

A decision support platform to connect chemical, supply chain & environmental objectives

The case of Silver Fir (*Abies alba*) in the Grand Est region

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The bioeconomy of extractives: Opportunities & Challenges

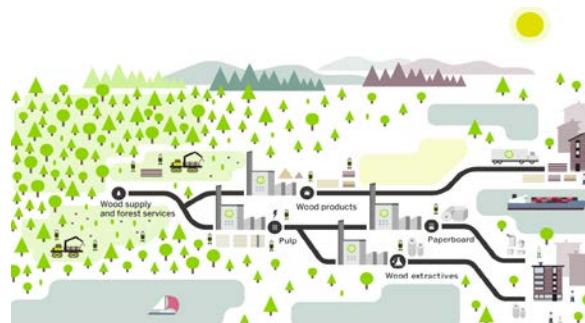
Consumers and chemical companies
want molecules with novel properties



- What molecules can be extracted?
- How much can we extract?
- Where can we get them cheaply?



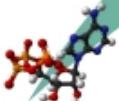
Great diversity of molecules in French forests





Scientific challenge

Infer knowledge at larger scales?



Molecule

Identification of extractives and concentrations in the different tree organs



Organs → Tree

Assessment of organ volumes & density → quantity of extractives in the trees



Resources (region)

Assessment of quantities of wood extractives at a regional scale (forest growth model)



Supply chain (region)

Assessment of quantities of wood extractives in co-products wood residuals along the supply chain (supply chain model)

Can we trust upscaled knowledge?



Methodological challenge

++ scales



Récoltes futures
→ quantité dans les récoltes futures

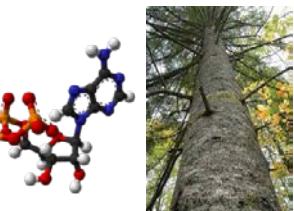
Conso. Industries
→ quantité dans les connexes

++ models

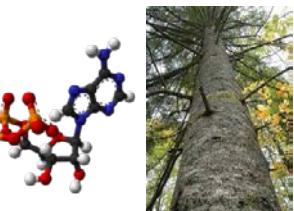
$$\text{Quant. d'extr./comp.} = f(D130, H)$$

$$\text{Dendrométrie (volumes, infadensité)} = f(D130, \text{position})$$

Ech. - récolte → quantité dans la récolte actuelle

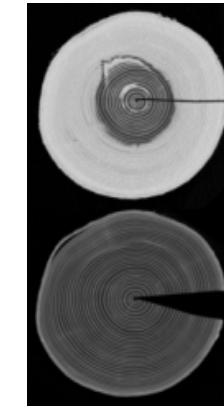
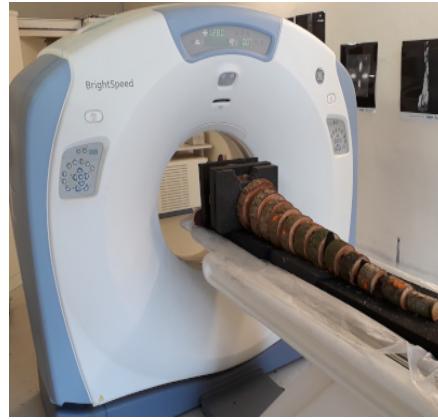


$$\text{Chimie Taux} = f(\text{compartiment, position})$$



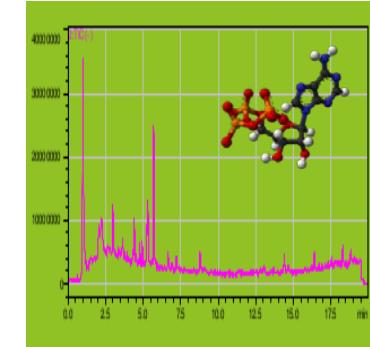
1 platform

Harvest, Sampling & Steaming



Infrastructure
scientifique
collective

Silva
TECH



lernab

Variables for various tree organs

For Silver Fir (*Abies alba*)

Parameter category	Average	Error margin, or min / max	n	Sources.
Extractive variables				
Bark Volume [kg/kg]	14.49%	$4.8 \times 10^{-4}\%$	12096	here
Bark Density [kg/m ³]	533.64	0.36	283	here
Bark extractive concentration [kg/kg]	21.28%	0.346%	257	here
Knotwood Volume [kg/kg]	??	1-3%	12096	here
Knotwood Density [kg/m ³]	751.48	0.19	283	here
Knotwood extractive concentration [kg/kg]	??	??	??	here

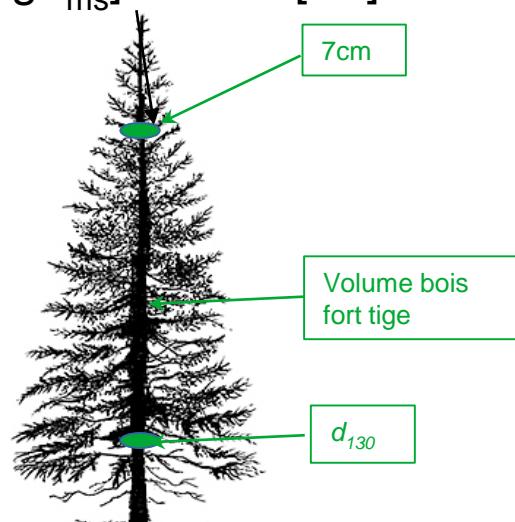


Tree scale

Sampled trees



$$\text{Quantité} = \frac{\text{Taux}}{[\text{kg}]} \times \frac{\text{Volume}}{[\text{m}^3]} \times \frac{\text{Infra-densité}}{[\text{kg}_{\text{ms}} \cdot \text{m}^{-3} \text{ mh}]}$$



