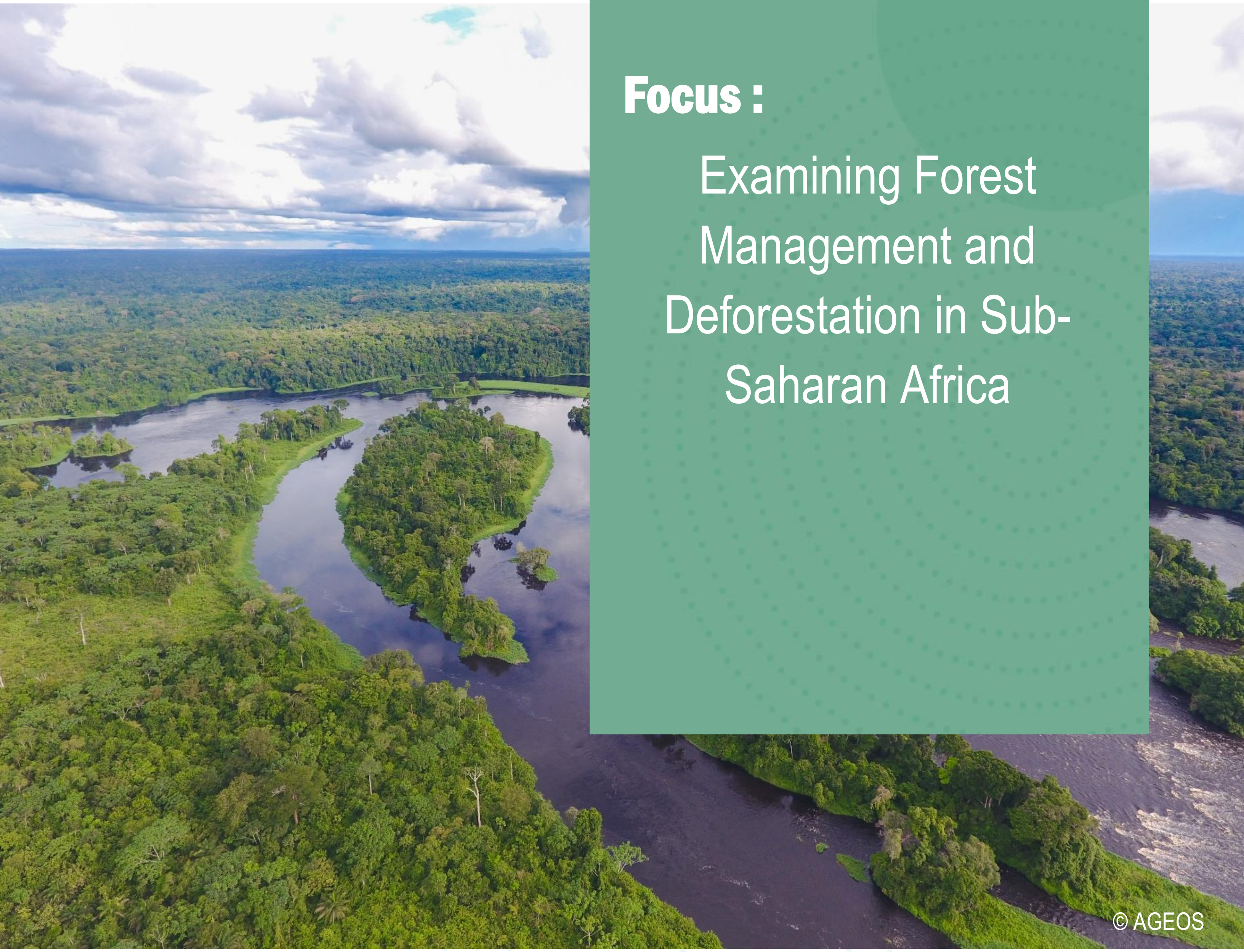

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The vital contribution made by forests and trees to populations and the planet has been widely acknowledged. Forests help cope with climate change by sequestering carbon, stabilizing soils, regulating waterways, and hosting a significant portion of terrestrial biodiversity. They are also sources of food, medicine, energy, and income, while contributing to the food security of local communities. Lastly, forests are complementary to agricultural activities as they provide habitat for pollinators and the natural enemies of agricultural pests.

