Taking forests into account in LCA

ScoreLCA Seminar

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Agenda

I. Goal and scope of the study
II. Description of forests
III. Biogenic carbon and equilibrium: 2 key aspects
IV. Example of dynamic visualisation
V. Conclusions and recommendations

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Goal and scope

Goals of the study

The challenges to model forests in LCA go beyond the carbon contained in wood:

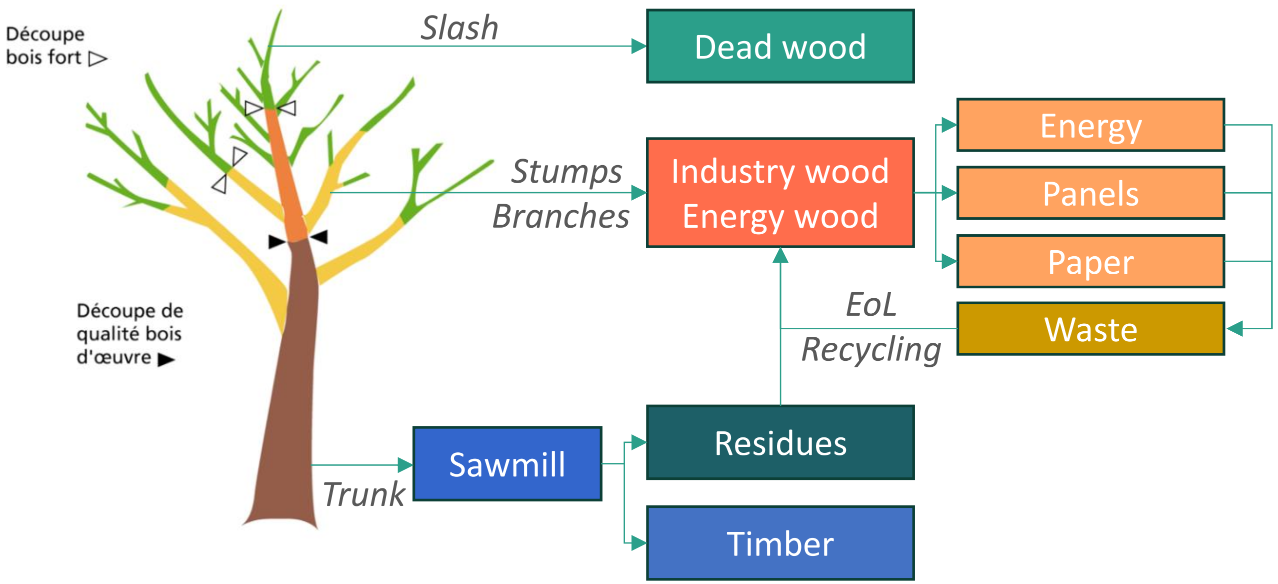
- Databases only model the carbon stocks in products (not in the forest)
- The impacts depends on forest management practices
- The lifespan of the products is long and can justify a dynamic study
- A forest is a complex system: different species, practices, co-products, …

→ To improve the practices, ScoreLCA asked Solagro (specialist on forests) and RDC Environment (specialist on LCAs) to study "**how to take forests in LCA**"

Forest management practices and biogenic carbon cycles

1) Different wood usages
2) Biogenic carbon dynamics

Production of wood in forest and usages



Generally, the production objective is timber and therefore aims to maximise "strong stem" (brown in the figure)

Selection/thinning → to promote the growth of promising trees

- Produce industry wood / energy wood quality timber

Harvesting timber trees

- Trunks → sawmill for timber production,
- Branches and/or stumps → industry wood / energy wood or left in the forest

