

CONSEQUENTIAL MODELLING

- IN LIFE CYCLE INVENTORY ANALYSIS

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LATEST UPDATED FEBRUARY 2022

Overview of videos



- 1) Attributional and consequential responsibility
- 2) ISO 14040/44: A standard for consequential LCA
- 3) Fully reflecting physical and monetary causalities
- 4) Temporal issues in LCA
- 5) Learning from non-intuitive results
- 6) *The comparability algorithm*: Defining the functional unit
- 7) *The linking algorithm*: Composing a consumption mix
- 8) Identifying determining products
- 9) *The co-product algorithm*
- 10) Errors in background databases

LCA – a matter of social responsibility

- LCA is regulated in the **ISO 14000 series** on environmental management systems, particularly **ISO 14044**
- **Social responsibility** is fundamental to the ISO 14000 series: That actors should be **responsible for the consequences (impacts) of their production or consumption actions**



ISO 14040/44:

A standard for consequential LCA

- “LCA can assist in
 - identifying opportunities to improve the environmental performance of products at various points in their life cycle,
 - informing decision-makers (...), e.g., for the purpose of strategic planning, priority setting, product or process design or redesign,
 - the selection of relevant indicators of environmental performance,
 - marketing (e.g., implementing an ecolabelling scheme, making an environmental claim, or producing an environmental product declaration).”

(ISO 14040:2006 – Introduction)

When we wrote the original standard (1998) we did not think of attributional LCA. The term was not invented before 2001 and not defined before 2011.

ISO 14040/44:

A standard for consequential LCA

“Priority of scientific approach”

“Decisions within an LCA are preferably based on **natural science**. If this is not possible, **other scientific approaches** (e.g. from social and economic sciences) may be used or international conventions may be referred to. If neither a scientific basis exists nor a justification based on other scientific approaches or international conventions is possible, then, as appropriate, decisions may be based on **value choices**.”

(ISO 14040:2006 – 4.1.8 Principles for LCA)

Consequential responsibility: The product life cycle according to the ISO 14040-series

- With respect to **intermediate inputs**:
 - “The supplementary processes to be added to the systems must be those that would actually be involved when switching between the analysed systems. To identify this, it is necessary to know: (...) which of the **unconstrained suppliers/technologies** has the highest or lowest production costs and consequently is the **marginal supplier/technology** when the demand for the supplementary product is generally decreasing or increasing, respectively.” (ISO 14049, Clause 6.4)
- and with respect to **co-production**:
 - “Wherever possible, **allocation should be avoided** by dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes, or expanding the product system to **include the additional functions related to the co-products** (...) The inventory is **based on material balances between input and output**. Allocation procedures should therefore approximate as much as possible such fundamental input-output relationships and characteristics.” (ISO 14044, Clause 4.3.4.2)

Consequential responsibility: The product life cycle according to the ISO 14040-series

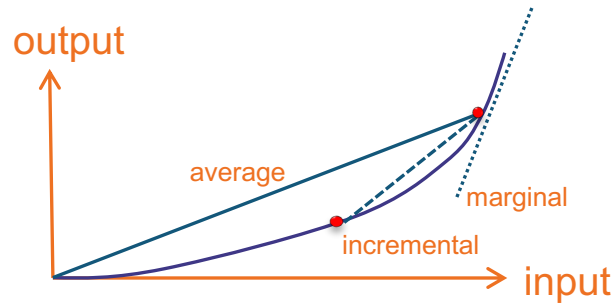
- What is reflected in these quotes is that the study of (potential) impacts must necessarily imply:
 - modelling the *changes* resulting from a (potential) decision, i.e.,
 - modelling *marginal* changes when the studied changes are small, and *incremental* changes when the changes are larger, as opposed to the average modelling implied in the delimitation of value chains and supply chains
 - For both marginal and incremental modelling “the supplementary processes to be added to the systems must be those that would actually be involved when switching between the analysed systems” (ISO 14049, Clause 6.4)

Scale of change

- **Small-scale:** A change that does not affect the determining parameters of the overall market situation, i.e., the direction of the trend in market volume and the constraints on and production costs of the involved products and technologies → **marginal modelling**
- **Large-scale:** A change that affects the determining parameters of the overall market situation, i.e., the direction of the trend in market volume OR the constraints on OR production costs of the involved products or technologies → **incremental modelling**

Cause-effect modelling

- Average, marginal, and incremental



- Consequential modelling is relevant for both marginal and incremental changes, but only marginal changes can currently be modelled systematically in LCA databases

Scale of change:

Small changes with large effects

Large, long-term changes may be the consequence of the sum of many small decisions

Small, short-term decisions have both:

- small, short-term consequences
- long-term consequences (on investments)

Consequential modeling is as relevant for small decisions as for larger decisions



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Scale of change:
Small changes with large effects



Verification of LCA

- What is verifiable?
- The whole system?
- No, but indirectly a model is verifiable by verification of its:
 - Individual datapoints
 - Individual model elements(provided that the model does not contain normative elements)

THANKS FOR YOUR ATTENTION