In this respect, certain uses of forests (such as plantations, agricultural land, cattle rearing, the extraction of tree species, the production of firewood, cultural rites, recreational activities, etc.) raise the question of the trade-off between the services derived from forest exploitation for present generations and their medium- and long-term impact on the living conditions of future generations, climate change, and biodiversity. This trade-off is particularly tricky because it rests on several aspects of governance which may threaten its effectiveness. First, leaving aside the loss of forest cover due to natural phenomena (thunderstorms and forest fires), part of the trade-off consists in choosing between the use of forests by local populations and that by extractive industries that are often foreign-owned. Then, deciding on the use of forests also means that present generations implement policies limiting their own use of forests for the benefit of future generations and for the preservation of the planet. In other words, some user communities will have to forgo the benefits that they could derive from the use of the forest resources to which they have access in order to preserve the services that these resources may produce in an uncertain future. Yet, when decision makers enjoy benefits without bearing a proportional share of the costs, their decisions are unlikely to be optimal for society.

In this context, studying the impact of different forest management methods on deforestation has several advantages. First, it allows assessing the evolution of deforestation based on the policy adopted, and in certain cases, measuring the impact attributable to each policy on the deforestation avoided. This exercise offers the opportunity to identify the most effective management methods to limit deforestation, and therefore to account for the real efforts made by present generations to preserve forests. Then, the assessment of the avoided deforestation attributable to the implementation of effective forest management policies allows compensation mechanisms in recognition of the environmental and ecological services rendered. This is the case of programs to reduce the emissions caused by deforestation and forest degradation (REDD+), with their financial measures to reward low-income countries that implement policies to measure and reduce forest degradation in order to quantify and decrease the resulting carbon dioxide emissions.

In this issue of *Dialogue*, I address some of the constraints and opportunities related to measuring deforestation in sub-Saharan Africa, and present a recent study that aims to document the effects on deforestation of forest management plans within forest concessions in the Congo Basin.

The work presented here results from a joint research project with Isabelle Tritsch (IRD), Benoît Mertens (IRD) from UMR 228 Espace-Dev, Jean-Sylvestre Makak (Geospatial Company (GEOCOM), Gabon), Patrick Meyfroidt (Université de Louvain La Neuve), Gwenolé Le Velly (Centre d'Économie de l'Environnement – Montpellier (CEE-M)), and Christophe Sannier (Systèmes d'Information à Référence Spatiale (SIRS)). The project was part of a research agreement entitled "Assessment of the impact of forest management methods on forest cover in the Congo Basin" between the Département Évaluation et Apprentissage de la Direction Innovation, Recherches et Savoirs of the Agence Française de Développement, the Fonds Français pour l'Environnement Mondial, and the IRD's UMR ESPACE-DEV.

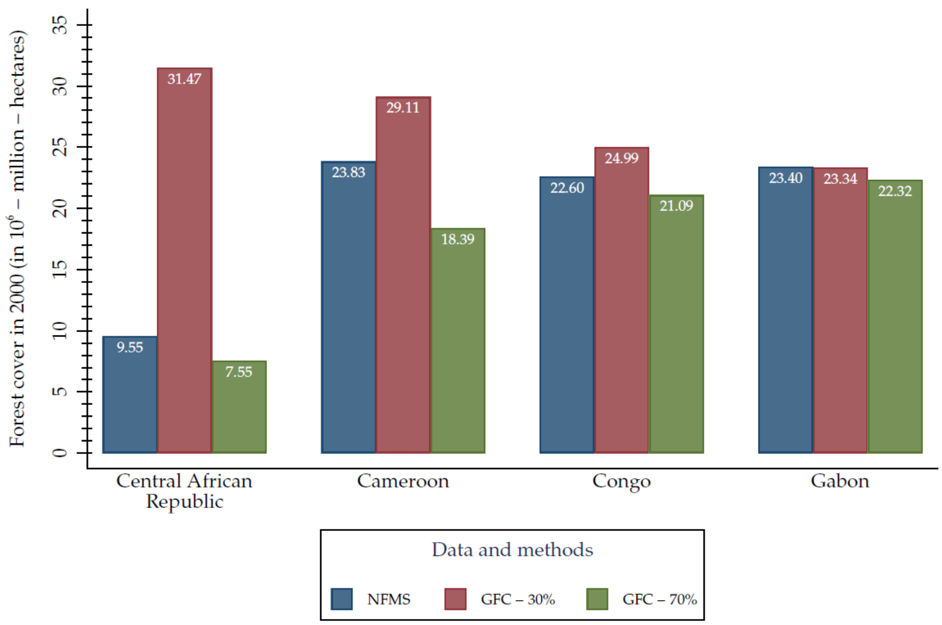
Some of the stakes related to measuring deforestation