Primary processing

- In the sawmill: production of by-products → industry wood or energy wood

End of life

- Wood can be recycled into industry wood or recovered in energy wood

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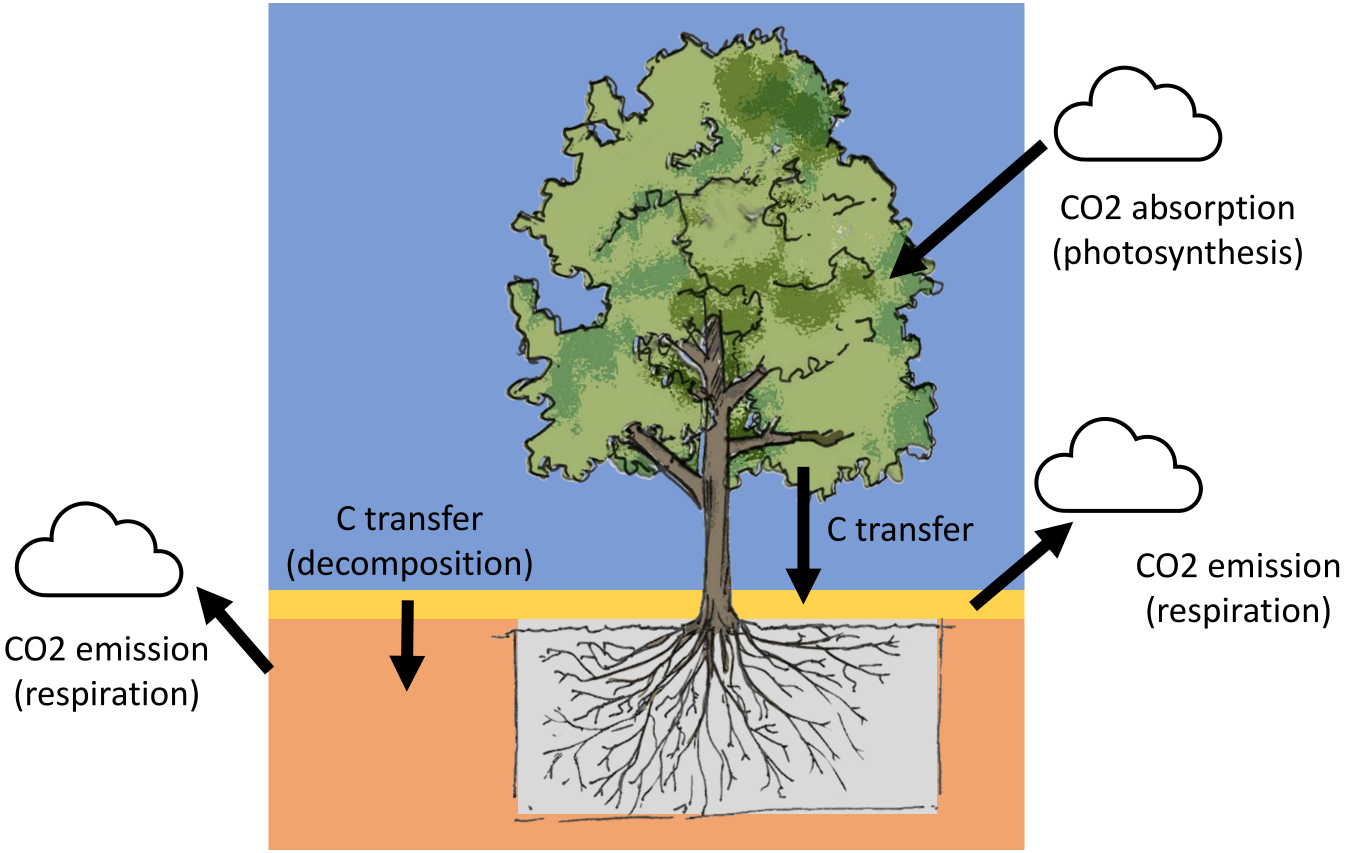
Forest has different biogenic carbon pools that interact with atmosphere

- Soil
- Above-ground biomass
- Below-ground biomass
- Dead wood / litter

Where is the carbon stocked ? In temperate forests :

- 45% in living biomass
- 10% in dead wood and litter
- 45% in soil organic matter



Photosynthesis: absorption of atmospheric CO_2 by leaves

Respiration: emission of CO_2 for the tree's metabolism. Tree growth.

Litter and dead wood: Addition of fresh organic matter to the soil surface

Decomposition of organic matter:

- ○ Storage of carbon in organic form in soil microorganisms
- ○Microorganism respiration and CO_2 emissions.

Biogenic carbon and equilibrium: two key methodological aspects to consider

There are other aspects to consider, such as the scope of the study, multifunctionality, dynamics, land use change

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Biogenic carbon

In many cases, biogenic carbon isn't neutral:

