Master thesis

Sylvain SCHMITT

2017-05-30

Mémoire de stage

présenté par

Sylvain SCHMITT

pour obtenir le diplôme national de master

mention Biodiversité, écologie, évolution

parcours Biodiversité végétale et gestion des écosystèmes tropicaux (BIOGET)

Sujet :

(COMPLETER)

soutenu publiquement le XX xxxx 201X

à (COMPLETER par la ville du lieu de soutenance)

devant le jury suivant : (Titre = DR pour docteur et Pr pour professeur)

Titre Prénom NOM	Tuteur de stage
Titre Prénom NOM	Examinateur
Titre Prénom NOM	Examinateur
Titre Prénom NOM	Enseignant-référent

Contents

Résumé et Abstract

Écrire le résumé français ici...

Write the english abstract here...

Acknowledgments

I would like to thank...

Introduction

Sutainable forest management in the tropics (i.e. managed selective harvesting of timber) has been widely promoted internationnaly to combat tropical deforestation and degradation [Zimmerman and Kormos, 2012]. Currently tropical logging accounts for one eight of global timber production [Blaser et al., 2011] and is still increasing. Most tropical timber production originates from selective logging, the targeted harvesting of timber from commercial species in a single cuttint cycle [Martin et al., 2015].

On the other hand, tropical rainforests have fascinated ecologists due to their outstanding diversity [Connell, 1978]. Effectively tropical forests host over half of the Earth's biodiversity [Scheffers et al., 2012]. High biodiversity from tropical rainforests is the source of many ecosystem functions. Amongst others, tropical forests play a key role in biogeochemical cycles, including carbone storage [Lewis et al., 2004]. **Add insights into carbon storage role of tropical forest.** Ecosystem functions from tropical forests support numerous ecosystem services, such as timber production and climate regulation.

But several authors argue that selective logging represents a major threat to biodiversity [Carreño-Rocabado et al., 2012, de Avila et al., 2015, Gibson et al., 2013, Martin et al., 2015, Zimmerman and Kormos, 2012], challenging the sustainable definition from current selective logging. We consequently need to assess both short and long term impacts of selective logging on tropical forest ecosystems to implement better syslvicultural practives in order to reach sustainability.

The question of selective logging impact on tropical forest can be directly related to the emerging field of biodiversity and ecosystem functionning [Loreau, 2000]. Tropical forest outstanding biodiversity will be both a factor and a result of forest ecosystem response to logging disturbance. And forest ecosystem response to logging disturbance will directly modify ecosystem functionning in both short and long term. Consequently assessing selective logging effect on tropical forest linking biodiversity and ecosystem seems an obvious and promising way [Loreau, 2010]. **Paragraph to fully review !**

Negative short term impacts of selective logging have been assessed [Carreño-Rocabado et al., 2012; de Avila et al., 2015; but see Martin et al., 2015]. Much less is known about the long term impact [Osazuwa-Peters et al., 2015]. The main reason is the difficulty to conduct long term empirical study [but see Herault et al., 2010], which can be completed by the use of forest simulators [Huth et al., 2004, K hler and Huth, 2004, Rüger et al., 2008, Tietjen and Huth, 2006]. Individual-based models of forest dynamics present the perfect framework to develop such joint biodiversity-ecosystem approaches [Maréchaux and Chave]. Individual-based models describe forest 'patches' accumulating carbon through time, assessing tree growth within the patch, or releasing carbon through gap opening [Bugmann, 2001]. Up to several dozens of different Plant Functional Types (PFTs) are generally defined and models can sometimes be fully spatially explicit **Cite Pacala et al. 1996**. Recently, the forest growth simulator TROLL [Chave, 1999], an individual-based and spatially explicit forest model, was developped to introduce recent advances in plant physiological community. TROLL model relates physiological processes to species-specific functional traits [Maréchaux and Chave]. Consequently, TROLL model allow to simulate fully a neotropical forest biodiversity to study biodiversity-ecosystem functionning link response to logging disturbance.

Major question greater diversity (taxonomic and functional) brought a better resilience to disturbance ?