Quantifying deforestation and, by extension, identifying the most efficient forest management methods is a more complex undertaking than it may seem. To illustrate these difficulties, let us consider the case of the Congo Basin, the second largest tropical forest after the Amazon, whose area was estimated at around 178 million hectares of dense tropical forest in 2005 (see Mayaux et al., 2013). Given how large the area covered by the forests of the Congo Basin is, the periodic monitoring of the evolution of the forest area is made easier by the use of satellite images. Thus, the work of Mayaux et al. (2013) relies on images from MODIS (Moderate Resolution Imaging Spectroradiometer) satellites to estimate the forest area in the Congo Basin in 2005 with medium resolution (i.e. for pixel sizes between 250m and 1km). Other estimates of the area of forest cover are based on different satellites. For instance, the data on the loss of forest cover from

Global Forest Change (GFC) in Hansen et al., (2013) come from Landsat satellite images with a resolution of 30m. The GFC data provide an estimate of forest cover on a global scale, and allow localizing tree cover losses and gains since 2000 based on automatic classification algorithms. What is more, the GFC maps are open access, regularly updated, and easy to use for the purpose of extracting the evolution of tree cover loss at any scale every year since 2000. In fact, the GFC maps are probably the most frequently used data when it comes to assessing the impact of forest management policies on deforestation.

With the implementation of REDD+ measures and the reduction in the costs linked to acquiring and processing satellite images, the countries of the Congo Basin like Cameroon, the Central African Republic, Congo, and Gabon have undertaken to map forest cover at the national level and to measure deforestation over the 1990-2000 and 2000-2010 periods. The maps produced by the national forest monitoring systems (NFMS) rely on several sources of satellite images (including SPOT – satellite for observation of earth – images whose highest resolution is 20 m for the SPOT 4 program), as well as on local knowledge to classify the use of the different types of tree cover. These maps aim to offer even more detailed measurements of forested and deforested areas that are compatible with the local situation.

Figure 1 – Forest cover estimates based on maps from the national forest monitoring systems and tree cover estimates based on GFC data



Source: Author's illustration based on measurements of forest cover by the NFMSs and the GFC.

Figure 1 compares the forest area estimated in 2000 by the NFMSs with two measurements of the tree cover area from GFC data, first by defining a forest as any pixel with at least 30% tree cover (GFC-30%) or by assuming that a pixel is a forest if it has at least 70% tree cover (GFC-70%). For some foresters, defining a forest according to the density of tree cover at the level of a 900m² square without taking into account its actual use (a tree plantation is not a forest) is questionable. It is therefore not surprising that the forest area estimated in Figure 1 by GFC-30% (which classifies any pixel covered by more than 30% of trees over 5 m as a forest) systematically tends to be greater than the area reported by the NFMSs. However, modifying the canopy size (30 or 70% as in Figure 1) is not enough to make the measurements from the GFC and the NFMSs converge. For example, the estimated differences between the measurements produced by the NFMSs and GFC-70% indeed tend to vary from country to country and suggest that national definitions are more likely to fit different types of forests while disentangling between forests and plantations. In Gabon, Sannier et al. (2016) indeed show that it is not possible to find a canopy size that allows the forest cover measurement data from the NFMSs and GFC to converge. Furthermore, Alix-Garcia and Millimet (2020) find that measurement errors associated with the use of GFC data to study deforestation are correlated with certain observable characteristics of pixels, such as topography and the presence of a cloud cover.

