Life Cycle Assessment of Body Soap Bars

Project: Accelerating the Reduction of the Environmental Impact of Humanitarian Action

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Science and Technology for Humanitarian Action Challenges (HAC)

Project website: https://climateactionaccelerator.org/accelerating-the-reduction-of-the-environmental-impact-of-humanitarian-action/

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Contents

Introduction

Objectives and scope

Objectives:

- Using models of the humanitarian supply chain to identify key levers to reduce the impact of body soap bars (climate, human health, plastic leakage) and analysing potential product variations accordingly.
- Establishing emission factors for soap bars adapted to the humanitarian sector.

Scope & System Boundary:

- Cradle-to-grave system boundary for the assessment of impact across the complete life cycle.
- System boundary:
  - The materials, production, distribution, use and disposal of the product are in scope of our study (see slide 10 for details)
  - Any additional processes applied to the product after production are not in scope e.g. unplanned storage, etc.
  - The procurement of the packaging is modelled, with the upstream activities of the packaging being out-of-scope

Methodology

The results are calculated following the Environmental Footprint 3.1 indicator system in two categories:

- **Climate Change**: Global Warming Potential (GWP100)
- **Impact on Human Health**:
    - Human Toxicity: Carcinogenic and Non-carcinogenic
    - Ionising Radiation
    - Particulate Matter Formation
    - Photochemical Oxidant Formation
  - Weighted using the approach detailed in the EF methodology – with a percentage assigned to each sub indicator (see reference)
  - Normalized for one citizen so as to aggregate and represent as a single score for human health

Plastic leakage: Experimental projection of the amount of plastic leaked into nature via mismanagement of waste

References:
"European Platform on LCA | EPLCA.". https://eplca.jrc.ec.europa.eu/EnvironmentalFootprint.html
Joint Research Centre (European Commission), Alessandro Kim Cerutti, Rana Pant, and Serenella Sala. 2018. Development of a Weighting Approach for the Environmental Footprint. Publications Office of the European Union. https://data.europa.eu/doi/10.2760/945290

End-of-life

This study aims to model the impact differences between various waste management methods tailored closer to humanitarian contexts. The following end-of-life options were modelled in the analysis, as appropriate:

- **Open dump** (unmanaged)
- **Open burning** (unmanaged)
- **Unsanitary landfill** (minimal management)
- **Sanitary landfill** (managed site)
- **Municipal incineration** (managed plant)
- **Recycling** (as modelled)

For plastics, the differences in measured impact between each end-of-life scenario are similar. (For more info on the impacts and sources of end-of-life impact measurement please see annex.)

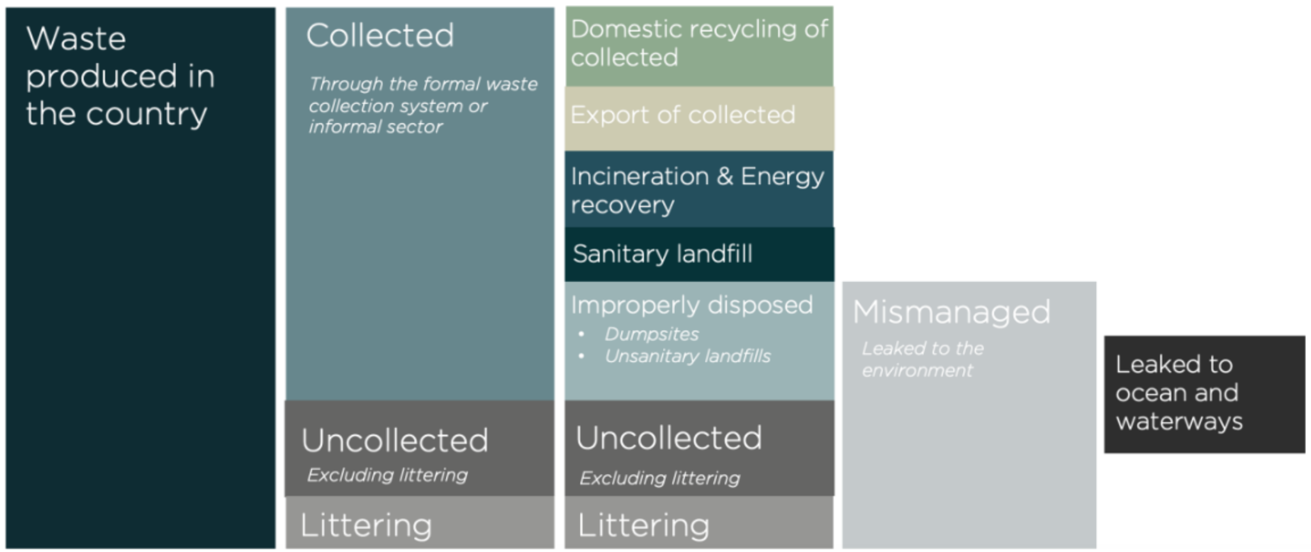
According to the LCA methodology, the analysis of greenhouse gas (GHG) emissions (Global Warming Potential)—is limited to a 100-year timeframe. As a result, any additional impact from plastic degradation in landfills occurring beyond this period is neither measured nor compared to other waste disposal methods.

