English

What is Life Cycle Assessment?


Courtesy: www.Photos8.com

Life Cycle Assessment is a tool used to **determine all the direct and indirect impacts of a product or an activity.**

Life Cycle Assessment *(LCA), is the* ***process through which the total environmental impacts of a given product or activity are calculated.*** *The underlying philosophy is that the impact of salt, for example, is not just the impact of its production, like fuels or electricity used in machinery. To obtain the total impact of salt, we must add to those direct impacts the indirect environmental burden, which results for example from the production of the machines themselves. LCA is also referred to as "cradle-to-grave analysis", since it* ***describes and quantifies the impacts of the whole production chain of a product:*** *since the production of its inputs, to its final destiny.*

Therefore, the LCA approach tells us that, as consumers, ***our environmental impacts do not come just from the energy we use and the waste we produce, but also from the products we buy.*** *The concept is widely applied to optimize the environmental performance of products (ecodesign), or to optimize the environmental performance of a company in all its activities.*

ECOSALT uses an LCA perspective, in the sense that salt producers must be responsible for the whole production and disposal chain of their products. *Therefore, when optimizing processes and activities, they must necessarily take into account the whole chain of events that leads from primary inputs to the final packaging waste.*

What is Life Cycle Assessment?

Life Cycle Assessment (LCA), is a **tool used to quantify the total environmental impact of a given product or activity.** All steps in the whole life cycle are taken into account, from primary production of inputs to production, transportation, use and final waste disposal. LCA is an important tool for decision making, if used to compare two different products or production systems. Its importance is now recognized by the European Integrated Product Policy.

LCA has the advantage over other impact assessment methods of being a standard procedure for calculations. The ISO 14000 environmental management standards series was created to set standards in LCA. Regulations are stated in ISO 14040:2006 and 14044:2006 (ISO 14044 replaced earlier versions of ISO 14041 to ISO 14043). Amongst other positive effects, this series establishes guidelines that guarantee that different studies for different products are comparable between themselves.
According to ISO 14040, every **LCA study must contemplate four stages:**

1. Goal and scope definition;
2. Inventory analysis;
3. Impact assessment;
4. Interpretation.

Even though they happen in a succession, most LCA studies are iterative. When all steps are done, the experience collected by preliminary results allows us to better define our goal and our inventory requirements.

Goal and scope definition

Regarding the goal and scope definition stage, it is a crucial step in any LCA, since results are deeply influenced by it. It is the stage where the question to answer during the study is posed. There are four aspects to cover:

- System description and functional unit;
- Main procedures for the study;
- Evaluation criteria for results;
- Data requirements.

System description is needed to define the boundaries of the system studied. These boundaries relate to the functional unit, which is the quantity of final input that all inputs and impacts will be determined in relation to. As for the definition of procedures, it is required in order to make all assumptions clear. The evaluation process will have to be as clear as possible, so that calculations may be repeated by all interested parts. The determination of evaluation criteria is also where impact categories are chosen. Data will be required depending on these categories.

There are **two methods with widespread use in LCA studies:**

- Ecoindicator 95
- Ecoindicator 99.

The **"Ecoindicator 95"** approach **classifies, characterizes and normalizes the environmental impacts based upon their effects.** The environmental aspects related to a given product are first aggregated into a number of effects caused, and those are then characterized according to the degree of damage inflicted to the ecosystems. Finally, these results are normalized into a single score, based on subjective evaluation.

