

FNRS LCA contact group meeting, 9th March 2026, UCLouvain

Bridging Theory and Practice: Integrating an Operational Workflow and Progressive Strategy for Uncertainty Analysis in LCA

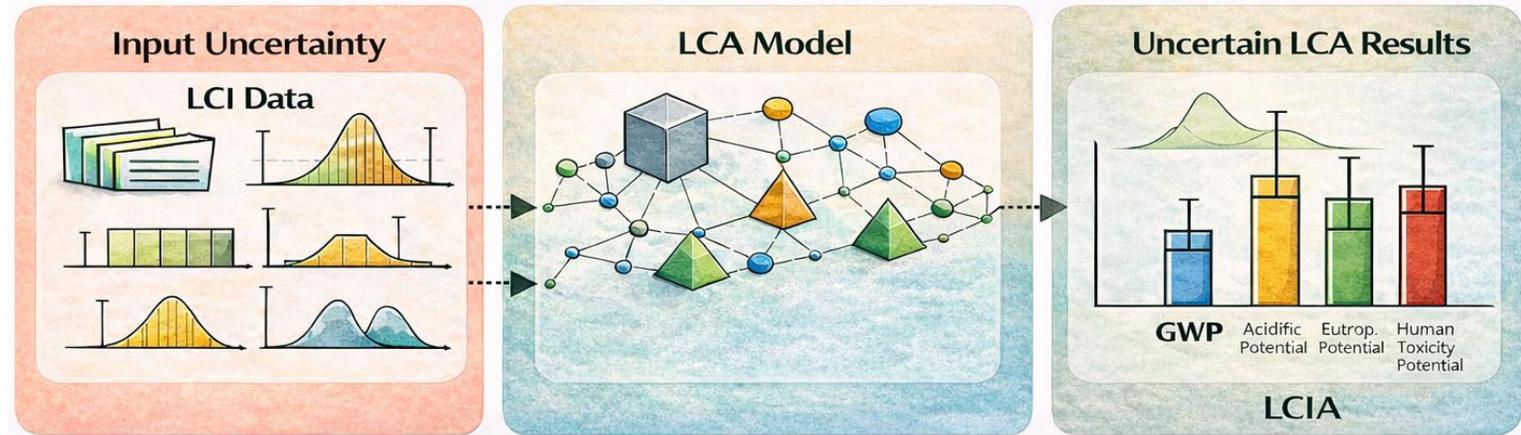
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Why Uncertainty Analysis (UA) is Crucial for LCA?

- ❖ Mandatory in ISO 14040/14044/PEF
- ❖ Avoid false precision
- ❖ Ensure reliability, transparency, comparability
- ❖ Identify key improvement areas

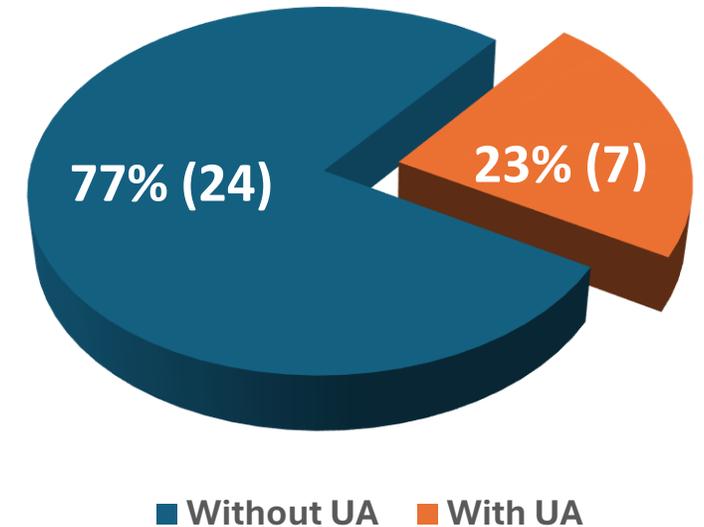


LCA results require not just quantity, but also quality (confidence level → UA)

