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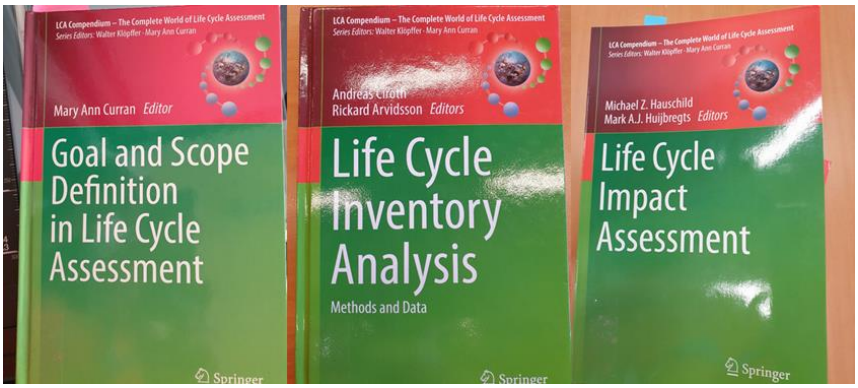
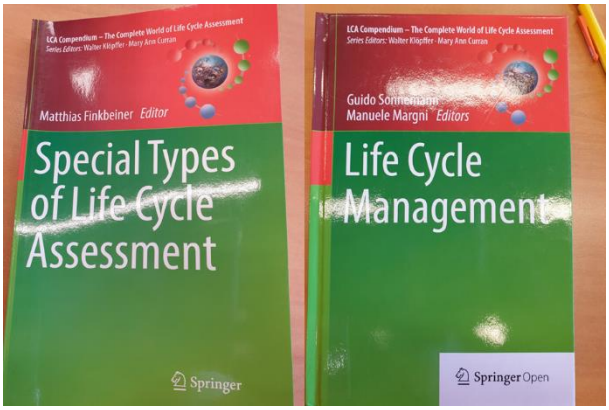
ESTUDIO ECOLOGIA : METODOLOGIA Y FUENTE INFORMACION :
0.1. COMPENDIO MUNDIAL SOBRE LA ANALISIS DEL CICLO DE VIDA (LCA) 2021.
Fuente : Universidad GUSTAVE EIFFEL, Nantes, Francia, Nov. 19 2021.

-Lista de introducción al Compendio (*Compendium*) **:**
* Libro n°1 : Historial y Perspectivas Futuras de la Evaluación del Ciclo de Vida (*Background and Future Prospects in Life Cycle Assessment).*

-Los 4 libros de la Evaluación del Ciclo de Vida (*Life Cycle Assessment)* que corresponden a ISO :
1. Libro n°2 : Objetivo y Alcance de la Evaluación de Vida (Goal and Scope Definition in *Life Cycle Assessment*).
2. Libro n°3 : Analisis de Inventario de la Evaluación de Vida (*Life Cycle Inventory Analysis*).
3. Libro n°4 : Evaluación del Impacto del Ciclo de Vida (*Life Cycle Impact Assessment*) :
4. Libro n°5 : Interpretación, Evaluación Crítica y Reporte (*Interpretation, Critical Review and Reporting*).



-Otro libros afuera del la estructura ISO de la LCA :
*Libro n°6 : Applications of LCA.
* Libro n°7 : Tipos Especiales de Evaluación de Ciclo de Vida (*Special Types of Life Cycle Assessment*).
* Libro n°7 : Gestión del Ciclo de Vida (***Life Cycle** Management*)
* Libro n°8 : Life Cycle Sustainability Assessment.



