Modeling the dynamics of microhabitats

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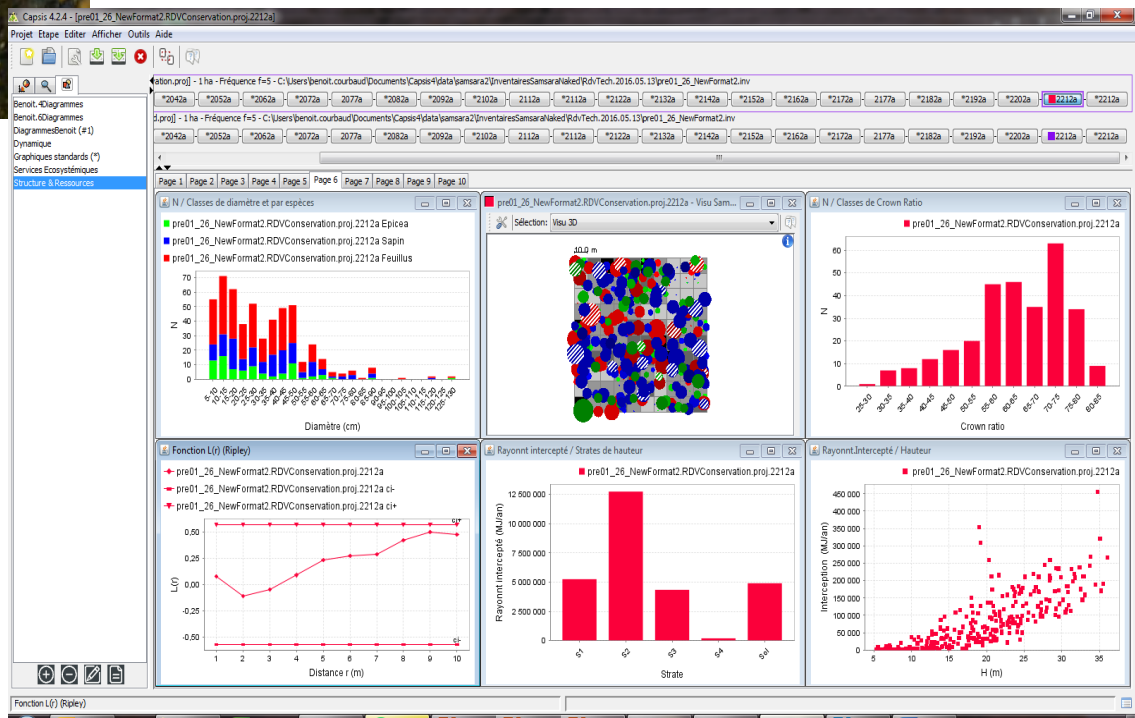
irstea

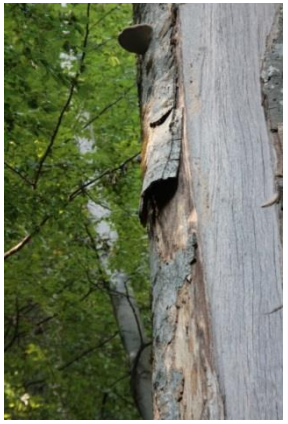
CNPF CENTRE RÉGIONAL MIDI PYRÉNÉES

INRA SCIENCE & IMPACT



Questions

Sustainable forest biodiversity conservation requires
the maintenance of a permanent flux of TreMs
-> We need a balance
between TreM formation and TreM disappearance rates



Available TreM data today are cross sectional :

Observations of TreMs on different trees at a single time
The rate of TreM formation is not measured directly

Can we estimate the probability of TreM formation on a tree ?

Can we integrate a TreM submodel
in a forest dynamics simulator ?