Plastic leakage

This project aims to estimate the mismanaged waste that may occur at the end of life of products distributed by humanitarian organisations.

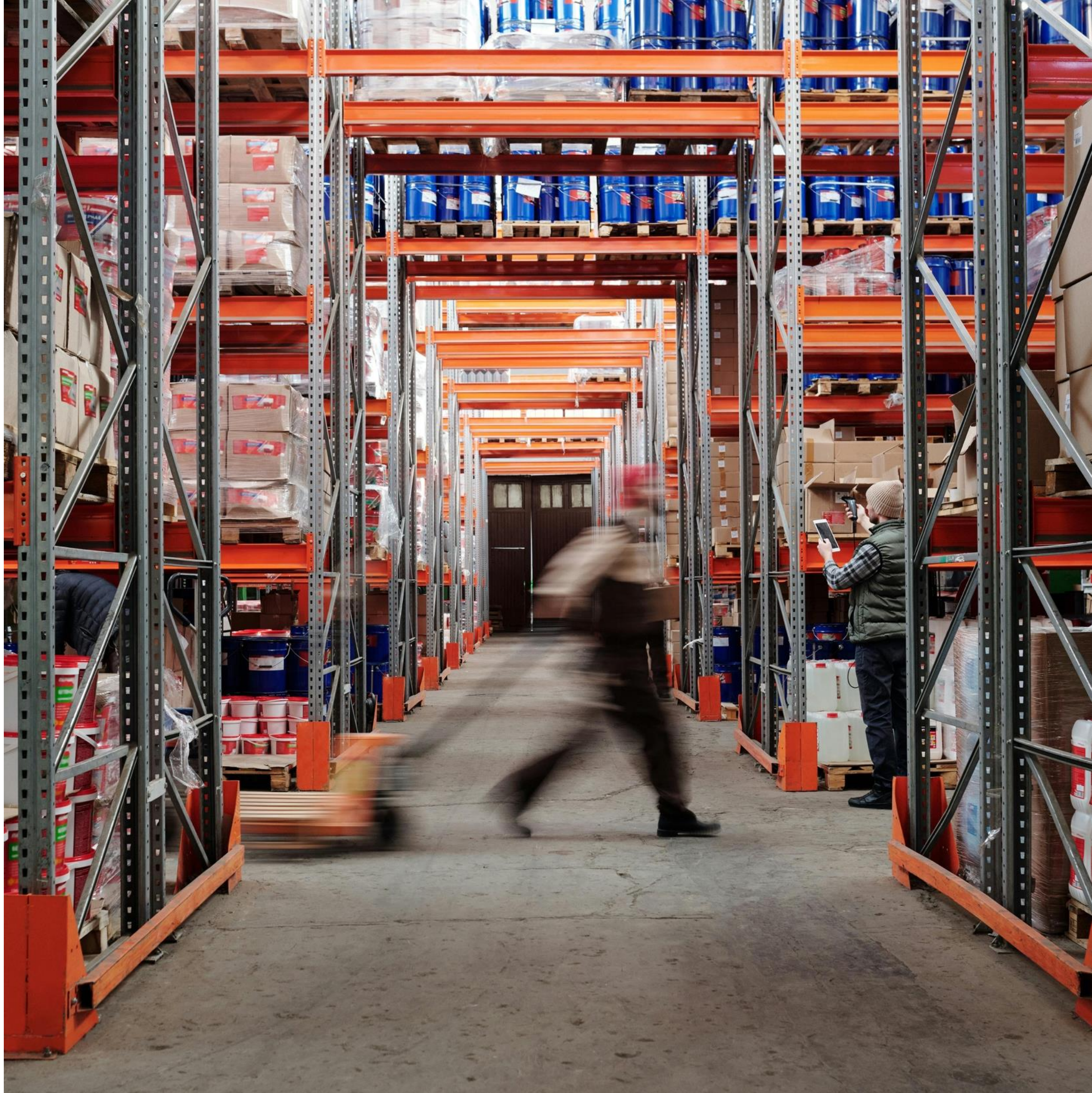
The modelled scenarios are analysed for plastic leakage by selecting the waste management method that is modelled and calculating the projected leakage (or lack thereof) due to the same.

For more information, please refer to: "Global Plastic Environmental Analytics Platform." Plasteax. https://plasteax.earth/.



