

IEooc_Methods4_Exercise5: Life cycle impact assessment

Goal: Practice LCA thinking, work with impact assessment method LC impact, calculate regional endpoint indicators

This exercise was provided and is © by Prof. Francesca Verones, NTNU, Trondheim, Norway

The aim of this exercise is to take you through all stages of an LCA, using LC-Impact as the LCIA method. You should compare results with regionalized and with not regionalized values (as specified below). Please note that it is not a complete LCA in the sense that neither all inputs and outputs nor all impact categories are considered. The problem set is based on a real-life case, albeit numbers and systems were simplified.

The aim of this LCA is to compare the performance of four different shopping bag use patterns:

- 1) Polyethylene (PE) bag, one-time usage,
- 2) Polyethylene (PE) bag, multiple uses possible,
- 3) Paper bag,
- 4) Biodegradable bag (manufactured from maize starch).

Tasks:

1. One option for a functional unit is to just compare the bags with each other. That might not be the best functional unit though. Define an appropriate functional unit for comparing the four shopping bag alternatives. It is assumed that an average customer goes 45 times a year to the supermarket and buys on average 200 l of goods each time.
2. In the following table some more information on the four bags is given. How many bags are used to pack the shopping volume of one year? What is the mass of the used bags per option, assuming that the re-usable bags are used three times? Round the number of bags. Which option uses most and least material?

	PE bag, one-time	PE bag, multi-use	Paper bag	Biodegradable bag
Material	high density PE	high density PE	paper (recycled)	50% maize starch 50% Polycaprolacton
Mass per bag	6.04 g	44 g	52 g	17 g
Volume	14 l	29.6 l	20.5 l	25 l
Re-usable?	No	Yes	No	No

Part II Methods

Methods part 4 (Life cycle assessment)

<http://www.teaching.industrialecology.uni-freiburg.de/>

3. Life Cycle Inventory. Look at the Life Cycle Inventories for the four options (sheet 'LCI' in provided spreadsheet *LCMS2017_Exercise3_LCIA.xlsx*). The values are collapsed over all life cycle stages. What are the largest and what are the smallest emissions per bag?
4. Calculate the LCIA for the four different options. To do this, you will use the provided values from LC-Impact together with the provided LCIs. Remember that one substance can lead to damages in multiple impact categories.
 - a. Calculate the LCIA on endpoint level in DALY and PDF for all four options, using the site-generic values from LC-Impact. Assume "forestry" as land occupation type for the plastic and paper bags. Assume "annual crops" for the biodegradable bag. Which option performs best regarding human health and which performs best regarding ecosystem quality? Compare the options *per bag* and *per year*.
 - b. Calculate the LCIA again, this time, assume that the four different options are implemented in four world regions, as specified in the table below. Use the provided region-specific impact factors from LC-Impact as specified in the table below. What difference does it make for the impacts on human health and ecosystem quality?

	PE bag, one-time	PE bag, multi-use	Paper bag	Biodegradable bag
Land occupation, PDF/m ²	India: 3.77e-12	Japan: 1.38e-13	Norway: 7.82e-15	South Africa: 4.49e-12
Particulate matter (PM2.5), DALY/kg	India: 0.00336	Japan: 0.00147	Norway: 0.00147	South Africa: 0.000315