The role of large trees in the biomass production of heterogeneous forest

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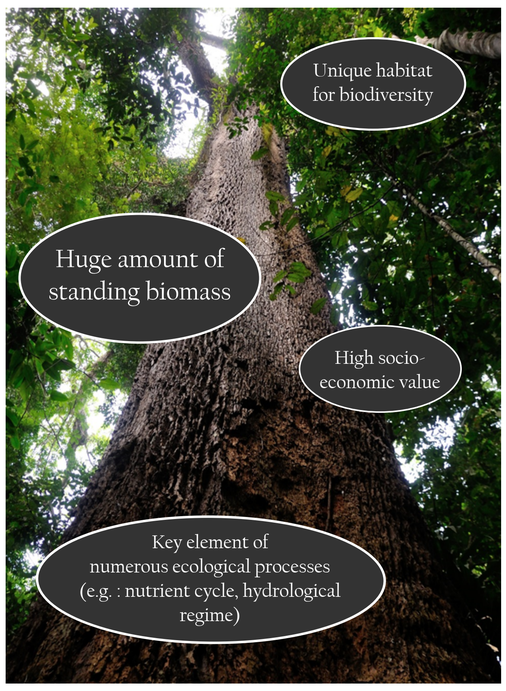
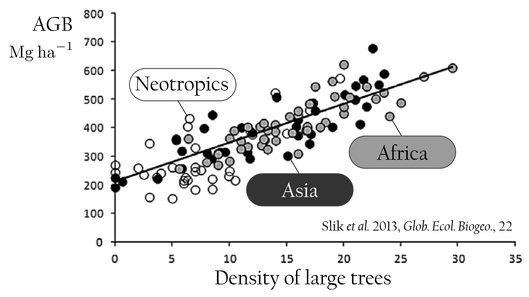


At the stand level

The more the large trees, the greater the above-ground biomass (AGB) accross tropical forests



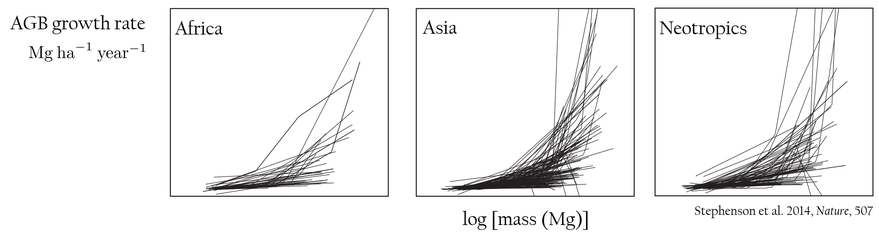
Tree mortality can be the driving process of biomass dynamics, and particularly the **mortality of large trees**

Rutishauser *et al.* 2014, *J. Veg. Sci*, 21

In natural tropical forests, **large trees are rare and particular**, e.g. in terms of species (pioneer species) and life history

