Deepening the uncertainty dimension of environmental Life Cycle Assessment: addressing choice, future and interpretation uncertainties.

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PROPOSITIONS

Thesis: Deepening the uncertainty dimension of environmental Life Cycle Assessment. Addressing choice, future and interpretation uncertainties

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1. The full range of LCA results due to all possible combinations of choices for allocation methods and inventory data can be shown by means of statistical methods. Not showing all (or many) possible combinations can be misleading when evaluating the environmental impacts of a production system, even more when comparing two or more systems. (Chapter 2)

2. Applying paired sampling of all parameters under consideration is the most suitable experimental setup for uncertainty analysis in comparative LCA because it is vital to account for relative uncertainties between the pairs of product-systems compared. (Chapter 3)

3. Linking coherent-worldwide integrated assessment model scenarios with background inventory data helps acknowledge epistemological uncertainty by accounting for varied socio-technical future paths of development. (Chapter 4)

4. Methods to interpret LCA uncertainty analysis results can 1) help in identifying differences and trade-offs in impacts between alternatives and point to places where data refinement could benefit the assessment (exploratory methods) and 2) establish statistical significance of the difference (confirmatory methods). (Chapter 5)

5. Relative uncertainties are particularly important as disregarding them can lead to incorrect recommendations. (Chapter 3, Chapter 5)

6. "Uncertainties in LCAs are cumbersome, easily ignored, and not wanted" (Ciroth, 2004). Yet ignoring them misses vital information on the stability of the result important for decision-making.

7. "LCA results are usually presented as point estimates, which strongly overestimate the reliability" (Björklund, 2002). Misrepresentations of the environmental impacts of products which ignore uncertainty, may lead to inappropriate decisions and undesired outcomes.

8. Acknowledging uncertainty appears important for future LCAs: "[…] the core problem is neither the method nor specific model capabilities: It is the need to predict the behavior of a nonstationary, complex system based on human behavior rather than on physical laws (Plevin, 2016). If we want to know the effect of an action over decades, the answer is necessarily uncertain, whatever method is used (Ekvall 2002; Weidema 2009)."

9. "The only certainty seems to be that the future will hold surprises" (Pesonen et.al, 2000). Exploring the future with scenarios can help guide our thinking about what directions to follow in the presence of surprises.

10. "After centuries of dormancy, young women... can now look towards a future molded by their own hands" (Rita Levi-Montalcini, 1909-2012). Further involvement of young girls and boys in science is essential to perpetuate this legacy.

11. "The human race is challenged more than ever before to demonstrate our mastery, not over nature but of ourselves" (Rachel Carson, 1907-1964). Consumption changes are fundamental for a transition to a sustainable world yet are not the only necessary changes.

12. "In science it often happens that scientists say, 'You know that's a really good argument; my position is mistaken,' and then they would actually change their minds and you never hear that old view from them again. They really do it. It doesn't happen as often as it should, because scientists are human and change is sometimes painful. But it happens every day. I cannot recall the last time something like that happened in politics or religion" (Carl Sagan, 1987).