Source: EA – Earth Action

LCA Results



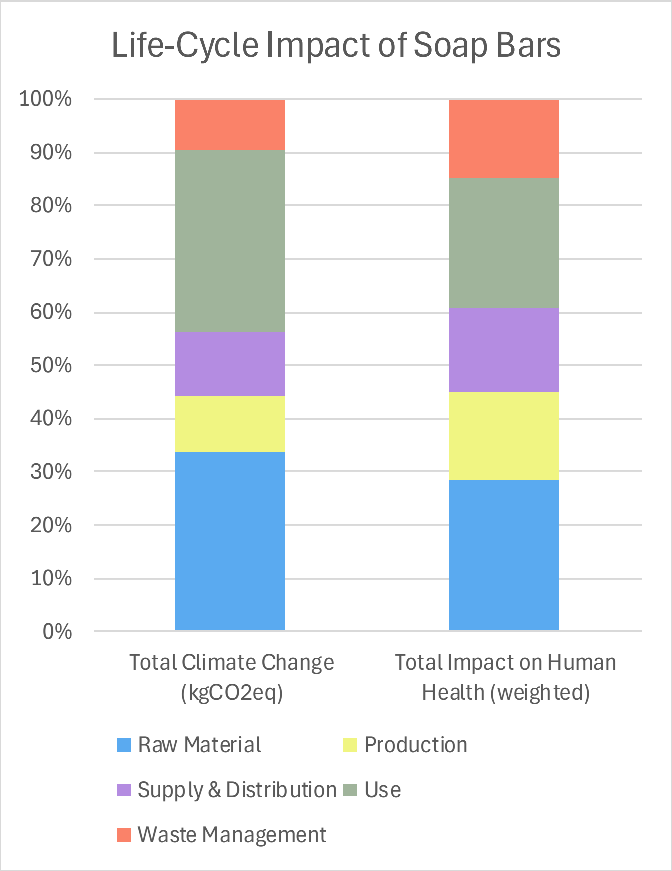
Key Product Parameters & Assumptions

LIFE-CYCLE STAGE	PARAMETER	DESCRIPTION OF MODEL
GENERAL	Field Context	Given their essential role in household hygiene and frequent inclusion in the initial phase of aid responses, soap bars are pre-stocked in regional distribution centres.
Raw Material	Bill of Materials	Crude Palm Oil, Sodium Chloride, Sodium Hydroxide (0.26 kg net weight)
	Packaging	PE film (10 g)
Production	Manufacturing Location	Local to warehouse and distribution location (i.e. within 1,500 km)
	Manufacturing Processes	Standard saponification
Supply & Distribution	Transport Chain	International oil procurement (10,000 km by sea) TRUCK for procurement of other materials (500 km) TRUCK to warehouse (1,500 km) & distribution (1,500 km)
Use	Lifespan	50 uses with 10 litres of water per use
	Usage Processes	-
Waste Management	Product Disposal Method	Wastewater generation (cubic m of water used)
	Packaging Disposal Method	Open dumping

Baseline Results

- Considering the life-cycle of the product, the impacts are evenly distributed among several stages
- Raw material accounts for **(34%)** of the total GHG emissions and **(29%)** of total impact on human health
- The largest share of impact for GHG emissions comes from the use of tap water during the life of the soap bar **(34%)** while for impact on human health it is the second largest share of impact **(24%)** after raw material.
- Plastic leakage
  - The product is non-plastic, hence causes no leakage
  - The packaging is dumped/littered causing leakage for all scenarios

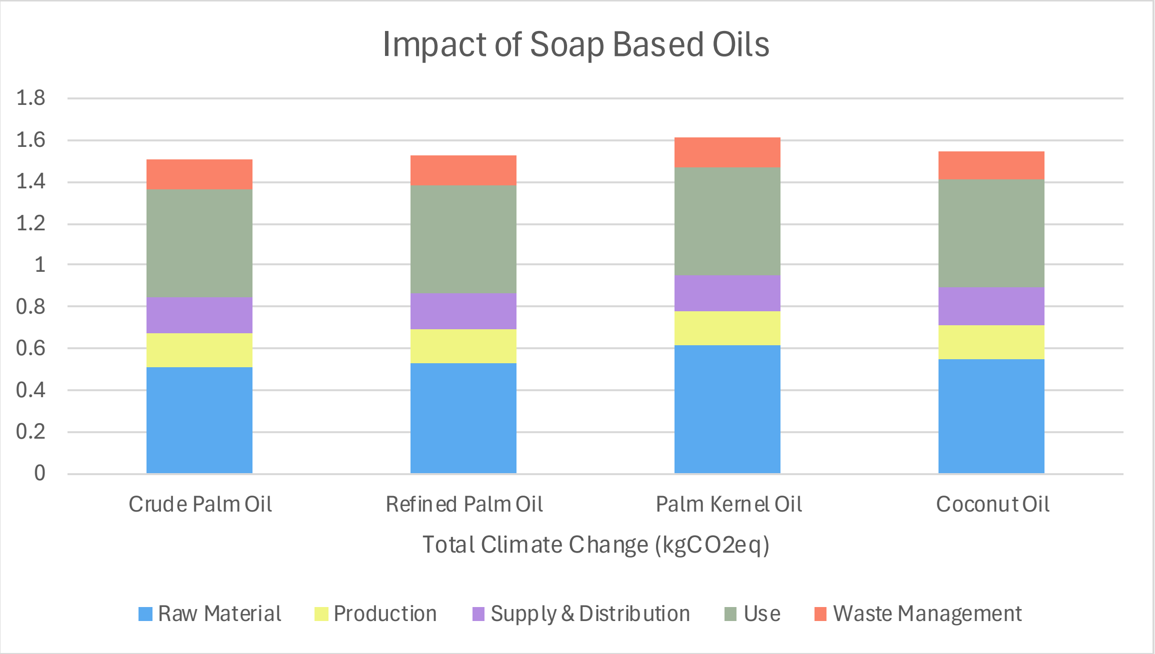
Emission factors		**Unit**
Cradle-to-grave	1.50	kgCO2eq/unit
Cradle-to-gate	0.67	kgCO2eq/unit

