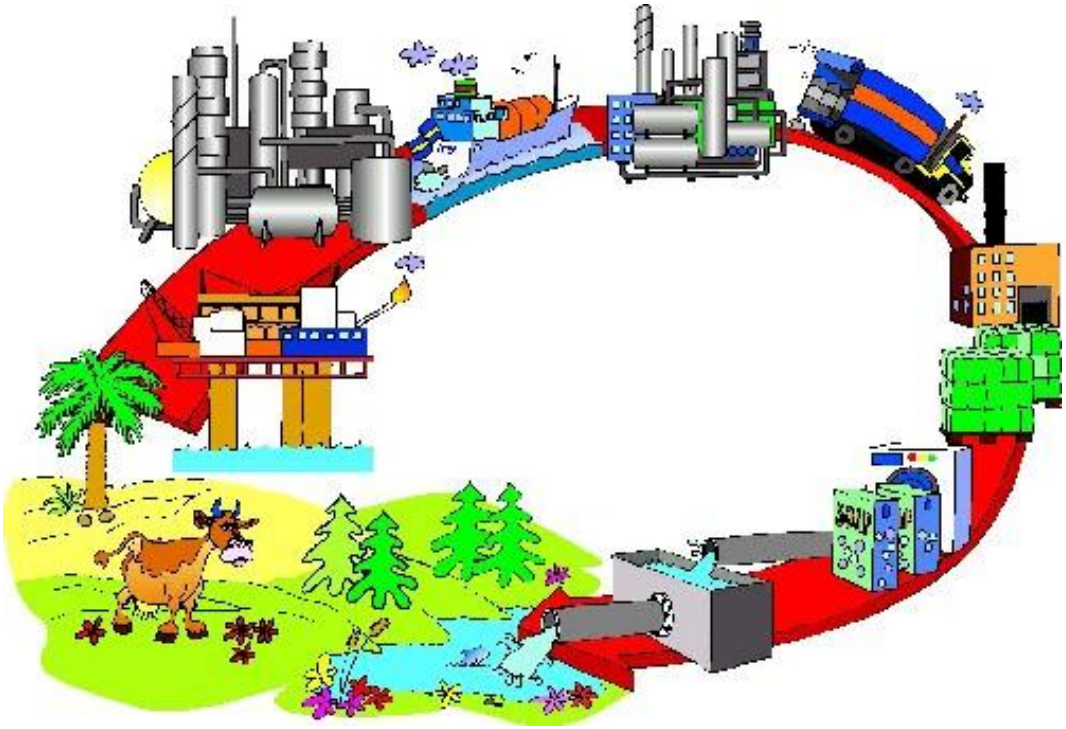
Environmental Life Cycle Assessment
PSE 476/WPS 576/WPS 595-005



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Lecture 4: Goal and Scope:

Goal definition

- Goal of study should unambiguously state (ISO 14044: 2006E):
  - The intended application
  - Reasons for carrying out the study
  - Intended audience (who will the LCA be communicated to?)
  - Whether the results are intended to be used in **comparative assertions** intended for the public
    - **Comparative assertion:** environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function.

