Towards a consensual method to assess climate change impacts from bio-based systems

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Research question

Climate change

Atmospheric concentration of GreenHouse Gases (GHG)

CO₂

Bio-based systems

How to assess resulting impacts on climate change?

CO₂ uptake processes (photosynthesis, water dissolution)

C

Standing biomass

Soils

Oceans

Fossil reserves

Carbon compartments / sinks
General approach

Research question:
How to assess impacts on climate change from bio-based systems?

- Critical analysis of current methods
- Framework for climate change impact assessment for bio-based systems
- Development of a new characterisation method
## Critical analysis: Material & methods

<table>
<thead>
<tr>
<th>7 methods considered...</th>
<th>... according to 8 criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dealing with biogenic GHG emissions</strong></td>
<td><strong>Completeness</strong></td>
</tr>
<tr>
<td>Conventional GWP: carbon neutrality approach</td>
<td>Cause-effect chains and C compartments</td>
</tr>
<tr>
<td>Conventional GWP: full accounting approach</td>
<td>Scientific soundness</td>
</tr>
<tr>
<td>Time-adjusted GWP</td>
<td>General principles</td>
</tr>
<tr>
<td>Biogenic GWP</td>
<td>Underlying calculations</td>
</tr>
<tr>
<td>Biogenic Accounting Factors (BAF)</td>
<td>International acceptance</td>
</tr>
<tr>
<td><strong>Dealing with land occupation and/or transformation</strong></td>
<td>Genericity</td>
</tr>
<tr>
<td>ILCD / IPCC recommendation for land transformation</td>
<td>Application context</td>
</tr>
<tr>
<td>Müller-Wenk proposal</td>
<td>Modelling approach</td>
</tr>
<tr>
<td><strong>Easiness of use</strong></td>
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<td>Generating new CF</td>
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</table>
## Critical analysis: Results

<table>
<thead>
<tr>
<th></th>
<th>GHG emissions</th>
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<tr>
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<tr>
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<td>4</td>
</tr>
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<td>2</td>
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</tr>
<tr>
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</tr>
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<td>Underlying calculations</td>
<td>N/A</td>
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</tr>
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<td>1</td>
<td>4</td>
</tr>
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</tr>
<tr>
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1 2 3 4 5: Criterion rating scale, from 1 (weak) to 5 (strong)
Bio-based system assessment framework

- Proposal for human-based agriculture or forestry:

Agriculture or forestry stage → Harvest → Transformation into bio-based products, and use

CO₂ uptake

Land use impact assessment framework

Not yet satisfactory?

GHG emission impact assessment framework (current climate change assessment framework)

Conventional GWP with a full accounting approach

If needed: ILCD recommendation for delayed emissions (based on Time-Adjusted GWP principle)
# Critical analysis: Results

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### Scoring Key

- **General principles**: 2
- **Underlying calculations**: N/A
- **International acceptance**: 1

### Completeness

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### Scientific soundness

- **General principles**: 2
- **Underlying calculations**: N/A
- **International acceptance**: 1

### Genericity

- **Application context**: 2
- **Modelling approach**: 4

### Easiness of use

- **Collecting LCI data**: 5
- **Generating new CF**: 5

1 2 3 4 5: Criterion rating scale, from 1 (weak) to 5 (strong)
Critical analysis: *Complementarities*

- **Time-adjusted GWP**
  - Graph showing time-adjusted GWP of CO₂ over emission years.

- **Müller-Wenk proposal**
  - Diagram illustrating carbon sequestration potential with stock levels over time.

### Comparison Table

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</tr>
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<td>5 (4)</td>
<td>4 (3)</td>
</tr>
<tr>
<td><strong>Easiness of use</strong></td>
<td>1 (5)</td>
<td>5 (3)</td>
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O research group for environmental life cycle & sustainability assessment
Proposal for a new characterisation method

- **Environmental mechanism considered**
  Carbon sequestration potential → Climate change

- **Scientific foundations and objectives**
  • Compliant with the land use framework
  • Based on Time-Adjusted GWP principle
Proposal for a new characterisation method

- Obtaining Characterisation Factors (CF)

  Transformation processes

  Occupation processes

  **Step 4:** Applying Time-Adjusted GWP to the resulting emission profiles to obtain CF

  **Step 3:** Deriving **direct** and **avoided** emission profiles from the framework

  **Step 2:** Identifying **direct** and **avoided** processes carbon storage dynamics
CF calculations: 1st example

- At global land use level

Based on assumptions and data from Müller-Wenk & Brandão (2010): 7 biomes, 3-4 land uses per biome
CF calculations: 2\textsuperscript{nd} example

- At a land use management practice level

  Case study on forestry systems, data from FCBA and CNPF

  Effect of revolution period (40, 60 or 80 years)

Attributional modelling
Take-home messages

- Proposal for an harmonized framework for climate change impact assessment for bio-based systems
- Proposal for a new characterisation method for climate change impact assessment from land use

- Method description and applications
  - Available in French on ADEME website
  - English publication under writing
Thank you for your attention!

Contact: anthony.benoist@cirad.fr

Thanks to ADEME for its funding.

Thanks to Alice GUEUDET and Miriam BUITRAGO for their valuable comments.
Main references

- **Conventional GWP**

- **Time-Adjusted GWP**
Main references

- **Biogenic GWP**

- **Biogenic Accounting Factors**

- **ILCD / IPCC recommendation for land transformation**

- **Müller-Wenk proposal for land use impact assessment**
Land use & Attributional/consequential LCA

Attributional modelling

Consequential modelling

Avoided process
Reference land use

Direct processes

Avoided process (reference land use)

Direct processes (land use under study)

Carbon sequestration potential

Stock_{ref}
Stock_{max}

Studied land use

Stock_{min}

Time