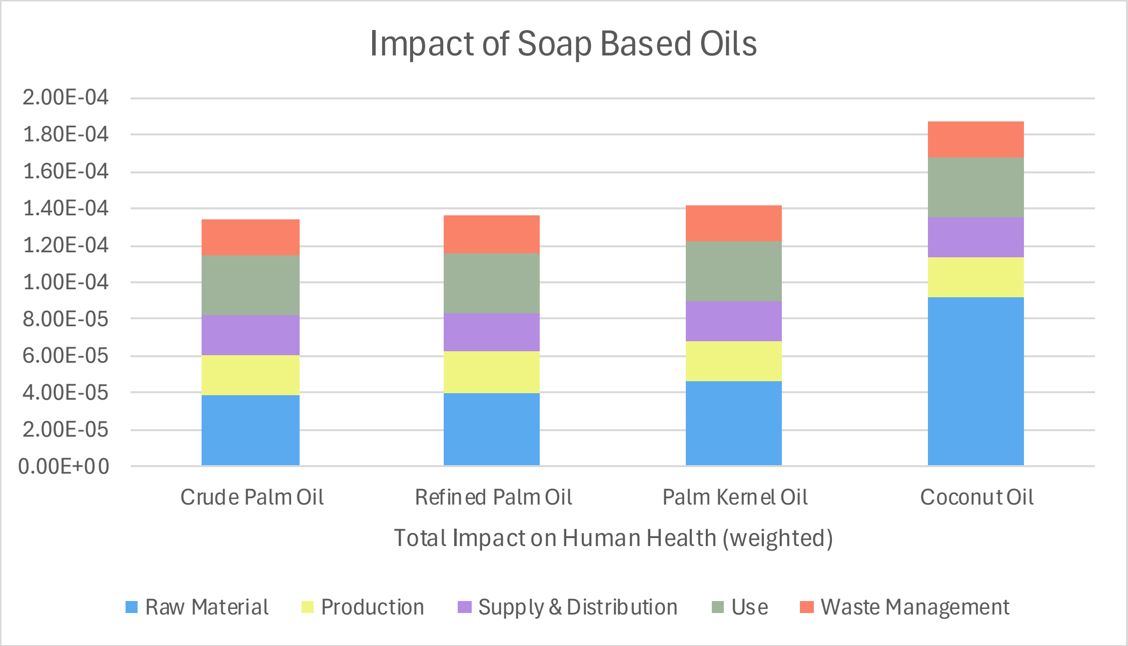


Variations per lifecycle stage

	Raw Material	Production	Use Life	Supply & Distribution	Waste Management
Baseline	Crude Palm Oil	Heating from natural gas	Tap Water	Local purchase with overseas procurement of oils	Wastewater
	Refined Palm Oil Palm Kernel Oil Coconut Oil Without Packaging	Heating from waste incineration	Harvested rainwater		