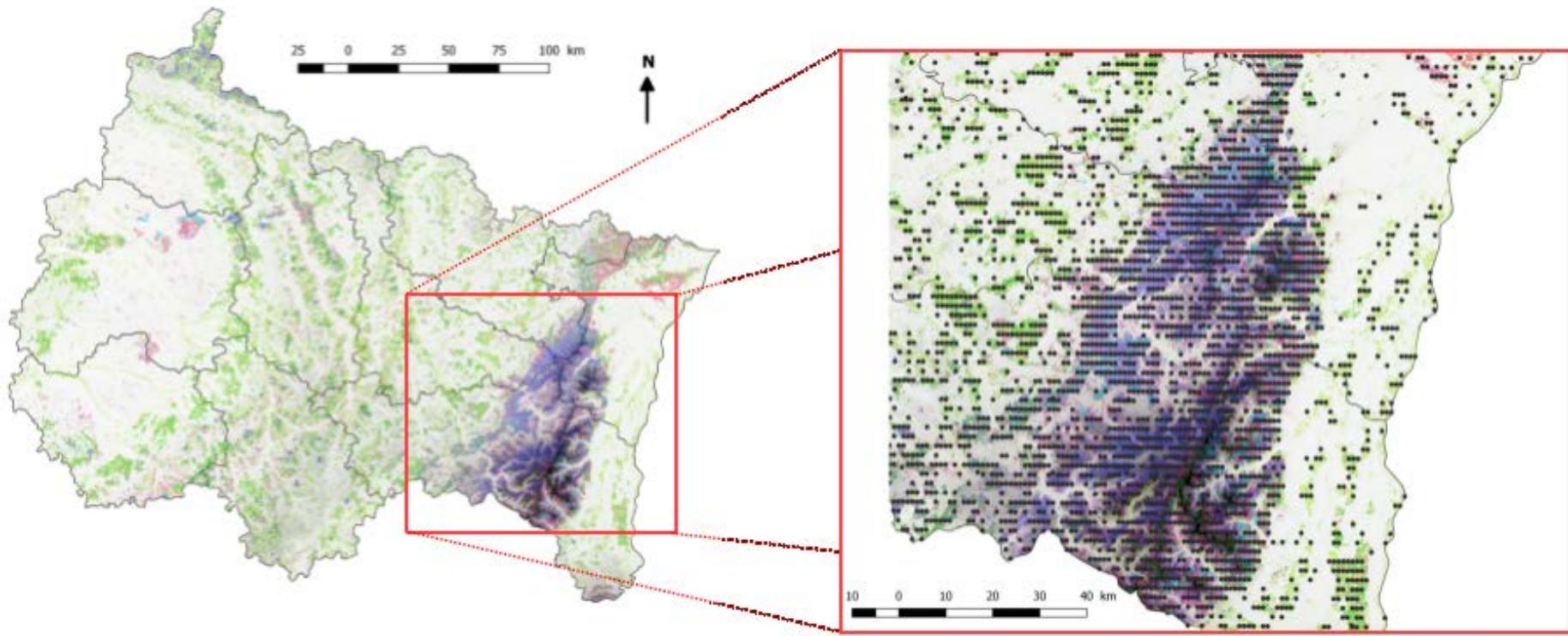
Extrapolation to other
trees (allometric model)

$$\text{Quantité} = f(d_{130}, h, \dots)$$

[kg]

Regional scale

Mobilisation des données spatialisées IGN du Grand Est

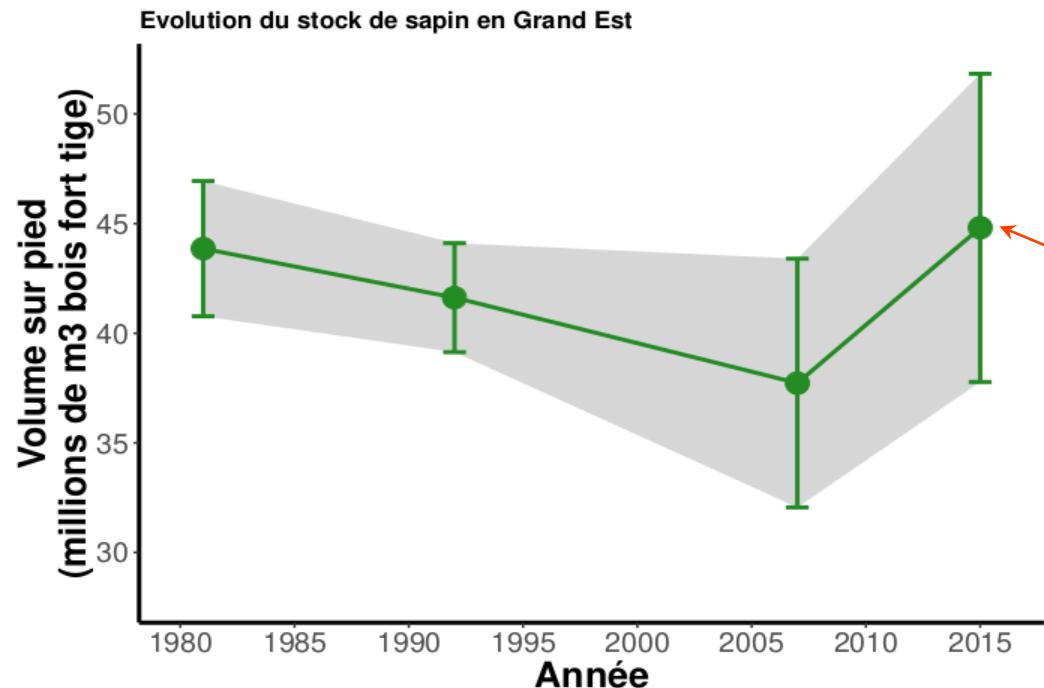


- ~ 10500 plots (inventory since 2005)
- 100 variables per plot
- detailed description (standing trees & harvest)

