Value judgment integration model for allocation in LCA

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1. Introduction and context

- 1.1 Why LCA
- 1.2 What is doing LCA ?
- 1.3 Is the methodology finished and OK ?
- 1.4 Methodology under development

2. LCA a new model

- 2.1 Unified Theory of Allocation
- 2.2 Some correction proposal
- 2.3 Consequences

3. Summing-up results

4. Perspectives

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Different impacts reports.

FIGURE 1 : Rebound principle, toward other life stages

FIGURE 2 : Rebound principle toward other nature of impacts.

Large indicators sets (~15 in usual LCA methods, $\exists$ 200 indicators in social LCA) clustered in 4 to 5 categories.

LCA aims at AVOIDING IMPACT REPORTS, without control, from one life cycle stage to another, from one indicator to another.

Schema global de l'Analyse en Cycle de Vie.

FIGURE 3 : Flows that count, a bit of LCA's vocabulary. ILCD Cycle modified [1].

- LCA -> Comparison. the key = FUNCTIONAL UNIT (F.U.)
- Ecosphere = no human intervention (before input flow, after output flow).
- $\sum$ elementary and products flow = **INVENTORY** (When multi-functionality is solved, no product remains.)

Impacts methods

FIGURE 4 : Different levels of information in LCA. From inventory to end-point [1, ILCD's guidance Fig. 15].

LCA, a normalized framework

FIGURE 5 : Normalized framework of LCA according to ILCD [1, Figure 1 p.1 Framework for life cycle assessment (from ISO 14040 :2006 ; modified)].

Born in...

FIGURE 6 : Historical development of LCA and context. Expansion of Chen's work [2].

FIGURE 7 : Decision support interrogation

Table 2 Combination of two main aspects of the decision-context: decision orientation and kind of consequences in background system or other systems.

Decision support?		Kind of process-changes in background system / other systems	
		None or small-scale	Large-scale
Yes		Situation A "Micro-level decision support"	Situation B "Meso/macro-level decision support"
No		Situation C "Accounting" (with C1: including interactions with other systems, C2: excluding interactions with other systems)	

1st publication of ISO standard

ISO14040:2006 revision

ILCD

Open recognition of standardisation failure (Weidema, 14)

Standardisation march

- not recognising systematic decisional context
- insufficient cross-domain communication to solve complexity

Recognition of failures leads to improvement

Has ISO 14040/44 Failed Its Role as a Standard for Life Cycle Assessment ?

Bo Weidema 2014 [3]

"There is a different, but related, conflict in interpretation with respect to the allocation rules for recycling, both among practitioners and guidelines. [...] The difference in interpretation is related to—or at least amplified by—an ambiguity in ISO 14044."

Controversial and unspoken theme of... Values. "From behind the curtain : talking about values in LCA" Freidberg 2015 [4]

A criticised methodology, 15 unresolved problems

Ambiguity
 + Absence of value judgement global integration

= Large scale issues, non-operational methodology and tools

FIGURE 8 : A survey of unresolved problems in life cycle assessment 2008 [5].

Table 1 LCA problems by phase

Phase	Problem
Goal and scope definition	Functional unit definition ^a
	Boundary selection ^a
	Social and economic impacts ^a
	Alternative scenario considerations ^a
Life cycle inventory analysis	Allocation
	Negligible contribution ('cutoff') criteria
	Local technical uniqueness
Life cycle impact assessment	Impact category and methodology selection
	Spatial variation
	Local environmental uniqueness
	Dynamics of the environment
	Time horizons
Life cycle interpretation	Weighting and valuation ^a
	Uncertainty in the decision process
All	Data availability and quality

^a One might reasonably consider these problems to be pivotal decisions.

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What we see of an Ice-berg : Allocation, maths

Unified Theory of Allocations and Constructs in Life Cycle Assessment and Input-Output Analysis, some of the formalism. Majeau-Bettez et al 2014 [6, eq. 11 eq. 38],

Z Commodity i used in activity J to produce commodity j . U_{ij} the use of i for activity J ; V_{ij} the production (supply) of i by activity J

$$\underline{a}_{ijk} = u_{ij} \frac{\psi_{kj}}{\sum_{j \in \bullet} \psi_{jj} v_{jj}} \quad (1)$$

$$\forall k | (k, J) \in \mathcal{J}, i \in \bullet, J \in *$$

Majeau-Bettez

- ψ_{kj} mono-criterion allocation
- implicit and absolute preference

$$a_{ijk} = u_{ij} \sum_{n \in N} \frac{\psi_{nkj}}{\sum_{j \in \bullet} \psi_{nj} v_{jj}} \text{Pref}(\psi_{nj/N}) \quad (2)$$

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- ψ_{nj} multi-criteria allocation
- Explicit relative preferences (priority vector)

$\text{Pref}(\psi_{nj/N})$ could be expressed by geometric mean $p_i = \frac{\sqrt[n]{\prod_{j=1}^n A_{1j}}}{\sum_{i=1}^n \sqrt[n]{(\prod_{j=1}^n A_{1j})}} \quad 1$

