key drivers of post-disturbance forest recovery

lessons from the Paracou experiment

bruno HERAULT camille PIPONIOT

Centre International de Recherche en Agronomie pour le Développement

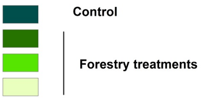
Centre National de la Recherche Scientifique

Institut National Polytechnique Félix Houphouët-Boigny

tropical forestry in the eighties

- lack of long-term experiments
- no or a few logging rules
- no or a few management plans
- just harvesting trees or being more interventionist ?
- rotation time ?

based on the example of M'Baïki (RCA) Cirad decided to invest in Paracou



Forestry treatments

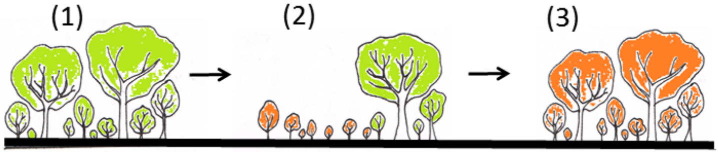
	Treatment 1	Treatment 2	Treatment 3
Logging for timber	Nb trees / ha : 10 Basal area (m^2/ha): 3,3	11 trees 3.8	10 trees 3.3
Thinning		21 trees 5.2	11 trees 3.6
Logging for fuel wood			19 trees 3
Total	10 trees 3.3	32 trees 9	40 trees 9. 9
Damage	78 trees 2.3	85 trees 8.2	148 trees 4.2

What is the relative importance of

- endogeneous (forest structure and composition)
- exogeneous (local environment and climate stress)

drivers on the rates at which post-disturbance ACS changes converge to a theoretical steady state ?

Survivors and *Newcomers*



partitioning their contributions to post-disturbance

- ACS gain (from growth and recruitment)
- ACS loss (from mortality)

Newcomers

$$cNr \sim \mathcal{N}\left(\alpha^{Nr} \times (t - \frac{1 - exp(-\beta^{Nr} \times t)}{\beta^{Nr}}), (\sigma^{Nr})^2\right) \quad (1)$$

$$cNg \sim \mathcal{N}\left(\alpha^{Ng} \times (t + \frac{1 - exp(-\beta^{Ng} \times t)}{\beta^{Ng}}), (\sigma^{Ng})^2\right) \quad (2)$$

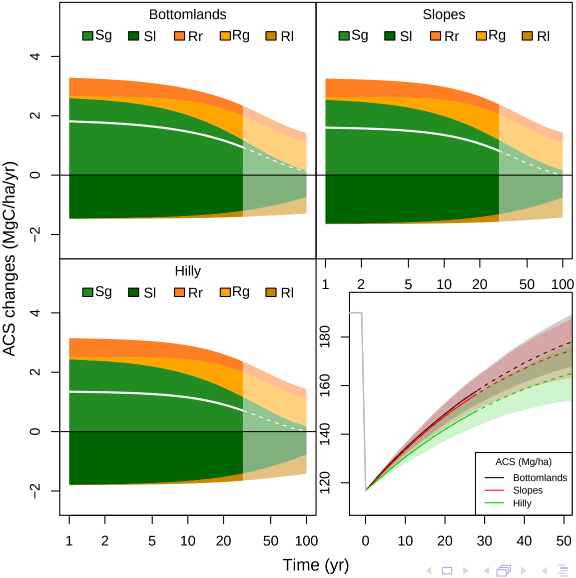
$$cNr \sim \mathcal{N}\left(\alpha^{Nl} \times (t + \frac{1 - exp(-\beta^{Nl} \times t)}{\beta^{Nl}}), (\sigma^{Nl})^2\right) \quad (3)$$