Points IFN for *Abies alba*

Ressource dynamics

Silver fir dynamics for the Grand Est region (by IGN)

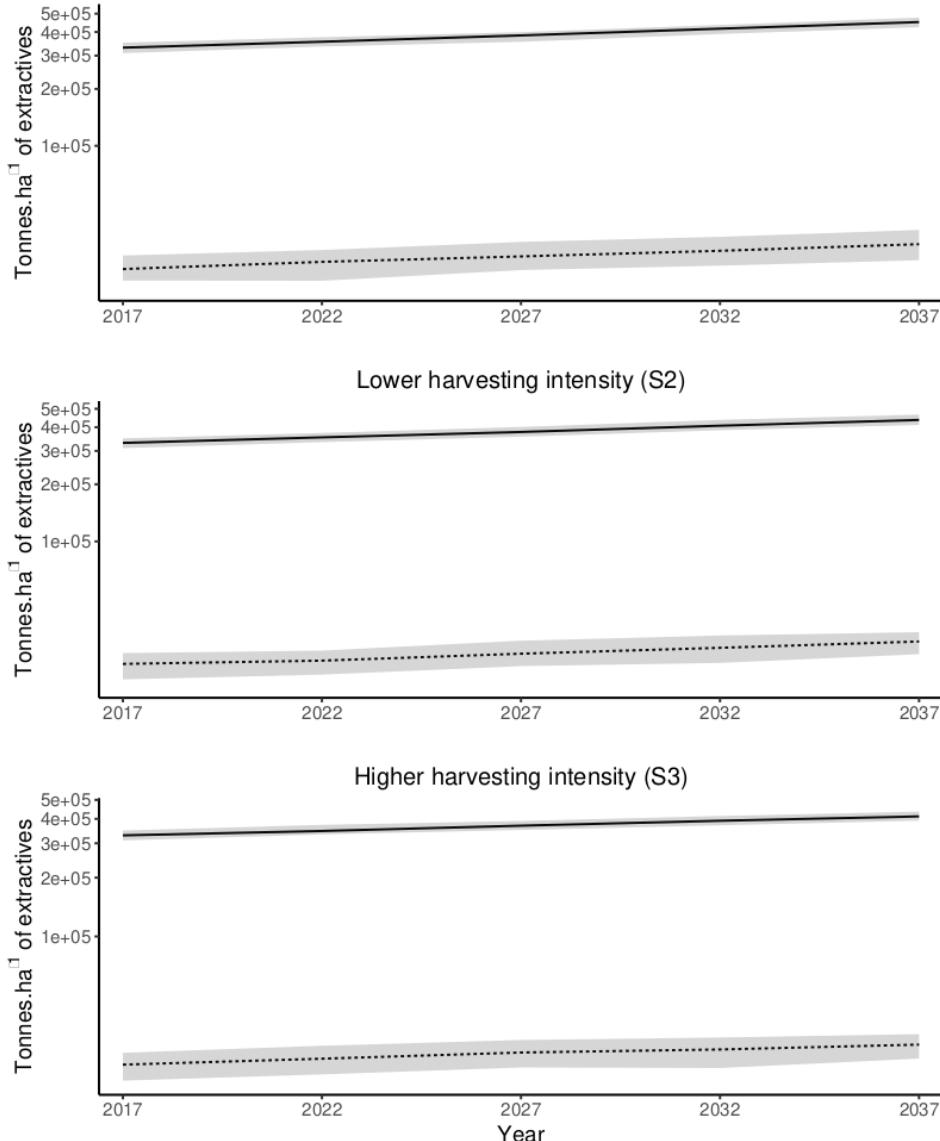
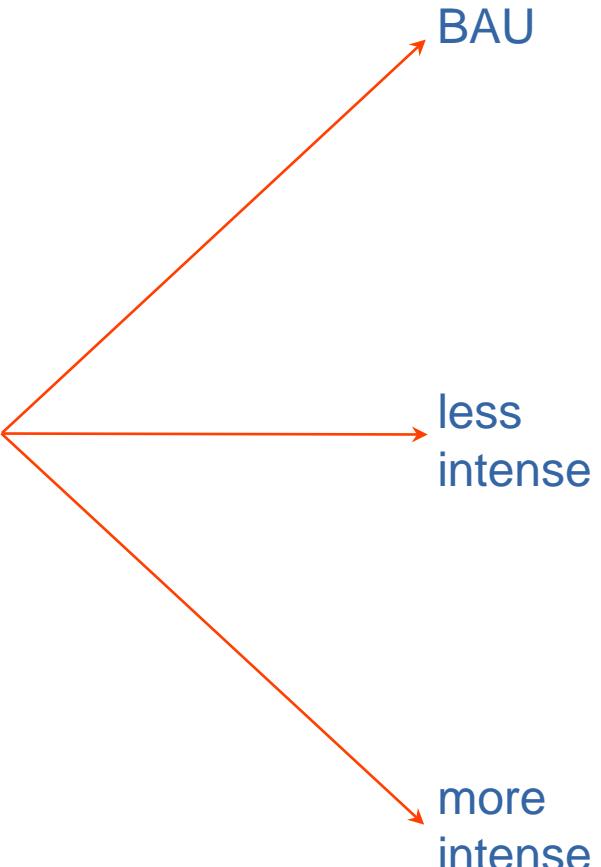