TreM data

Indirect estimation methods are required:

We hypothesize a model for the probability of TreM formation

We calculate the probability of observing the data given the process model and estimate the parameters of the model

A harmonized data base of expert data in Europe:

~ 30 000 trees / 12 tree species / 106 sites / 8 types of TreMs

Presence/Absence of TreMs on trees

covariables: tree DBH / tree species / site

Estimating the probability of TreM formation on a tree

Survival analysis : indirect method to estimate the time of a discrete event

Transposition to our case:

D : random variable corresponding to the DBH at which the first TreM forms

F(d): Cumulated Distribution Function (CDF) of the random variable D.

Corresponds to the probability of presence of at least one TreM on a tree

$$F(d) = P(D \leq d)$$

h(d): Hazard rate function of the random variable D

Probability of formation of the first TreM on a tree that has no TreM yet

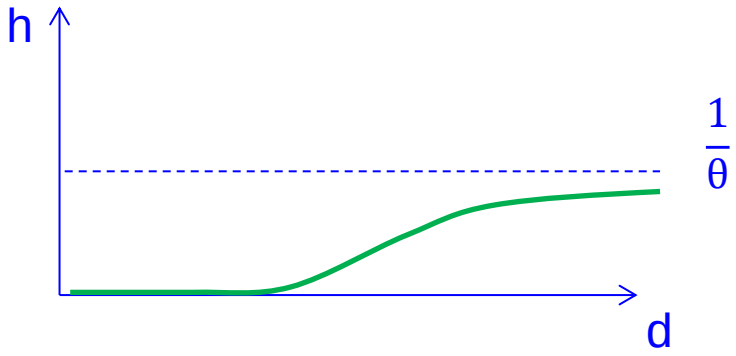
$$h(d)\partial d = P(D \in [d, d + \partial d[\mid D \geq d)$$

(Courbaud et al. Submitted)

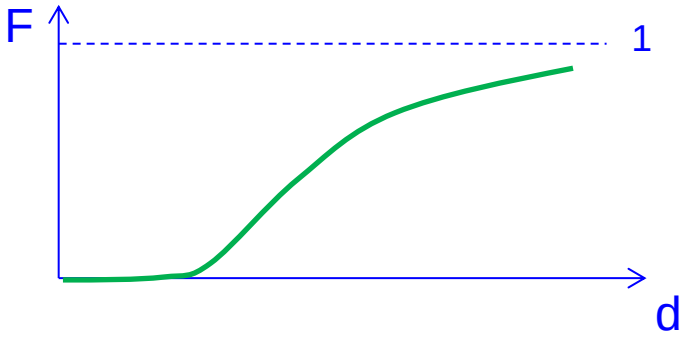
Estimating the probability of TreM formation on a tree

Gamma model : θ regulates the maximum hazard rate
k regulates how the hazard rate changes with DBH

