Life Cycle Assessment (LCA) Methodology

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Introduction

This methodology is a description of the steps taken to evaluate the life cycle impact of the products selected for the project, "*Accelerating the reduction of environmental impacts within humanitarian action*" conducted by EPFL, Climate Action Accelerator, and the ICRC.

The focus of the study is to analyse the most intensive areas of impact within the products' life cycle and pinpoint the scope of action for impact reduction. The modelled LCA data is tailored to humanitarian contexts and will be used as reference material to facilitate further assessments in the humanitarian sector to make concrete progress in impact reduction.

The methodology has been derived and adapted from the ISO 14040:2006 Environmental management framework, with impact assessment conducted using the Environmental Footprint 3.1 indicator system.

Objective and scope definition

The general objective of each assessment is as below:

- Conduct a study to produce cradle-to-gate and cradle-to-grave environmental impact factors for the chosen product(s)
- Establish definitive pathways in transforming the chosen product(s) to better serve its function sustainably

This objective is further tailored to the chosen product(s) before the scope definition.

Each study is preceded with secondary research & literature review to account for previous studies that may have been done for the product family in question, and how they may relate (or differ) from the current study.

In case an LCA has already been conducted and is accessible (with usage permissions), the scope of the study changes to being a 'review' of the existing research, with the below objectives

- Assessing the impact after aligning the existing LCA to humanitarian contexts
- Producing environmental impact factors (especially GHG emission factors) that can be used by humanitarian organizations
- Adding relevant impact indicators (like human health) to the previous LCA that were not covered

The methodology for a 'review' LCA is described in the section "Review LCA" below.

The specifications of the 'baseline product(s)' are detailed as part of the scope, including the procurement information (order details, packaging, sourcing, etc.) used as a reference. For each LCA conducted as part of this project, the procurement information is derived from the ICRC supply chain.

System boundaries

The system boundary is defined to elaborate on the life cycle of each product involved in the study by the component and process involved in each stage, being as follows

1. Raw Material: extraction and processing of materials involved in the product life cycle (incl. packaging materials when relevant)
    a. Transportation to the production site as part of the 'supply & distribution' stage
2. Production: manufacturing of the product (& packaging materials when relevant)
1. Supply & Distribution: Transportation of the finished product with packaging to the distribution site
2. Use of the product
3. End-of-life and disposal of the product
    a. Transport to the disposal site (if applicable) as part of the 'supply & distribution' stage

Function, Functional Unit, and Reference Flows

A function and functional unit is defined for each product involved in the study based on the service provided to the beneficiaries of the product(s). This unit is required for each study to be able to compare two or more products or product variations and determine aspects of their environmental impact.

The functional unit varies based on the category of the product in question. For example, a lighting product's unit could be 'lighting [x]m2 of space for [y]hrs' to then determine how much of the product is needed to fulfil this unit in the reference flows. Similarly, for cooking the functional unit can be [x] GJ of heat used to cook for [y] number of households per year (GJ/HH/year).

Based on the defined functional unit, reference flows are defined to compare all scenarios being studied for the comparative analysis.

Key Parameters and Assumptions

In this section the parameters of the baseline product(s) (i.e. the product specifications being use as comparative reference in the study) are detailed to make clear the sources of information used to build the inventory. Any assumptions taken and/or variabilities in the inventory data and impact assessment are mentioned in this section to determine possible uncertainties in the results of the study.

Broadly speaking, assumptions are made for two purposes:

- Lack of field data availability
- Selecting one possible variant (e.g. countries of production) out of several being used in the field to produce generalised data

The key parameters and assumptions of the variations (i.e. changes made in the baseline to conduct the comparative analysis) are also detailed in this section, to then form collective 'scenarios', i.e. a collection of variations forming a fictional product alternative.

Inventory Analysis

This section contains the data gathered and environmental impact calculated for the product variations in each study. The data is calculated in variations of each life-cycle stage, and then made available in the spreadsheet tool to be selected to 'build' each scenario for comparative analysis.

The process of data collection and inventory analysis is as follows.