Exemple : estimation 2015 :

~ 62000t d'écorce (11.5% volume bft),
~ 12000 tonnes extractibles (taux ~20%)

Resource dynamics (future)

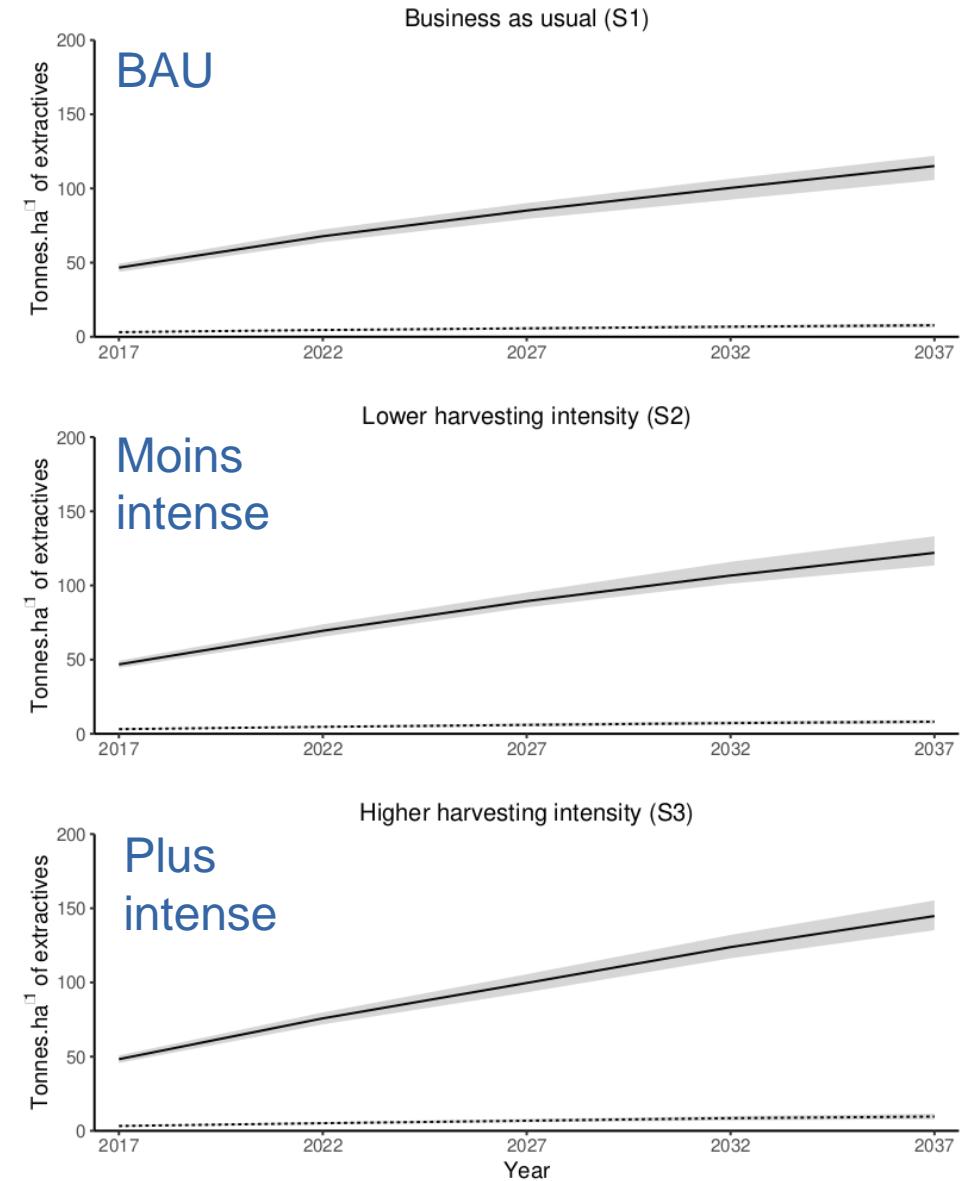
3 harvesting scenarios



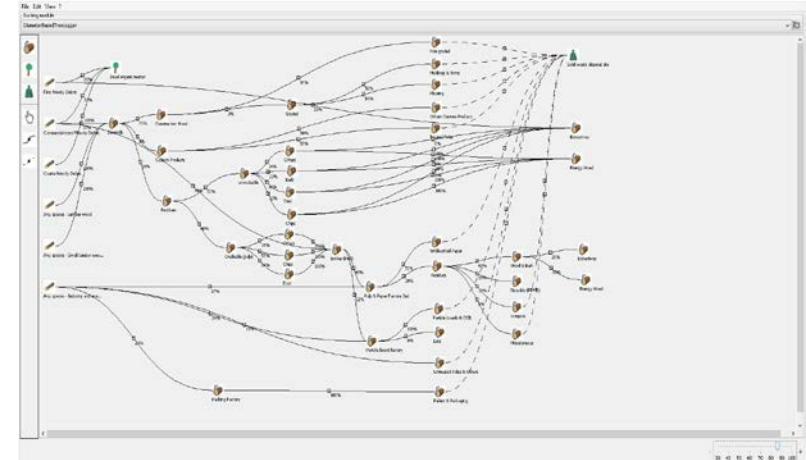
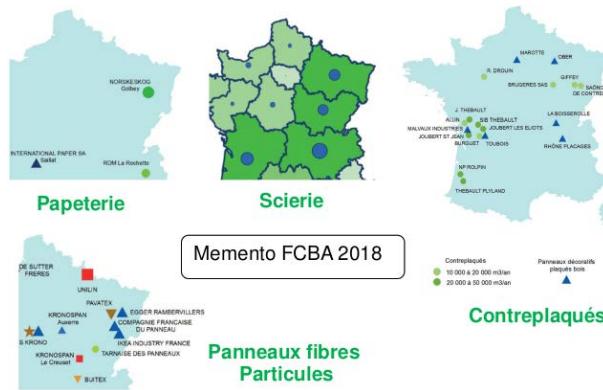
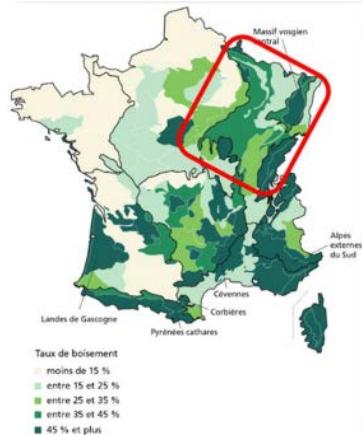
Fichier Edition Affichage ?
Modèle de billonnage
DiamètreBasedTreeLogger

The screenshot shows a software interface for managing wood fluxes. On the left, there's a vertical toolbar with icons for different types of wood debris: Petit débris ligneux, Débris ligneux commerciaux, Gros débris ligneux, Toute espèce - Lumber wood, Toute espèce - Small lumber wo..., and Toute espèce - Industry and en... Below this is a main window titled "Module de billonnage basé sur le diamètre è 1,3 m". It contains tabs for "Fichier", "Edition", "Espèces", "Catégories de billon", and "Outils ?". Under "Catégories de billon", "Lumber wood" is selected. A dropdown menu shows "ANY" and "Lumber wood" as options. Other categories listed are "Small lumber wood" and "Industry and energy wood". There's also a "DHP minimum (cm)" field set to 37.5. At the bottom are "Ok" and "Annuler" buttons.

Pichancourt, J. B., Manso, R., Ningre, F., & Fortin, M. (2018). CAT - a Carbon Accounting Tool for complex and uncertain greenhouse gas emission life cycles. Environmental Modelling & Software, 107, 158-174.



