

A review of three textbooks for LCA have been published as Weidema B P, Brandão M. (2019): Book Review. Journal of Industrial Ecology. This file provides more detailed comments for one of the textbooks:

Detailed comments on the ILCA assessment criteria for a good beginner's LCA textbooks for Hauschild, M.Z., Rosenbaum, R.K. and Olsen, S.I. eds. (2018). *Life Cycle Assessment: Theory and Practice*. Springer.

By Bo P. Weidema & M. Brandão

General requirements

Low (or no) price

€95.19 (Electronic version; February 2018)

Up-to-date

Large parts based on the ILCD Handbook, which gives a very specific perspective on some topics, that do not necessarily reflect current general practice nor scientific consensus.

Readability (Numerical score: Flesch–Kincaid test, using word length and sentence length, applied to textbook introduction)

Text is often overly convoluted and complex. At times imprecise and even ambiguous. For example, "The 100-year time horizon adopted in the Kyoto Protocol includes impacts of the first 100 years of every greenhouse gas emission, regardless of when the emission occurs, cutting off only the so-called 'tails' of the emissions that are left 100 years after the emission." Flesch–Kincaid score: 18.5 (Very difficult).

All new topic-specific terms explained when introduced and/or in glossary

Comprehensive glossary (12 pages), where each entry is referenced (although in the case of "Environmental aspect" the reference is incorrectly to ISO 14044 (should have been ISO 14001). Some definitions are taken from the ILCD Handbook and are rather imprecise, bordering to the meaningless, e.g. the terms "Attributional modelling" ("...all processes of a system as they occur..."), "End-of-Life product" (def: Product at the end of its useful life...), "System" and "System expansion". The book applies the old term "Environmental intervention" rather than the parallel "Elementary exchange" (recommended by ilca.es), both being broader than "Elementary flow" (ISO 14044). There is no separate definition of Environment. The term "environment" and especially "environmental" is used implicitly in the book as meaning "natural environment" (un-managed ecosystems and landscapes), i.e. excluding the social and economic environment.

Mentions alternative terms used in practice, to provide the student with an appropriate vocabulary to comprehend the general literature that use these alternative terms

Two definitions are provided for "waste", but these are not internally consistent, and their rationales are not further explained.

Does not introduce unnecessary terms or use terms in other ways than usual, unless clearly justified and announced

Given the size of the author team, terms may be used in different ways. The definition of "Releases" (Emissions to air and discharges to water and soil) is not used consistently throughout the book. Many places "emissions" (and one place even "discharge") are used for the totality of releases in an LCA.

Logical structure, avoiding repetition and avoiding introducing topics that later turn out to be unnecessary

The size of the book, along with the size and composition of the author team (a total of 68 authors, often junior researchers, contributing to 40 chapters, yielding over 1,000 pages of text) makes it virtually impossible to completely eliminate repetition. However, the division of the book in 5 parts (each consisting of several stand-alone chapters) minimises this concern.

Contextualizing LCA within its broader field

The Introduction part consists of 55 pages that make 5 chapters. Therefore, the book offers a comprehensive introduction of all topics pertinent to LCA: from its history and applications, over strengths and limitations (Ch. 2.3), to a dedicated chapter on "LCA and Sustainability", where it is reported how the scope of LCA has been continually increasing. There is no systematic comparison of LCA to other related tools. On limitations, one important limitation that is not mentioned here is that LCA cannot be used to identify what questions are the best to ask, what environmental issues are the most important in general, i.e. to identify hotspots outside of the product system or comparison that one has chosen to assess.

Clear relationship to Life Cycle Costing and Life Cycle Sustainability Assessment

Chapter 15 is dedicated to Life Cycle Costing (LCC), both conventional LCC (thoroughly introduced with reference to several international standards), Environmental LCC, which is presented as one of three pillars of Life Cycle Sustainability Assessment (LCSA), and Societal LCC (unfortunately somewhat misrepresented in Table 15.2). Figure 15.2 comparing the three types of LCC has been modified from UNEP but misunderstanding and misrepresenting the meaning and intentions of the original figure. Several definitions provided (in Table 15.1) are imprecise (value added, inflation rate, exchange rate) and inflation correction is misunderstood (and used to increase future costs based on current costs and the inflation rate, rather than for calculating current prices from costs of previous years). It is (incorrectly) stated that system expansion is not performed in Environmental LCC and an example (incorrectly) presents revenue allocation as a procedure for allocation in a combined production situation (in a petroleum refinery). Discounting is introduced but without an explanation on the difference between private and social values (opportunity costs and intergenerational equity, respectively) that provides the rationales for the different private and social discount rates. Instead the text presents the controversial suggestions that different internal and external costs should be discounted differently and that a low discount rate (0.0001% !) should be applied in the very long term, implying that equality would be given no importance in an intergenerational context. LCSA is introduced in Section 5.5, but strongly biased in favour of an absolutist (strong sustainability) view that does not allow trade-offs for overshoots on carrying capacity (which harmonises badly with deciding on how to deal with the situation where more than one absolute value exists) and considers that "the costs quantified by LCC are only relevant to sustainability if these costs apply to the poor" (while a weak sustainability view would be that costs are costs - like impacts are impacts and if internalised they still exist and should be accounted for - whoever they accrue to, and while

any inequalities in costs or impacts of course needs to be taken into account, this does not make any cost become irrelevant). The introduction to LCSA does not provide any of the many reasonable arguments for "weak" sustainability. A more balanced discussion would present both viewpoints, their strengths and weaknesses (e.g. also the impossibility of handling trade-offs in the strong position and its political implications) and possibly a discussion. The description on Section 6.2.3 also stresses the difference rather than the commonality between LCA, LCC and Social LCA and no discussion is provided of the (missing) distinction between what is social and what is "environmental".

