Sustainability appraisal methods

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Agenda for today

Sustainability appraisal methods

- Introduction to the day (5 min)
- Groups 3 and 4 present (20 + 20 min)

---------- BREAK (15 min) ----------

- Groups 2 and 1 present (20 + 20 min)

---------- BREAK (10 min) ----------

- Wrap-up & summary of the methods (30 min)
- Group discussion (15 min)
- Next steps

Learning outcomes

After the teaching session and Task 2 you should be able to:

- Describe how sustainability can be assessed through engineering methods
- Identify some key methods for sustainability appraisal and define their main characteristics
- Evaluate limitations of the methods in terms of sustainability
- Find and communicate the key contents of the material given to you

Pre-survey results, sustainability appraisal methods

	Never heard	I know the basics	I know it very well	Can apply the method in practice. Please, specify your experience:	Keskiarvo	Mediaani
Environmental Impact Assessment EIA	20%	66,67%	13,33%	0%	1,93	2
Life Cycle Assessment LCA	0%	80%	6,67%	13,33%	2,33	2
Material Flow analysis MFA	86,67%	13,33%	0%	0%	1,13	1
Material Input Per unit of Service MIPS	80%	20%	0%	0%	1,2	1
Cost-benefit analysis CBA	60%	33,33%	6,67%	0%	1,47	1
Multi-criteria (decision) analysis MCA/MCDA	73,33%	26,67%	0%	0%	1,27	1

Quantitative sustainability appraisal methods

The order of presentations today:

1. Cost-Benefit Analysis CBA (group 3)
2. Material Flow Analysis MFA (group 4)
3. Material Input Per Service MIPS (group 2)
4. Multi-Criteria Decision Analysis MC(D)A (group 1)

20 min / group

Evaluation criteria:

1) Addressing the guiding questions in presentation, max 6p.

2) Presentation: ability to emphasise key messages in an understandable way, max 4p

Cost - Benefit Analysis (CBA)

- Assesses the total monetary value of the overall benefits and costs (→ information on profitability)
- Costs and benefits measured in equivalent units (= money)
- Should include- all benefits and costs - discounting and possible interest, i.e. future value
- Social discount rate to consider future

monetary gain, if the same investment was put to second best alternative then the project in hand. If the monetary gain of that would be 5%, the SDR is then 5%.

Sustainability and CBA, limitations

- tries to evaluate what cannot be evaluated in money (intangibles)

  → results in approximations that are not perfect representation of the true value

  → results in the use of value judgements, and assumptions become unavoidable

    → possibility of manipulation

- aims to determine economic efficiency, does not consider who gets the benefits and who incur the costs (equity concerns)
- traditionally emphasizes short-term gain, minor weight to costs far in the future

CBA variants and related methods

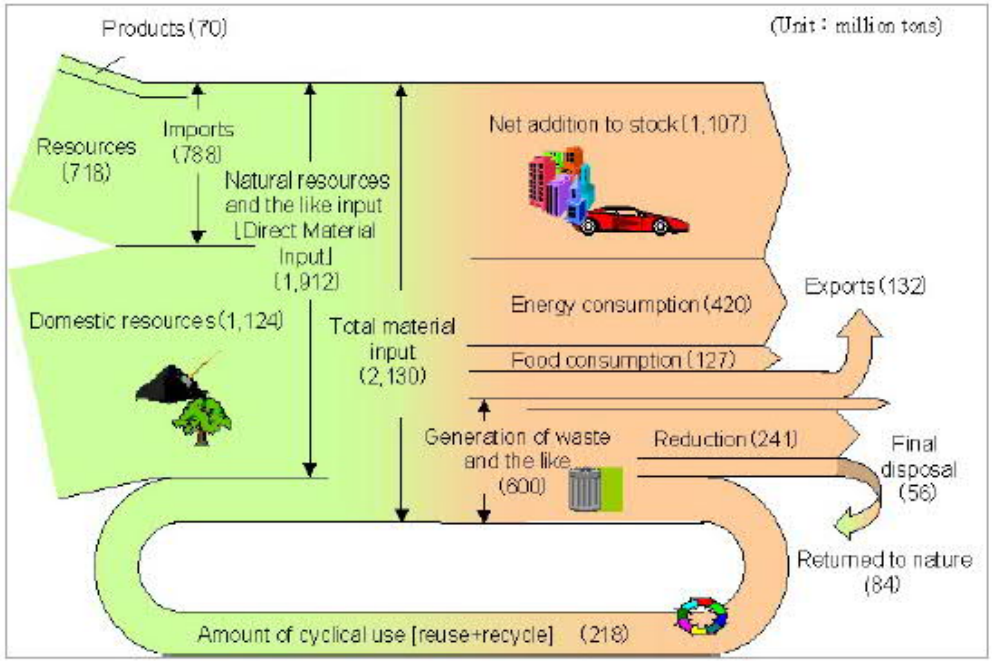
- **Life Cycle Costing/Cost Analysis (LCC/LCCA)**
  - Costs assessed from a life cycle perspective
- **Cost-effectiveness Analysis (CEA), Cost Utility Analysis (CUA)**
  - No need to monetize benefits (nor quantify)
  - Typically used for ranking within a given budget
- **Economic Impact Analysis (EIA)**
  - measures the economic impact (activity generated) rather than the net benefit created
- **Eco-Efficiency (EE) Analysis**
  - EE = Product or service value / Environmental influence
- **Environmental CBA: see OECD 2018:**

