

## Global Guidance on Environmental Life Cycle Impact Assessment Indicators: outputs from 2<sup>nd</sup> Pellston Workshop® 2018

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### Abstract

*Life Cycle Initiative (LCI) was jointly established by SETAC and UN Environment in 2002. This initiative is a multi-stakeholder partnership enabling the global use of credible life cycle knowledge by private and public decision makers. The overarching goal of the initiative is to provide science-based life cycle knowledge, advices and capacity building in order to enlighten public and business decisions to help to reach the sustainable development goals (SDGs). This initiative has been playing a key role in providing recommendations on life cycle impact characterisation by organising scientific workshops, where scientists and other stakeholders come together to review best available methods and agree on operational recommendations, and by publishing global guidance documents. In June 2018, the second Pellston Workshop® took place in Valencia bringing 43 people together for one week to work and decide on recommendation updates. This present paper recalls the consensus building process and provides key insights on the outputs from this second international workshop.*

### 1. Introduction

The Life Cycle Assessment (LCA) community is committed to the continuous improvement of the LCA methodology in particular of the concepts and models behind the life cycle impact assessment (LCIA) based on an updated state-of-the-art. There is a great emulation among researchers, LCA practitioners and end-users to work towards a more accurate modelling of the various impact pathways in order to provide more useful results. Since, the 1990s, almost 8,000 papers were published (Figure 1), representing roughly 90,000 citations.

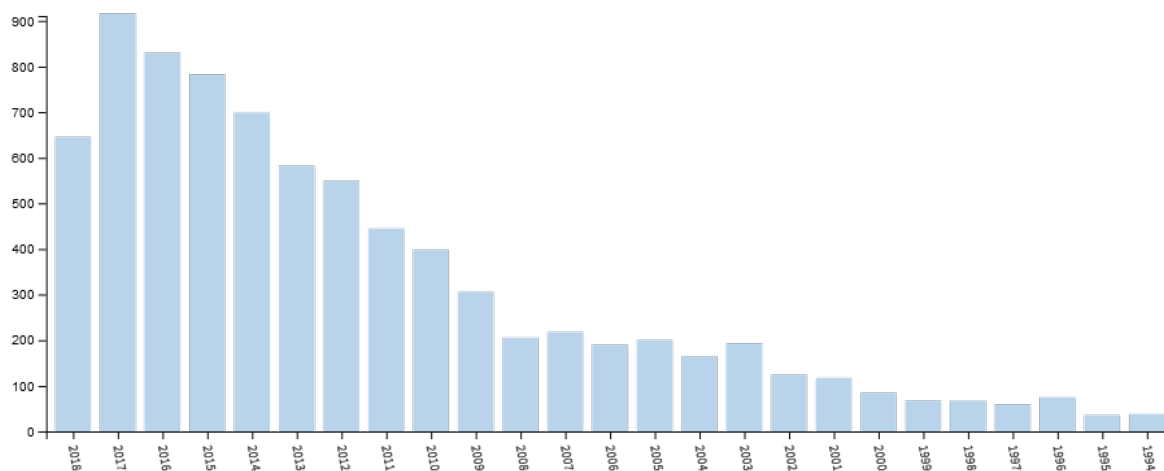


Figure 1: 7,975 records in the Web of Science databases for TITLE: ("Life cycle assessment") OR TITLE: (LCA) OR TITLE: ("Life cycle analysis") AND TOPIC: ("impact characteri\*") OR TOPIC: (LCIA), period: 1900-2018

The Society of Environmental Toxicology and Chemistry (SETAC) is one of the most important international scientific organisations dealing with structural issues of LCA (Jolliet et al. 2010). In the early 2000s, SETAC initiated the dynamics to develop and publish the ISO standards for LCA (ISO 14040/44), which are continuously updated. In 2002, the Life Cycle Initiative (LCI) was jointly established by SETAC and UN Environment. This initiative is a multi-stakeholder partnership enabling the global use of credible life cycle knowledge by private and public decision makers. The overarching goal of the initiative is to provide science-based life cycle knowledge, advices and capacity building in order to enlighten public and business decisions to reach sustainable development goals (SDGs) faster and more efficiently. Besides, by itself, UNEP SETAC LCI achieves the SDG N°17 as a global partnership for the goals. Among the key targets, UNEP SETAC LCI aims at training at least 2,500 policy makers, business decision makers and LCA practitioners and at offering a solution to access all interoperable LCA databases globally, with a library of recommended impact assessment factors linked through a nomenclature system. In order to provide such recommendations, UNEP SETAC LCI partners have implemented an international consensus-finding process that started in 2012 (Figure 2). This consensus process aims at providing both consensus impact category indicators, where possible to achieve, and guidelines on how to best reach consensus in LCIA indicators. The process project is named Global Guidance for Life Cycle Impact Assessment Indicators and Methods (GLAM). Several documentations including scientific papers presenting results so far have already been published (ref). This paper presents the key outputs from the Task2b, *i.e.*, the key outputs from the consensus finding work during the second Pellston Workshop® held in Valencia in June 2018.