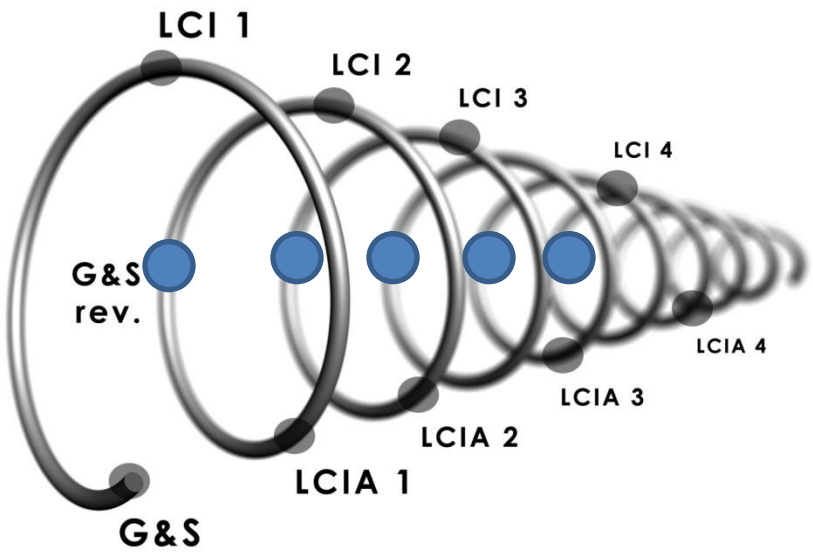
Refs: Michael Hauschild, DTU

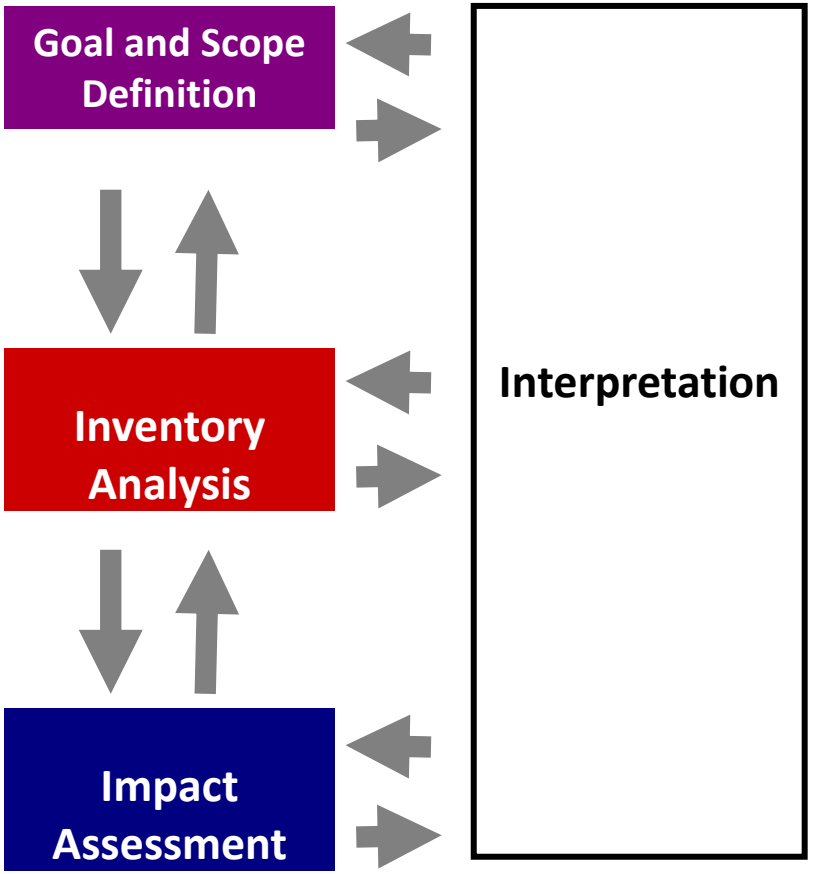
Goal definition

- **Goal:** Reasons for carrying out the study
  - ID opportunities to improve the environmental performance of products at various points in their life cycle
  - Informing decision makers in industry government, non government organizations (NGO's)
    - Strategic planning, priority setting, product or process design or redesign
  - Selection of relevant indicators of environmental performance, including measurement techniques
  - Marketing
    - Environmental claims
    - Eco labeling
    - Environmental product declaration

Refs: ISO 14044: 2006E

Goal definition





Scope

- Project Scope "The work that needs to be accomplished to deliver a product, service, or result with the specified features and functions.“

- A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fourth Edition. Project Management Institute, 2008. ISBN 978-1-933890-51-7

Scope definition

- Scope definition must be in accordance with the goal definition
- Scope definition should consider and clearly describe (ISO 14044: 2006E):
  - The product system studied
  - The functions of the product(s) studied
  - The functional unit
  - The system boundary
  - Allocation procedures
  - LCIA methodology and types of impacts
  - Interpretation to be used
  - Data requirements
  - Assumptions
  - Value choices and optional elements
  - Limitations
  - Data quality requirements
  - Type of critical review, if any
  - Type and format of the report required for the study

  - temporal scope
  - technological scope
  - allocation or system equivalency

Refs: Michael Hauschild, DTU

Functional Unit and Reference Flows

- **Functional unit:** Quantified performance of a product system for use as a reference unit (ISO 14044: 2006E)
- Reference flow: measure of the outputs from processes in a given product system required to fulfill the function expressed by the functional unit

Time, gloss, color, opacity,

Functional Unit and Reference Flows

- Example: We are critically evaluating the environmental LCA of students having breakfast. We believe there are two options that we would like to study:
  - A bowl of cereal
  - A traditional eggs and meat breakfast

- What is the functional unit?