the process
proba of TreM formation during a growth step



the result
proba of TreM presence today



$$\theta_{i,j,s} = e^{\alpha_j + \beta_s + \varepsilon_i}$$

α_j : effect of tree species j

β_s : effect of site s

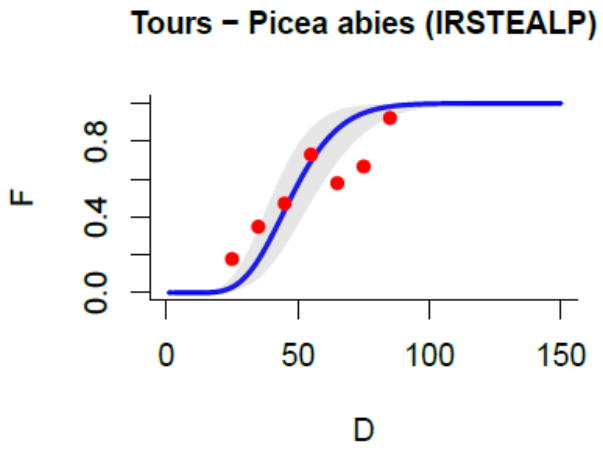
ε_i : random effect of tree i

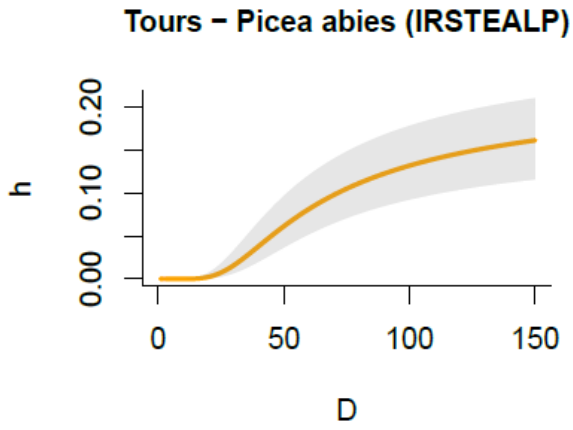
(Ph.D A.Letort in progress)

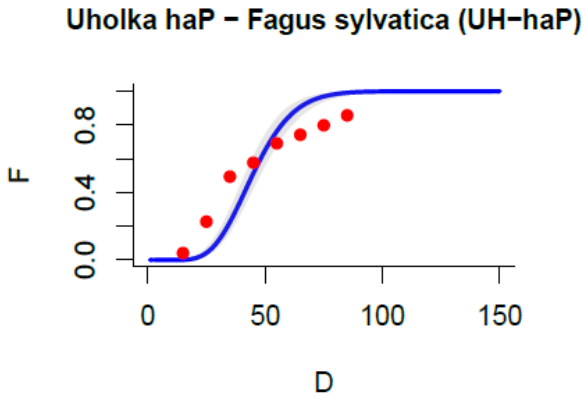
First results

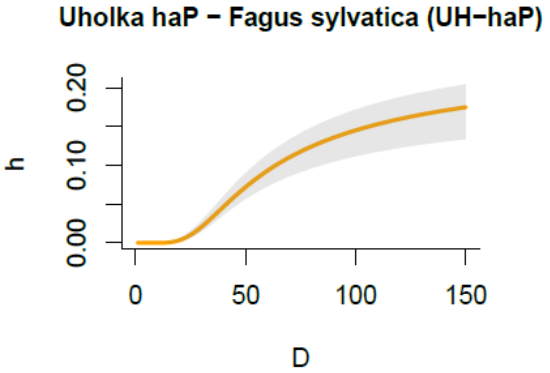
We calibrate
The function F
on presence data