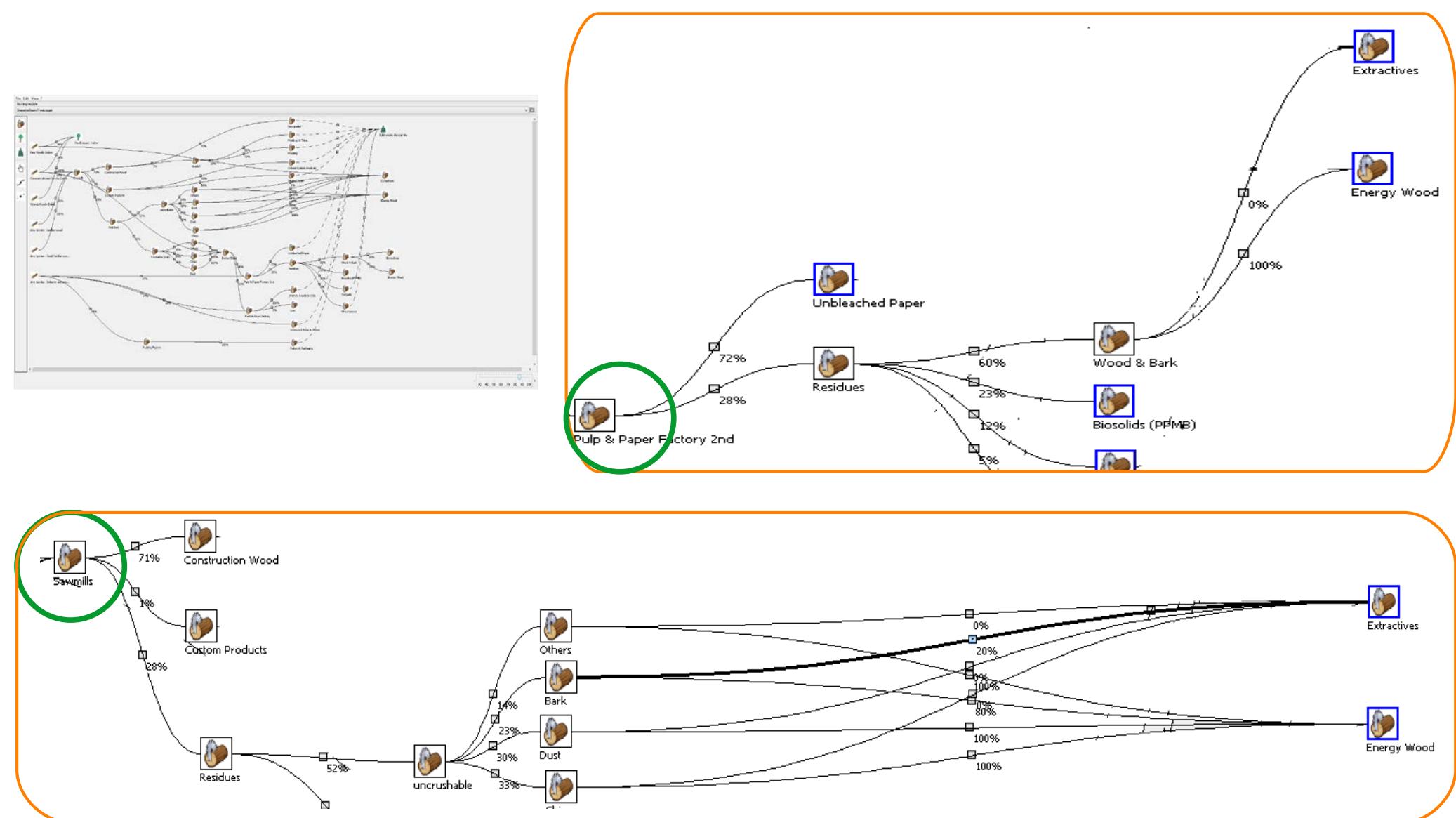
Supply chain modelling



Variables

- Industries
- biomass flux
- supply chain structure

ChAT (Pichancourt et al., in prep)
Chemicals Accounting Tool



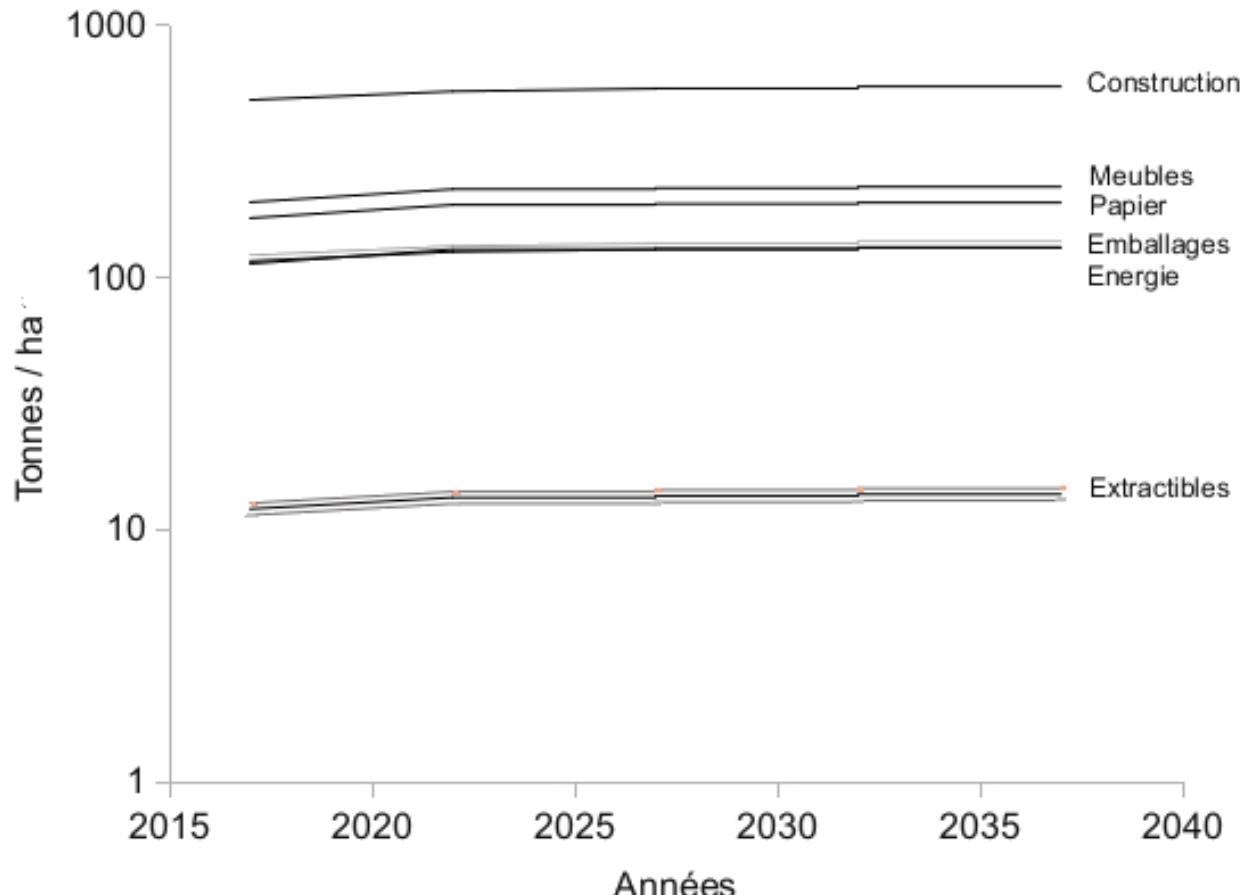
Dealing with uncertainties

Parameter category	Average	Error margin, or min / max	n	Sources.
CAT variables				
Biomass expansion factors of trees		1%		
Basic wood density of trees	400	5%	???	
Carbon fractions above & bellow ground biomass		1%	??	
Average lifetimes of end-use wood products		50%	?, Ch. 12	
Substitution factors of end-use wood products		50%	?	
Extractive variables				
Bark Volume [kg/kg]	14.49%	$4.8 \times 10^{-4}\%$	12096	here
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Bootstrapping