For studies that seek to isolate the mechanisms underlying deforestation and aim to identify the impact attributable to the policies studied, the problem of measuring forest cover and deforestation is of particular concern in so far as the forest cover maps produced by the NFMSs are not necessarily easy to access and are not the subject of scientific publications detailing their production process and reliability. While GFC data are the most widely used data sources to study changes in forest cover, it is important to at least verify the extent to which the results of studies on the impact of forest management methods on deforestation are robust to the use of other data that attempt to disentangle the changes in tree cover in plantations and those in forests.

Forest management and deforestation in sub-Saharan Africa

To preserve the ecosystem services they provide, some policies favor controlling the access to forests by creating protected areas. Several studies indeed suggest that protected areas tend to reduce deforestation, although the effect may be rather weak (see for example, Andam et al., 2008; Ferraro et al., 2011; Miteva et al., 2012). However, the effectiveness of protected areas in reducing deforestation varies depending on factors such as accessibility, size, age, and governance. For example, Pfaff et al. (2015) find that in the Brazilian Amazon, the most efficient protected areas in terms of avoided deforestation are those located near roads and cities, where the pressure from deforestation is the greatest, and not those located in areas with little such pressure. They also find that the deforestation avoided is greater in those protected areas which were less restrictive with regard to human activities (known as sustainable development protected areas, where local communities retain the rights of access to natural resources) than in highly restrictive areas (known as integral protection areas), because the latter are often located in isolated areas and are therefore less threatened.

However, effectively "insulating" forest areas imposes economic, social, and cultural costs which can affect long-run effectiveness and require considering more effective alternative approaches to reconcile the services provided by the access to forests while limiting deforestation. Examples include initiatives that encourage individuals and businesses to limit the environmental impact of their activities (such as payments for environmental services) or to create activities that produce environmental services (such as planting trees, collecting and incinerating greenhouse effect products, choosing livestock feed that limits methane emissions, etc.). In the Congo Basin, due to the proportion of world forests that the region represents (44 million ha according to Megevand et al., 2013), it is necessary to study how forest management plan (FMP) policies in production forests (areas allocated to logging under public-private partnership) help limit deforestation within forest concessions.

Forest management plans and deforestation in the Congo Basin

Compared to protected areas (22.6 million ha according to Doumenge et al., 2015), sustainable logging through the management of logging concessions represents an instrument for forest conservation which could combine biodiversity conservation, economic production, and local development (see Nasi et al., 2012). In theory, forest management plans (FMPs) encourage the adoption of silvicultural techniques that allow the selective extraction of trees based on their species, their commercial value, and their stage of growth, while limiting the impact on the remaining stand. By doing so, the use of FMPs in concessions should allow the regeneration of commercial species, so as to allow rotations (generally 25 to 30 years) to carry out new harvesting (Bertrand et al., 1999a; Bertrand et al., 1999b; Fargeot et al., 2004). For these reasons, the adoption of FMPs is often considered as a policy that can contribute to the conservation of tropical forests, and various institutional actors have supported the management of forest concessions in the Congo Basin for over twenty years (Clark et al., 2009; Lambin et al., 2014).

In theory, the implementation of FMPs spreads logging activities within concessions over time and should protect the forest from alternative uses that cause more deforestation (see Angelsen, 2010). In Cameroon, Bruggeman et al. (2015) indeed find that deforestation is relatively lower in reserved forests and logging concessions. However, the theoretical impact of FMPs on deforestation in forest concessions that have adopted FMPs remains ambiguous. The deforestation avoided by silvicultural techniques such as selective extraction and rotations can indeed be more than canceled out by the forest losses linked to the construction of a road network to access commercial species. Also, the adoption of FMPs has been heterogeneous depending on the country and forest concession (Cerutti et al., 2008), and the issue of the sustainability of FMPs is still being debated (Brandt et al., 2016, Brandt et al., 2018; Karsenty et al., 2017).

