Modeling the dynamics of microhabitats

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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?
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

\[ F(d) = P(D \leq d) \]

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

\[ h(d)\,\text{d}d = P(D \in [d, d + \text{d}d] \mid D \geq d) \]

(Courbaud et al. Submitted)
Estimating the probability of TreM formation on a tree

Gamma model: \( \theta \) regulates the maximum hazard rate
\( k \) regulates how the hazard rate changes with DBH

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

\( \alpha_j \): effect of tree species \( j \)
\( \beta_s \): effect of site \( s \)
\( \varepsilon_i \): 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

Tours – Picea abies (IRSTEALP)

Uholka haP – Fagus sylvatica (UH–haP)
Integration in the simulator Samsara

Samsara: an individual-based, spatially explicit simulation model

Recruitment → Light interception → Growth → Mortality → wood decomposition

Development platform Capsis

Courbaud et al., 2003
Courbaud et al., 2015

Coligny et al., 2003
Dufour-Kowalski et al., 2012
Long term projection with Samsara

Evolution of TreM density

Production-biodiversity trade-offs

Lafond et al., in press
Collaborative approaches are key to

Powerful data sets

Complex simulation tools

A range of relevant case studies and silviculture scenarios
Thank you for your attention

Collaborations:
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