We deduce
The function h
describing the process





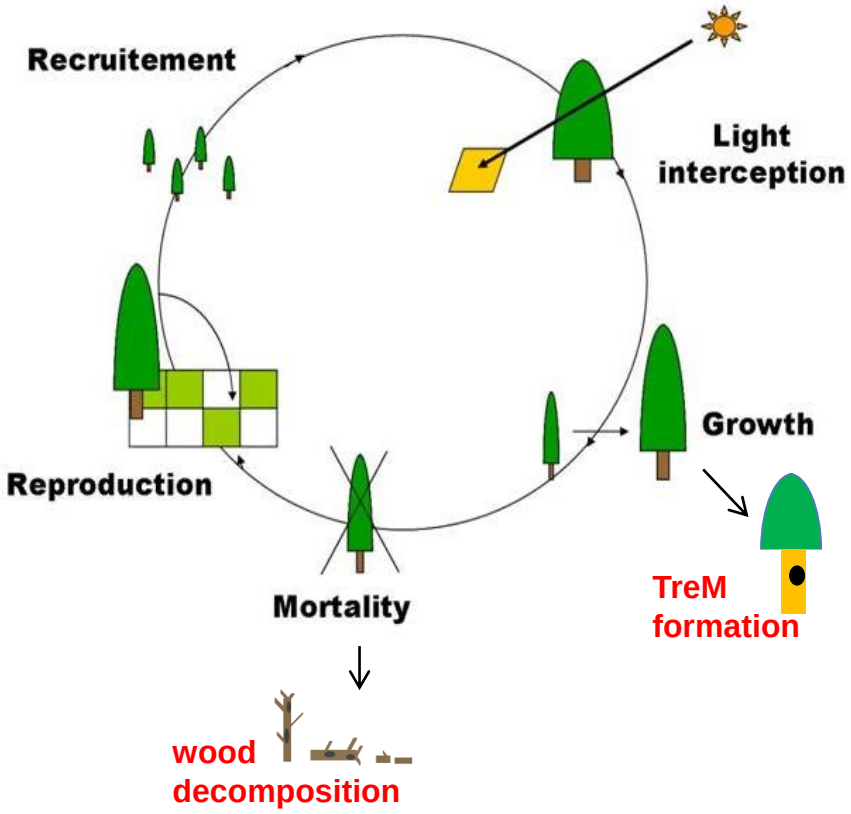




Integration in the simulator Samsara

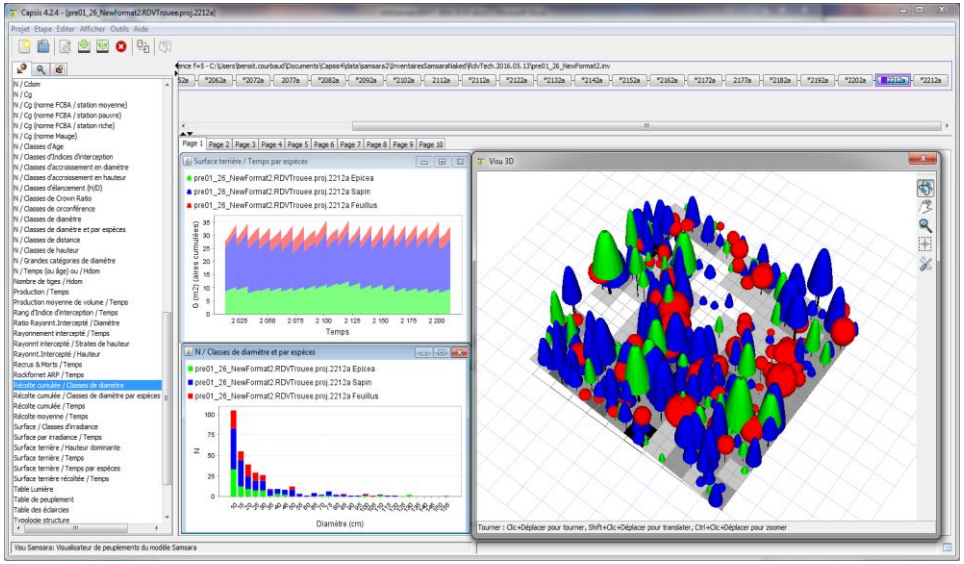
Samsara : an individual-based, spatially explicit simulation model