- What are the reference flow(s)?

Time, gloss, color, opacity,

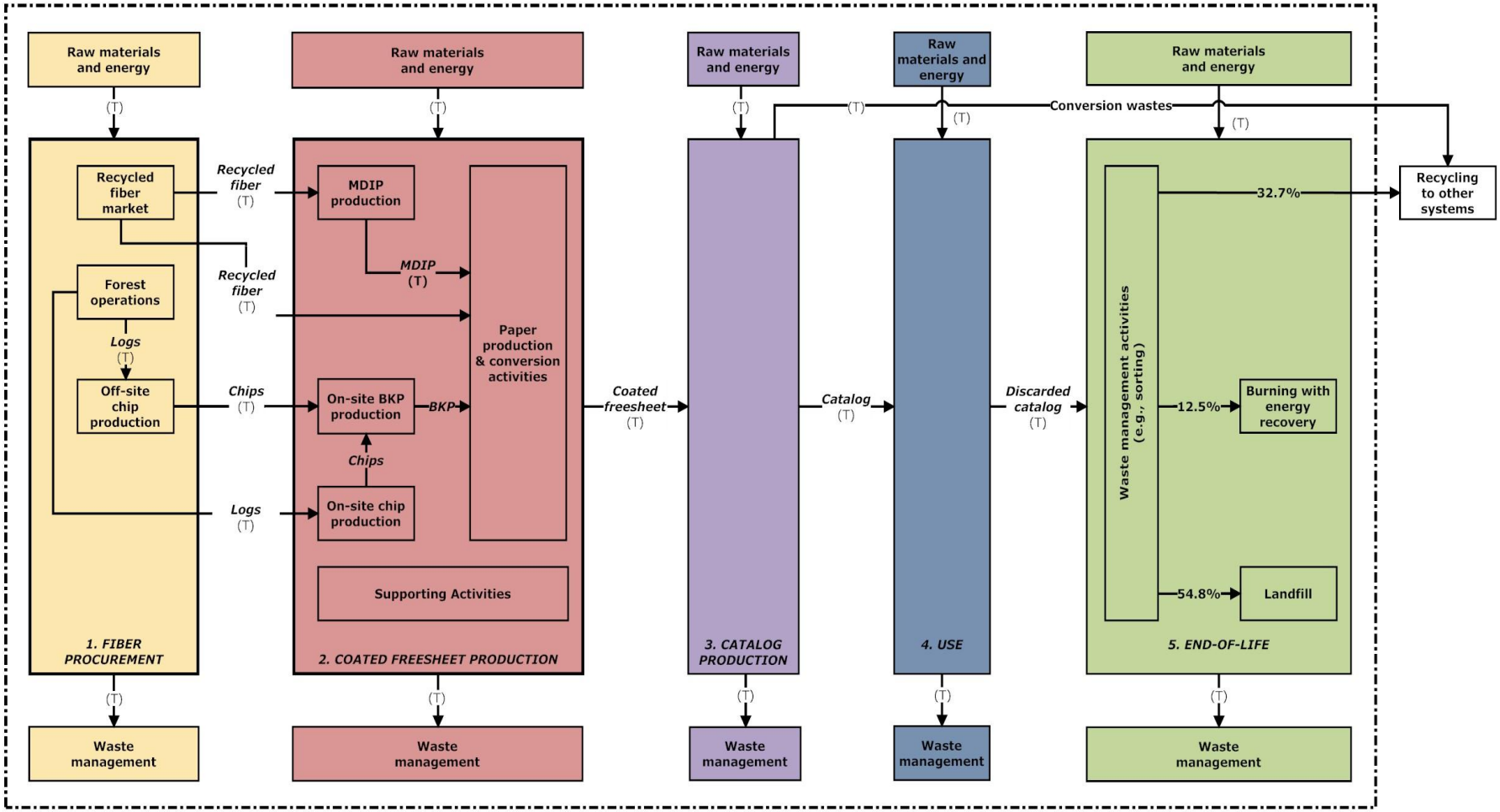
System Boundary

- Which unit processes are included in the LCA
- Must be consistent with the goal
- Deletion of a life cycle stage, process, inputs or outputs only permitted if it does not significantly affect the overall conclusions
- Any decision to omit must be justified

- Ideally, the system boundary so that inputs and outputs are all elementary flows and product flows