Raw Material

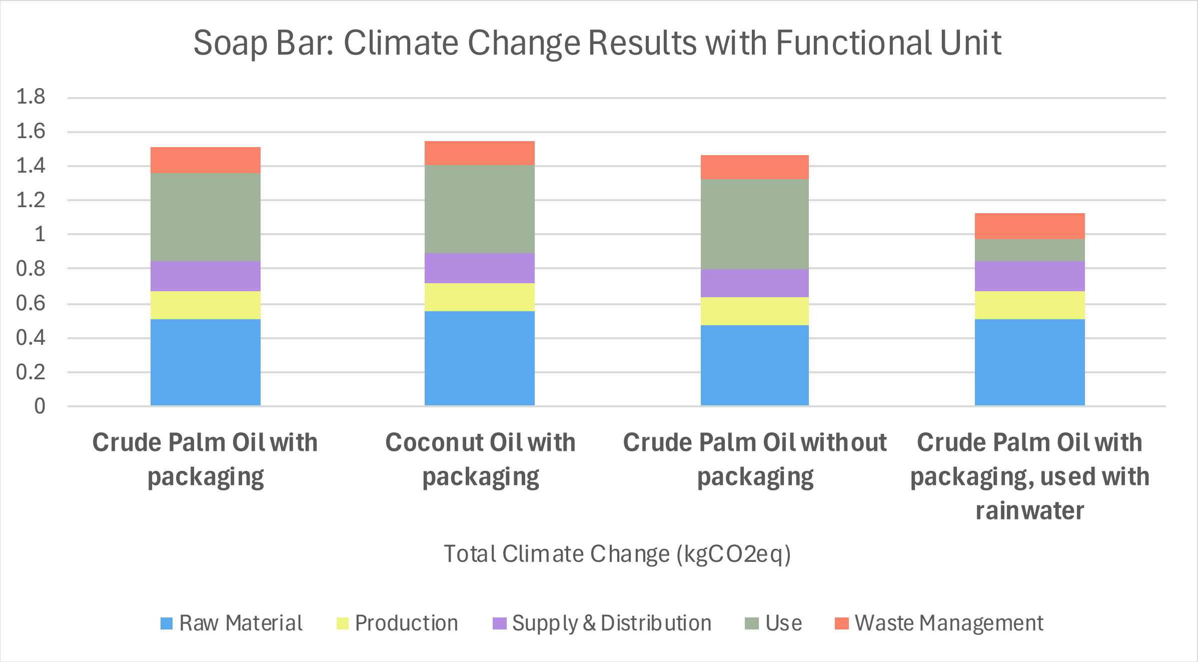


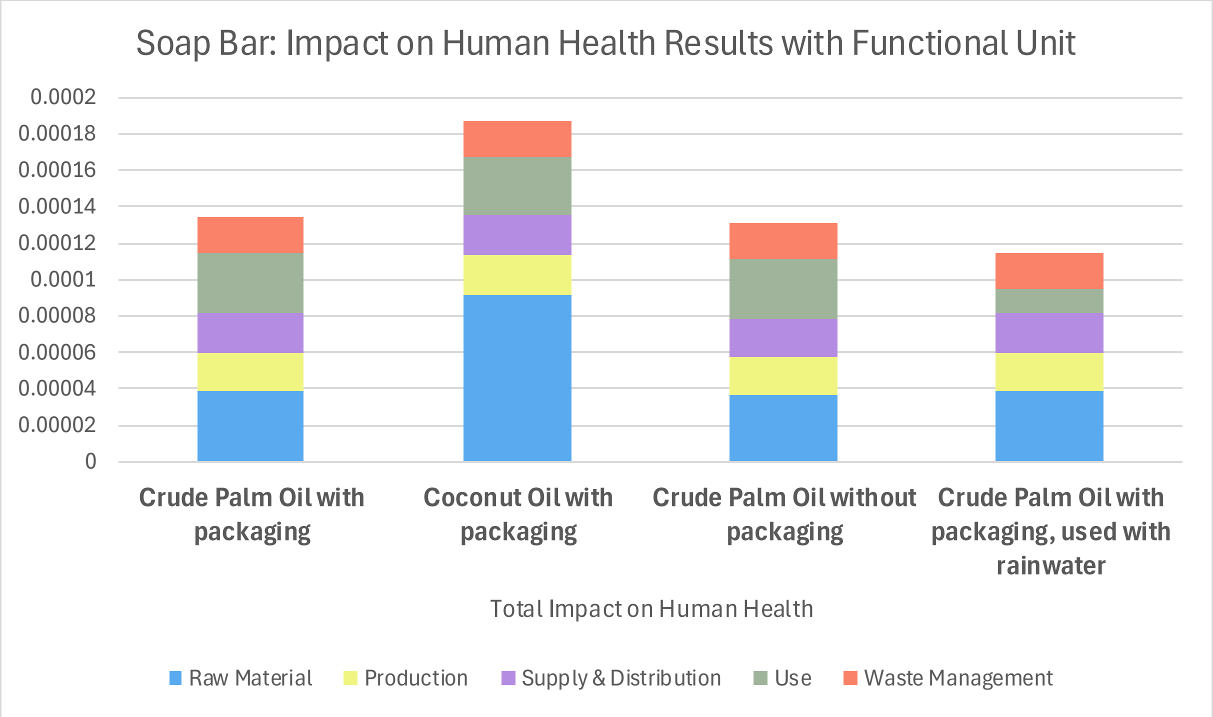


Materials

- This study revealed that varying the type of palm oil used – crude palm oil, refined palm oil, palm kernel oil – did not affect the impact of the soap bar significantly, with all scenarios changing the impacts between **1-7%** in both impact categories.
- However, replacing palm oil with cocount oil sees an increase in impact that is vastly different between the two categories – coconut oil (and the additional fatty acids added to the materials for its formulation) -- increases GHG emissions by **3%** but also increases impact on human health by **40%.**