Courbaud et al., 2003
Courbaud et al. 2015

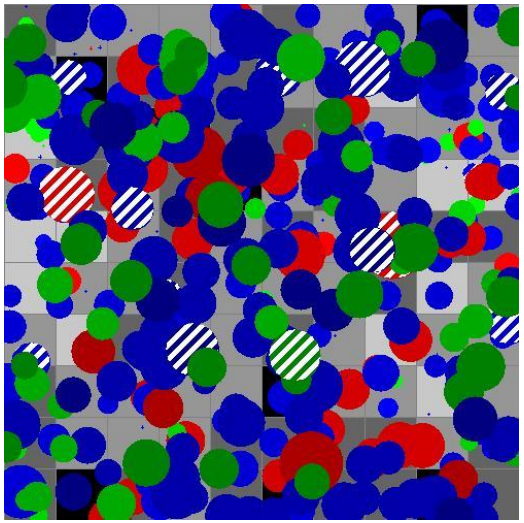


Coligny et al., 2003
Dufour-Kowalski et al. 2012

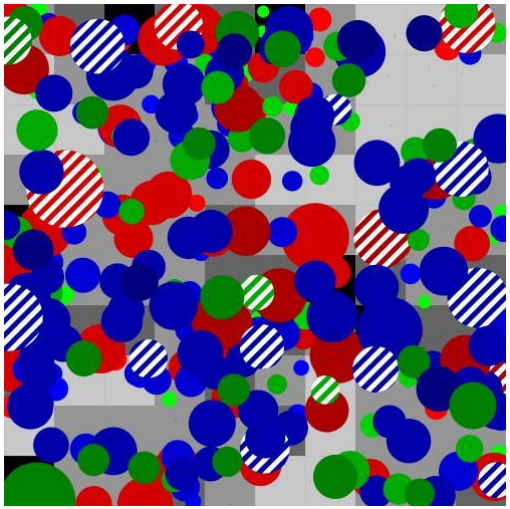
Development platfom Capsis



Long term projection with Samsara



200 years



Spruce

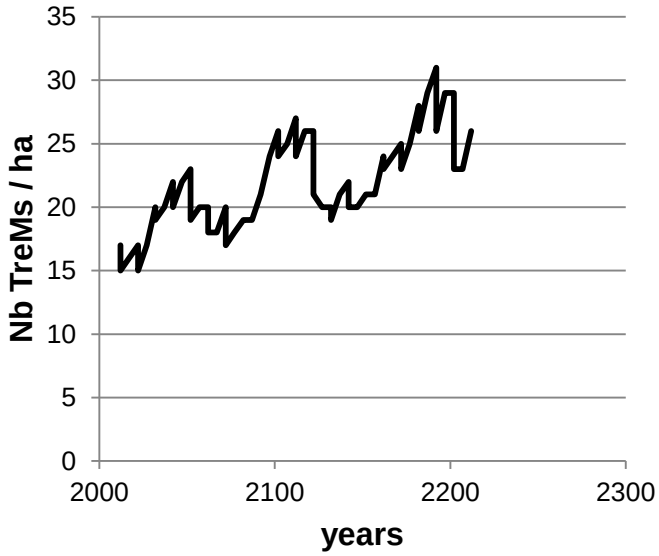
Fir

Beech

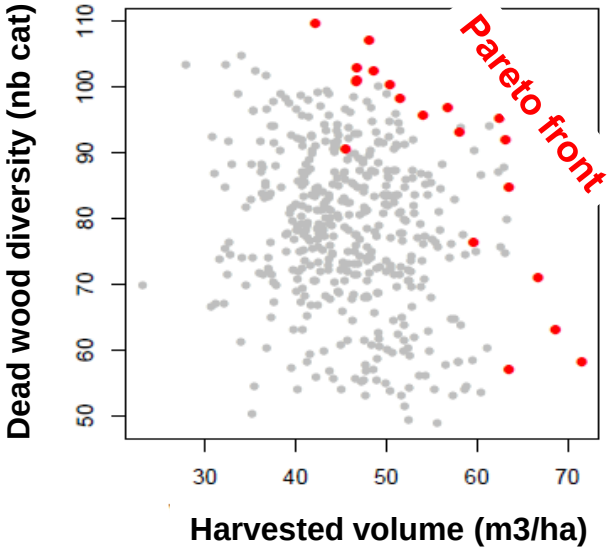
Habitat tree

Light level under canopy

Evolution of TreM density



Production-biodiversity trade-offs



Lafond et al., in press

Discussion

Collaborative approaches are key to

Powerfull data sets

Complex simulation tools

A range of relevant case studies and silviculture scenarios

Thank you for your attention

Collaborations:
Daniel Kraus, Thibault Lachat, Brigitte Commarmot, Yoan Paillet, Nicolas Debaive