Refs: ISO 14044: 2006E

Example: System Boundary for a Catalog



NCASI LCA NA P&W Grades, 2010

System Boundary

- Cut off criteria: specification of the amount of material or energy flow or the level of environmental significance associated with unit processes or product system to be excluded from the study
  - Mass, all the inputs that contribute less than X% to the total mass input of the product system
  - Energy, all the inputs that contribute less than X% to the total energy input of the product system
  - Environmental significance, any input that contributes less than X% of a the environmental significance of a specially selected environmentally relevant individual data

- Similar criteria for outputs

Refs: ISO 14044: 2006E

Allocation

- **Allocation:** partitioning the input and output flows of a process or a product system between the product system under study and one or more of the other product systems

(ISO 14044: 2006E)

Allocation Procedures

- Step 1: allocation should be avoided
  - by dividing the unit process into 2 or more subprocesses and tracking data for both separately
  - Expanding the system to include the additional functions of the related co-products
- Step 2: partition the inputs and outputs between products in a way that reflects underlying physical relationships
- Step 3: partition the inputs and outputs between products in a way that reflects other relationships between them, eg, economic value

Refs: Michael Hauschild, DTU

Allocation Issues: Divide the process

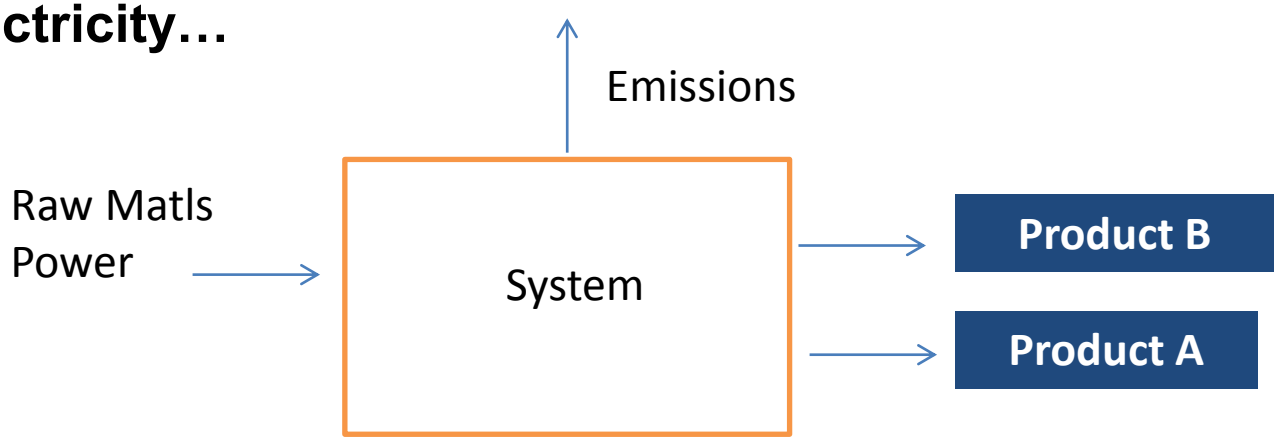
- **Example: A plastic injection molding device makes beverage containers and also makes toy parts.**

Allocation Issues: System Expansion

- **Example: municipal waste is burnt, reducing the amount of waste landfilled but also producing electricity**

Allocation Issues: Co-products:

- **Co-products Allocation: a single process produces multiple products,**
  - **Burdens can be partitioned by mass flows, volume flows, piece flows monetary values….**
  - **Must use process/product knowledge to determine partioning method**
  - **Example for paper production: paper, Tall Oil, turpentine, electricity…**