- **Task 1: Scoping phase** (2012-2013)
  - Short list of impact category indicators and themes for first and second stage
  - Yokohama 2012 & Glasgow 2013 scoping workshops
  - Stakeholder feedback at events worldwide
- **Task 2a: Consensus finding**, stage 1 (2013-2015/16)
  - Pellston workshop™ 1 (24-29 January 2016, Valencia)
- **Task 2b: Consensus finding**, stage 2 (2016-2018)
  - Pellston workshop® 2 (24-29 June 2018, Valencia)
- **Task 3: Dissemination and Stewardship** (2017+)
  - <https://www.lifecycleinitiative.org/applying-lca/lcia-cf/>

Figure 2: Steps in the UNEP SETAC LCI consensus building process

## 2. Material and method

The second Pellston Workshop® was held in Valencia between the 24<sup>th</sup> and 29<sup>th</sup> of June 2018. It was organised by the LCI hosted by UN Environment and SETAC and co-chaired by Rolf Frischknecht and Olivier Jolliet. In order to complement the previous Pellston workshop® outputs, there were one crosscutting issue sub-task and five sub-tasks investigating specific impact pathways:

1. Human toxicity;
2. Ecotoxicity.
3. Acidification and eutrophication;
4. Soil quality and related ecosystem services;
5. Natural resources (mineral primary resources);
6. Crosscutting issues.

Ahead of the workshops, working documents were prepared by dedicated working groups, each one investigating one of the five sub-tasks. In total, more than 100 people were involved over about two years gathering the updated scientific information to feed into the workshop consensus building. Finally, 43 people from 18 countries representing experts from academic, governmental and industrial institutions participated to the workshop.

Along the workshop, working group sessions and plenary sessions were alternated in order for each group to focus on its topics meanwhile ensuring transversal consistency, communication and agreement reaching during the plenary sessions. The work process was similar for all groups, using the same outline as reproduced in the topical chapters, *i.e.*, i) describing the impact pathway and reviewing the potential indicators; ii) selecting the best-suited indicators or methods; iii) providing the characterisation factors; iv) applying those to an LCA rice case study; and v) providing recommendations and potential supplementary materials.

A particular attention was paid to the homogeneity in the decision mechanism and guidelines were provided to agree on the recommendation level. Although full consensus was the first choice, provision was made to ensure that minority statements and recommendations would be allowed and that justifications would be made in case more than one approach or none could be recommended. On a practical side, all documents were shared among all participants on a Google drive also allowing for synchronized collaborative works on the documents.

### 3. Results

The following main recommendations were agreed upon:

**Human toxicity:** Three human toxicity indicators are recommended considering different severity for cancer, non-cancer developmental, and other non-cancer effects. For human exposure, these indicators build on a matrix framework consistently coupling environmentally mediated exposures with indoor and consumer product exposures. The non-cancer indicators build on a stochastic dose-response model recommended by the WHO and the 10% population response level to derive effect factors, combined with severity factors based on the latest Global Burden of Disease statistics.

**Ecotoxicity:** Promising solutions have been found for harmonized assessment of chemical emissions in Product Environmental Footprint (PEF) and LCIA. The major recommendations are: 1) to consider effects of chemicals on organisms living in coastal waters, soil, and freshwater sediment; 2) to base effect modelling on a concentration domain that is close to the domain of environmental concentrations; 3) to disregard bioaccumulation as removal mechanism in exposure modelling, and 4) to consider ageing and weathering of metals in soil and freshwater sediment.

**Acidification and Eutrophication:** Selected indicators and factors are recommended for freshwater eutrophication, terrestrial acidification, and midpoint marine eutrophication (interim recommended for marine eutrophication endpoint, which needs further investigation). Further consensus recommendations are 1) to use spatially explicit models with global coverage, 2) to aggregate CFs (to country or global level) using agricultural, non-agricultural, or overall emissions weighting (and apply these according to goals of a study), and 3) to use existing environmental concentrations for effect modelling. These changes will move these categories towards increasing relevance of models for LCA results.

