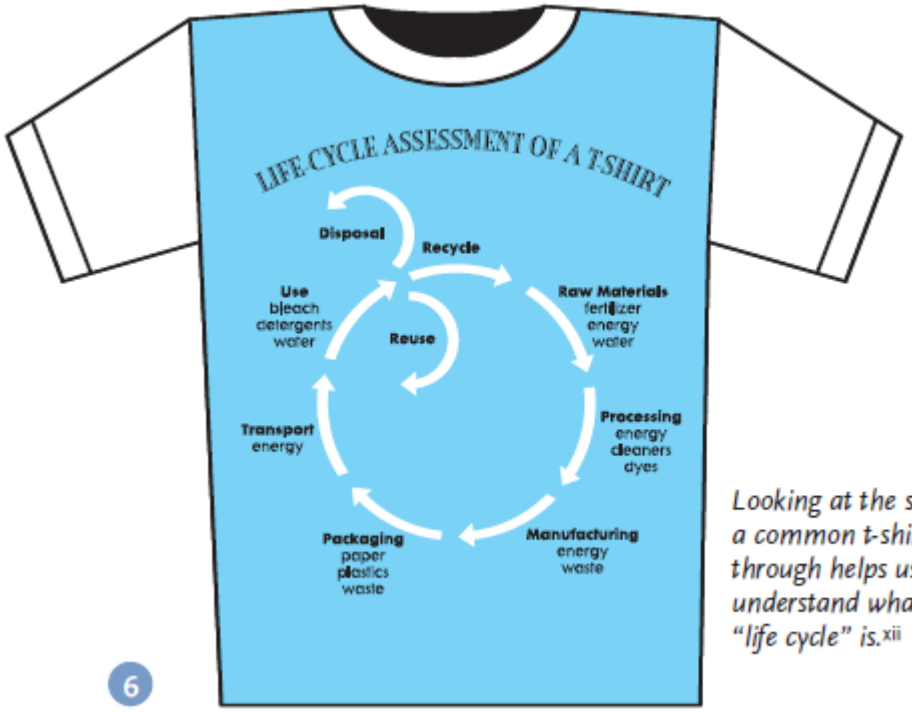
The EU funded SWIM-SM: developing capacity for Sustainable and Integrated Wastewater Treatment and Reuse

Online Course on Natural Treatment Systems: Life Cycle Assessment of WWT

Life Cycle Assessment (LCA) of WWT



Looking at the stages a common t-shirt goes through helps us understand what a "life cycle" is.[xii]

SWIM OLC

on

Natural Treatment Systems

http://www.unep.org

LCA

- Technique to quantify the impacts associated with all the stages of a product, service or process from cradle-to-grave.
- Covering a wide range of environmental aspects
  - impacts on human health (climate change, ozone depletion, smog, toxicity, etc.)
  - impacts on ecosystem quality (acidification, eutrophication, toxicity, etc.)
  - impacts on resource availability (depletion of minerals, fossil fuels, etc.)
- Since 1960s, since 1990s pressure to standardize LCA methodologies: ISO 14040 series