Significant Implementation Gap in Reality

- ❖ **77% Omit UA**
- ❖ **Narrow Scope:** Mostly quantity; model and context ignored
- ❖ **UA ≠ SA:** Frequent misuse between UA and Sensitivity Analysis

LCA of CO₂ adsorption (N = 31)

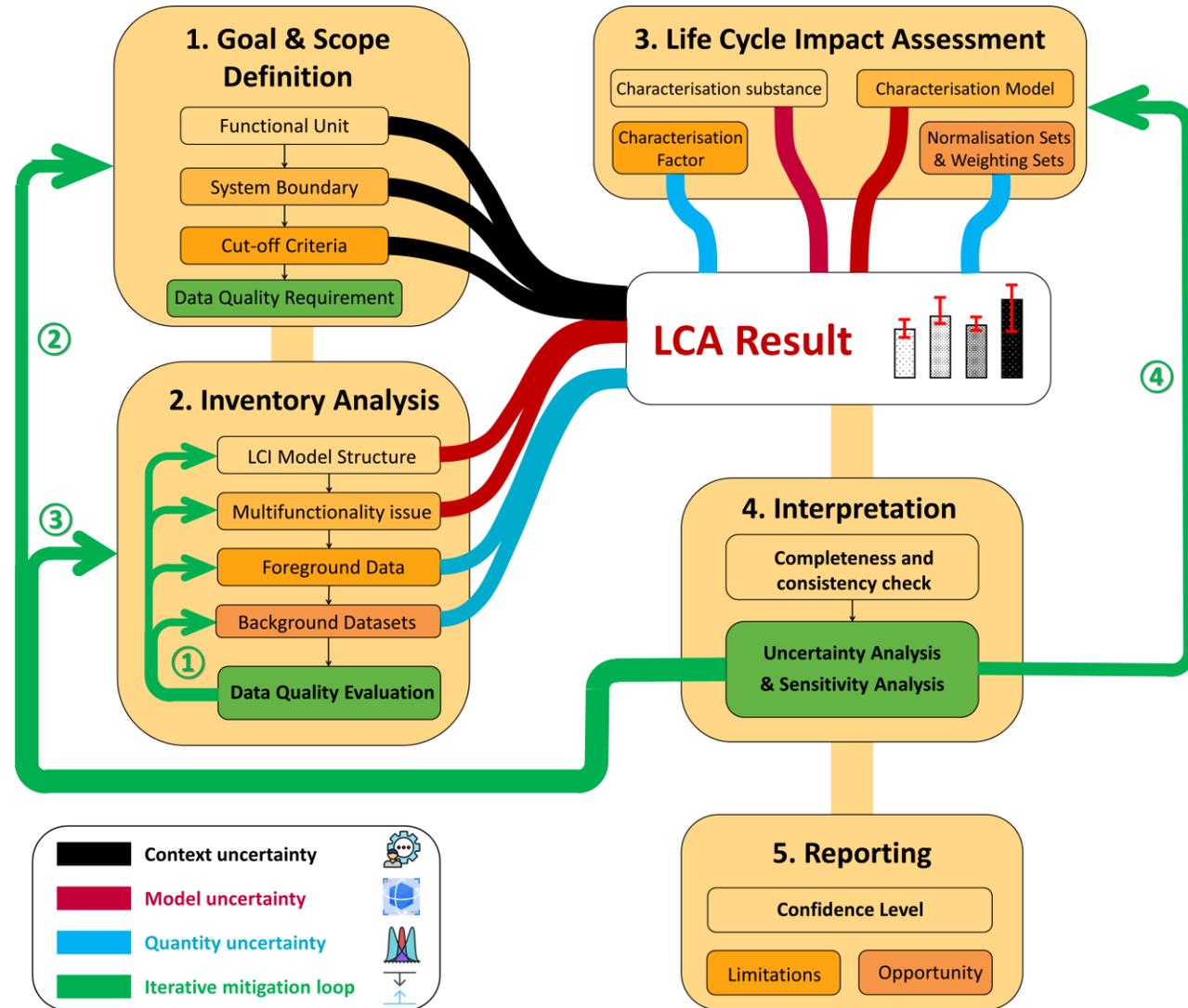


Source: Yao et al., 2025, Applied Energy

Challenge: inherent multidisciplinary complexity & No Standard Protocols

A Global Visual Mapping: Cognitive Barrier ↓

- ❖ Sources
- ❖ Types
- ❖ Propagation
- ❖ Evaluation
- ❖ Mitigation
- ❖ Reporting