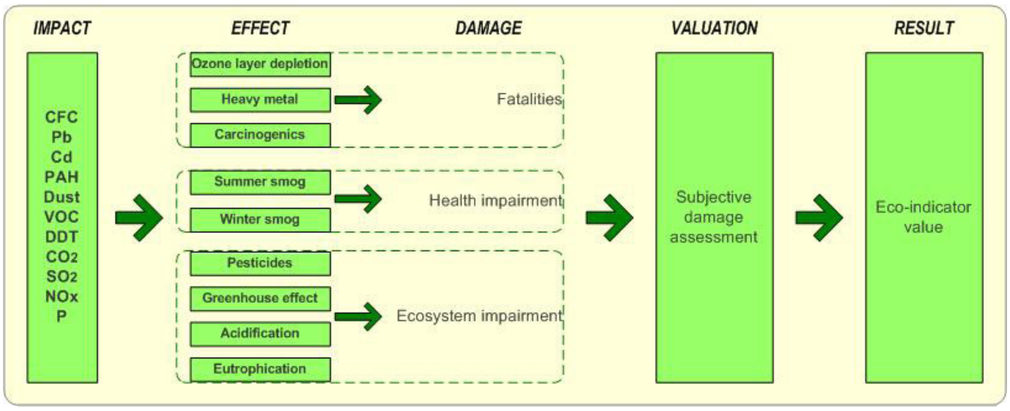

Figure 6 – Ecoindicator 95 weighing method. Environmental categories are shown in the "effect" column. Adapted from: Goedkoop (1998)

From all themes, the most important for the case of agriculture were considered to be greenhouse, eutrophication, acidification, energy resources and heavy metals.

"Ecoindicator 99" is an update and an **extension of Ecoindicator 95, based on a more damage-oriented methodology.** It considers **three types of environmental damage:**

- **human health** (measured in DALY – Disability Adjusted Life Years),
- **ecosystem quality** (expressed as PAF – Potentially Affected Fraction and PDF - Potentially Disappeared Fraction);
- **resource depletion** (expressed as MJ/kg).

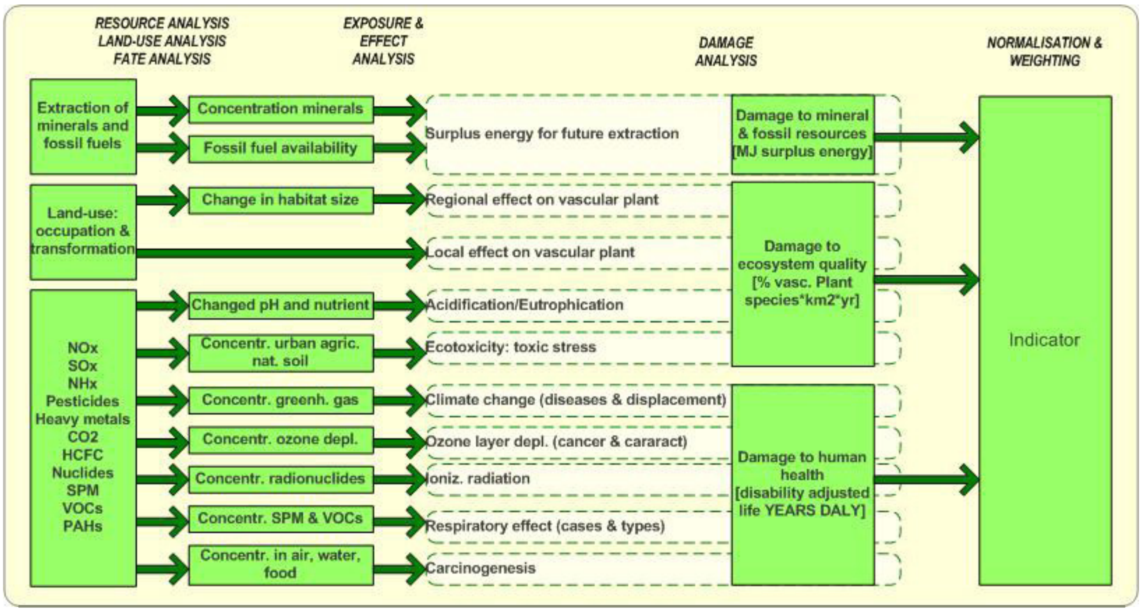

Figure 7 – Ecoindicator 99 weighting method.
Environmental categories are shown in the "exposure and effect analysis" column.
Adapted from: Goedkoop and Spriensma (2000)

The units used may be described as follows:

- **DALY** - **D**isability **A**djusted **L**ife **Y**ears. It measures disabilities caused by a given substance or action on a scale of 0 to 1, where 0 is perfect health and 1 is death, which means different disability caused by diseases are weighted. This unit is used for all themes concerning directly human life.
- **PAF** – **P**otentially **A**ffected Fraction of species. It expresses the effect on every living organism of a given action or substance, and may be interpreted as the fraction of species exposed to a concentration equal or higher than the "no observed effect concentration". This unit is used for toxicity.
- **PDF** - **P**otentially **D**isappeared **F**raction of plant species. PDF is used to express effects on vascular plant populations in a given area, and may be interpreted as the fraction of that population that may not occur due to unfavourable conditions. This indicator is used for acidification/eutrophication and land use.
- **MJ surplus energy.** This represents the additional energy requirement to compensate lower future ore grade. This unit is used to evaluate minerals and fossil fuels.

Inventory analysis

The inventory stage identifies and quantifies inputs and outputs in the process. Some databases are available, such as the Ecoinvent European database. If no standard database is used, it has to be built specifically for the study.

The most **important steps** in this stage are:

- **System boundary definition.** In this stage, we define how far we want to regress in the life cycle in our study;
- **System description** by a block diagram. This stage is important to formulate the problem in a system modeling approach;

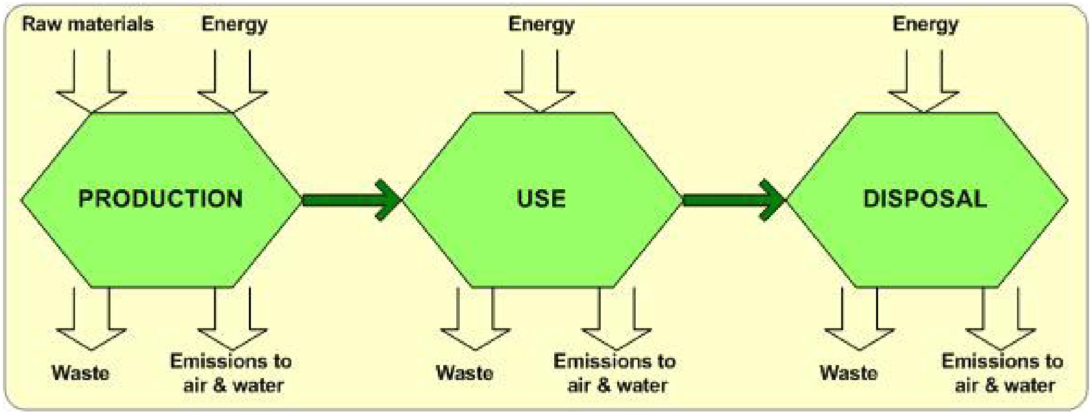

Figure 8 – LCA generic block diagram.
Adapted from http://www.sustainability-ed.org.

- Identification of **unit processes** to model with special care. This may require some pre-calculations to determine which processes have a higher impact;
- **Data search.** When available data is not enough, a plan to find the remaining required data must be devised;
- **Data processing,** including impact allocation between co-products.

Impact assessment

During the impact assessment stage, all impacts are determined and grouped per impact category. The two main **impact assessment methods are Ecoindicators 95 and 99,** as previously defined.

The **three main steps** in impact assessment are:

- Selection of impact categories, indicators and characterization models;
- Results calculation for each impact category;
- Calculation of indicators for each category.

Three more steps are facultative:

- Determination of the significance of the impact in each category in relation to an average figure (normalization);
- Conversion and aggregation of impacts in different impact categories into a single score, using

subjective quantitative figures;

- Data quality analysis, with possible use of an uncertainty analysis.

Interpretation

The last stage in any LCA is the analysis of results, in order to draw conclusions, and answer the question posed in the first stage. This is also when the need for one more iteration is assessed. In that case, the study should be redone, including new data for the processes where it was required that it is needed.

The end result of an LCA study may be **obtaining quantitative values for environmental impacts,** may be the decision for one product against the other according to some environmental category.

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