Water & packaging





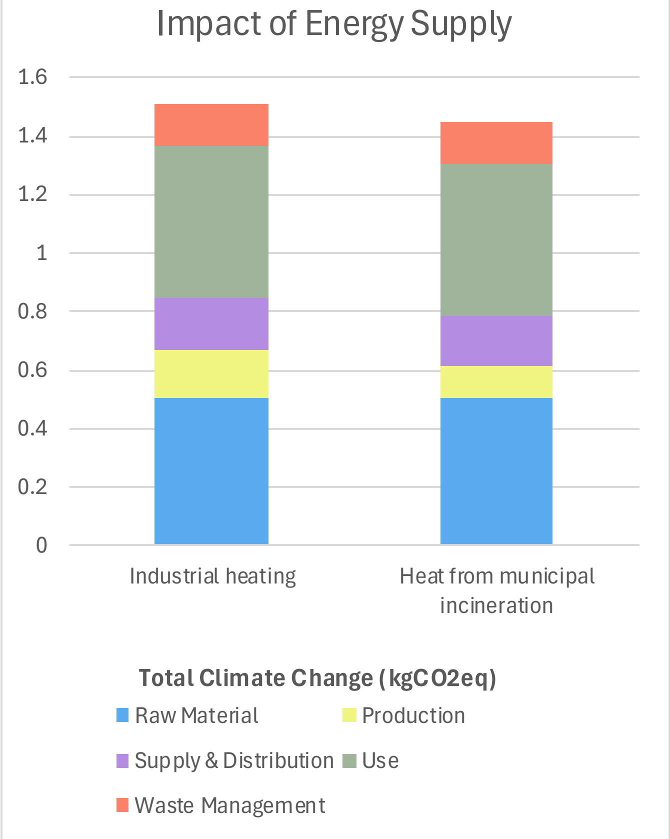
Water Supply

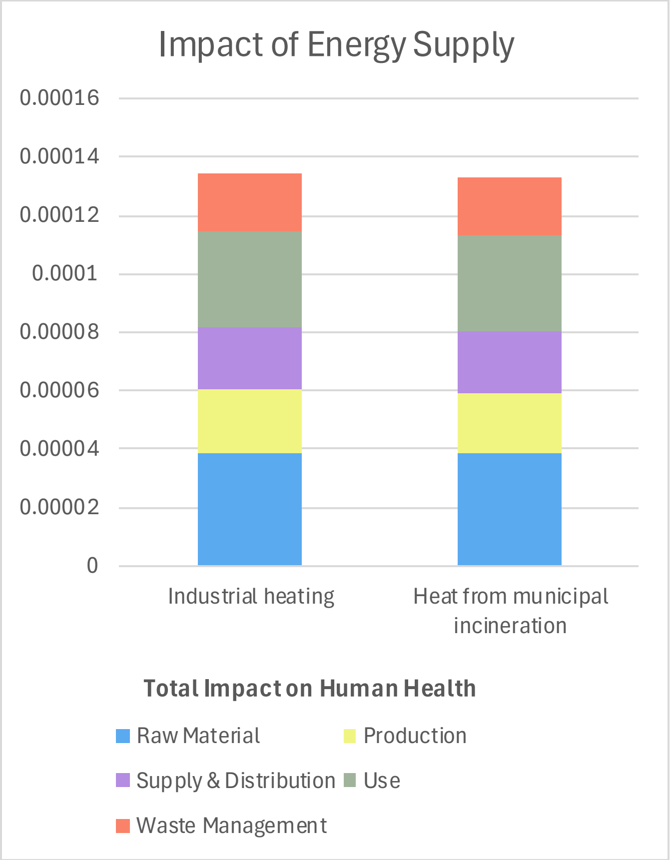
- Water use alongside soap contributes significantly to the overall impact in both categories. In the model using 'tap water', a substantial portion of this impact stems from the energy and resources required for water pumping, treatment, and distribution.
- To assess a scenario where water supply activities have a lower environmental burden, this study compares tap water (used in Scenarios 1, 2, and 3) with harvested rainwater. The latter results in a **26%** reduction in the soap's GHG emissions and a **15%** decrease in its impact on human health (Scenario 4).

Packaging

- Eliminating plastic packaging results in a reduction of no more than **2-3%** in impact across both categories. However, this could lead to the soap chipping or depleting more quickly, making it an inconclusive solution.