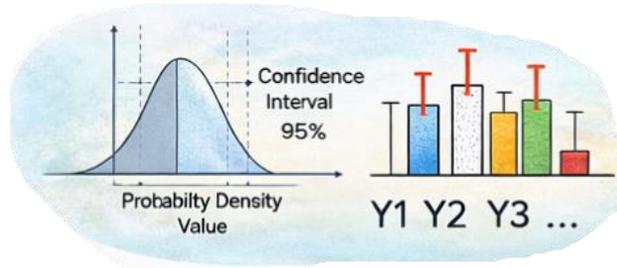


Core four steps to perform UA



To the audience

4. Communication

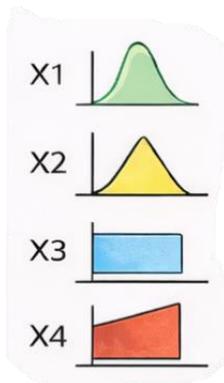


Output uncertainty (confidence level)?

2. Propagation

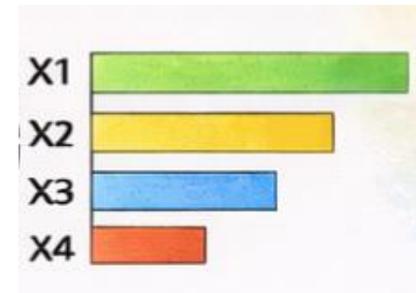
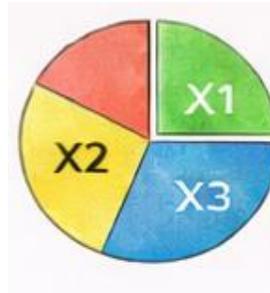
3. Sensitivity analysis (SA)