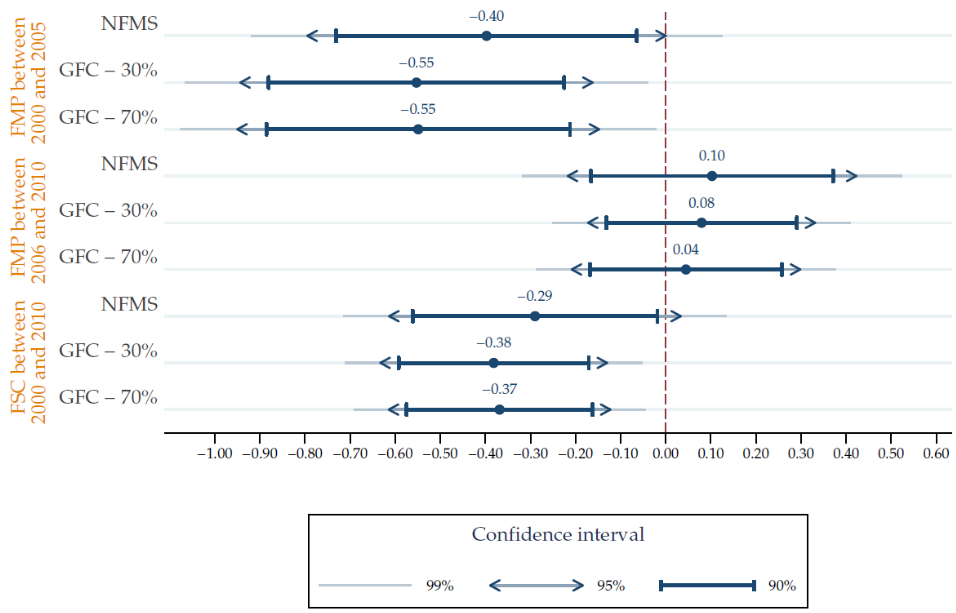
To study the effect of FMPs on deforestation in the Congo Basin, we take advantage of the fact that Cameroon, the Central African Republic, Congo, and Gabon successively enacted forest laws in the 1990s and 2000s which compel companies to formulate forest management plans for the concessions they manage and to have them approved. In practice, the obligation for concessions to formulate and adopt FMPs gradually took hold in the 2000s as environmental regulations were being developed. Since the preparation and approval of FMPs is a long process, extraction activities in the concessions allocated to logging companies was allowed to begin while awaiting the approval of their FMPs. Thus, in 2010, a third of the active concessions in the area studied (Cameroon, Central African Republic, Congo, and Gabon) had approved FMPs. In this context of slow but gradual preparation and approval of FMPs, some concessions with and without FMPs in 2010 likely shared similar levels of deforestation risk linked to their activities. We use this feature to match concessions with approved FMPs and active concessions without FMPs which had similar characteristics that were likely to affect their level of deforestation between 2000 and 2010. We can thus compare the deforestation observed between 2000 and 2010 in the concessions that obtained their FMPs before 2010 to the deforestation observed in the other concessions without FMPs over the same period.

For several reasons detailed in Tritsch et al. (2020), the effect of FMPs on deforestation is more likely to become apparent in the medium and long term, and we distinguish between concessions that obtained their FMPs before and after 2005. The former are more likely to have implemented their FMPs early enough to hope to observe possible impacts on deforestation in 2010. Moreover, the approval of an FMP does not necessarily imply that it was implemented. Without external control, some operating companies may not implement the restrictions documented in the FMPs of the managed concessions. In this case, the methodological approach may underestimate the impact of FMPs. To assess whether such a bias exists and its extent, we can compare the estimated effects in concessions with FMPs with the estimated effects in concessions that obtained the FSC (Forest Stewardship Council) certification. The FSC certificate is issued after a company's operations have been verified by a third party. As the powers of regulatory bodies are limited, this control by third parties can ensure that the logging operations in concessions comply with their FMPs. Since the process of obtaining an FSC certificate presupposes having an approved FMP (the majority of concessions with an FSC certificate in the area studied had obtained their FMPs before 2005) measuring deforestation in concessions with FSC certificates is therefore less likely to underestimate the effects of FMP implementation.

Thus, to study the effects of FMPs on managed concessions, we consider three different states for these managed concessions: an FMP approved between 2000 and 2005; an FMP approved between 2006 and 2010; and an FSC between 2000 and 2010. Then, we use the maps of deforestation between 2000 and 2010 produced by the NFMSs of the countries in the area studied and the official data collected at the country level by the Observatory of Central African Forests (OFAC) and the forest atlases of the WRI. These data allow mapping the perimeters of the concessions, and determining the periods when the concessions were active and the dates of management and certification. Finally, we test the robustness of the results by using GFC data to produce alternative estimates of deforestation over the 2000-2010 period. Figure 2 summarizes the main results.