**Soil quality and related ecosystem services:** High quality functional soil is important for the supply of ecosystem services such as providing biomass and regulating climate. Land use and land use change (LULUC) are key human stressors that can affect soil quality. Change in Soil organic carbon ( $\Delta$ SOC) stock) is interim recommended as the indicator of soil quality as it is a good integrative indicator of soil functions. Suggestions are also provided to improve the representation of forestry and permanent crops, in order to move to a full recommendation. Soil loss is recommended as a separate indicator linked to natural resources, to address erosion impacts.

**Natural resources (mineral primary resources):** The Area of Protection related to mineral resources has been defined and methods have been grouped depending on whether they assess the impacts of a product system's resource use on the opportunities of future generations to use resources (inside-out) or resource availability

for a product system (outside-in). For the inside-out perspective, Abiotic Depletion Potential ultimate reserves is recommended to assess the depletion of stocks. Methods to assess the consequences of a declining resource quality, to assess economic externalities, and to assess resource use based on thermodynamics are interim recommended. Methods addressing the outside-in perspective are recommended to be used as a complement to (environmental) LCA.

**Crosscutting issues:** For uncertainties, it is strongly recommended to follow a tiered approach, interpreting and reporting all relevant types of uncertainty and associated variability. For the connection between LCI and LCIA, It is strongly recommended to develop a common reference nomenclature and classification system. Further research is recommended on improving available options for the instrumental values framework and for addressing ecosystem vulnerability consistently, to allow aggregation of indicator scores across all impact categories.

#### **4. Conclusions and perspectives**

The outputs from the 2<sup>nd</sup> Pellston Workshop® are being finalised and will be published early 2019. Besides recommendations based on the state-of-the-art, the various sub-tasks identified needs for future research and proposed roadmaps towards the continuous improvement of the various impact pathways modelling and also relating to crosscutting issues. The characterisation factors and impact category indicators recommended include the latest findings of topical research and consensus building, and clearly go beyond current practices in the respective subjects. The levels of recommendation show the variable maturity of the indicators. At the same time, care has been taken to ensure immediate applicability in current LCA environments. The community should take care of capacity building and establish recommendations on the proper use and interpretation of the environmental indicators they developed.

Spatial resolution is an issue common to several of the topical areas, i.e., ecotoxicity, human toxicity, acidification and eutrophication, as well as soil quality. All groups agreed on providing characterisation factors on the native scale (like watersheds or ecoregions), as well as on more aggregated levels such as countries, continents, the globe or archetypes situations. While the need for spatial differentiation is acknowledged in decision situations dealing with the foreground system, it is a challenge to underpin spatially explicit product LCA models with the life cycle inventory data and information required. Thus, it is an important task to derive smart and parsimonious approaches from the knowledge gained in LCA research projects in which a high geographic resolution is applied.

The United Nations Sustainable Development Goals (United Nations 2015) cover topics such as climate action (SDG 13), clean water and sanitation (SDG 6), life on land (SDG 15), and good health and wellbeing (SDG 3). It will be a promising and important challenge to liaise the environmental indicators developed and operationalized in the UNEP-LCI process to these SDGs, and to actively explore the possibilities application and utility of using the environmental indicators recommended in the UNEP-LCI reports in supporting actions to improve the environmental situation and to monitor progress relative to selected sustainable development goals. Similarly, we strongly recommend exploring options and opportunities on how to make use of the environmental indicators when quantifying for decision-making processes in the context of environmental planetary boundaries.

#### **Acknowledgements**

The workshop was supported by the European Commission, The French Ministry for the Ecological Transition and Solidarity, The German Federal Ministry for the Environment, the Nature Conservation, Building and Nuclear Safety, the Swiss Confederation, American Chemistry Council, PlasticsEurope, Unilever, the Alliance for Beverage Cartons and the Environment, ExxonMobil Chemical, Ibict60, ABCV, Braskem, PréConsultats, Wrap,

The 3rd International Conference Series on Life Cycle Assessment: Life Cycle Assessment as a metric to achieve Sustainable Development Goals 24-25 October 2018, Jakarta

FCH Fundación Chile, International Copper Association, IFU Hamburg, Metals Environmental Research Associations and other financial sponsorship from participants.

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