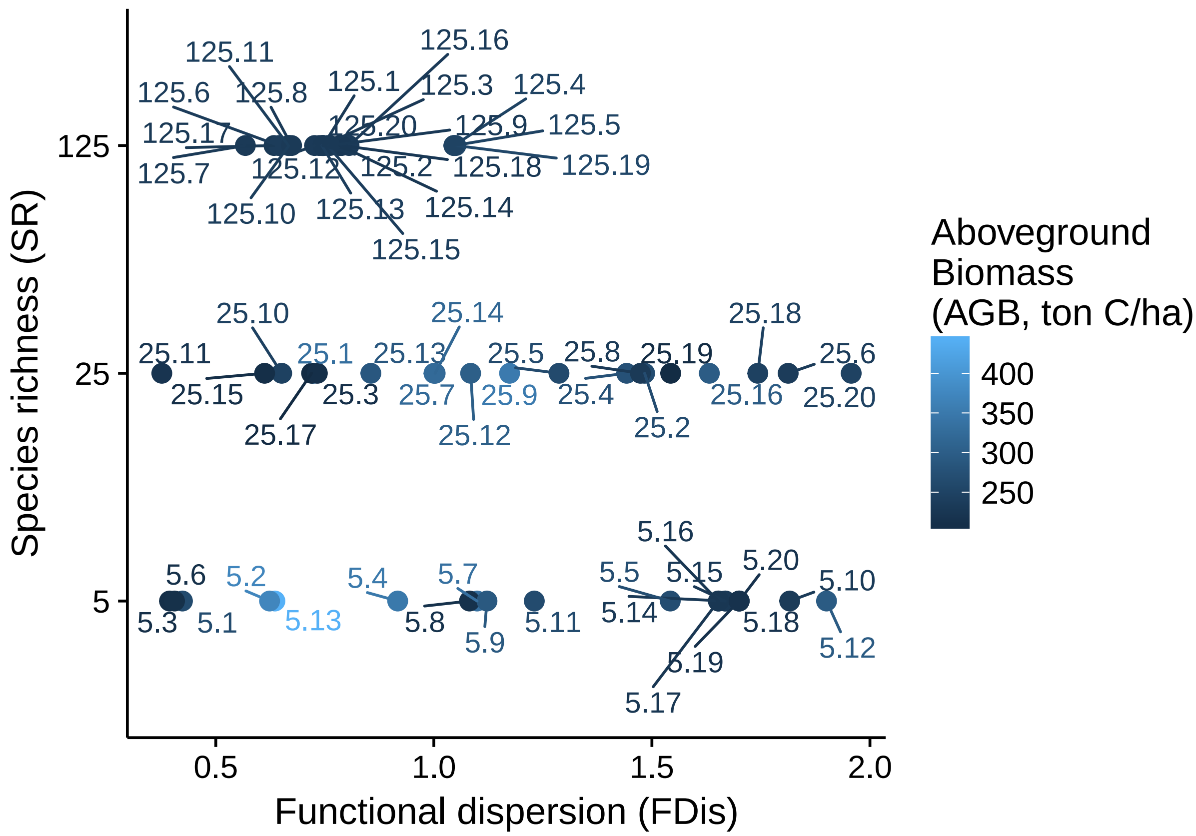

Figure 1: Experimental design before disturbance. Communities are implemented along a gradient of species richness (SR) and functional dispersion (FDis) resulting in a broad range of aboveground biomass (AGB). FDis was caluclated based on 4 functional traits (leaf mass per area, wood specific gravity, maximum diameter, maximum height).

1 Model description

1.1 Overview

1.2 Abiotic environment

1.3 Photosynthesis

1.4 Autotrpohic respiration

1.5 Carbon uptake

1.6 Tree growth

1.7 Seed dispersion, production and recruitment

1.8 Mortality

2 Sensitivity analysis

2.1 Functional traits

2.2 Seed rain

3 Disturbance

3.1 Model description

3.2 Design of experiment

3.3 Outputs anlaysis ?

3.3.1 Resistance and resilience metrics

3.3.2 Biodiversity partitioning

4 Selective logging

4.1 Model description

4.1.1 Designation

4.1.2 Selection

4.1.3 Rotten trees

4.1.4 Felling

4.1.5 Tracks

4.1.6 Gap damages

4.2 Design of experiment

Harald Bugmann. A review of forest gap models. *Climatic Change*, 51(3-4):259–305, 2001. ISSN 01650009. doi: 10.1023/A:1012525626267.

Geovana Carreño-Rocabado, Marielos Peña-Claros, Frans Bongers, Alfredo Alarcón, Juan Carlos Licona, and Lourens Poorter. Effects of disturbance intensity on species and functional diversity in a tropical forest. *Journal of Ecology*, 100(6):1453–1463, 2012. ISSN 00220477. doi: 10.1111/j.1365-2745.2012.02015.x.

Jérôme Chave. Study of structural, successional and spatial patterns in tropical rain forests using TROLL, a spatially explicit forest model. *Ecological Modelling*, 124(2-3):233–254, 1999. ISSN 03043800. doi: 10.1016/S0304-3800(99)00171-4.

Joseph H Connell. Diversity in tropical rain forests and coral reefs. *Science*, 199(4335):1302–1310, 1978. URL http://www.colby.edu/reload/biology/BI358j/Readings/Diversityinrainforestsandcoralreefs.pdf.

Angela Luciana de Avila, Ademir Roberto Ruschel, João Olegário Pereira de Carvalho, Lucas Mazzei, José Natalino Macedo Silva, José do Carmo Lopes, Maristela Machado Araujo, Carsten F. Dormann, and Jürgen Bauhus. Medium-term dynamics of tree species composition in response to silvicultural intervention intensities in a tropical rain forest. *Biological Conservation*, 191:577–586, 2015. ISSN 00063207. doi: 10.1016/j.biocon.2015.08.004. URL http://dx.doi.org/10.1016/j.biocon.2015.08.004.