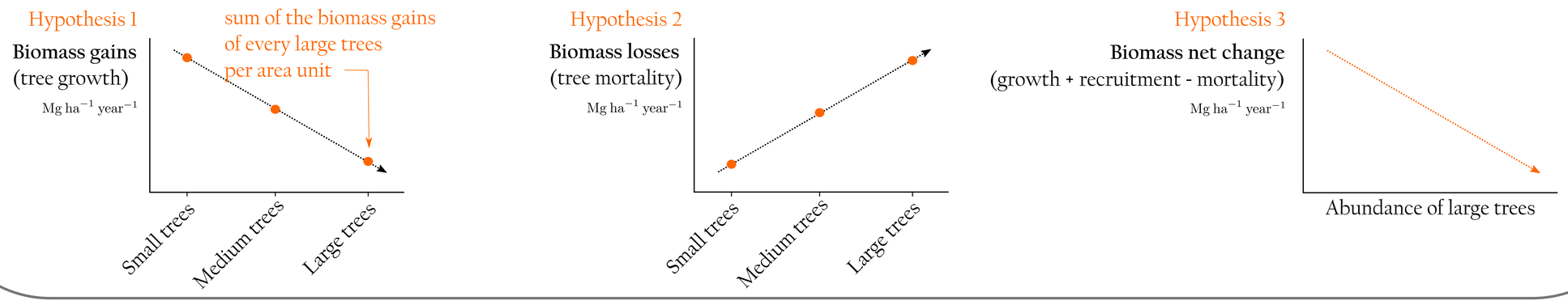
At the tree level

But, the bigger the tree the higher its above-ground biomass (AGB) growth rate

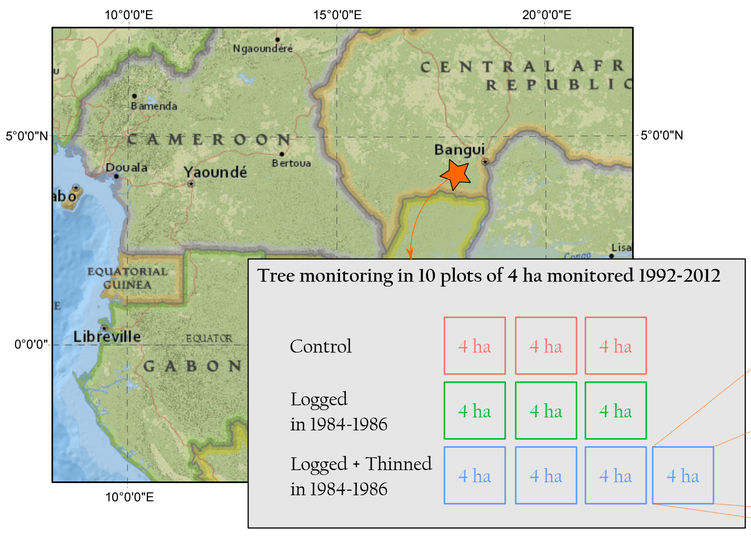


Under the assumption of steady state, the metabolic theory of ecology predicts that tree growth increases with size whereas mortality rate decreases with tree size

While the role of large trees to the stock of biomass is clear, their contribution to the annual production of biomass per area unit (at the stand level) is unclear. We aim at disentangling the contribution of large trees to stand-level biomass production



Experimental forest of M'Baiki



Computation and statistics

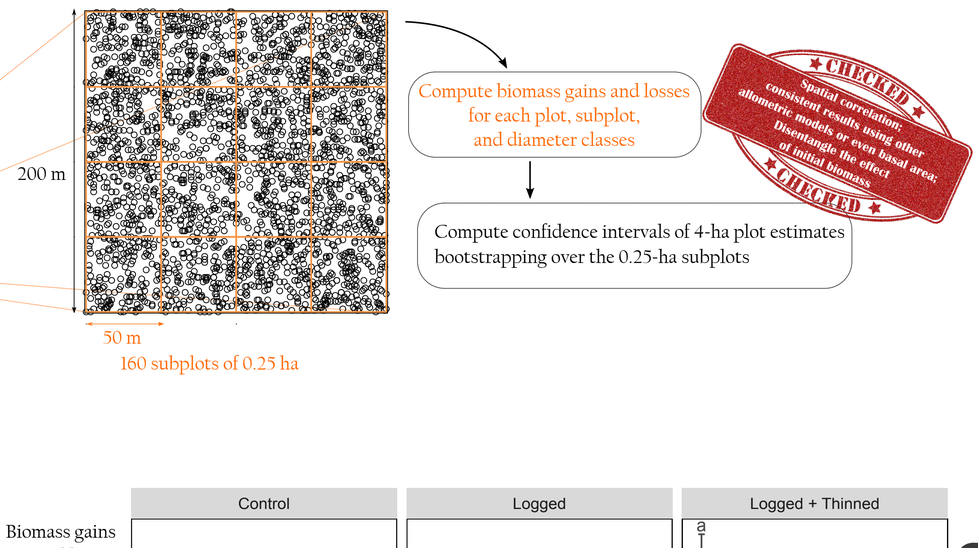
Estimation of tree AGB with allometric equations

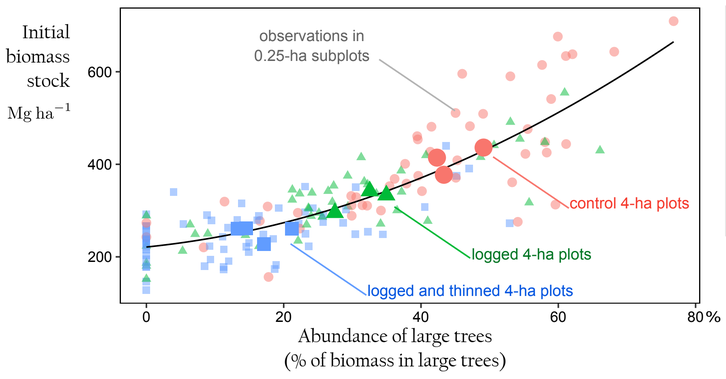
tree agb = f(tree diameter, wood density)