https://www.oecd.org/environment/cost-benefit-analysis-and-the-environment-9789264085169-en.htm

Material Flow Analysis (MFA)

- Quantifies stocks, flows, inputs, i.e. material flows of process chains from extraction/ harvest to recycling and disposal
  - usually in terms of weight units, such as kg, ton
- Systematic assessment within a system defined in space and time

- Can be considered as a part of a full LCA = serves as an inventory
- Used also in describing flows, e.g. nutrients in WWTP
  - MFA focusing on a specific substance = Substance Flow Analysis (SFA)



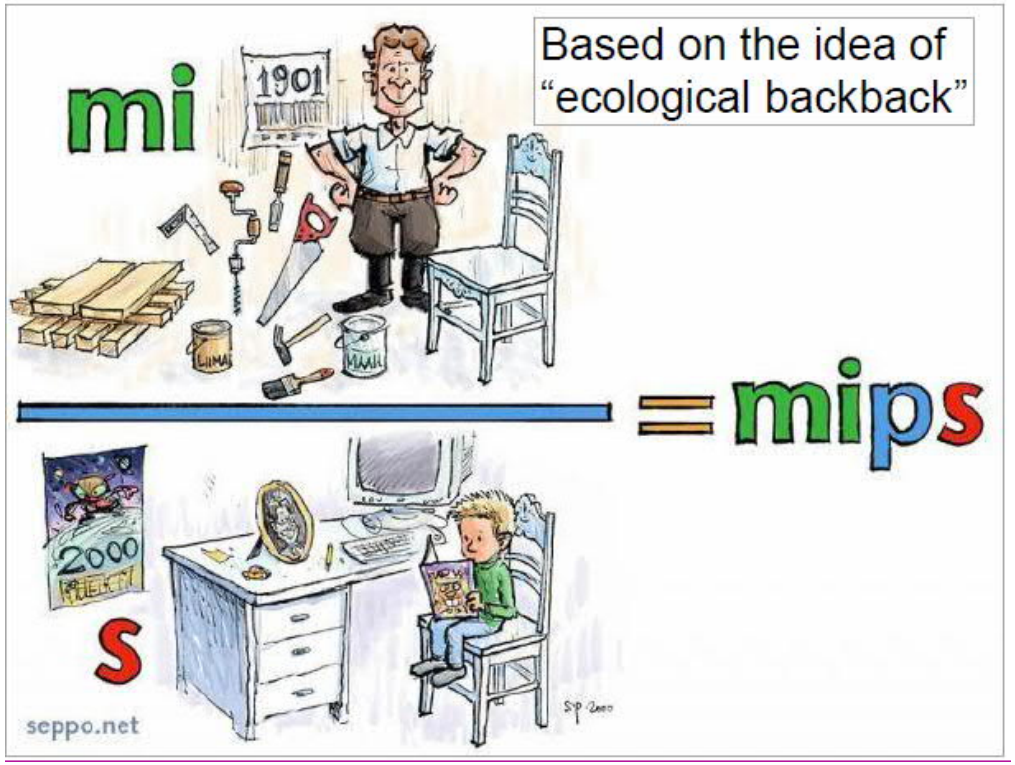
Sustainability and MFA, limitations

- Traditionally considers only material flows (i.e. substances and goods, energy flows are ignored)
- Only evaluates the flows passing through a system
- Does not consider impacts as precisely as a full LCA
  - Total material rate does not correlate with total env. impacts
- MFA considers a limited number of substances, LCA considers as many as possible

Material Input Per Service unit (MIPS)