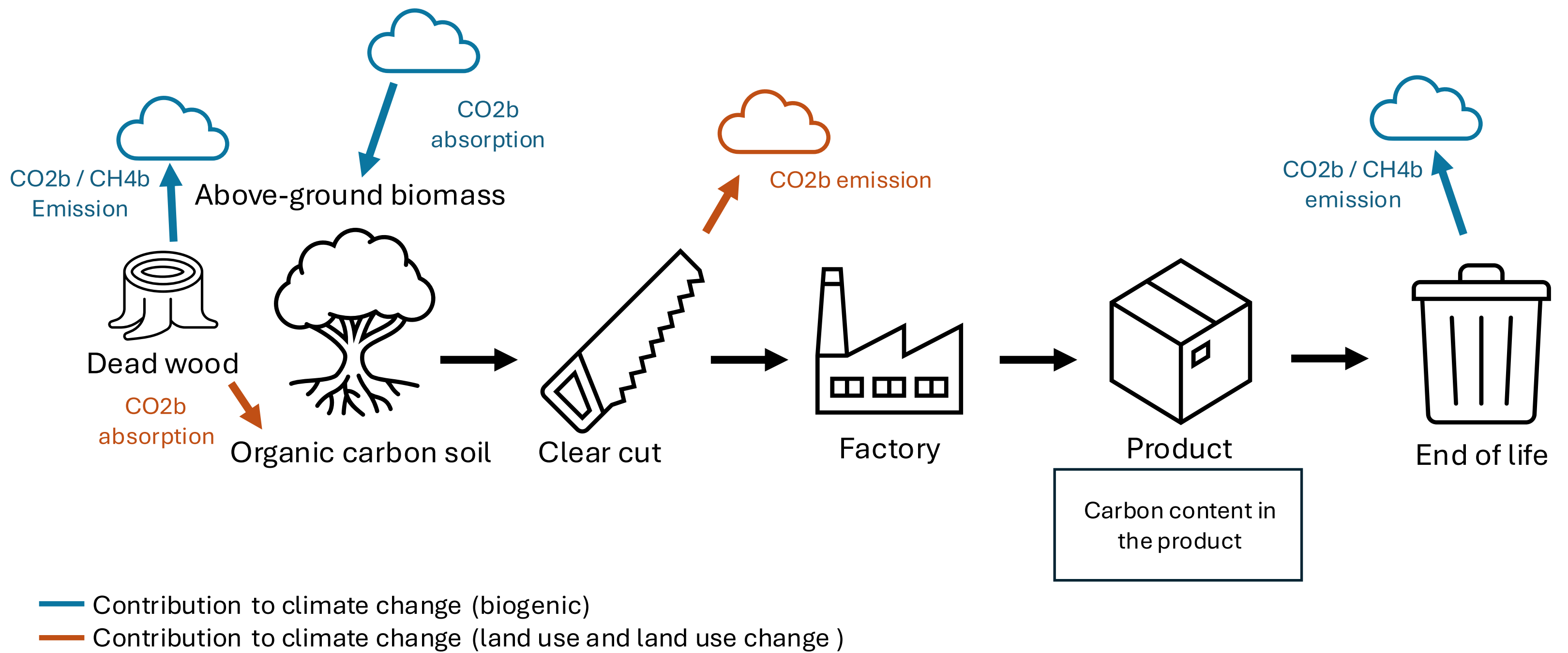
- Other emissions than CO2 (ex: CH4)
- Delayed emissions (products with long lifetime)
- Increase of the forest carbon stock (in the soil, in living biomass, …)

Biogenic carbon <u>must</u> be studied

→Absorption in biomass (above and under ground) during growth

→Emissions of CO2 / CH4 during the end of life

→Using -1/+1 as GWP for CO2 ; 29,8 for CH4



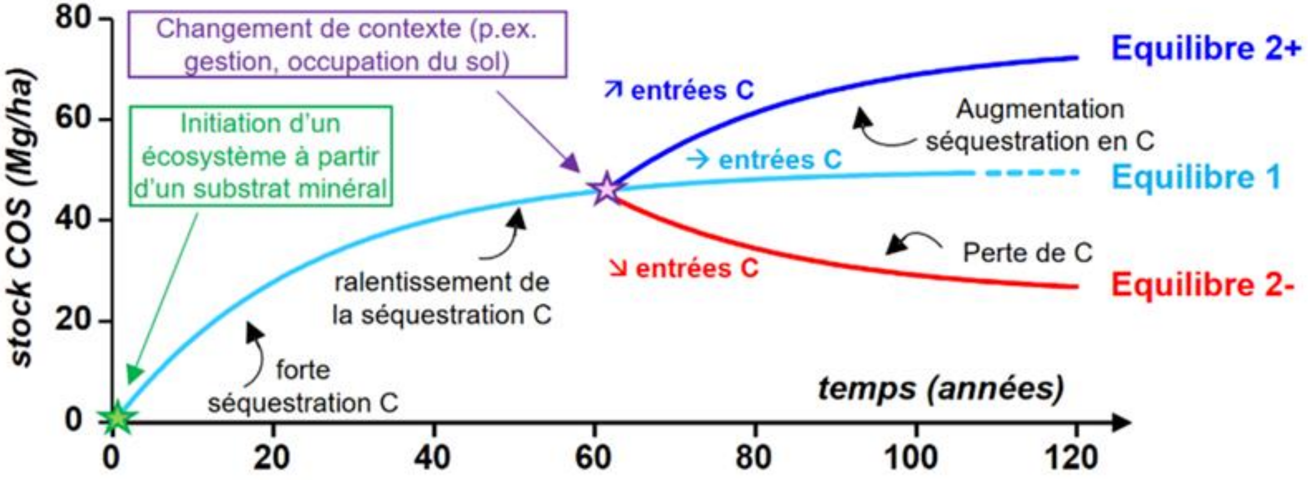
Sustainability and equilibrium

- Carbon stocks in forests generally reach equilibrium when constant forest management practices are implemented over long term

→ for above-ground biomass: wood growth compensates harvesting losses.