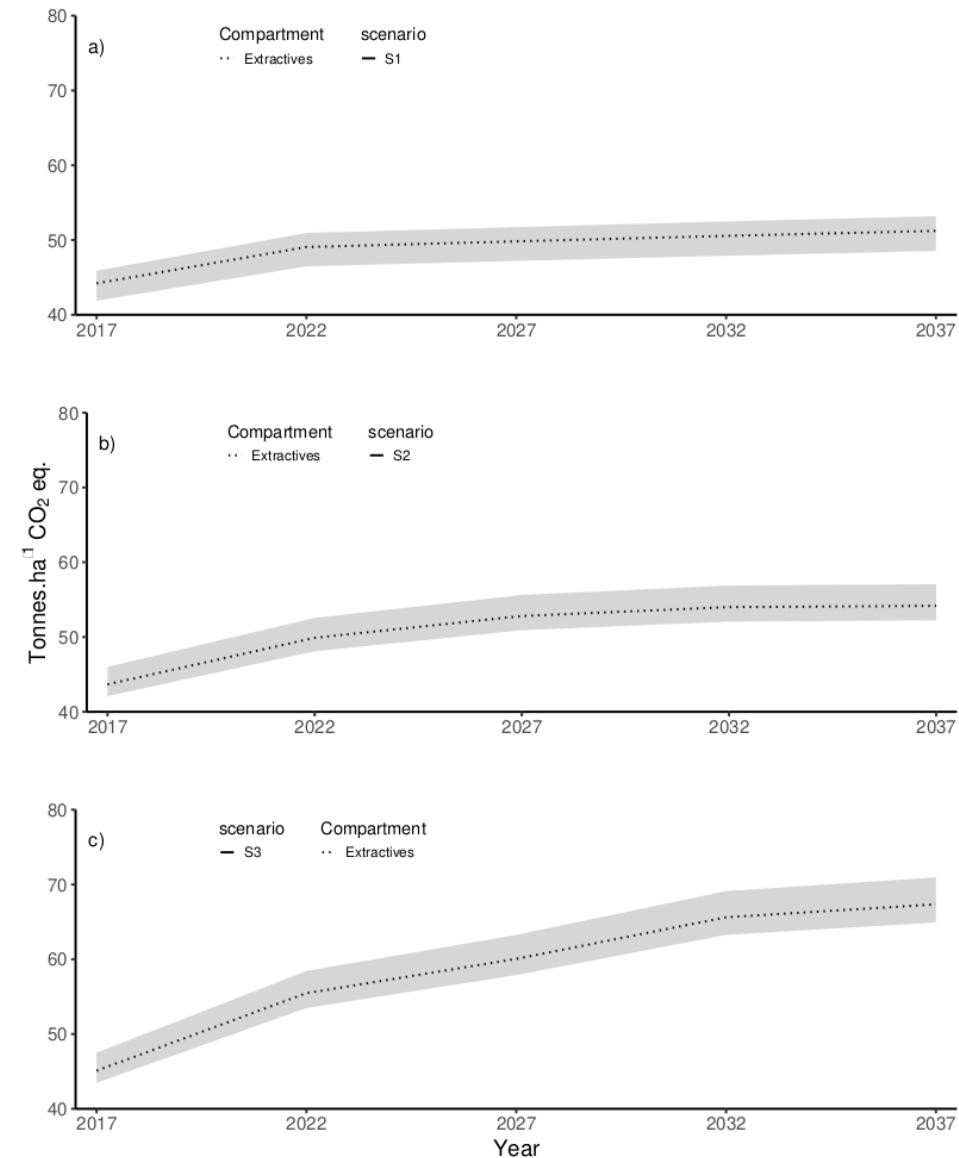
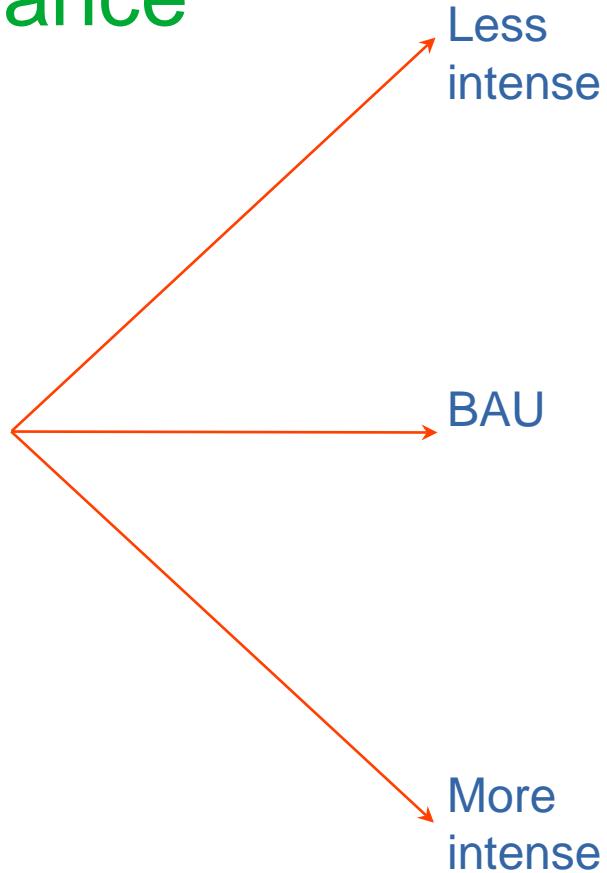