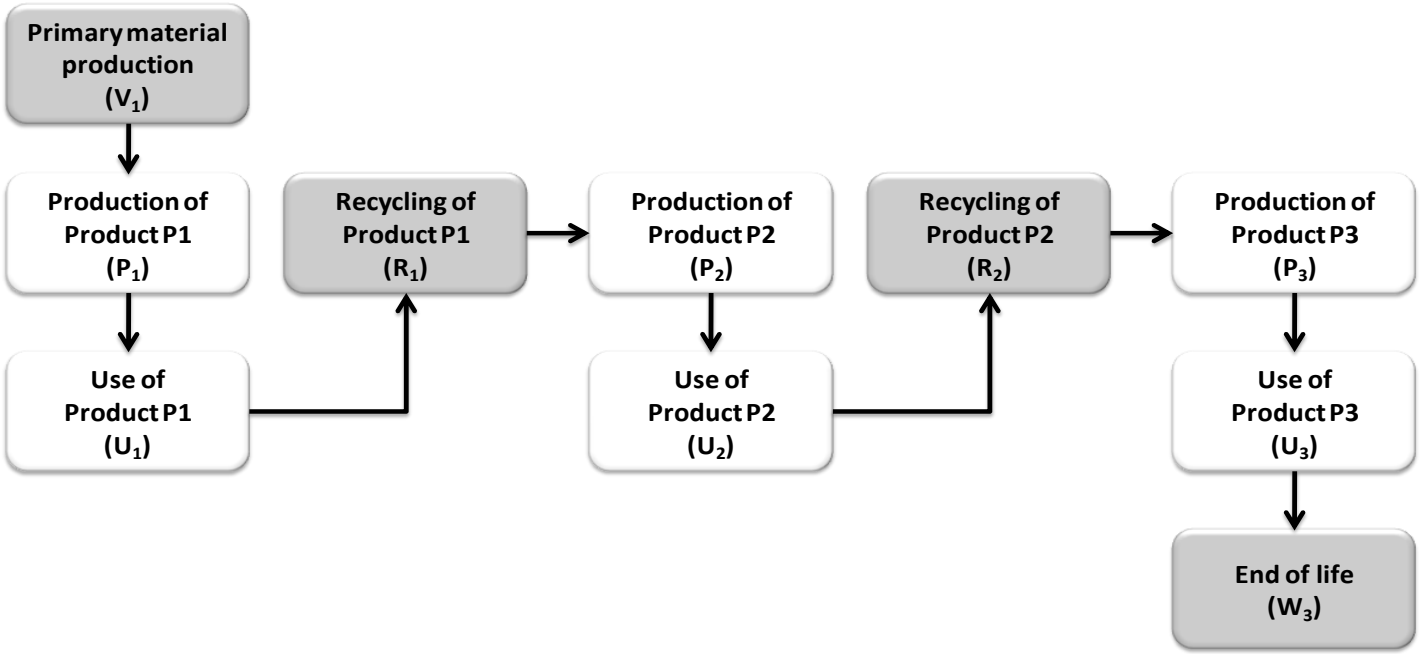


Allocation Issues: Co-products:

- **Example: Papermaking process co-products:**
- **paper**
- **tall oil**
- **turpentine**
- **electricity**

Allocation Issues: Recycling

- **Recycling Allocation: a virgin product is recycled or re-used in a subsequent life**
  - **There exists operations that are required by the virgin and the recycled products (shared operations)**
  - **Example shared operations: virgin raw material production, final disposal**
  - **Many ways to allocate the burdens of the common operations**



Life Cycle Impact Assessment Methodology and Types of Impacts

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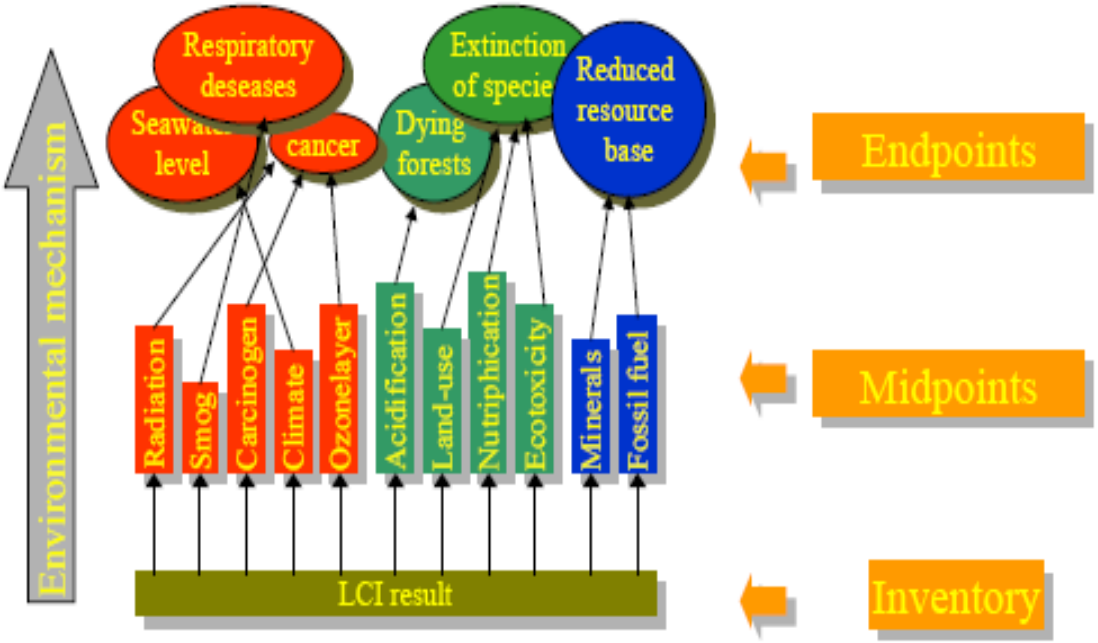