- Principle: inputs from nature (biosphere) converted into outputs(in technosphere) with environmental impacts
- Material = all required natural resources (= raw materials, also energy carriers and transports) in weight units (kg, tons)
    - 5 factors: abiotical (non-renewables) and biotic resources (renewables), water, air (O2), soil

- Can be used to assess eco-efficiency / to compare material efficiency of services
    - E.g. natural resources used / km of transportation



MIPS & sustainability, limitations

- Focus on ecological sustainability
- Does not consider environmental impacts explicitly
  - Indicator for material efficiency, not env. Impacts
- Does not take biodiversity & hazardous chemicals into consideration at all
- Reducing MIPS either by:
  - Decreasing the use of materials
  - Increasing the service unit: in the case of a recreational area, high risk of overusing and destruction of the area

→ Requires also other tools to gain a comprehensive picture

MIPS vs. LCA

- Considers material use throughout the entire life cycle (from extraction to disposal) = similarity with LCA
- Considers direct and indirect material use & used and unused extraction
- Service unit ≈ functional unit of LCA
- Inputs: 1) abiotic (metallic and non-metallic minerals, i.e. ores, rocks, sand, etc.; fossil energy carriers, e.g. coal, mineral oil, natural gas) 2) biotic, 3) water, 4) air, 5) earth movements in agriculture and forestry

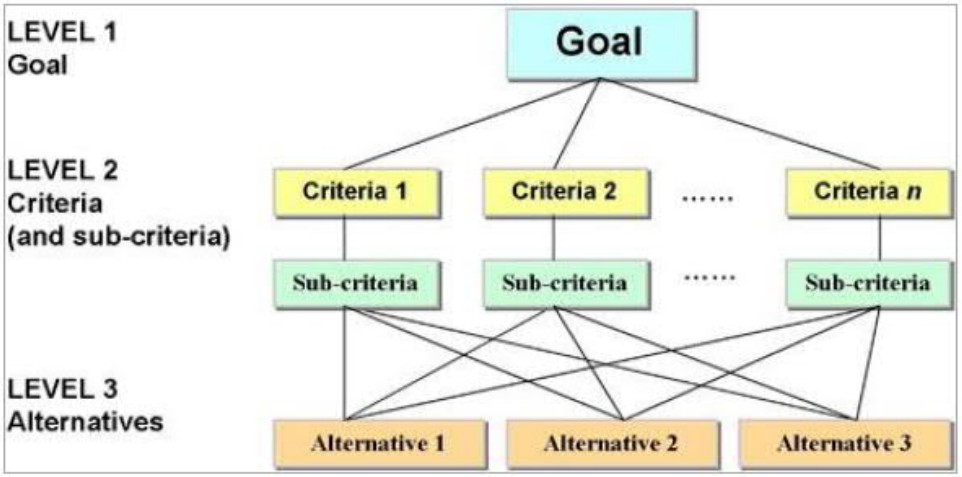
Multi-Criteria (Decision) Analysis (MC(D)A)

- Complex of multiple methods and approaches
  - Enables systematic (quantitative) consideration/ranking of different factors (= decision criteria) involved in complex decision-making
  - Can be used in decision-making that involves several actors/stakeholders
- Does not produce new information → structured way of organizing and refining existing information
  - Break down, analyse → combine, understand
    - The aim is to create a clearer picture on the issue at hand
  - Learning process for participants
- Resource-intensive

Multi-Criteria (Decision) Analysis (MC(D)A)

- Used in participatory environmental planning (your case very typical, in Finland often used in stormwater management and water resources management)

- Decision criteria can have different units and different scale, possibility to criteria weighting
- Two major classes of methods in terms of weighting approach: Compensatory and Outranking, cover numerous different methods
- No standard methodology



CBA and MCDA

- MCDA takes into account the preferences of decision makers
- CBA aims at objective, monetary comparison of existing options
- MCDA engages stakeholders and weighs different preferences
- CBA results are equally relevant to all stakeholders
  - → CBA applied to achieve resource-effective solutions and measure societal cost-effectiveness

→ Complement each other; CBA can be used as one criteria of a more comprehensive MCDA

Limitations of MCDA

- Weighing the criteria according to their importance challenging
- How “right” the final outcome actually is?
- Resource intensive
- Many schools around the methodology with varying vocabulary
- The role of the person performing the actual analysis highlighted

Challenges to sustainability appraisal (SA)

Complexity

= multidimensionality: environmental, economic, social issues

= need for system approach

= need for life cycle perspective

= involves/affects several stakeholders and actors

= dynamism

= interrelation of sustainability factors

= can encompass different assessment process stages

Challenges to SA – no established approach

Scope

- What is the time scale of SD ? (”next generations”)
- Different sustainability elements have different temporal and spatial dimensions, how to combine them ?
- How to select the scope even within one sustainability element ?