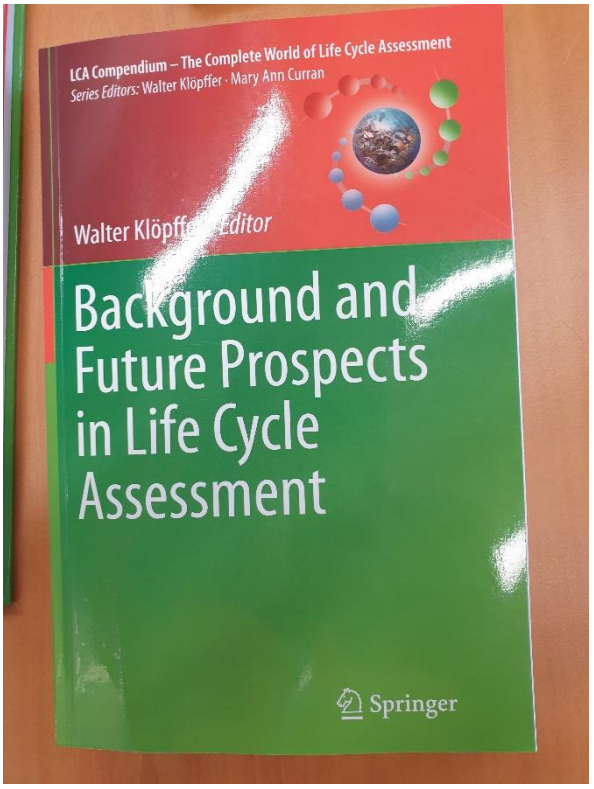
Book n°1 :
Background and Future Prospects in Life Cycle Assessment :

CHAPTER 1 : Introducing Lfe Cycle Assessment and its Presentaction in 'LCA Compendium'.

Summary :

I WHAT IF LIFE CYCLE ASSESSMENT ?

Life Cycle Assessment (LCA) is a science-based, comparative analysis and assessment of the environmental impacts of product systems.



1. It has two distinctive features with other methods and allows to compare productive systems :
The analysis is 'cradle-to-grave'.
All the important steps in the life cycle of a product are included in the analysis;
* Extraction of raw materials from the environment; soil, water, air etc.
* Production of materials.
* Production of final product.
* Use of final product.
* Waste removal or recycling.
* All kind of transport involved.

The 'functional unit'.

2. ´Products are defined as 'Goods and services´ in all relevants standards.
Product or good is tangible and requires also energy sources and processes.
Service is intangible but requires also energy sources and processes.
Life cycle can also apply to a functional unit.

3. The 'life cycle´is the physical life, not the 'marketing cycle´, that starts earlier with planning, R&D and design, until the product is taken out to the market.

4. A Life Cycle Costing (LCC) can be added to a LCA but great care has to be taken to avoid confusion, and in that case the LCC should be better called ´Environmental LCC´ to show that it adheres to the physical life.

5. Functional unit is the basis of comparison of product systems, example packaging of 100 l of a beverage and its transport to the selling point.
Small differences between products like aesthetic of no importance on environment are neglected.
But the definition of boundaries with the environment and technosphere is of paramount importance; it must be provide in the Goal and Scope of Definition.
Product is more product systems as it is more than the material product or the service it seld but comprehends also a multitude of upstream and downstream processes; intermediate products, transport processes, packaging and energy use etc.

-The use phase 1 starts the End-of-life phase (EOL) phase (waste management and recycling).
Two consequences :

1. A construction of the product tree has to be done on the basis of the best available information and may require some research.
2. The system has to be tailored and small amounts of residual inputs and outputs need to be cut off.
The boundaries have to defined in the same way.
-In the phase n°2 Life Cycle Inventory, the smallest units for which data are available are drawn as a boxes which are interconnected with other unit processes from which they obtain inputs and to which they transfer substances, materials and energy.
Release into the environment (emissions) leave the system.
They are also imports from the environment inf the form of oil, coal, gases, amterials, water, radiation from the sun etc.
The system of the LCA is part of the technosphere, whereas the environment is receiving releases and provides inputs at the interface between the two spheres.
-In the phase n°3 called Life Cycle Impact Assessment LCIA, are studied the specific interactions between environment and technosphere,
-and discussed in the **4th Phase of Interpretation.**
-The success of LCA lies in its broad applcations to all product systems for which data can be generated and allow comparison with competint of improved systems.
This provides opportunity to improve product and the technosphere, and thus the environment.

II LCA : HOW IT CAME ABOUT.