ISO International Organization for Standardization

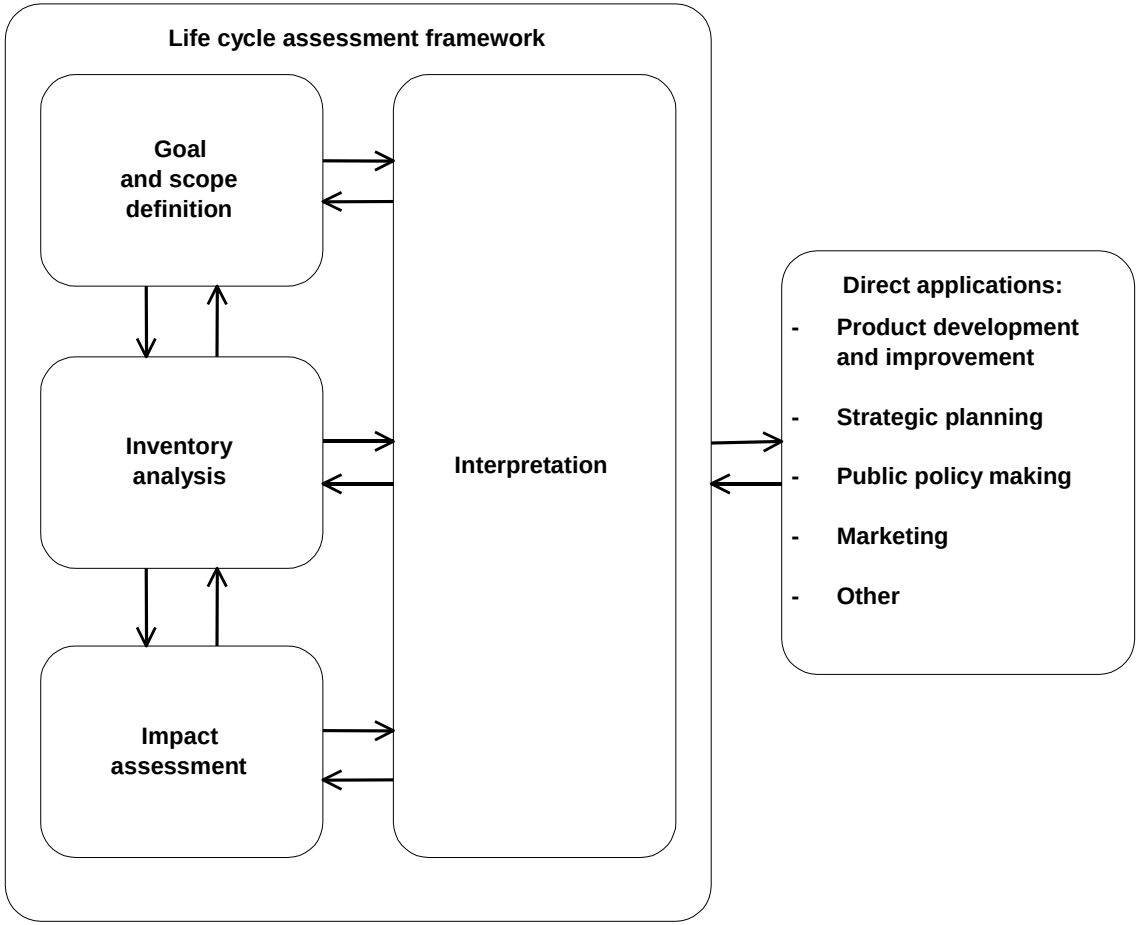
LCA for comparing environmental policy options

- Typical questions addressed include the following.
  - What are the environmental gains of composting organic waste compared with fermentation or incineration with energy recovery?
  - What is the preferred application of thinning wood: electrical power generation or paper production?
  - How do biomass-for-energy programmes affect climate change?
  - What requirements should be set on sustainable building activities, in terms of both the energy characteristics of the building(s) in question and the construction materials used?

ISO 14040 standards

1. Goal and scope definition
2. Life cycle inventory (LCI)
3. Life Cycle Impact Assessment (LCIA)
4. Interpretation

LCA: ISO framework



http://www.unep.org

LCA WWT

- WWT: LCA was already applied in the 1990s
- LCA is a valuable tool to elucidate the broader environmental impacts of design and operation of a WWT
- Since then, more than forty studies have been published in international peer-reviewed journals

Review: Life cycle assessment applied to wastewater treatment: State of the art. Corominas et al, water research 47 (2013) 5480-5492.

LCA studies e.g.

- 1st: inventory to evaluate different small-scale WWT technologies
- 2nd: Societal sustainability of municipal WWT in Neth.
  - importance of reducing effluent pollution
  - minimizing the sludge production
  - impacts related to energy consumption were very low (WWTPs contributed to less than 1% of energy consumption in Neth.) = normalized
  - Construction impacts and the use of chemicals were not found to be significant