Abundance and diversity of methods

- Screening level – detailed
- Qualitative vs. quantitative
- For a single decision maker or a group of stakeholders?

Challenges in quantitative SA

- Needs (in general) a vast amount of data
- Requires adequate technical expertise and objectivity
- Requires understanding of the calculation methods
- How to include factors that are not easily measurable, e.g. social aspects ?
- Which methods and/or structure to choose inside the method (e.g. hierarchy?, weighting method in MCDA?)
- Can involve high level of uncertainty: sensitivity analysis needed

To sum up

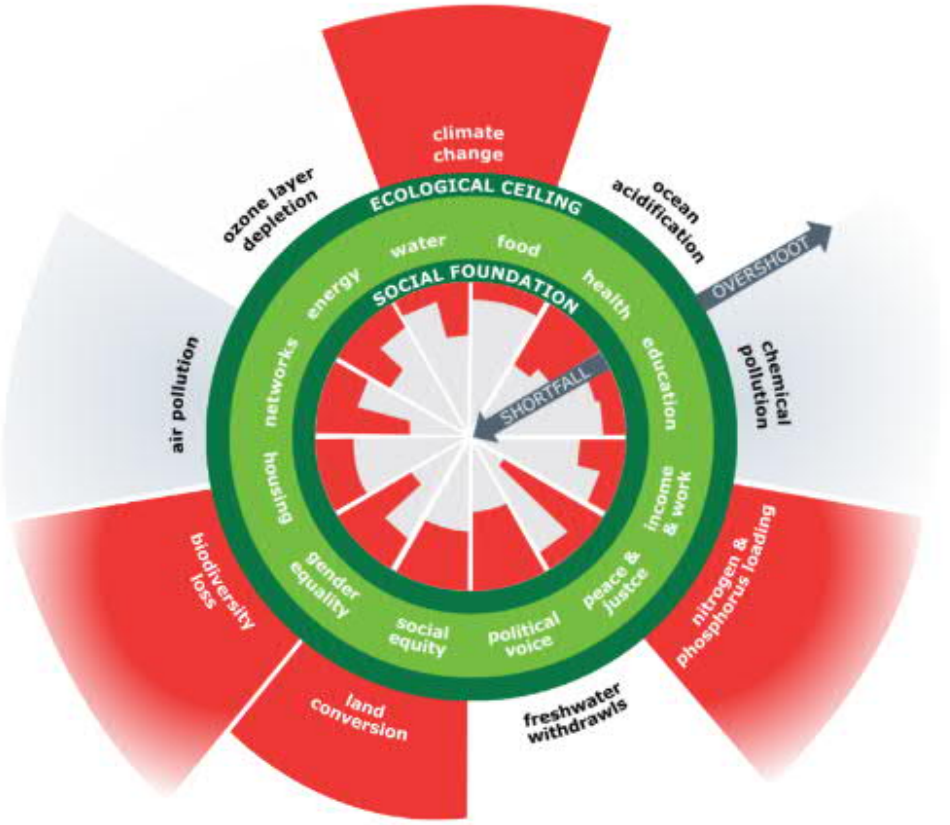
Different level of sustainability appraisal methods are needed for different purposes

- Check lists, indicators, quantitative models → a toolbox?
- To provide a systematic means to compare decision

Quantitative tools

- Do not provide absolute answers
- Use requires expertise
- Should include uncertainty assessment
- Require often a lot of data
- Assume often quantification of intangible factors

Linkage to global sustainability?



World as a resource **Interconnected** **Regenerative**

Anthropocentric **------ Ecocentric ------**

Scales (time, space), actors, values

Next steps

(today at 23.55 DL for Task 1)

1) **Wed at 23.55 DL for Task 2**
   - Finalised slides: include your group reflection
     - *~250 words: take home messages from this session & methods discussed*

2) **Wed: Visiting lecturer Juudit Ottelin / Aalto**
   - LCA: Rebound effect
   - Delivery of Task 3

3) **Fri: Visiting lecturer Outi Ugas / Positive Impact**
   - Life cycle thinking in companies' "real life"
   - Delivery of pre-reading for EIA lecture on Wed 18.11.