2.1. Early time.

-1970-1990; first Proto-LCAs, the emphasis was on energy saving and resource conservation rather than on pollution.
Proto- LCA consisted only of a life cycle inventory
-1983; first PhD by Franke at Berlin University.
-1985; Sweden, Jensen, LCAs on carton packaging (Tetra Pack).
-1992; USA, Franklin Associate Ltd, first LCA with Coca-Cola.
-1995; France with Blouet & Rivoite, of Ecobilan in Paris, inventory allocation.

2.2. Harmonisation by SETAC.

- 1990-1993 :
- Aug. 1990 : SETAC (Society of Environmental Toxicology and Chenistry); basic discussions. Workshop Vermont USA; 1rst LCS-structure;

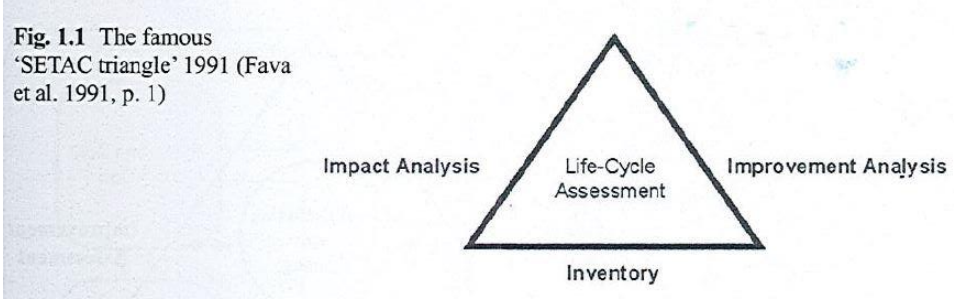
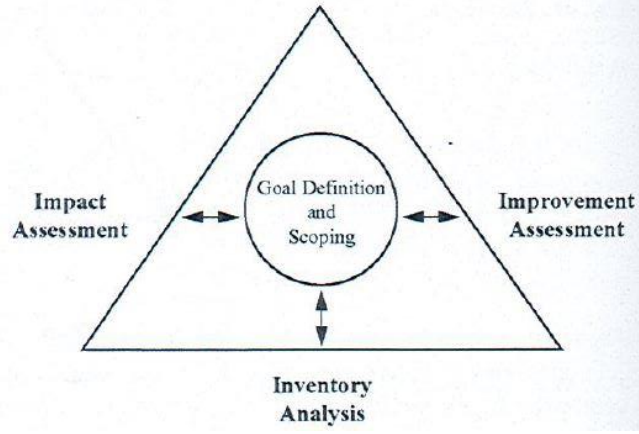


Fig. 1.1 The famous 'SETAC triangle' 1991 (Fava et al. 1991, p. 1)

'SETAC triangle' = Inventory + Impact Analysis + Improvement Analysis.
1. Inventory.
2. Impact Analysis.
3. Improvement Analysis.

*1993 : revision the frameworkand inititation of standardisation process; 'Guidelines for Life-Cycle Assessment; A Code of Practice".

Fig. 1.2 LCA structure in the SETAC 'Code of Practice' of 1993. p 11



Now four components =
1. Goal Definition and Scoping (novelty)
2. Inventory Analysis; materials and energy acquisition, manufacturing, use, waste management.
3. Life Cycle Impact Assessment (focus of LCA); LCIA ecological health, human health, resource depletion.
*Classification; assigning the data from the inventory table to impact categories
* Characterisation; aggregation of impact with the impact categories
*Valuation; weighing of impact results in case of unclear situations.
4. Improvement Assessment. 5. An interactive peer review process was also added.

2.3. Autumn 1993-2000, Paris, International Standardisation Process by ISO;
Still four components =
Goal Definition and Scoping
+ Inventory Analysis
+ Impact Assessment
+ Interpretation Analysis (instead of Improvement Analysis).
Peer review became 'critical review'.

-1997; ISO 14040, first international standard, was the 'mother' of all subsequent LCAs.
ISO 14041, ISO 14042, ISO 14043.

