

The fundamental limitation of LCA: Robustness

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Context

Stéphane Grumbach & Olivier Hamant advocate for suboptimal systems for humans to co-exist with Earth [1]. They define the concept of **suboptimality** as a state in which randomness, heterogeneity, slowness, redundancy and other forms of inefficiencies at individual levels lead to **robust outcomes**. By analyzing various examples, they conclude that suboptimality seems to be a well-supported way to regulate the trade-offs between individuals and society. They propose a list of trends that **could** represent optimal and suboptimal answers for different contexts. Table 1 shows the trends for **robust communications and decision making**.

Table 1: Robustness in communication and decision making (Adapted from [1])

Context	Optimal answer	Suboptimal answer (Robustness [†])
Communication	Precise and concise (e.g., scientific writing)	Redundant, heterogeneous (e.g., human, telecom)
Decision making	Multi-criteria approach [†]	Viability, holistic, long term assembly

Goals of this poster

Get **your personal opinion** on:

- the methodologies to evaluate and improve the robustness of LCA results
- the potential mismatch between the suboptimality concept and the purpose of LCA

References

- [1] Stéphane Grumbach and Olivier Hamant. "How humans may co-exist with Earth? The case for suboptimal systems". In: *Anthropocene* 30 (2020), p. 100245.
- [2] Sayaka Ogasawara. "Semantic change of robust: Recent development from an adjective to a quasi-intensifier". In: *English Today* 41.2 (2025), pp. 96–107.
- [3] Bernard Roy. "Robustness in operational research and decision aiding: A multi-faceted issue". In: *European Journal of Operational Research* 200.3 (2010), pp. 629–638.
- [4] Albert Munoz, Jon Billsberry, and Veronique Ambrosini. "Resilience, robustness, and antifragility: Towards an appreciation of distinct organizational responses to adversity". In: *International Journal of Management Reviews* 24.2 (2022), pp. 181–187.
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A polysemic concept

Robustness is a polysemic concept, spanning from statistical reliability to biological viability. Explicitly defining its boundaries is a critical prerequisite for rigorous scientific discourse.

Robustness definitions

The authors of [2] traced the etymology and semantic development of **robust**. They conclude that the adjective *robust* is undergoing a **semantic shift**, transforming itself into a **quasi-intensifier** of nouns. Table 2 shows some examples of the chronological first attested meanings of robust. The author of [3] discusses robustness in operational research and **decision aiding** by classifying the work from the literature in so-called territories for robustness concerns.

Table 2: The chronological first attested meanings of robust (Adapted from [2])

Year	Meaning
1490	Strong and hardy; strongly and solidly built, sturdy; healthy.
1511	Coarse, rough, rude. <i>Now rare</i> .
1652	Relating to, requiring, or promoting physical strength or hardiness; energetic, vigorous.
1670	Of a material object: sturdily constructed, solid; not easily damaged or broken, resilient.
1766	Of an immaterial thing (thought/emotion): powerful; firm, unyielding; resilient.
1886	Economics: Of a market, economy, etc.: strong, thriving; resilient.
1955	Statistics: Of a test: yielding approximately correct results despite the falsity of certain underlying assumptions.
1979	Computing: Of a program: able to recover from errors; unlikely to fail, reliable.

In addition, engineering-related work define the robustness of a **system** as:

- "The degree a system is **sensitive** to exogenous influence" [4]
- "A [property] of a [system] is robust if [invariant] with respect to a [set of perturbations]" [5]
- "robustness as insensitivity of the results of inference to alternative specifications" [6]

Robustness in LCA

Robustness in LCA	
ISO 14040 (1997)	The scope should be sufficiently well defined to ensure that the breadth, the depth and the detail of the study are compatible and sufficient to address the stated goal .
ISO 14044	Completeness check to ensure that all the relevant information needed for the interpretation is available. Sensitivity check aims to determine the influence that a potential change in the applied assumptions, used data, and applied LCIA methodology may have on the result.
PEF	Assessing the robustness of the PEF model evaluates the extent to which methodological choices such as the system boundary, data sources, and allocation choices influence the analytical outcomes (using completeness checks, sensitivity checks, consistency checks)
Hauschild et al. 2018	Sensitivity analysis and uncertainty analysis are applied as part of the interpretation to guide the development of conclusions from the results, to appraise the robustness of the conclusions , and to identify the focus points for further work in order to further strengthen the conclusions.