For ease of comparison between the various estimates, we have normalized the measure of deforestation, and the results represent the relative variation in standard deviation points of the deforested area between 2000 and 2010 for each treatment considered. Thus, we observe that the area deforested between 2000 and 2010 is approximately 0.4 standard deviation points lower than the average area deforested in similar active concessions without FMPs (in view of the observable characteristics). There is no statistically significant difference between concessions that obtained their FMPs between 2006 and 2010 and similar active concessions without FMPs. In addition, the concessions with FSC certificates have deforested areas which are on average 0.3 standard deviation points lower than the average deforested areas in active non-managed concessions. This suggests that the concessions which had their FMPs approved between 2000 and 2005 were on average likely to respect the principles of sustainable management certified by the FSC. Finally, these conclusions do not vary significantly according to the data sources used to measure deforestation.

Figure 2 – Average effect of FMPs and the FSC on deforestation in managed concessions between 2000 and 2010



To identify the mechanisms through which forest management may reduce deforestation in the area studied, we reconstructed the theory of the changes stemming from FMPs, and studied how the incidence of deforestation varies spatially within managed concessions. The analysis suggests that sections of concessions close to the boundaries of previously deforested areas (those observed between 1990 and 2000), or to local communities within or near the concessions, or to roads are relatively less likely to be deforested in managed concessions. These results are consistent with the principles of FMPs which tend to promote crop rotation far from previously exploited areas. In addition, managed concessions are more likely to have better control over the access to their perimeter, as well as a greater ability to limit deforestation around the village communities that are located within or near the concessions.

Further work is needed to better understand the environmental impact of FMPs in the Congo Basin. First, the results of the study are driven by the initial wave of concessions that obtained their FMPs between 2000 and 2005. It may be that the logging companies that managed these concessions paid particular attention to controlling their environmental impact. It is therefore important to study whether there was less deforestation between 2005 and 2015 in the concessions with FMPs approved between 2005 and 2010. It would also be interesting to study whether there is an additional decrease in deforestation when forest management is assessed over even longer periods. Second, forest management also aims to bring benefits other than decreased deforestation, such as reducing forest degradation, preserving biodiversity and wildlife, and improving the living conditions of local populations. Future work should therefore also document how the adoption of FMPs in the Congo Basin has affected other dimensions of development and conservation. Finally, beyond the impact of FMPs on local populations, on the forests of the Congo Basin, and on the rest of the world (through the supply of timber and the effects on climate and health), it is also important to study the effects of other forest management methods to better understand and shed light on the management of the Congo Basin forests.

Kenneth Houngbedji

References

Alix-Garcia, J., & Millimet, D. L. (2020), “Remotely Incorrect?”, *Mimeo*.

Andam, K. S., Ferraro, P. J., Pfaff, A., Sanchez-Azofeifa, G. A., & Robalino, J. A. (2008), “Measuring the effectiveness of protected area networks in reducing deforestation”, *Proceedings of the National Academy of Sciences*, 105(42), 16089-16094.

Angelsen, A. (2010), “Policies for reduced deforestation and their impact on agricultural production”, *Proceedings of the National Academy of Sciences*, 107(46), 19639-19644.

Bertrand, A., Babin, D., & Nasi, R. (1999a), “Les composantes de l'aménagement forestier et leurs incidences financières”, *Bois et Forêts des Tropiques*, 261(261), 51-59.

Bertrand, A., Babin, D., & Nasi, R. (1999b), “L'adaptation de l'aménagement forestier à des situations diverses”, *Bois et Forêts des Tropiques*, 261, 39-49.

Brandt, J. S., Nolte, C., & Agrawal, A. (2016), "Deforestation and timber production in Congo after implementation of sustainable forest management policy", *Land Use Policy*, 52, 15-22.

Brandt, J. S., Nolte, C., & Agrawal, A. (2018), "Deforestation and timber production in Congo after implementation of sustainable management policy: A response to Karsenty et al. (2017)", *Land Use Policy*, 77, 375-378.

Bruggeman, D., Meyfroidt, P., & Lambin, E. F. (2015), "Production forests as a conservation tool: Effectiveness of Cameroon's land use zoning policy", *Land Use Policy*, 42, 151-164.