Contribution of each input uncertainty



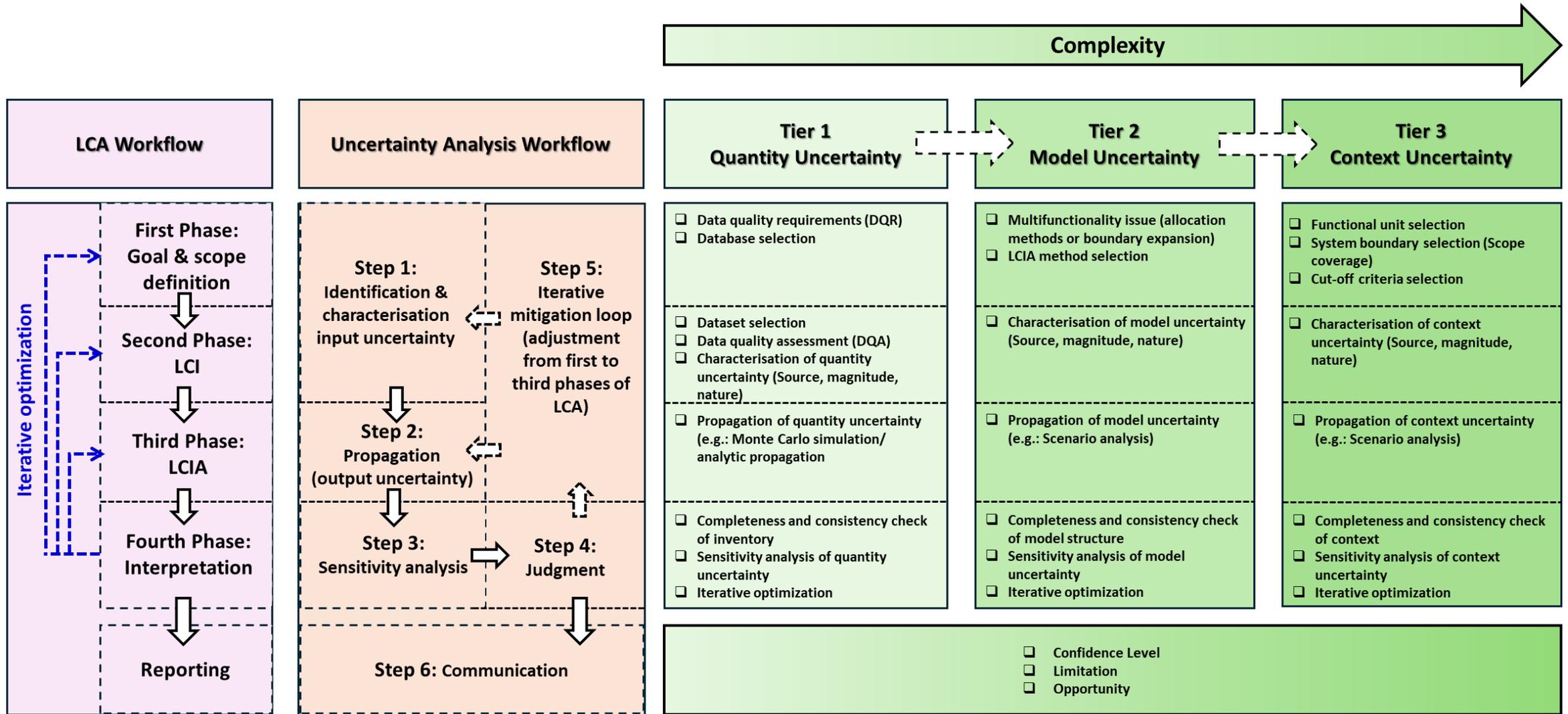
1. Characterisation

Locations and magnitude of input uncertainty



Uncertainty Analysis (UA)
≠
Sensitivity Analysis (SA)

The Full Six-Step Workflow & Progressive Strategy



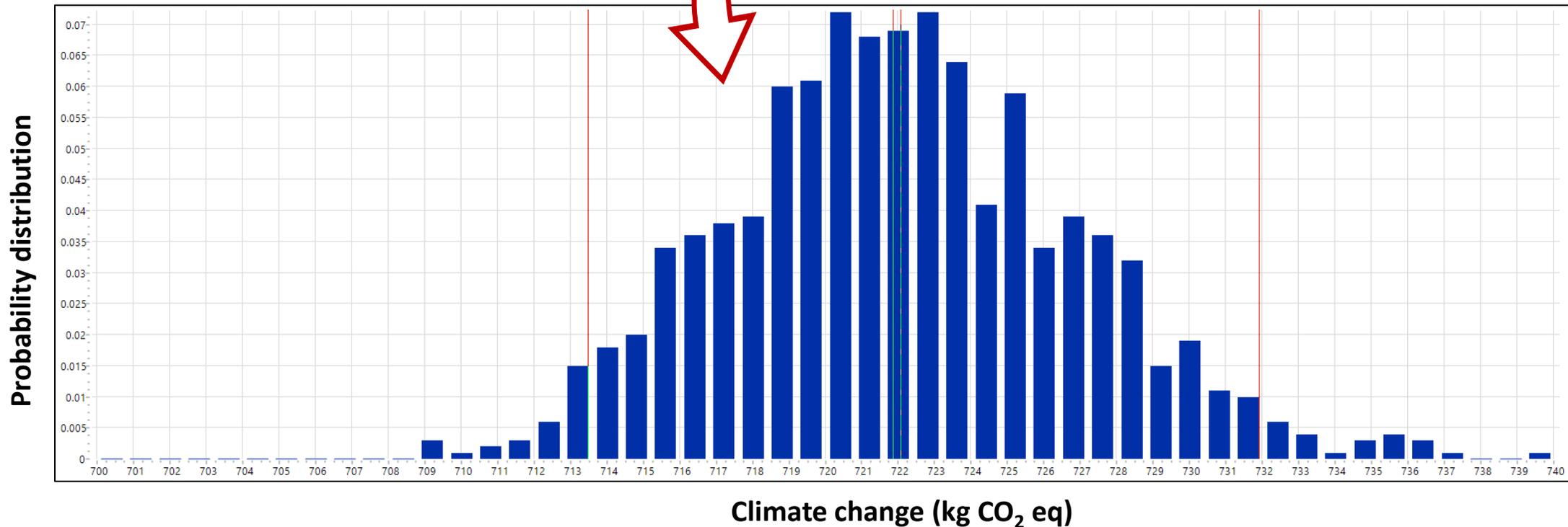
Case 1: single value → confidence interval