- **If a change of practice occur, there will be a change in the carbon storage**

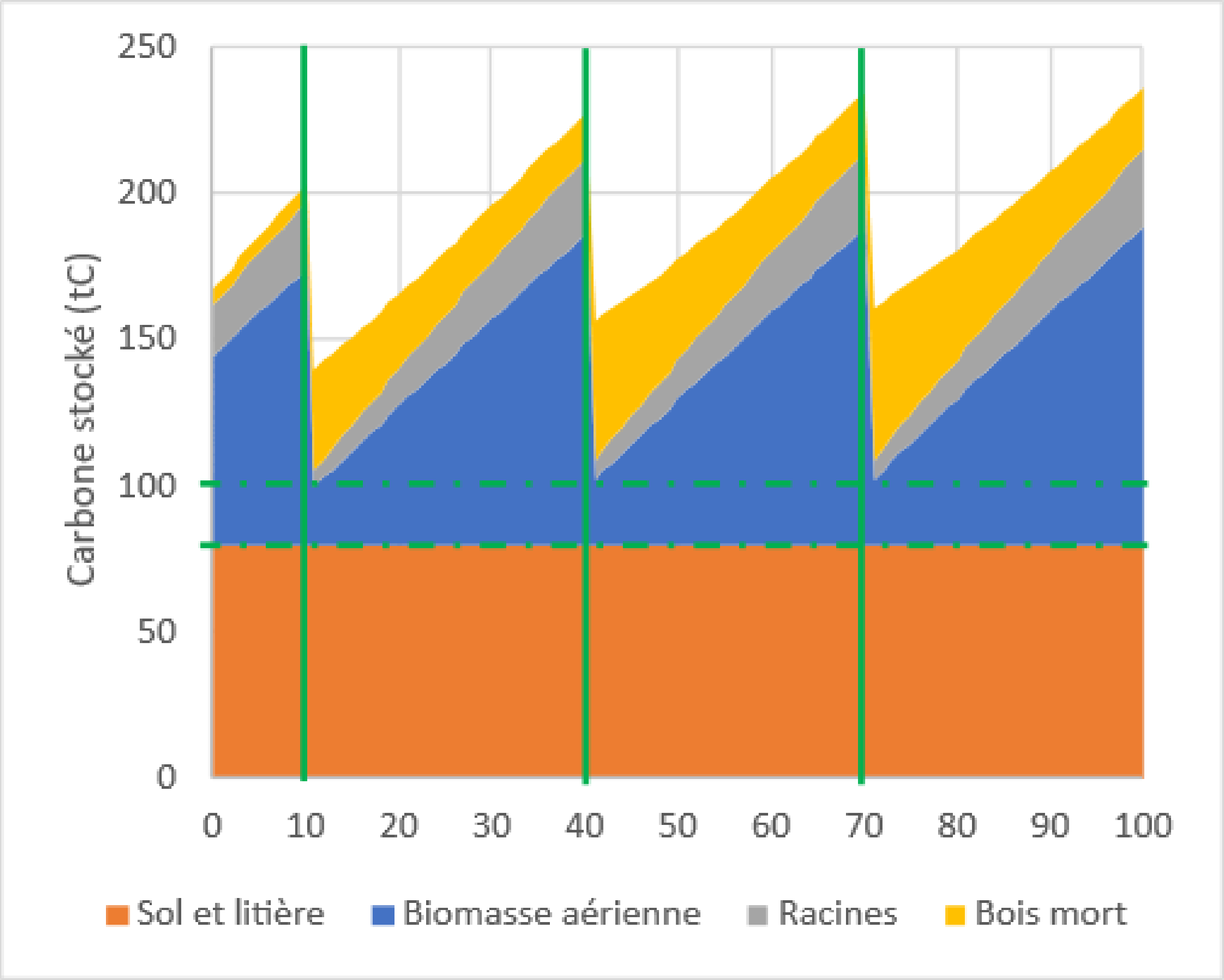
Figure 2 : Evolution temporelle du stockage de COS
(adaptée d'un support de présentation ; courtoisie de Julia Le Noë [IRD])



→ If the forest has reached **equilibrium**, a **static assessment** may be sufficient.