Luke Gibson, Tien Ming Lee, Lian Pin Koh, Barry W. Brook, Toby A. Gardner, Jos Barlow, Carlos A. Peres, Corey J. A. Bradshaw, William F. Laurance, Thomas E. Lovejoy, and Navjot S. Sodhi. Corrigendum: Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature*, 505(7485):710–710, 2013. ISSN 0028-0836. doi: 10.1038/nature12933. URL http://www.nature.com/doifinder/10.1038/nature12933.

Bruno Herault, Julia Ouallet, Lilian Blanc, Fabien Wagner, and Christopher Baraloto. Growth responses of neotropical trees to logging gaps. *Journal of Applied Ecology*, 47(4):821–831, 2010. ISSN 00218901. doi: 10.1111/j.1365-2664.2010.01826.x.

Andreas Huth, Martin Drechsler, and Peter Köhler. Multicriteria evaluation of simulated logging scenarios in a tropical rain forest. *Journal of Environmental Management*, 71(4):321–333, 2004. ISSN 03014797. doi: 10.1016/j.jenvman.2004.03.008. URL http://www.sciencedirect.com/science/article/pii/S0301479704000568.

Peter K hler and Andreas Huth. Simulating growth dynamics in a South-East Asian rainforest threatened by recruitment shortage and tree harvesting. *Climatic Change*, 67(1):95–117, nov 2004. ISSN 0165-0009. doi: 10.1007/s10584-004-0713-9. URL http://link.springer.com/10.1007/s10584-004-0713-9.

Simon L. Lewis, Malhi Yadvinder, and Phillips Oliver L. Fingerprinting the impacts of global change on tropical forests. *Philosophical Transactions: Biological Sciences*, 359(1443):437–462, 2004. ISSN 0962-8436. doi: 10.1098/rstb.2003.1432. URL http://rstb.royalsocietypublishing.org/content/359/1443/437.shorthttp://www.jstor.org/stable/4142193.

M Loreau. Biodiversity and ecosystem functioning: recent theoretical advances. *Oikos*, 91(May):3–17, 2000. ISSN 1600-0706. doi: doi:10.1034/j.1600-0706.2000.910101.x. URL http://onlinelibrary.wiley.com/doi/10.1034/j.1600-0706.2000.910101.x/full.

Michel Loreau. Linking biodiversity and ecosystems: towards a unifying ecological theory. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 365(1537):49–60, 2010. ISSN 1471-2970. doi: 10.1098/rstb.2009.0155. URL http://apps.webofknowledge.com/full{_}record.do?product=WOS{&}search{_}mode=CitingArticles{&}qid=7{&}SID=V1TwrrLNJKUhYkGvYOi{&}page=10{&}doc=91{&}cacheurlFromRightClick=no.

Isabelle Maréchaux and Jérôme Chave. Joint simulation of carbon and tree diversity in an Amazonian forest with an individual-based forest model. *Inprep*, pages 1–13.

Philip A. Martin, Adrian C. Newton, Marion Pfeifer, Min Sheng Khoo, and James M. Bullock. Impacts of tropical selective logging on carbon storage and tree species richness: A meta-analysis. *Forest Ecology and Management*, 356:224–233, 2015. ISSN 03781127. doi: 10.1016/j.foreco.2015.07.010. URL http://dx.doi.org/10.1016/j.foreco.2015.07.010.

Oyomoare L. Osazuwa-Peters, Iván Jiménez, Brad Oberle, Colin A. Chapman, and Amy E. Zanne. Selective logging: Do rates of forest turnover in stems, species composition and functional traits decrease with time since disturbance? - A 45 year perspective. *Forest Ecology and Management*, 357:10–21, 2015. ISSN 03781127. doi: 10.1016/j.foreco.2015.08.002. URL http://dx.doi.org/10.1016/j.foreco.2015.08.002.

Nadja Rüger, Guadalupe Williams-Linera, W. Daniel Kissling, and Andreas Huth. Long-Term Impacts of Fuelwood Extraction on a Tropical Montane Cloud Forest. *Ecosystems*, 11(6):868–881, sep 2008. ISSN 1432-9840. doi: 10.1007/s10021-008-9166-8. URL http://link.springer.com/10.1007/s10021-008-9166-8.

Brett R. Scheffers, Lucas N. Joppa, Stuart L. Pimm, and William F. Laurance. What we know and don't know about Earth's missing biodiversity, 2012. ISSN 01695347. URL http://www.sciencedirect.com/science/article/pii/S0169534712001231.

Britta Tietjen and Andreas Huth. Modelling dynamics of managed tropical rainforests—An aggregated approach. *Ecological Modelling*, 199(4):421–432, 2006. ISSN 03043800. doi: 10.1016/j.ecolmodel.2005.11.045. URL http://www.sciencedirect.com/science/article/pii/S0304380006002869.

Barbara L Zimmerman and Cyril F Kormos. Prospects for Sustainable Logging in Tropical Forests. *BioScience*, 62(5):479–487, 2012. ISSN 00063568. doi: 10.1525/bio.2012.62.5.9.