

Unit 4: Life Cycle Assessment

Session 4: Impact Assessment

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Impact Assessment

- Attempt to describe the *environmental consequence* of the activity being studied
 - Accomplished by translating inventory into consequence (impact)
- Allows inventory information to be aggregated into fewer metrics

Issue 1: Translating Environmental Impact

- The impact of pollution is rarely a simple one
 - CO₂ → Increases thermal absorption → Raises Temperature
 - So what?
 - Increased temperature →
 - Ice melting
 - Desertification
 - ...
- Assessment method, must take into account causal chain

Which Environmental Impacts should we care about?

Issue 2: What Effects to Track?

- ISO establishes three broad categories of concern
 - Resource use
 - Human health
 - Ecological consequence
 - There is debate over whether to include damage to the man-made environment (e.g., acid rain damage to ancient structures)
 - What about aesthetics? Comfort?
- Key issue: Double counting
 - Boundary between categories is fuzzy
 - Oil depletion vs. Emissions from oil use

Impact Assessment

- Impact Category Definition
 - Identify what impacts are of concern and which models will be used to translate inventory to impact
- Classification:
 - Environmental stressors are correlated with specific impact categories
- Characterization
 - Quantify amount of impact
- Valuation
 - Possibly weighting impacts to rank or aggregate

Impact Categories: Many differing approaches

- Nordic Guidelines
 - Resource depletion
 - Energy & material
 - Water
 - Land use
 - Human health
 - Toxicological
 - Non-toxicological
 - Work/living environment
 - Ecological
 - Global warming
 - Photochemical oxidation
 - Acidification
 - Ozone depletion
 - Eutrophication
 - Ecotoxicological
 - Bio-diversity
- Environmental priorities system
 - Human health
 - Biological diversity
 - Ecosystem production capacity (crops...)
 - Abiotic resources (metals...)
 - Cultural & recreational value (e.g., aesthetics...)

In the end, you need to map effect of
inventory to consequence...
Or you can rely on others who work on
this problem

Ready-made Impact Assessment Methods

- Numerous methods exist
- Generally, LC impact is calculated by multiplying inventory versus some impact assessment index

$$\begin{aligned} \text{LC Impact} &= (\overline{\text{Inventory}}) \cdot (\overline{\text{Impact Index}}) \\ &= \sum_i (\text{Inventory}_i) \times (\text{Impact Index}_i) \end{aligned}$$

- We will look at two methods which provide a set of characterization indices
 - EPS
 - Eco-indicator

Eco-Indicator

- Represents impacts based on average conditions in Europe
- Calculations
 - Compute direct impact of an environmental load (i.e., inventory emission)
 - Compute how human health and/or ecosystem health is effected
 - Climate change, ozone layer depletion, ...
 - Compute a weighting factor to assess how serious this effect is
- Weighting factor: based on distance to target

Eco-Indicator: Weighting factors

- Distance to target
 - The further away current conditions are to an established target the more serious it is to worsen those conditions
 - Current CO₂ per year vs. 1990 CO₂ per year: 0.0297
 - Current NO_x vs. desired NO_x: 0.941
- Current conditions are generally objective
- Desired target is subjective
 - How much bio-diversity loss is okay?

Environmental Priority Strategies in Product Design (EPS)

- Developed by Chalmers University with Volvo
- Tracks impacts for five "safeguard subjects"
 - Human health
 - Biological diversity
 - Ecosystem production capacity (crops...)
 - Abiotic resources (metals...)
 - Cultural & recreational value (e.g., aesthetics...)
- Characterization maps to quantifiable effects
 - Changes in sick days
 - Deaths
 - Reduced crop production
- Weighting
 - For economic activity (crops) → Price
 - Non-economic activity → Willingness-to-pay to avoid
 - How much are you willing to pay to avoid death?

LCA: Methodology

- Goal & Scope Definition
 - What is the unit of analysis?
 - What materials, processes, or products are to be considered?
- Inventory Analysis
 - Identify & quantify
 - Energy inflows
 - Material inflows
 - Releases
- Impact Analysis
 - Relating inventory to impact on world