Before: Climate change

722 kg CO₂ eq

Now:

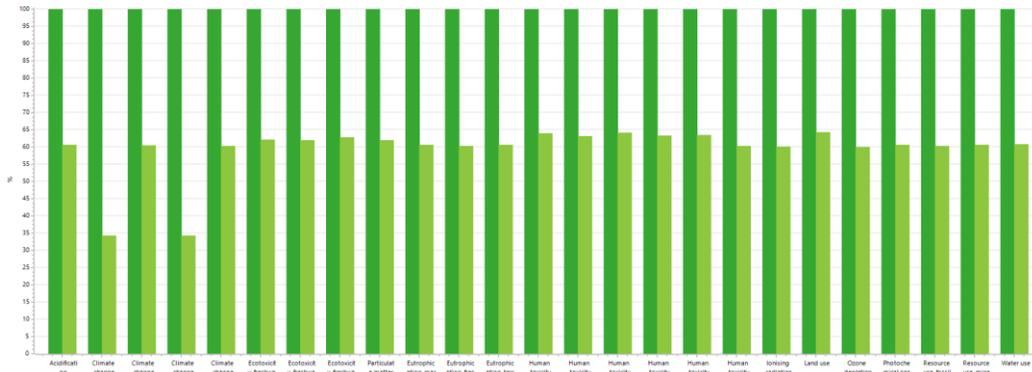
Item	kg CO ₂ eq
95% Confidence Interval (CI)	713 -732
Mean	722
Median	722
Coefficient of Variation (CV)	0.66%