Chave *et al.* 2009, Zanne *et al.* 2009

Biomass gains = sum of the biomass growth of all surviving and recruited trees during the census interval (1992-2012)
Biomass losses = sum of the biomass of all trees that died during the census interval
Biomass net change = the difference between stand biomass in 1992 and 2012

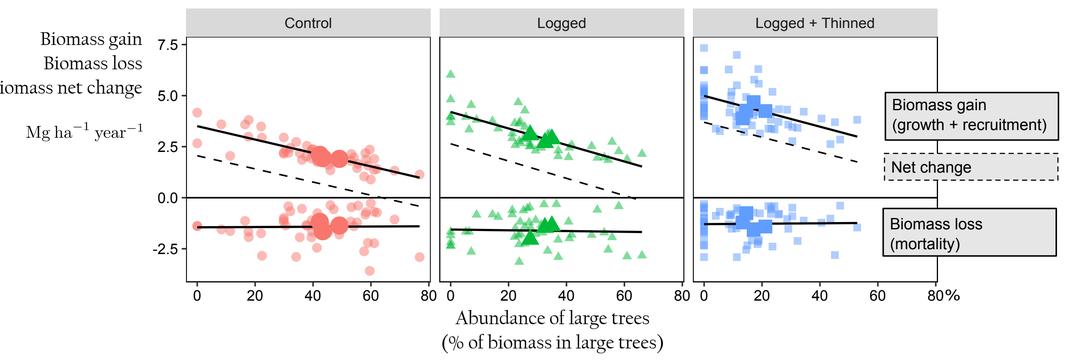
Spatial bootstrap

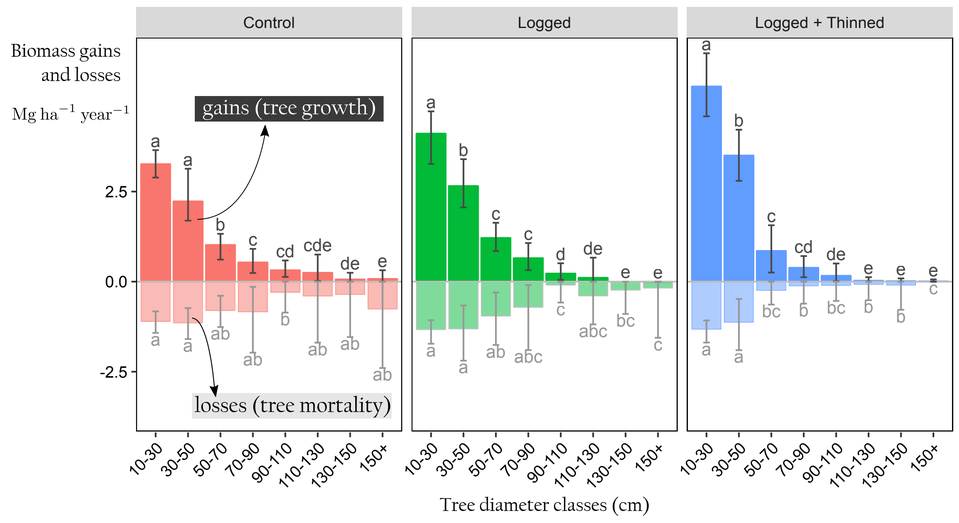




Total biomass varied significantly among plots and, as expected, we found that biomass stock increased with the abundance of large trees (r=0.816).

But biomass production decreased with the abundance of large trees mainly because of a reduction in biomass gains with the abundance of large trees rather than variation of biomass losses.
Accept hypothesis 3.





Accross all treatments, there was a significant decrease in contribution to stand-level biomass gains with tree size
Accept hypothesis 1.

Contribution to stand-level biomass losses depended more on treatment and initial biomass stock than tree size. Contribution to biomass losses did not increased with tree size.
Reject hypothesis 2.

Conclusion

Despite large trees have high individual growth rate and stock substantial amount of biomass, we showed that stand-level biomass production likely decreases with the abundance of large trees in unlogged and logged natural forests. The contribution of large trees to annual stand-level biomass production at the stand level appears limited in comparison to that of the small trees. This pattern does not only originate from differences in abundance of small versus large trees or differences in initial biomass stocks among tree size classes but also from a low efficiency of large trees to produce biomass and a relatively constant mortality rate among tree size classes.

TAKE HOME MESSAGE

Large trees play numerous key ecological roles, but they likely play a minor role for the annual biomass production or carbon capture.
Preserving large trees might be a poor strategy to maximize biomass production or carbon capture.

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