Case studies

Case study – Example of evolution of carbon stock in the pools



In above-ground biomass and roots biomass

- Linear growth until the cut
- Depends on the species and management practices

In dead wood

- Increase of dead wood when the biomass is cut
  → because leaves and small branches stay in the forest

In the soil

- Assumption of equilibrium
- But several models exist

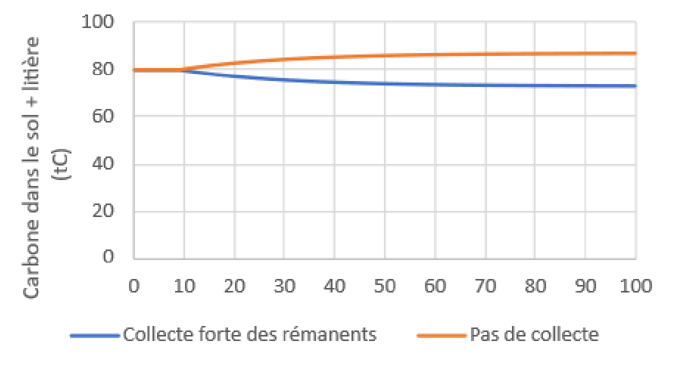
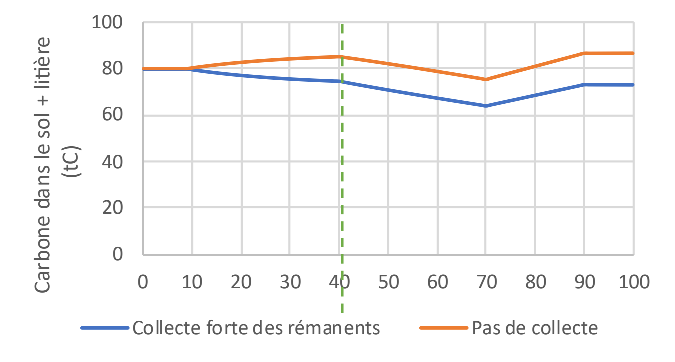
In wooden products (not modelled in the study)

- Not visualized in the figure.
- The amount of carbon in products shall increase when the biomass is cut

Case study – Example of the carbon stocked in the soil

Influence of the soil model

Hypothesis: High forest management, with a rotation period of 60 years and thinning every 15 years

	Csoil supposed at equilibrium	Evolution linked to the dead wood	Evolution linked to the dead wood + after clear cutting
Soil model	Fixed value (equilibrium)	Linked to the quantity of dead wood left in the forest	Decrease of Csoil after clear cutting + evolution linked to the quantity of dead wood left in the forest
	Constant stock = 80 tC		

Conclusions and recommendations

Recommendations for the practitioners

To model a forest

- Changes in practices can lead to variations in forest carbon stocks (±15% in our case study 1)

➔ **It is necessary to model the forest with sufficient detail:**

  - If possible, by collecting specific data (species, growth rate, …)
  - If not, by using models that characterise the different biogenic carbon pools and their evolution

- The forests are not directly part of the databases (only the coproducts): when using them, the practitioner doesn't consider carbon stored in the forest

➔ **It can lead to either an overestimation or underestimation of the forests benefits**

➔ **Key point to remember: The practitioners must adapt the datasets to take into account when needed:**

- Carbon stock in living biomass (above and bellow ground)
- Carbon stock in the soil
- Land use change

A logigram was created in the report to help practitioners to do this

To model a forest

Specific data is preferred → depending on the hypothesis on the influential factors, the amount of carbon stocked in the forest can vary from +30% / -30%

Carbon in biomass

Always use a model for the living biomass growth

- Consider the cutting frequency, type of forest, species, …
- How to do it: IPCC formulas, data from the forest manager

Carbon in soil

→ If the forest is at equilibrium (not exploited, same practice on a long period, …)

- Use a constant and generic value (ex: IPCC data)

OR

→ If the forest is not at equilibrium (change in practice, more harvesting than the forest can regenerate, …)

- Use a model depending on the management practices
- Or at least a sensitivity analysis on the value

Land use change (direct or indirect)

→ If there is a land use change (new forest or deforestation)

- Use the databases to model direct land use change ("land use change" data) or specific data to model indirect land use change