Case 2: normalization value → probability in comparison

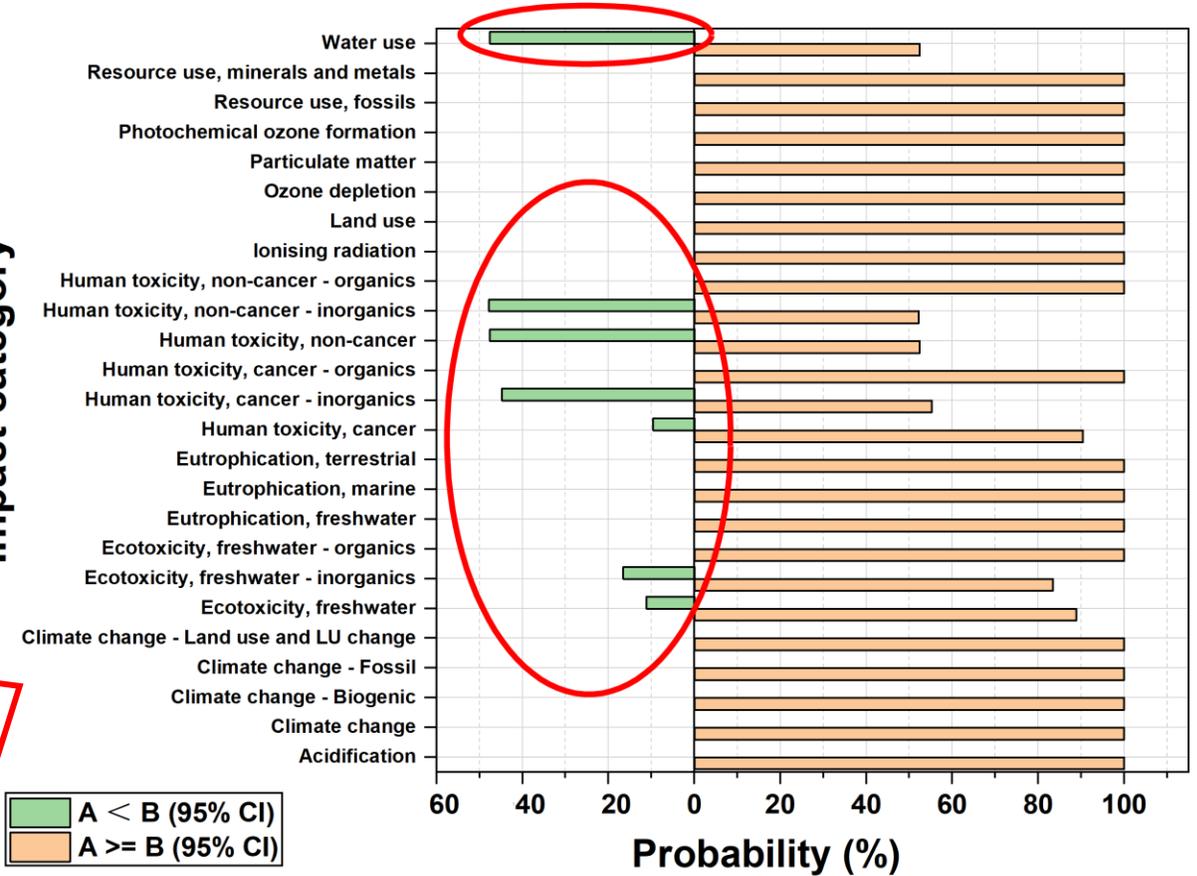
Before:

A > B in all categories

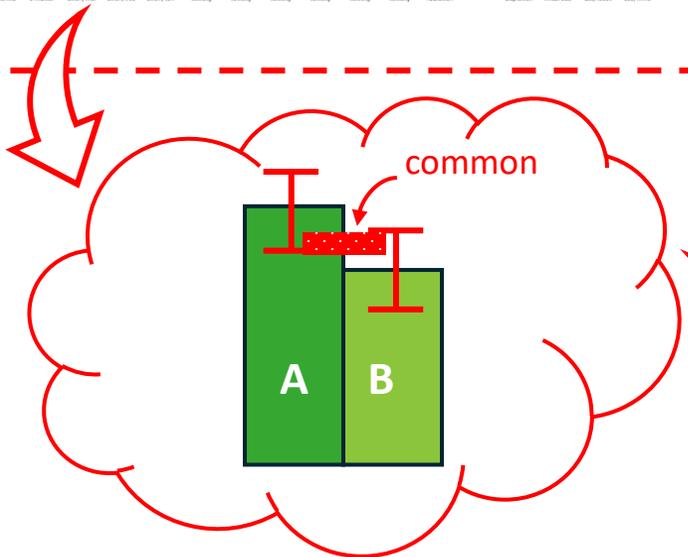


Now:

Impact category



Uncertainty view



Takeaways

- 1) Uncertainty analysis (UA) is critical for ensuring the reliability, transparency, and comparability of LCA.
- 2) There is a significant implementation gap in UA that must be bridged.
- 3) A comprehensive visual mapping that integrates the sources, types, propagation, evaluation, mitigation, and reporting of UA significantly reduces cognitive obstacles.
- 4) A standardized workflow and stepwise strategy, harmonising with the four LCA phases, offer greater practicality.
- 5) More detailed validation cases are forthcoming.

Thank you!



Q & A

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