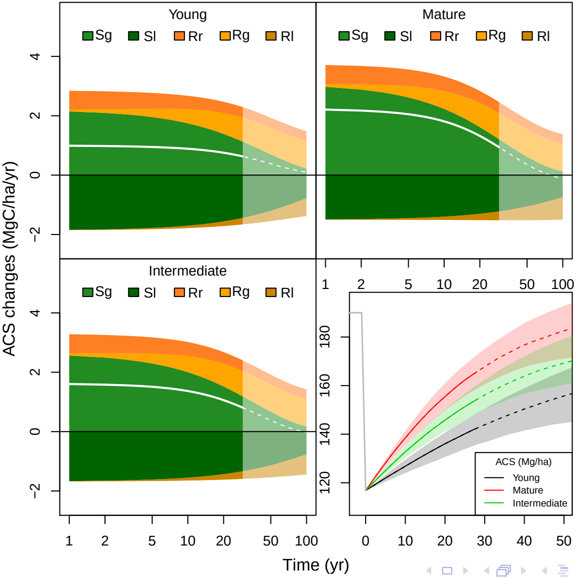
Survivors

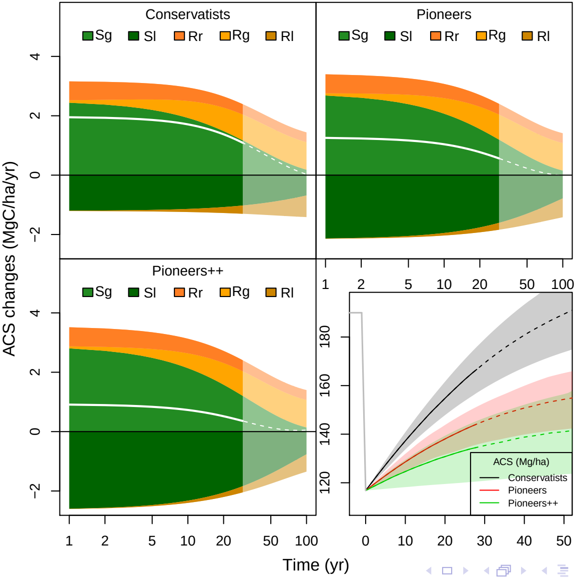
$$cSg \sim \mathcal{N}\left(\alpha^{Sg} \times \left(1 - exp(-\beta^{Sg} \times t)\right), (\sigma^{Sg})^2\right) \quad (4)$$

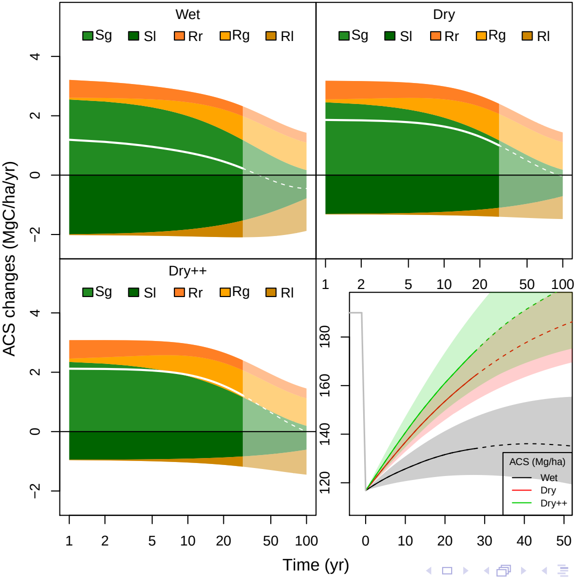
$$cSl \sim \mathcal{N}\left(\alpha^{Sl} \times \left(1 - exp(-\beta^{Sl} \times t)\right), (\sigma^{Sl})^2\right) \quad (5)$$

- drivers tested on βs
- inferred in a bayesian framework under STAN language

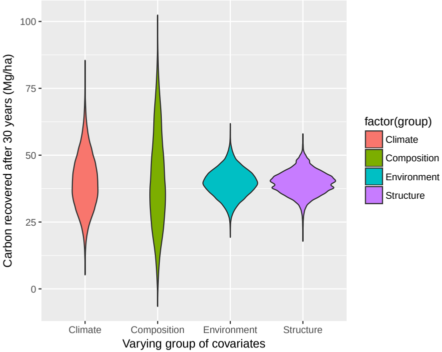

Bottomlands
Slopes
Hilly
Sg
Sl
Rr
Rg
Rl
ACS changes (MgC/ha/yr)
Time (yr)
ACS (Mg/ha)
Bottomlands
Slopes
Hilly


Young
Sg Sl Rr Rg Rl
Mature
Sg Sl Rr Rg Rl
Intermediate
Sg Sl Rr Rg Rl
ACS changes (MgC/ha/yr)
Time (yr)
ACS (Mg/ha)
Young
Mature
Intermediate


Conservatists
Pioneers
Pioneers++
Sg
Sl
Rr
Rg
Rl
ACS changes (MgC/ha/yr)
Time (yr)
ACS (Mg/ha)
Conservatists
Pioneers
Pioneers++


Wet
Sg Sl Rr Rg Rl
Dry
Sg Sl Rr Rg Rl
Dry++
Sg Sl Rr Rg Rl
ACS changes (MgC/ha/yr)
Time (yr)
1 2 5 10 20 50 100
4 2 0 −2
120 140 160 180
0 10 20 30 40 50
ACS (Mg/ha)
Wet
Dry
Dry++

sensitivity analysis



- forest composition and climate are the key drivers
- effects of climate on already-disturbed systems ?

- focus on other ecosystem services
  - diversity : neutral, functional, phylogenetic
  - timber volumes
- apply the framework on a larger scale : TmFO network
- test different GIEC climate scenarios