Energy Supply



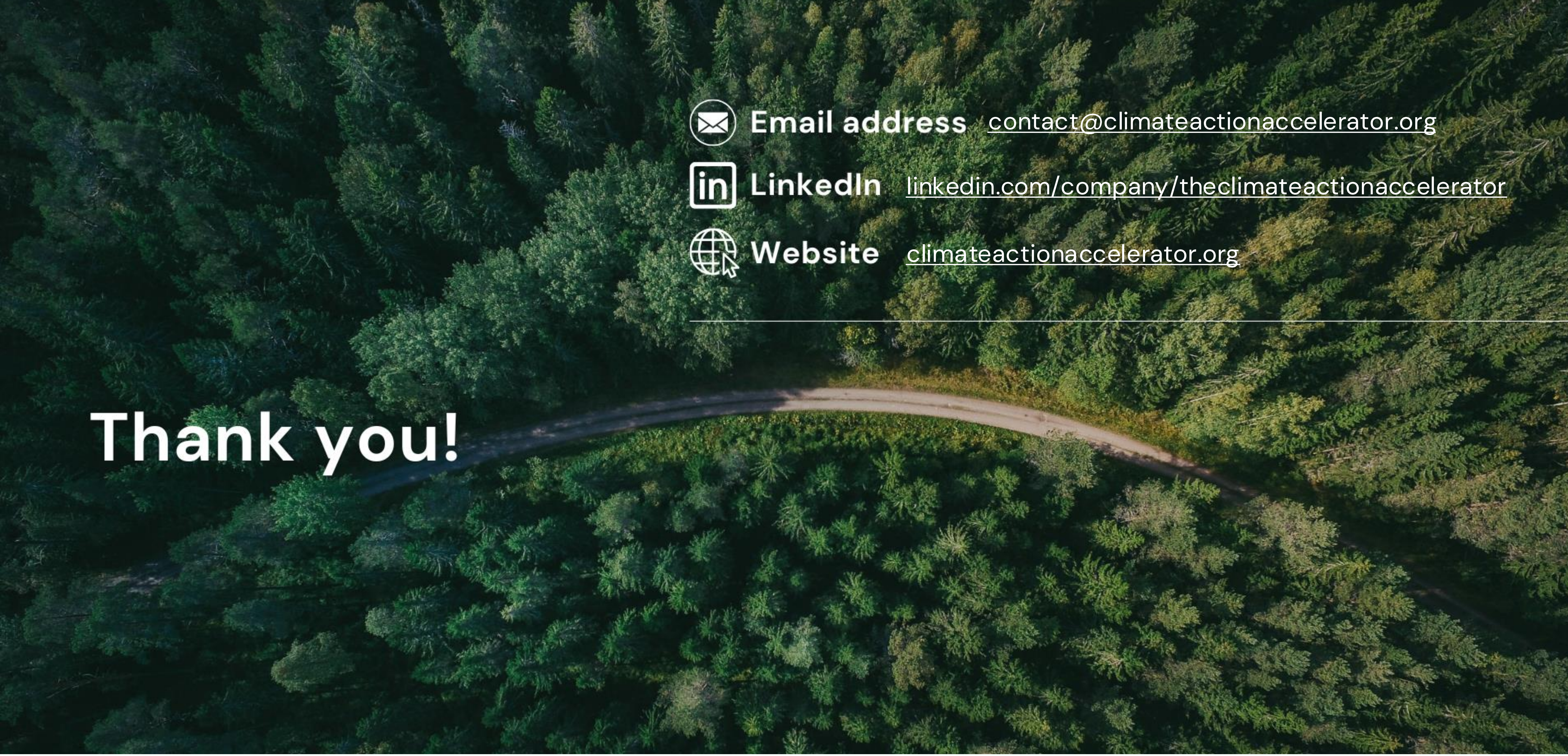


Energy

- This study modelled a standard combined saponification and neutralisation process that is not electricity-intensive (i.e. 0.05 kWh needed for every 1 kg of soap produced) -- therefore moving to solar panels for the electricity requirement has a negligible impact on the product life-cycle
- However, a fair amount of heat is needed to produce soap. At baseline, the study assumes a market mix of natural gas and other industrial heating processes for the soap production. Changing this to a market mix of heat derived from waste-to-energy processes (e.g. municipal waste incineration, biogas, etc) reduces the GHG emissions by **4%** and the impact on human health by **1%**, which is small enough to not be considered as having impact reduction potential. (Note: Greener sources for heat generation exist, but not at the industrial scale that is needed for this study)

Key conclusions of comparative analysis

- The water usage during the use phase, as well as the raw material of the soap (i.e. vegetable oils) make up the majority of the impact of the soap.
- Improving water supply can lead to:
    - ▼ 26% lower GHG emissions
    - ▼ 15% lower impact on human health
- While palm oil is commonly used and remains an impact-efficient choice, it is important to consider its significant deforestation effects. RSPO-certified palm oil could be considered; its impacts were not modelled due to missing data on human health impacts.
- For a more comprehensive conclusion on types of oil usage, the ecosystem/biodiversity impacts should be studied in further detail.



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Thank you!

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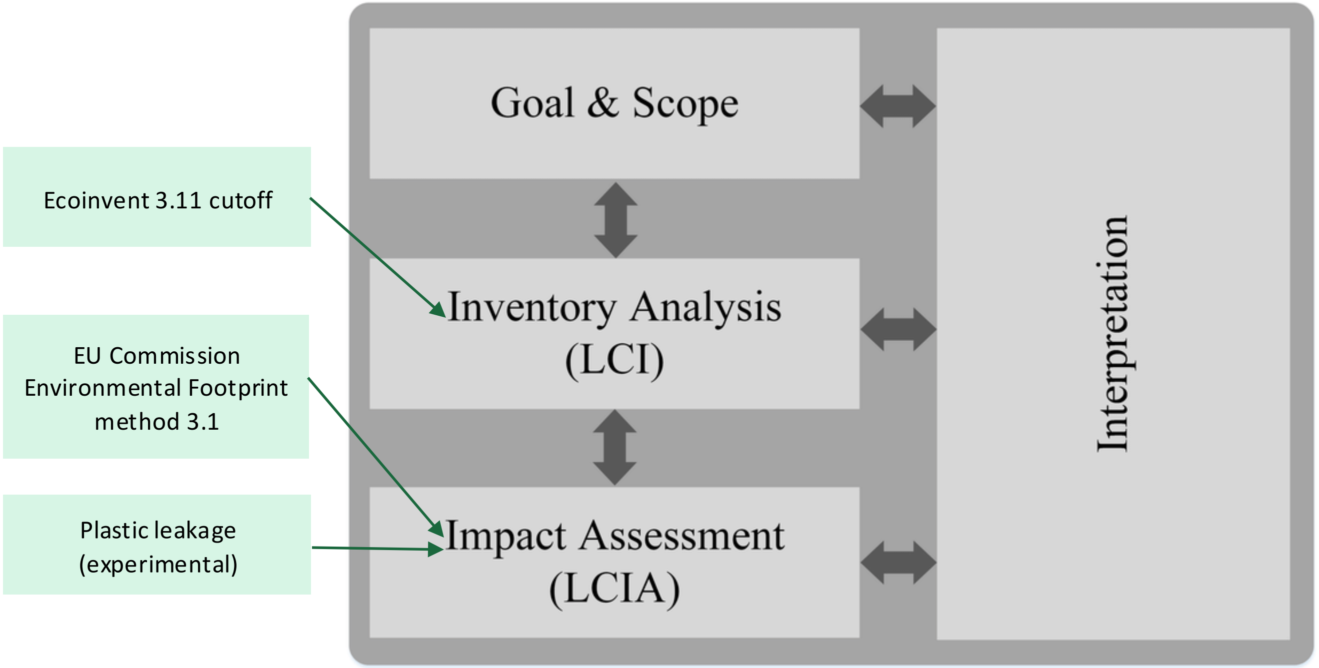
Methodology

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.