Cerutti, P. O., Nasi, R., & Tacconi, L. (2008), "Sustainable forest management in Cameroon needs more than approved forest management plans", *Ecology and Society*, 13(2).

Clark, C. J., Poulsen, J. R., Malonga, R., & Elkan, Jr, P. W. (2009), "Logging concessions can extend the conservation estate for Central African tropical forests", *Conservation Biology*, 23(5), 1281-1293.

Doumenge, C., Palla, F., Scholte, P., Hiol Hiol, F., & Larzillière, A. (2015), *Aires protégées d'Afrique centrale - État 2015*. OFAC, République Démocratique du Congo, Cameroun.

Fargeot, C., Forni, É., & Nasi, R. (2004), "Réflexions sur l'aménagement des forêts de production dans le bassin du Congo", *Bois et Forêts des Tropiques*, 281(281), 19-34.

Ferraro, P. J., Hanauer, M. M., Miteva, D. A., Canavire-Bacarreza, G. J., Pattanayak, S. K., & Sims, K. R. (2013), "More strictly protected areas are not necessarily more protective: evidence from Bolivia, Costa Rica, Indonesia, and Thailand", *Environmental Research Letters*, 8(2), 025011.

Ferraro, P. J., Hanauer, M. M., & Sims, K. R. (2011), "Conditions associated with protected area success in conservation and poverty reduction", *Proceedings of the National Academy of Sciences*, 108(34), 13913-13918.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R. & Kommareddy, A. (2013), "High-resolution global maps of 21st-century forest cover change", *Science*, 342(6160), 850-853.

Karsenty, A., Romero, C., Cerutti, P.O., Doucet, J.L., Putz, F.E., Bernard, C., Atyi, R.E.A., Douard, P., Claeys, F., Desbureaux, S. & de Blas, D.E., (2017), "Deforestation and timber production in Congo after implementation of sustainable management policy: A reaction to the article by JS Brandt, C. Nolte and A. Agrawal (Land Use Policy 52: 15–22)", *Land Use Policy*, 65, 62-65.

Lambin, E. F., Meyfroidt, P., Rueda, X., Blackman, A., Börner, J., Cerutti, P. O., Dietsch, T., Jungmann, L., Lamarque, P., Lister, J. & Walker, N. F. (2014), "Effectiveness and synergies of policy instruments for land use governance in tropical regions", *Global Environmental Change*, 28, 129-140.

Megevand, C., Mosnier, A., Hourticq, J., Sanders, K., Doetinchem, N., & Streck, C. (2013), *Deforestation trends in the Congo Basin: reconciling economic growth and forest protection*, The World Bank.

Mayaux, P., Pekel, J. F., Desclée, B., Donnay, F., Lupi, A., Achard, F., Clerici, M., Bodart, C., Brink, A., Nasi, R. & Belward, A. (2013), "State and evolution of the African rainforests between 1990 and 2010", *Philosophical Transactions of the Royal Society B: Biological Sciences*, 368(1625), 20120300.

Miteva, D. A., Pattanayak, S. K., & Ferraro, P. J. (2012), "Evaluation of biodiversity policy instruments: what works and what doesn't?", *Oxford Review of Economic Policy*, 28(1), 69-92.

Nasi, R., Billand, A., & van Vliet, N. (2012), "Managing for timber and biodiversity in the Congo Basin", *Forest Ecology and Management*, 268, 103-111.

Pfaff, A., Robalino, J., Herrera, D., & Sandoval, C. (2015), "Protected areas' impacts on Brazilian Amazon deforestation: examining conservation–development interactions to inform planning", *PloS One*, 10(7), e0129460.

Sannier, C., McRoberts, R. E., & Fichet, L. V. (2016), "Suitability of Global Forest Change data to report forest cover estimates at national level in Gabon", *Remote Sensing of Environment*, 173, 326-338.

Stern, N. (2007), *The economics of climate change: The Stern review*. Cambridge University press.

Tritsch, I., Le Velly, G., Mertens, B., Meyfroidt, P., Sannier, C., Makak, J. S., & Houngbedji, K. (2020), "Do forest-management plans and FSC certification help avoid deforestation in the Congo Basin?", *Ecological Economics*, 175, 106660.