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Financing improved forest management by carbon valuation, a bioeconomic modelling approach applied to Central African concessions

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Among the contributions expected from forest sectors in policies of climate mitigation, one consists in increasing forest carbon stocks by changing management practices. This activity, generally referred to as Improved forest management (IFM), is often obtained by a reduction of harvesting pressures on forest resources. In the case of "extension of rotation age/cutting cycle" (ERA) projects, the reduction of emissions comes from the increase of minimum cutting diameters (minimum cutting diameters) and/or the extension of felling cycle duration (FCD). However, such activities have negative consequences for the profitability of timber companies. Climate instruments such as the mechanism of REDD+ promote a compensatory approach to cover these income losses by the valuation of avoided carbon emissions.

To determine the feasibility of such a carbon-based compensation, it is necessary to predict over the long term both the dynamics of forest carbon and the time schedule of timber incomes. The two are closely interrelated. Selective logging can alter the structure and thus, the carbon stocks of tropical forests. Modelling these forest-logging relationships is challenging. Selective logging implies to deploy a species level representation of timber harvesting but the high diversity of tropical forests hinders the correct fitting of species-specific models.

We developed a bioeconomic approach coupling a mixture of inhomogeneous matrix models for forest dynamics and an object-oriented model for forest logging companies' operations. Our methodology addresses the challenge of taking into account the species richness by simultaneously clustering tree species into groups according to vital rate information and selecting group-specific explicative environmental variables. The object-oriented approach allows us to precisely describe harvest choices under technical and economic constraints. In the case of a Central African forest concession managed by a typical sawnwood export-oriented company, we predicted the carbon stock evolution for a wide range of ERA scenarios and for a time scale of 100 years. We calculated break-even prices that would enable carbon revenues to compensate logger's loss of timber incomes.

Our simulations are based on data from the M'Baïki site, in the Central African Republic (CAR), which has been monitored for 30 years. Economic data are taken from several forest concessionaires in Central Africa. We predicted that without any logging, carbon stock would increase naturally. When logging was simulated, the carbon stock decreased during the first felling cycle and although carbon recovery could be boosted by logging, this decrease was too sharp to catch up with unlogged levels. To ensure low break-even prices of carbon credits, ERA activities had to involve both FCD and minimum cutting diameters. Cost-effectiveness ranking of scenarios is sensitive to discount rate hence possible mismatch between private and public choices.

In the current context of REDD+ deployment, our work is a first step to bring some preliminary answers to the question of carbon-based compensation opportunities for industrial forest concessions in Central Africa, on the basis of an accurate modelling of tropical forestry.