1. Criticized by Saaty [7], 4 methods are shown in Ishizaka's work [8].

Judgement matrix building. SAATY AHP

FIGURE 9 : Pairwise comparison matrix principle, inspired by SAATY [9]

Pairwise Comparison				
Capacity Comparison	Receptacle A	Receptacle B	Receptacle C
Receptacle A		C1/C1	C1/C2	C1/C3
Receptacle B		C2/C1	C2/C2	C2/C3
Receptacle C		C3/C1	C3/C2	C3/C3

Reciprocal structure of pairwise comparison matrix for receptacles

Inspired from SAATY JOURNAL OF SYSTEMS SCIENCE AND SYSTEME ENGINEERING / Vol. 13, No. 1, March, 2004

p.3 Decision Making - The Analytic Hierarchy and Network Processes (AHP/ANP)

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Wili Murray (Willscrib), Beverage_Glass_(Tumbler).svg

Wili Murray (Willscrib), Bouteille_(for_screen).svg

TABLE 1 : The Fundamental scale of absolute numbers [9].

Intensity of Importance	Definition
1	Equal importance
2	Weak or slight
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong or demonstrated importance
8	Very, very strong
9	Extreme importance

Reality scarcely enables us to be consistent. A Melchizedek or Midas of Champagne (30 L), **crazy glasses** I fit in.

Axiological thinking is not simpler.

Not limited to AHP. What matters : the 'consistence' between decision-maker's values and the used technique.

Allocation on heterogeneous objects

Previous studies on multi-functionality treatment failed because mono-functional processes hardly exist :

GUINEE, CALCULATING THE INFLUENCE OF ALTERNATIVE ALLOCATION SCENARIOS IN FOSSIL FUEL CHAINS [10] "[...] a common physical parameter cannot be determined or derived, and therefore economic allocation has been applied here again."

	PRODUCT 1			PRODUCT 2			SCALE AHP	
TEST	EUR	kWh	KG	EUR	kWh	KG	PDT 1 SHARE	PDT 2 SHARE
A	2	6	15	8	7		39,3%	60,7%
B		102	56	24	15	33	21,3%	78,7%
C	13		32	25	16	19	37,1%	62,9%
D	14	104			17	12	77,6%	22,4%
E	10	100	11	22		27	37,1%	62,9%
DISSOCIATE	10		25		13		90,8%	9,2%

SO IT IS POSSIBLE TO ALLOCATE PRODUCTS WITHOUT THEM TO SHARE THE SAME PROPERTIES OR FUNCTIONS (NOT FALLING IN 0% - 100% SHARES).

A new perception of waste and products

FIGURE 10 : Co-treatment perspective, defining a new frontier for waste.

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- Enables heterogeneous functions confrontation
- The value declaration step shall target all LCA's phase
- Key for LCA's legitimacy as a decision aiding tool providing value input is not confiscated to those submitted to consequences of the decision

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On going of the LCA's methodology's correction

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^a One might reasonably consider these problems to be pivotal decisions.

- Develop explicit value judgement integration
- Operationalisation of the model to agent based modelling of LCA
- Building of a free-open wiki-based scientific journal **Journal scientifique libre (wikiversity project)**.

Thank you for your attention

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Slides available on HAL archive (or soon).

Discussion on Wikiversity: [Here](#)

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A new framework

FIGURE 11 : Schematic steps expansion to include processes and functions. Value (behind what is seen as functions) is not represented.

Life cycle impact assessment. Developed schematic steps from function to function crossing processes, inventory to category endpoints, (normalisation and weighting not shown).

This leads to agent based modelling.

Respectively a new standard

Preferences and consistency, why not-Fuzzy AHP

Consistency index :

$$CI = \sum_1^n \frac{AP_i}{P_i}$$

For a matrix $A(n \times n)$ (n attributes) one priority vector $P(p_i)$ could be given by^a :

$$p_i = \frac{\sqrt[n]{\prod_{j=1}^n A_{1j}}}{\sum_{i=1}^n \sqrt[n]{(\prod_{j=1}^n A_{1j})}}$$

a. Criticized by Saaty [7], 4 derivation methods are shown in Ishizaka's work [8].

The consistence ratio is determined by ratio between Consistency Indexes, one from the decision maker, the other random version of the same size.

$$CR = \frac{CI}{RI}$$

FIGURE 12 : Random index (RI) [9]

n	1	2	3	4	5	6	7	8	9	10
Random Index	0	0	.52	.89	1.11	1.25	1.35	1.40	1.45	1.49

Do not produce a consistent matrix out of an inconsistent one. Search for extension of the dimensions (classification and ontological issues generating the in-consistence).

The open-free journal protocol. Translation of a friend

FIGURE 13 : Principle of Journal Scientific Libre

我们为公共研究提出了一种全新的发布模式，一种自由的科学研究杂志。
我们这样做是为了避免在写作、阅读和审查中可能存在的任何瓶颈，
并利用集体的努力，来换取知识的聚集。

MENG Chao 2015 01 27. Chinese translation of Journal scientifique libre expl.svg
Illustration Journal Scientifique Libre model attributes.

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