Quantity of extractives from residuals

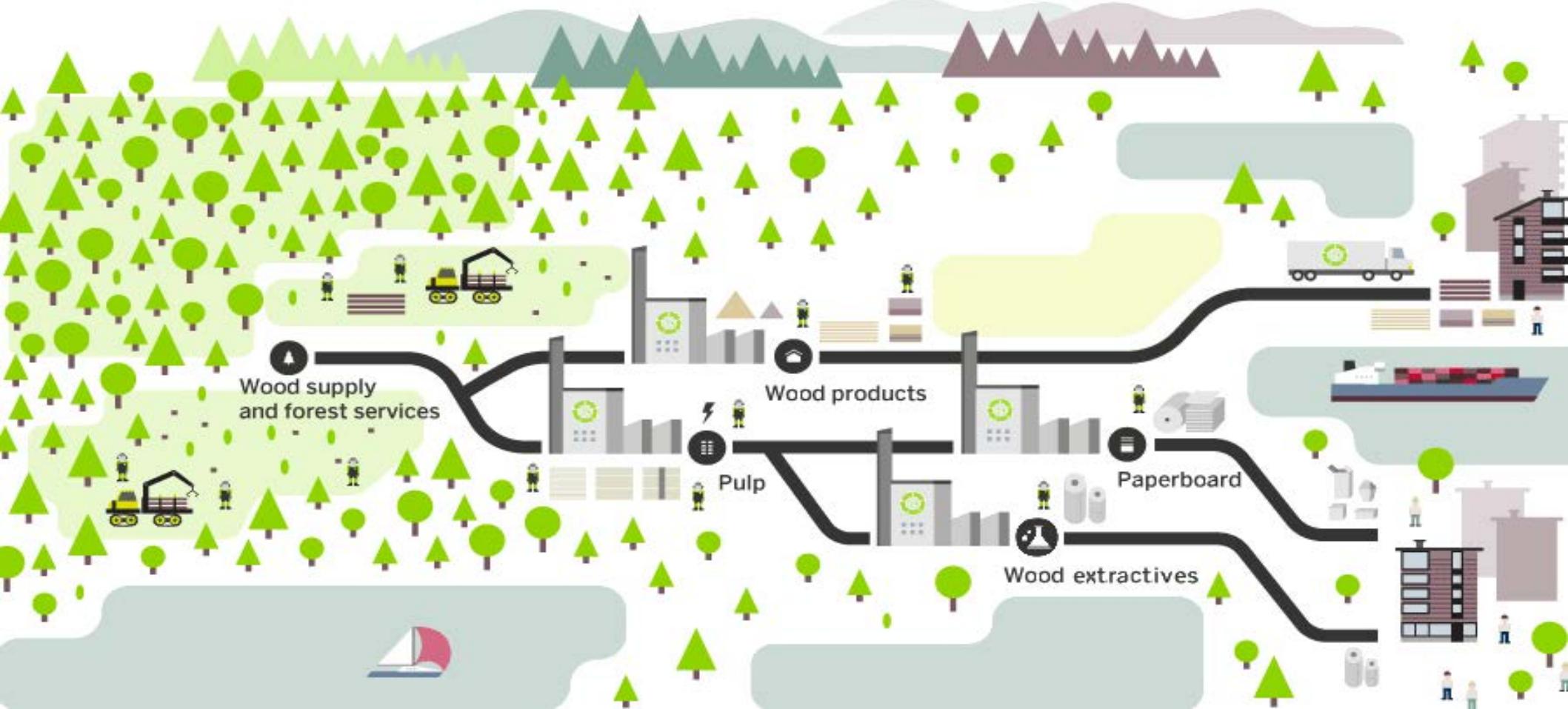


Impact on supply chain carbon balance

3 harvesting
scenarios



Discussion

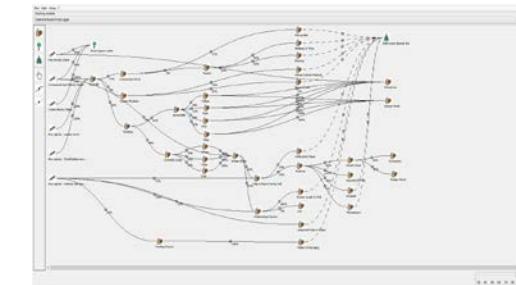


Is Silver Fir a promising source of extractives?

- 1) Yes: bark and knot-wood residuals (~10 t / ha / y)
- 2) Mostly from **sawmills, papermills & panel board mills**
- 3) **Quite stable and cost-effective provisioning**
- 4) **Weak competition with energy wood**
- 5) May improve **carbon balance?**

Multi-criteria Decision Support Platform

- BO, BI, BE, BC, bilan carbone, bilan minéraux (C_hAT Software)
- Online spatial tools
- geotagging and analysis of the supply chain
- Work with various partners



C_hAT Software



IGN/SILVA + trainees



Industrial partners



Development & Integration



Base données

Exploration spatiale & temporelle

Prise décision

Déploiement

On behalf of ...

INRA Orléans



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D. Rittié, F. Vast,
V. Rousselet, F. Bordat



C. Deleuze, F. Lévy



A. Bouvet



IPP + équipes administratives

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C. Ranger
A-F. Rémy
L. Le Maout
L. Mouritany-Nantz
N. Morel
E. Taillefumier
N. Morel
A. Vuillaume
M. Malik

C. Martin

A. Bénard
D. Maurice

Wood_DB

M2

H. Wernsdorfer
M. Blondet

A. Motz
C. Mola
J. Ruelle



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