OR

→ If there is no land use change

- No need for a model

The IPCC reports provides lots of data

RDC environment

Research Development & Consulting Environment

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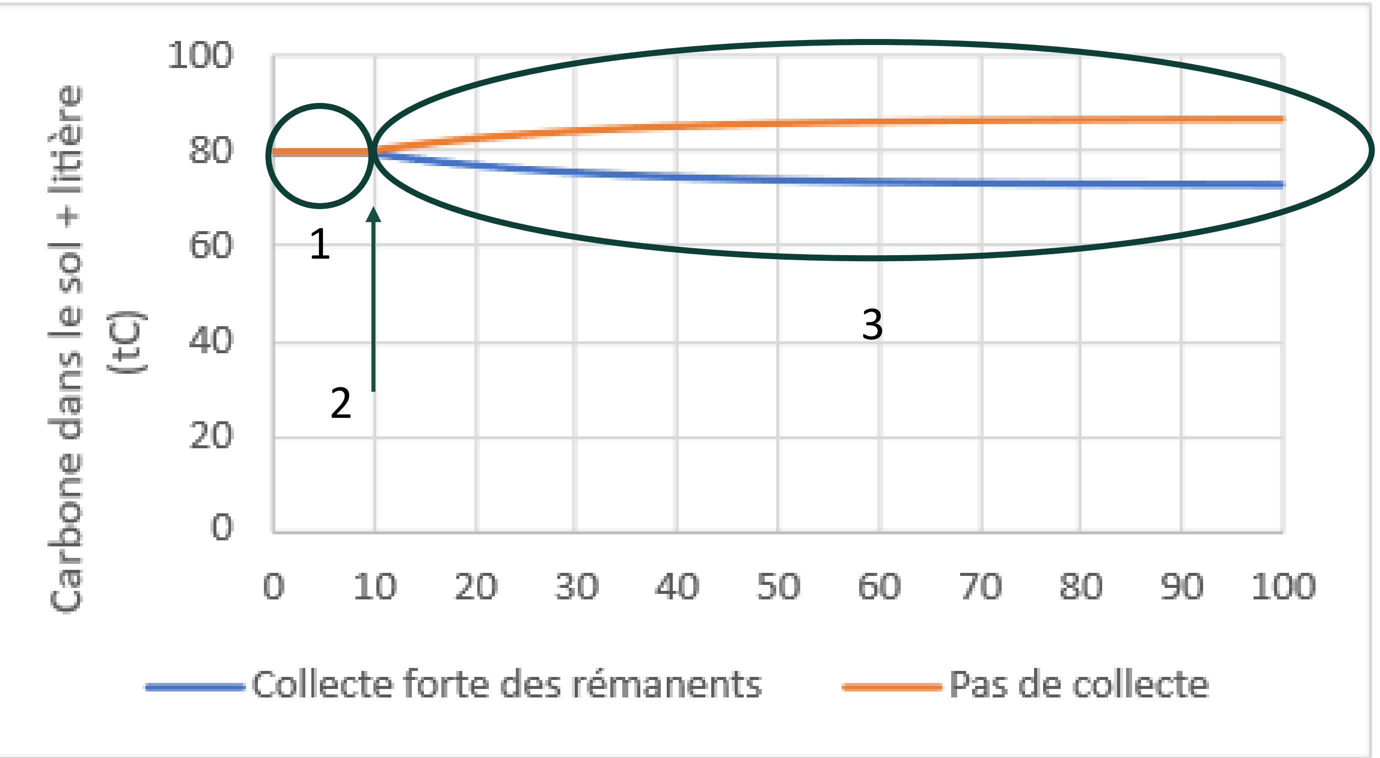
Appendix

Model for carbon stock in the pools

- In above-ground biomass
  - **Linear growth (constant growth rate)**
  - Forest management operations : **thinning** and **harvesting**
  - Climate change can decrease the growth rate with time
- In roots biomass
  - **Linear growth**: proportional to biomass growth rate
- In dead wood
  - **First order decay**: depends on half-life
- In the soil
  - **Several models** exists
- In wooden products (not used in the study)
  - **First order decay**: depends on half-life

Case study – Evolution of carbon stock in the soil



Assumptions:

The carbon stored into the soil depends on the quantity of dead wood remaining in the forest

- Practise of leaving remaining dead wood → increase in carbon stock
- Export of dead wood and harvested products simultaneously → decrease in carbon stock

1: equilibrium reached
The accumulation of carbon by decomposition compensates respiration of microorganisms

2: practice change = change in balance

3: towards a new equilibrium depending on the quantity of dead wood in the forest

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Conclusions from the case studies – Influential factors

There are uncertainties in forest modelling

Case study 1

The rate of biomass growth

- Depends on the variability of forest systems and global warming
- Influence on the results: +++, on the amount of carbon stored per hectare.
- Variability/Uncertainty: +++, extremely variable according to local conditions. Requires local expertise.

Risk factors (fire, storms, disease, browsing)

- Influence on results: ++, because fire has a temporary effect (regrowth necessary) and has little impact on the average result; if the frequency were high (ex: every 2 years), the effects could be greater.
- Variability/Uncertainty: +++, as it is impossible to predict when a fire will occur.

Case study 2

Quantity of harvesting residues left in forest

- Influence on results: +, on the amount of carbon stocked in the dead wood and soil
- Variability/Uncertainty: +, as the data is specific to the management practices

Carbon soil model

- Influence on results: +, on the amount of carbon stocked in the soil.
- Variability/Uncertainty: +++, as there are currently no consensual model in the litterature to take management practices into account

➔ Sensitivity analyses must be conducted on influential factors

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Recommendations for the practitioners

To model wooden products

Note: the wooden **products** weren't the focus of this study

Carbon in biomass/soil

→ If the forest is not at equilibrium

- See previous slide
- Choose a relevant allocation method
- Potentially a sensitivity analysis, with different allocation methods

→ If the forest is at equilibrium

- Consider a constant equilibrium value for all carbon pools
- Use a generic value (ex: IPCC or forest manager)
- Choose a relevant allocation method
- Potentially a sensitivity analysis to consider the variability of the influential parameters