Basic concepts are introduced

Comprehensive Introductory part introduces basic concepts, and most chapters start from a basic level.

Introduces basic quantitative skills required

Learning outcomes specified at the beginning of all chapters until the demonstrations of specific LCA applications to technologies (chapters 26 and beyond). Despite the existence of a section on "target audience" in the first chapter, no requirements on quantitative skills are mentioned. Chapter 9.4 "Constructing and quality checking unit processes" introduces a number of procedures for quality checks, such as mass balancing.

Clear relation to ISO standards

The textbook follows the ISO 14040/44 structure, and terms are kept consistent with that standard.

Provides additional detail and explanations relative to ISO

The textbook provides considerable additional detail and explanations relative to the ISO standards, borrowing from the wealth of published methods available in the published scientific literature, not least the ILCD handbook.

Quantitative uncertainty and data quality clearly stressed throughout in an operational manner

Uncertainty and data quality are mentioned in the Introduction chapter, and again in the Introduction to LCA methodology (ch. 6), LCIA (ch. 8), LCI (ch. 9), LCIA (ch. 10) and in a dedicated chapter to Uncertainty (ch. 11) and again in Interpretation (ch. 12). Several subsequent chapters mention the issue too, until Future-oriented LCA (ch. 21) deals with the issue more in-depth.

Rigour and prudence throughout the text, and providing rationales for any normative statements

The text, and particularly the chapter on Goal and Scope definition (ch. 8) borrow heavily from the ILCD classification of situations, as contexts defining the approach and data to follow. This is not entirely rigorous and mutually-exclusive.

Providing rationales and practicable procedures for all recommendations

See comment above on rigour and prudence. The procedures are generally explained and illustrated.

Text and calculations checked for errors

Contains typos and would benefit from proof-reading.

Real-life examples throughout, illustrating good practice and the points made in the text
Several chapters (26-36) represent case studies of the application of LCA to specific technologies.

Relevant and tested exercises provided
No exercises are provided.

Additional resources provided for download
No

References to relevant further reading
Yes

Option for providing feedback to authors (and having responses)
No

Specific content requirements

Introduces setting of goal and scope, including the core distinctions of average versus marginal modelling
One dedicated chapter to goal definition (ch. 7) and another to scope definition (ch. 8), the latter making reference to average and marginal modelling in attributional and consequential assessments, respectively.

Introduces the concept of a functional unit, including the conditions for substitution
Four pages dedicated to the concept of functional unit (Chapter 8 on scope definition), but no reference is made to the conditions for substitution.

Introduces procedures to ensure all relevant impacts are included in an LCA study, including social issues
Not mentioned. Suggests it's a choice dependent on the goal and scope.

Basic introduction to unit processes and data collection for these
In Chapter 8.

Introduces the construction of linked databases from unit processes, introducing also the parallel between matrix and flow chart notations
Yes, but not until Chapter 14 on input-output analysis. In the LCI chapter (Ch. 9) matrix inversion is mentioned as a calculation procedure, but without any further introduction.

Basic introduction to the inventory calculus, explaining also the similarity of process LCA and Input-Output calculus
Explains process-based LCA and input-output LCA in the History chapter (Ch. 3), which is elaborated in the methodology and LCI chapters (Ch. 6 and Ch. 9), before a dedicated chapter to IO-LCA (Ch. 14).

Introduces the options for combining process-based and IO LCA, highlighting the options for taking the best from both approaches and avoiding cut-offs
Mentioned in the introduction to chapter 9 on LCI. Chapter 14 is dedicated to IO LCA, including hybrid process/IO approaches.

Introduces the concepts of markets

Yes, particular in the LCI chapter (Ch. 9), where notions of market constraints are explored.

Introduces alternative procedures for handling of co-production, including the distinction between combined and joint production

Yes. However, the distinction between combined and joint production is only mentioned in Part IV (Cookbook)

Introduces the concept and procedures for handling rebound effects

Chapter 37 (Cookbook) mentions the concept but does not suggest ways of handling it in the assessment.

Introduces the relevance of temporality of emissions (e.g. the often erroneous assumption of neutrality of biogenic CO₂-emissions)

Yes, the chapter illustrating the application of LCA to biofuels and biomaterials (Ch. 30) includes a section on timing issues. The waste management chapter (Ch. 35) also explores the assumption of carbon neutrality.

Introduces Life Cycle Impact Assessment and the impact pathways (cause-effect chain, environmental mechanism) concept

Yes, the LCIA chapter (Ch. 10) explores the concept and Chapter 40 gives an overview of LCIA methods where the concept is picked up again.

Explains the implicit weighting that may occur when choosing and normalising impact categories

Yes, in the LCIA chapter (Ch. 10)

Introduces the procedural aspects of weighting, objectivity-criteria, the role of science in soliciting values, and democratic and consensus-based approaches to weighting

Yes, in the LCIA chapter (Ch. 10). Procedures for monetary valuation are introduced in Chapter 15 on Life Cycle Costing, but without a clear distinction between science-based methods, based on market prices and willingness to pay, and the abatement cost methods (which are only providing a minimum value of the impact when the costs are actually committed and thus reflects a market price). Adding to the confusion, Table 15.8 compares examples of a monetary value for impacts from greenhouse gas emissions (83 Euro per ton), the cost of abatement (24 Euro per ton), and the market price of emission permits (8 Euro), and presents this as if it was three different monetary valuations of the impacts (!).

Introduces mass balancing as quality assessment tool in both inventory and impact assessment

Yes!