Robustness

- A) **LCA results**. Yield *accurate* results despite the falsity of certain assumptions (Ogasawara 2025).
B) **LCA ecosystem**. The degree a system is sensitive to exogenous influence (Munoz et al. 2021)

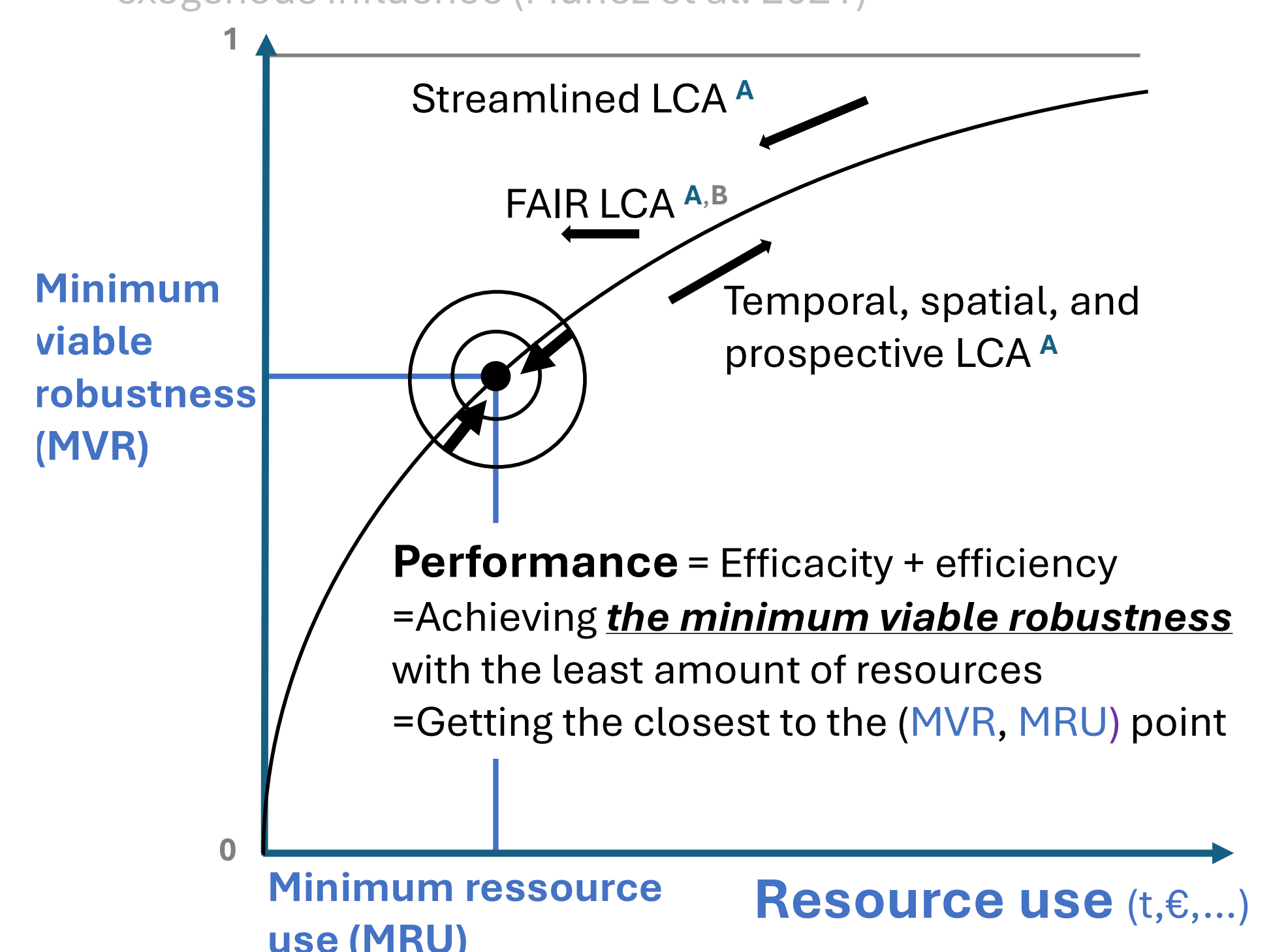


Figure 1: Robustness, resource use and performance in LCA

Interactive discussion

- How to **evaluate and improve** the robustness of: (a) LCIA results, (b) LCA outcomes, and (c) LCA ecosystem?
- If true systemic robustness requires suboptimality[†] ... what is the purpose of the multi-criteria optimization at the heart of LCA?