Carbon in products

→ If ecoinvent hypotheses on coproducts corresponds to the modelled system

- Use a generic value from databases (that represents the studied species) to model the carbon stocked in the product and the forestry operations

OR

→ If ecoinvent hypotheses on coproducts doesn't correspond to the modelled system

- Use a model for the carbon stocked in products
- Use a relevant allocation method
- Potentially a sensitivity analysis with different allocation methods

Land use change (direct or indirect)

→ If there is a land use change (new forest or deforestation)

- Use the databases ("land use change" data) or specific data
- Allocate the land use change to the co-products

OR

→ If there is no land use change

- No need for a model

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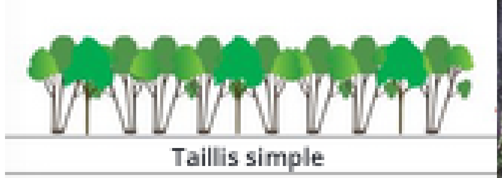
Structure of forest stands in France

Even-aged stands

59% of forests in France

Coppice-with-standards

20% of forests in France



Coppice

6% of forests in France

Uneven-aged stands

5% of forests in France

50% of the area in France is managed
(100% of public forests, 30% of private forests)

stand ≠ forestry management

+ 9% of undefined structure

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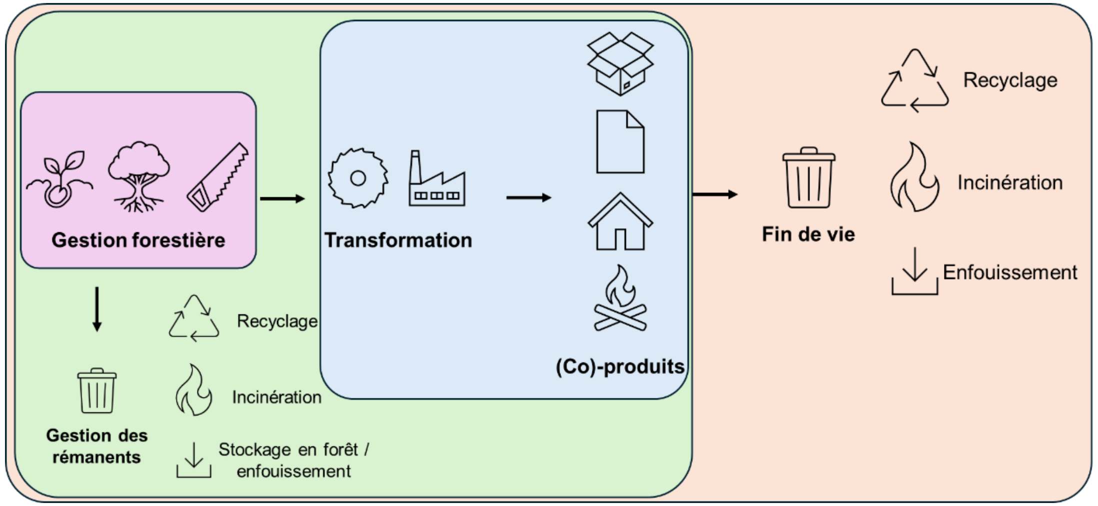
Key aspects to take into account for forests and forest products

Scope of the study

- Several scopes can be studied:
  - Cradle to grave
  - Centered on forest management
  - Centered on the product

→ This will influence the life cycle phases studied and the biogenic carbon cycle neutrality



Multifunctionality

Forest = Productive uses + non-productive uses

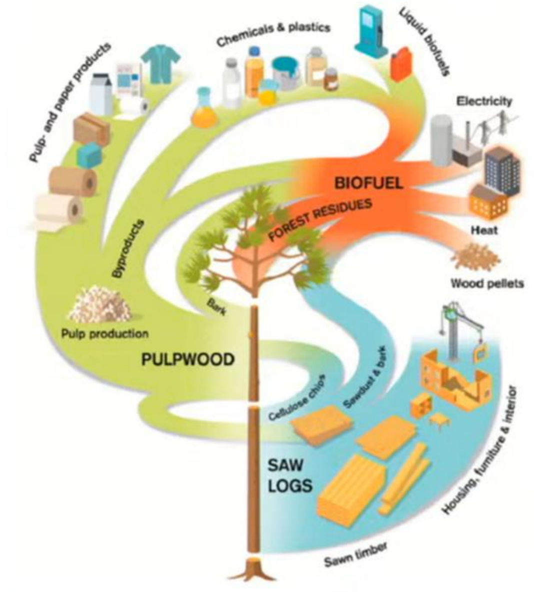
Productive uses: construction, packaging, paper, energy, …

→Allocations of impacts of forests must be done when considering on of the co-products: system boundaries expansion or economic allocation are preferred

Non-productive uses = recreation, biodiversity, water filtration, air purification, …