Life Cycle Impact Assessment Methodology and Types of Impacts

- TRACI, The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts
  - Global Warming
  - Acidification
  - Human health: Carcinogenics
  - Human Health: Non carcinogenics
  - Respiratory Effects
  - Eutrophication
  - Ozone Depletion
  - Ecotoxicity
  - Smog

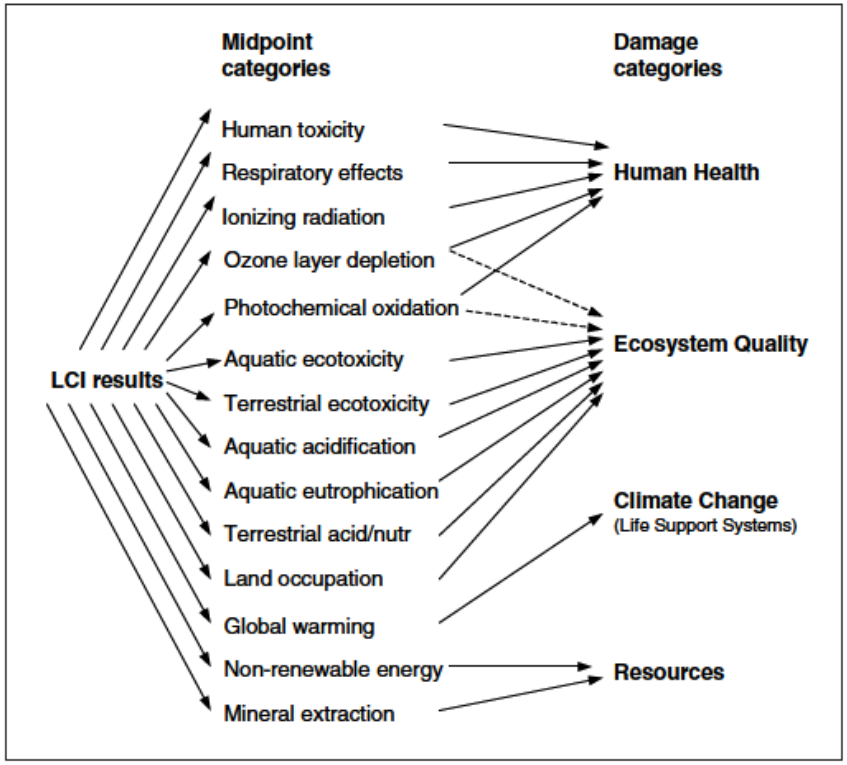

Fig. 1: Overall scheme of the IMPACT 2002+ framework, linking LCI results via the midpoint categories to damage categories, based on Jolliet et al. (2003a)

Data Quality Requirements

- Age of data
- Geographical coverage of data
- Technology data: specific or mix
- Precision: measure of variability
- Completeness: % of flow that is measured
- Representativeness
- Consistency
- Reproducibility
- Sources
- Uncertainty: for instance models

Refs: Michael Hauschild, DTU

Scope definition: Milk Example

- Design a goal and scope for milk production and sales functions up to the point of purchase.

Refs: Michael Hauschild, DTU

Milk: Goal and Scope

– Goal

– The product system studied

– The functions of the product(s) studied

– The functional unit

Refs: Michael Hauschild, DTU

Milk: Goal and Scope

– The system boundary

Refs: Michael Hauschild, DTU

Milk: Goal and Scope

– Allocation procedures

Refs: Michael Hauschild, DTU

Milk: Goal and Scope

– LCIA methodology and types of impacts

– Data requirements

– Assumptions

– Limitations

Refs: Michael Hauschild, DTU

Summary

- Goal
- Scope
- Functional unit
- Reference flow(s)
- System boundary
- Cut off criteria
- Allocation
- System expansion