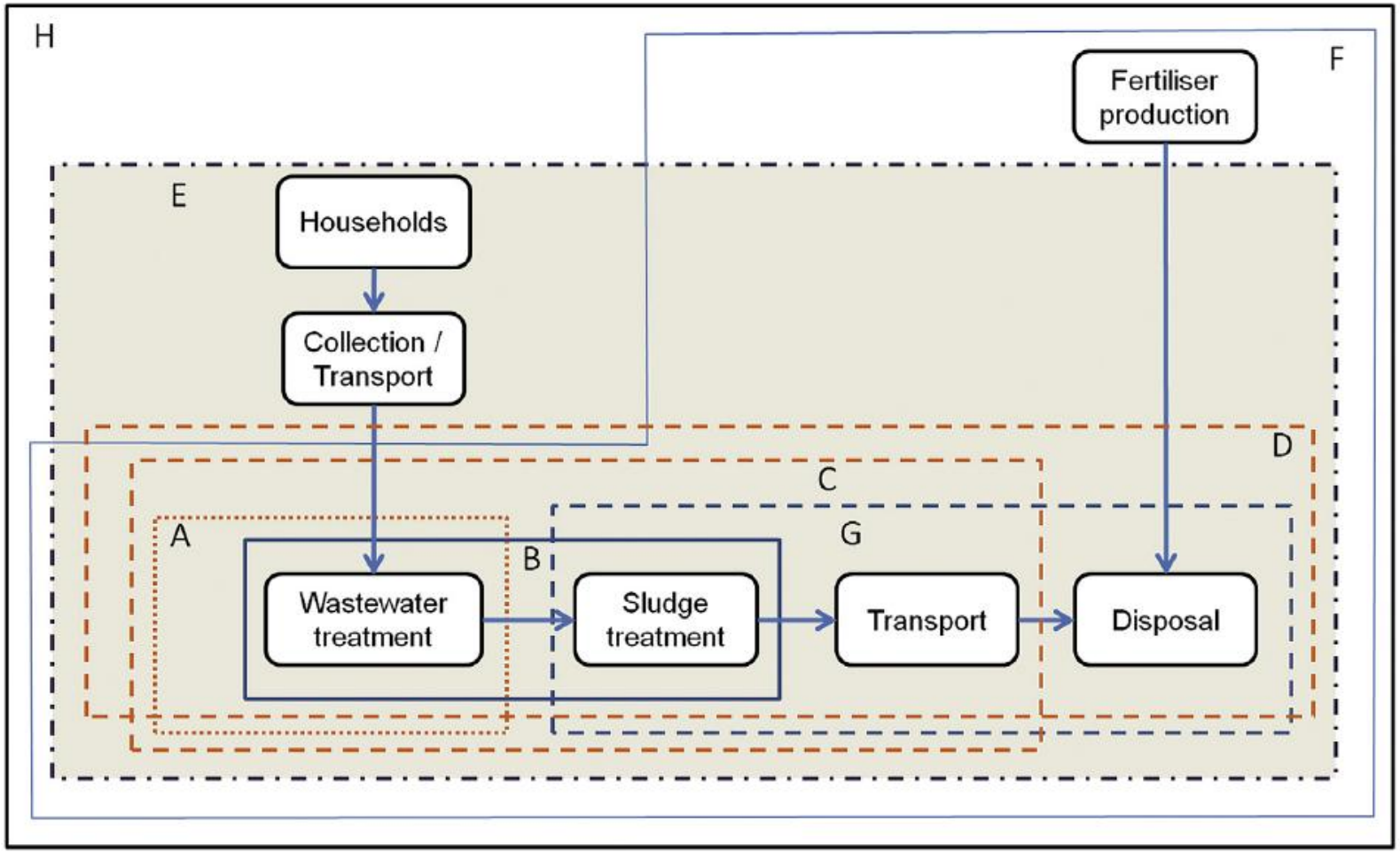
LCA studies conclusion

- The outcomes were very similar in all of the studies that involve nutrient removal: trade-offs between eutrophication, toxicity and global warming impact categories.
- Caused mainly by water discharge emissions, sludge treatment and disposal and electricity use.
- The improvement of local water quality is at the cost of regional/global effects resulting from energy and chemical production.
- Overall, the best alternatives: the ones that result in lower nutrient emissions.

ISO 14040 standards

1. Goal and scope definition:
   - Aims of the study
   - A functional unit, which characterizes the function of the system under consideration (E.g volume unit of treated wastewater, population equivalent , life span of the plant)
   - Boundaries (spatial and temporal) : include only operation, or also construction and demolition?

Boundaries used in LCA WWTP



Life cycle assessment applied to wastewater treatment: State of the art Corominas et al, Water research 47 (2013) 5480-5492

ISO 14040 standards

2. Life cycle inventory (LCI)
   - Data collection (list of in and Output flows)
   - Problems associated with data availability and data quality

ISO 14040 standards

3. Life Cycle Impact Assessment (LCIA)
   - impacts calculation includes
     1. Classification and characterization
        - Global warming
        - Acification
        - Eutrofication
        - Toxicity
        - Ozon layer depletion
     2. Normalisation (18 of 40 papers) and weighting (5 of 40 papers)
        - Regional and global databases
        - Used to convert and aggregate indicator results across impact categories into one single indicator

ISO 14040 standards

4. Interpretation: results are presented and discussed and a sensitivity analysis is conducted.
   - Identification of significant issues based on the results of the LCI and LCIA
   - Evaluation of the study considering completeness, sensitivity and consistency checks (only 15 of 40 papers)
   - Conclusions, limitations and recommendations

New approach for the LCA applied to WWT.

- Include the effect of micropollutants on ecotoxicity
- Boundaries: WWT more than protecting of human health and surface waters: also minimize loss of resources, reduce the use of energy and water, reduce waste generation, and enable the recycling of nutrients.

Expanding boundaries LCA are necessary

- Expanding boundaries for the evaluation of management strategies for the urban water/wastewater system to evaluate the environmental consequences of different systems
  - Nutrient recycling
  - Including the offset production of fertilizers
  - Recovering energy
  - Sustainability for water reclamation

IWA

- Working Group for Life Cycle Assessment of Water and Wastewater Treatment, LCA-Water WG
- Aim:facilitating the exchange of ideas, and to develop consensual methodologies to promote better use of LCA in the urban water systems