A. Map out the available supply data and secondary research across the life-cycle stages, highlighting the information not available at this stage
B. Use Ecoinvent and other databases to 'model' the impact calculations using generalised processes, supplementing field data with assumptions figures wherever needed
C. Identify stages/processes with the biggest concentrations of environmental impact from the model
D. Calculate impact across categories, with an uncertainty declaration for each life-cycle stage
    a. Steps using entirely modelled data and parameters will retain a high uncertainty, while steps using field data or widely known processes will merit a lower uncertainty. These notes will also be utilized in defining the areas of further study within the topic for future users.
E. Select the variations for each life-cycle stage needed to build comparative scenarios
    a. LCAs without variations are likely ones comparing two real products with each other, in which case the selection is done for the appropriate inventory for each product
F. Compute results and figures for cradle-to-gate and cradle-to-grave analysis

The primary database used is Ecoinvent 3.11 – the studies utilize the data from the cut-off system model which allocates the entire impact of the material to its primary user without any 'rewards' for its potential for being recycled. Consequently, any recycled materials do not carry the burden of the impact of the primary use of the material, and rather track the impacts from the recycling process onward.

"Review" LCA Process

In the event that the study is being conducted to review and format an existing LCA, the steps in the inventory stage are as follows:

1. Update the scope and system to align with the humanitarian contexts
2. Define potential deviations from existing study
3. Map out the new and old parameters and assumptions
4. Log the inventory from the existing study – with alterations wherever needed
5. Conduction scenario analysis (as detailed above) if needed
6. Compute results and compare with the study to assign uncertainty to the updated figures

Results

The results are calculated following the Environmental Footprint 3.1 indicator system[1], which covers several categories of impact beyond climate change. The project currently has the below list of impact categories being mapped for each product as part of the EF 3.1:

Impact Category	Subcategory	Impact Indicator + unit	Unit
Climate Change	Climate Change	Radiative forcing as Global Warming Potential (GWP100)	kg CO2-Eq
Human Health	Human toxicity, cancer	Comparative Toxic Unit for human (CTUh)	CTUh
Human Health	Human toxicity, non-cancer	Comparative Toxic Unit for human (CTUh)	CTUh
Human Health	Ionising radiation, human health	Human exposure efficiency relative to U^{235}	kBq U^{235} eq
Human Health	Particulate matter formation	Impact on human health	Disease incidence
Human Health	Photochemical oxidant formation: human health	Tropospheric ozone concentration increase	kg NMVOC-Eq

The results of the above list are shown in two categories:

I. **Climate Change:** directly taking the GWP100 results from the above list

II. **Impact on Human Health**

Climate change is calculated by direct use of the GWP100 (Global Warming Potential: 100 years) results from respective database. The indicators representing impact on human health are weighted using the approach detailed in the Environmental Footprint methodology[2] and normalized for an average citizen, to be aggregated and represented as a single score.

An experimental indicator on **plastic pollution**[3] has been added due to the relevance of the topic on the humanitarian supply chain, which will allow the project team to make relevant assessments with from the perspective of reducing plastic use, which calculates the approximate mismanaged plastic waste by geography.

The aforementioned tool developed to support flexibility in variations and scenarios for each LCA will be shared as a separate output, while the notable results of the study are displayed with graphical or visual interpretation to explain the important analytical learnings from the data such as:

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[1] Understanding Product Environmental Footprint and Organisation Environmental Footprint methods, 2021

[2]Source: Sala S, Cerutti AK, Pant R. (2018). Development of a weighting approach for Environmental Footprint. European Commission, Joint Research Centre, Publication Office of the European Union, Luxembourg. ISBN 978-92-79-68041-0.

[3]Plasteax Generic dataset for consumer packaging Model version 2.0 | 2023 https://plasteax.earth/

1. The computed cradle-to-gate and cradle-to-grave factors for the baseline as well as each scenario
2. The distribution of impacts across the life cycle stages of the product(s) involved in the study
3. Comparison of the impacts for each ‘built’ scenario and its assessment for each impact indicator

Impact Assessment & Interpretation

The Life Cycle Impact Assessment (LCIA) part of the study formulates the conclusions that can be derived from the inventory data.

The primary area to assess is the distribution of impacts across the life-cycle, to pinpoint the stages that weigh heavily on the total impact of the product(s) and why.

Next, the comparative analysis is concluded to produce key conclusions on improvements that are possible. The interpretation of the study is not necessarily to declare a ‘winning’ option or scenario, but rather focus on the what can be done to achieve the maximum impact reduction while maintaining the function of the product and its system.