Life cycle assessment (LCA) steps according to ISO 14040, 14044, and 14067.

References:
“Ecoinvent v3.11.” n.d. Ecoinvent. https://ecoinvent.org/ecoinvent-v3-11/

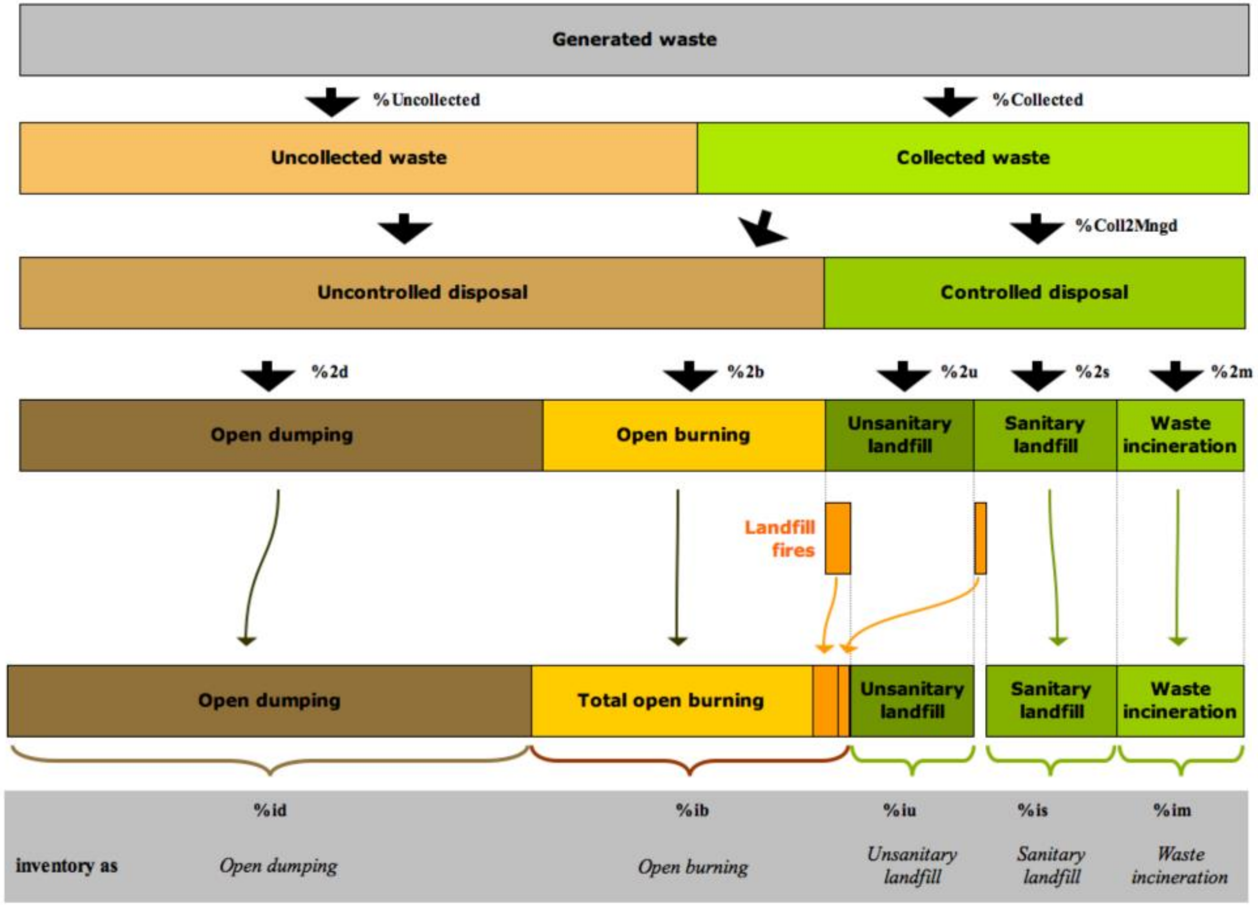
End-of-life waste management

This study aims to model the impact differences between **managed and mismanaged** waste tailored closer to humanitarian contexts.

The end-of-life impact for *a mix of plastic waste* reduces as below:

Method	GHG Emissions	Impact on Human Health
Open Burning	~HIGHEST~	~HIGHEST~
Municipal Incineration	-2.60%	-96.03%
Unsanitary Landfill	-93.80%	-99.40%
Open Dumping	-95.50%	-99.87%
Sanitary Landfill	-96.22%	-99.06%

Open burning creates maximum impact for both categories, but beyond that there are differences between climate change and human health on the specific magnitude of reduction.



Doka, G., 2018, Inventory parameters for regionalised waste disposal mixes

This study uses values for specific types of plastic wherever necessary, however the proportions of impact follow similar trends across the types of plastic product. This is therefore the standard impact implication for plastic products at end-of-life. Whenever possible, recycling is also modelled as a waste treatment option within the scope of the study.

NOTE: The methods listed above have differences in how long it takes for the plastic to be removed. It is part the LCA methodology that measurements are limited to a 100 years, therefore any further impact due to the degradation of plastic in landfills is not measured or compared with other methods of disposal.