→ The non-productive functions are difficult to capture with LCA, and generally not allocated

→ They have to be qualitatively mentioned



Key aspects to take into account for forests and forest products

Dynamic LCA

A dynamic study is relevant when studying forests because :

- **processes are long** : trees grow over several decades
- Wooden products can have a **long lifespan** (several decades for buildings)

→ Helps to fully understand the **mechanisms of carbon transfer** between different forest compartments

This dynamic perspective can be difficult to achieve in LCA

→ **The study can be conducted statically if the practitioner is aware of the temporal issues of the product being studied**

→ To move from a dynamic to a static perspective, the average value of the carbon in pools over a period of time can be used

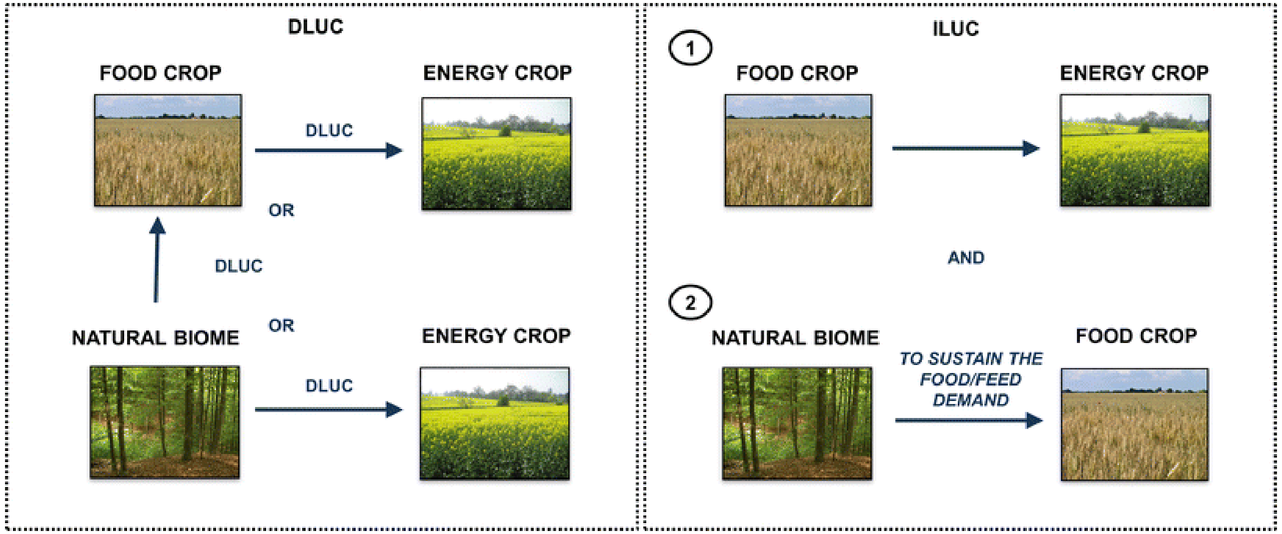
Key aspects to take into account for forests and forest products

Land use change

Direct (dLUC) and indirect (iLUC) land use change must be studied:

→ Did the forest exist in the past

→ Will it exist in the future



Source: ICare,University College Cork, E4SMA Srl

→It can be disregarded if not relevant = if the practices remains the same before and after the study

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ecoinvent database: which impacts are covered

LCA practices

What is (not) done?

	Often considered	Often <u>not</u> considered
LCA on forests	• Trees growth depending on the species, … • Direct land use change	• Influential factors for carbon storage (global warming, forests management practices) • Indirect land use change • Carbon storage in different pools • Dynamic approach
LCA on wood products	• Allocation of coproducts • Substitution / avoided emissions • Temporal carbon storage in products • End of life emissions	• International trade of wood • Dynamic characterization factors

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How is it used today?

Datasets are focused on products

Timber
- Sawlog and veneer log, hardwood/softwood, measured as solid wood under bark
- Bamboo culm – kg

Energy wood
- Cleft timber, measured as dry mass – kg
- Bundle, energy wood, measured as dry mass – kg
- Wood chips, wet, measured as dry mass – kg

Industry wood
- Pulpwood, hardwood/softwood, measured as solid wood under bark – m3

- Economic allocation between co-products (but not very transparent → we can't go back to the forest LCIA)
- Except for biogenic carbon

→ Hard to come back to the forest

ecoinvent database

- Biogenic carbon :
  - No model for the **carbon stock variations** in forest pools
  - **Carbon content** (biogenic) is summarized via **a single elementary flow "carbon dioxide, in air“**
    - The carbon content (m/m) is the same for all species (49.4%)

- **Indirect land use change** is not considered in the datasets

- Forest management well described for other impacts including fossil CO2 emissions

→ plantation of seeds

→ fossil fuel consumption (forest operations), use of machines in forest

→ gravel consumption, road and forest occupation