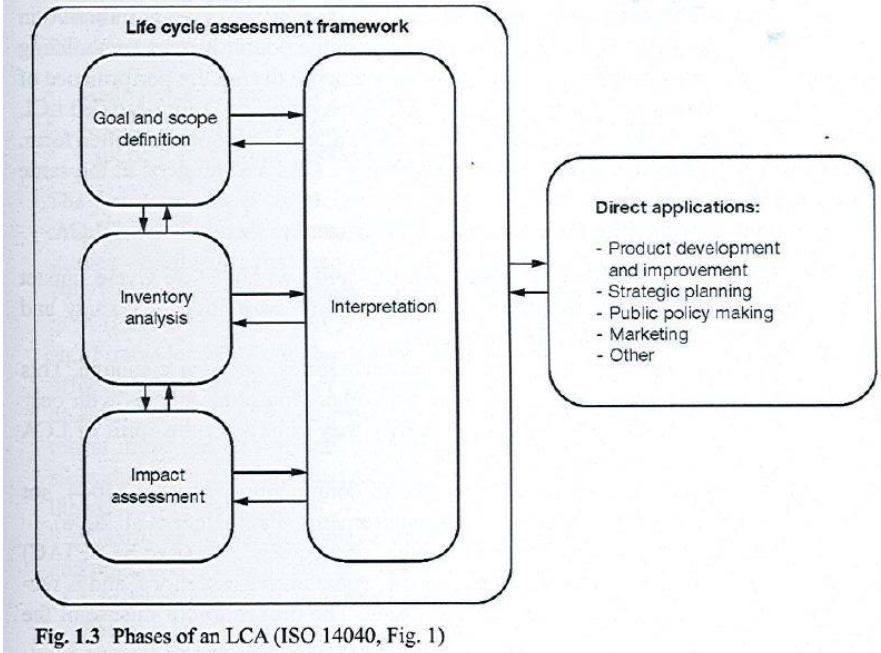


Fig. 1.3 Phases of an LCA (ISO 14040, Fig. 1)

Became the uncontested model of an environmental life cycle standard.
-2006; series 14040 revised and condensed in 14040 and 14044.
-Direct applications of LCA frame :
* Product development and improvement
* Strategic planning
* Public policy making
* Marketing
* Other
-Changes from SETAC frame :
1. Only one change; Improvement Assessment became Interpretation.
2. Ue of double arrows; phases can be modified during the performance of a LCA.
-Other rules :
1. An LCA has to consist of *all* stages.
2. An LCIA has to consist of a *set* of impact categories, one is *not* enough.
Example; the so-called carbon footprint only is NOT a LCA.
3. The norm 14040 has to be used in conjunction with ISO 14044.
4. A critical review is obligatory for LCA studies to be used for 'comparative assertions´.
-It became the uncontested model of an environmental life cycle standard.

2.4. Recent trends.
-Make it simpler and more flexible.
The Life Cycle Management LCM offered a broader palette of methods; 'tool box´.
Any simplified LCA studies should be used internally only.
-Reduce the life cycle impact assessment to one impact category.
En vogue recently especially under the name of ´footprint´, most for ' carbon footprint' CF , just another name for = Global Warming Potential CWP caused by the Green House Gas GHG emissions, mainly carbone dioxide CO2, methane CH4 and dinitrogen N2O2, also sulfur hexafluoride SF6, both last one do not contain Carbone, which is a technical problem.
A CF study is not a LCA.
Another footprint is that of water as a scarce resource, that recently has been integrated as an impact category
-Expand the environmental LC to a life-cycle bases sustainability assessment.
Interpretation of sustainability has three pillars; environmental (LCA), economic and social aspects, and all three have to weighted.

$$LCSA = LCA + LCC + SLCA$$

LCSA: Life Cycle Sustainability Assessment
LCA: (environmental) Life Cycle Assessment
LCC: (environmental) Life Cycle Costing
SLCA: Social Life Cycle Assessment

In order to give the full picture, the LCA should be accompanied by the LCC and and the SCLA.

It is essential that the boundaries of the three systems be equal.
But whereas LCA is already standardized (ISP 2006a,b), the LCSA has been recognized by SETAC only recently 2009, LCC has already a ´SETAC Code of practice' in 2011.
A kind of poorness index has been proposed.

III THE STRUCTURE OF LCA ACCORDING TO ISO 14040 AND 14044 : FOUR PHASES.

3.1. Goal and Scope of Definition.

The reat role of G&SD rests in the standards which are strict in some items; structure, origin of data, reporting, reviewing but loose in others.
Example in LCIA; noimpact categories, indicators and characterization factors are prescribed but any LCA must include a well-founded list of impact categories.
Some other standards require a collective G&SF for a group of related products in the form of so-called product category rules PCR; this the case of the Environmental Product Declaration EPD also called ´Level 3 labelling'.
Standards and conventions are not laws but become de facto when a ordinance how a law has to use them in practice.
The kind of critical review has to be declared including names.

3.2. Life Cycle Inventory Analysis; LCI is the core of any LCA study.

It is the most quantitative and scientific component.
Minimums steps to be followed :
1. System definition(s) including graphical presentation of the product trees.
2. Definition of the functional unit and the reference flow(s).
3. Date collection; input and output, foreground data has to be requested from producers.
4. Implementation of the dat into the system; applying a predetermined cut-off rule and allocation rules, if appropriate.
5. Performing the calculations; in Excell data sheet where LCC can be combined to pave the way to LSCA.

Commercial or home made software (?) is used in this phase.
The main result of LCI is the inventory table listing all inputs and outputs per unit process and aggregated per fu.
For partial LCIs; e.g. cradle-to-factory, gate or cradle-to-point of sale instead of cradle-to-grave, the results can also be related to a a mass unit per kg or t.

3.3. Life Cycle Impact Assessment.

Somewhat loose content because the European delegates more on the precautionary principle, 'less is better' and 'beyond compliance' whereas the Americans favoured risk assessment and compliance with existing legislation.

A. Mandatory elements : should already exist in G&SD but have to be refined.

-Selection of impact categories, category indicators and characterization models
-Assigment of LCI results (classification)
-Calculation of category indicator results (characterization) is a genuine impact assessment element and requires knowledge of the interrelation between releases.
-Category indicator results (LCIA results, LCIA prodile)

B. Optional elements.

-Calculation of the magnitude of category indicator results relative to reference information (normalization)

-Grouping
-Weighting

3.4. Interpretation.
It is the counterpart of the G&SD and essentially has to secure that the first three phases are well tuned and consistente.
A critical review has to be done if the study is intended to be used in comparative assertions to be disclosed to the public.
Structure :
-Identification of significant issues.
-Evaluation; Completenss check, Sensitivity check, and Consistencia check.
-Conclusions, limitations and recommendations.

IV THE STRUCTURE OF LCAS BEYOND ISO 14040.
4.1. Applications of Life Cycle Assessment.
- Product development and improvement
- Strategic planning
- Public policy making
- Marketing with environmental arguments and claims, based on environmental labels and product declarations (SPDs) is also regulated by the international standard series ISO 14020 ff.

The most demanding is 15025 (ISO 2006c) is firmly based on LCA 2006a and product category rules PCR a kind of common G%SD for group of similar products.
* Other

4.2. Beyond the Classical ISO LCA; considered as within the LCA.
-Footprint. -High degree of regionalization.

4.3. Life Cycle Management : LCM.
Important in industry and goes beyond LCA.
BASF; 'eco-eficiency' assessment of product systems method (LCA+LCC).

4.4. Life Cycle Sustainability Assessment; LCSA.
It goes further than 'eco-efficiency'.
The term´sustainability´is used today in a loose (sloppy) way meaning anything from environmental friendly, green, low carbon or even constant economic growth rates.

4.5. LCA worldwide.
-1992 UNEP (United Nations Environment Progam) in Rio de Janeiro paved the way to world-wide dissipation and acceptance, as sustainable development was declared as the guiding principle of the twenty-first century.
LC methods were specifically introduced and recommended.
LCA societies, networks and working groups have been founded.
Regionalisation brings enormous data problems.