Multi-Criteria Decision Analysis in sustainability impact assessment of Forestry Wood Chains
Concepts and implementation

Bernhard Wolfslehner, Werner Rammer, Manfred J. Lexer
the problem

Indicators

- costs
- GHG
- employment

Indicators

- costs
- GHG
- employment

Indicators

- costs
- GHG
- employment

Indicators

- costs
- GHG
- employment

EURO $ + GHG $/m^3 + employment [h/m^3] = ?
Objective

Developing a quantitative Decision Support Systems (DSS „ToSIA“) for Sustainability Impact Assessment (SIA) of Forestry-Wood Chains

- **proactive**
  - strategic competitiveness of EU industries
  - competitiveness of „biobased industries“ (forest sector)
- **reactive**
  - responding to legislative pressure
  - maintaining the status quo wrt competitors
- **impact assessment of policy actions**
The rationale for the SIA framework for sustainability indicators is to better assist decision-making relating to the sustainable development objective. (…) Main stages in SIA are (i) detailed assessment of proposed measures, and (ii) assessment of alternative mitigation measures…” (Kirkpatrick et al. 2002)

MCA is a set of methods designed to:

- take account of multiple, conflicting indicators, criteria or objectives
- to structure a decision problem
- to identify the most preferable option among alternatives
- to provide a formal model for such problems as a focus for discussion
- to support rational, justifiable, and explainable decisions
the process of MCA in EFORWOOD

ToSIA software (scheme)

- policy scenarios
- technological development

Sustainability Indicators
- economic
- ecological
- social

Cost-Benefit Analysis
- monetary valuation
- CBA performance indicators
- externalities

Multi-Criteria Analysis
- preferences of stakeholders / DM to the importance of indicators
- of indicator values

reporting
analysis & aggregation
demand on sustainability indicators…

- complete
- data availability
- measurable
- thematically balanced
- sufficiently specific
- sensitive to changes
experts
- definition of FWC
- selection of indicators
- provide indicator values
- provide threshold values for indicators

decision maker/user of TOSIA
- explore effects of various interests on ranking of FWCs in SIA

analyst / facilitator
- propose methods to
  - structure the decision problem
  - elicit preferences
  - combine preferences of individuals & across indicators
- guide interactive MCA

stakeholders
- judgements on importance of indicators
- judgements on importance of indicator values

...on people...
... and on methods.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Lexicographic</th>
<th>MAUT</th>
<th>SMART</th>
<th>AHP</th>
<th>ANP</th>
<th>PROMETHEE II</th>
<th>ELECTRE III</th>
<th>MACSETH</th>
<th>NAIADE</th>
<th>SMAA-AO</th>
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<td>SC</td>
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<td>low</td>
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### preference elicitation in PROMETHEE

<table>
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<th>Indicators</th>
<th>Alternatives</th>
<th>Pairwise comparison</th>
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<td></td>
<td>A(a)</td>
<td>A(b)</td>
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<tr>
<td><strong>cost</strong></td>
<td></td>
<td></td>
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<tr>
<td>[€/m³]</td>
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<tr>
<td>minimize!</td>
<td></td>
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</tr>
<tr>
<td><strong>GHG</strong></td>
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<tr>
<td>[tCO₂/m³]</td>
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<td></td>
</tr>
<tr>
<td>minimize!</td>
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</table>

**Equal weights for “costs” and “GHG”**

- A(a) = 1 + 0 = 1
- A(b) = 0 + 1 = 1
...and how we would implement this
a software prototype
weighting of indicators
group results
ranking of alternatives
module-specific weighting
ranking profiles
conclusions

• high degree of flexibility required
• high demand on consistency in the use of data and indicator values
• call for transparency in the evaluation process
• acceptance will also depend on user-friendliness
outlook

• prepare application for larger scales (case studies, European FWC)
• intensify stakeholder interaction
• test other MCA methods and hybrids
• technical integration within ToSIA
Thank You!

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13 stakeholder of regional FWC
-ranking of alternatives

MCDM - Methode
aggregate indicators
compensatory
non-compensatory

determine objective

criteria & indicators
- select
- structure

preferences
- indicator weights
- performance of alternatives

define alternatives

MCDM

Input

Output

input

preferences
- uncertainty
  - individual
  - group

define alternatives

MCDM - Methode
aggregate indicators
compensatory
non-compensatory

output

ranking of alternatives
- ordinal
  - individual/group
  - uncertainty
- cardinal
  - individual/group
  - uncertainty

 Berlin, 9 April 2008
SENSOR conference
Nachhaltigkeitsanalyse

  - Thematisierung von „nachhaltiger Entwicklung“
- UNCD Rio de Janeiro (1992)
  - Nachhaltigkeitsbegriff wird ausgeführt (3 Säulen)
- WTO Verhandlungen (1999)
  - Vorstoss der EU mit SIA setzt Standards
- auf EU-Ebene auch in anderen Politikfeldern eingesetzt / gefördert (2001)
  - Abschätzen der Auswirkungen von politischen Entscheidungen / Umfeldveränderungen / techn.Innovationen auf nachhaltige Entwicklung (sektorale, regionale, ...)
Wer soll dieses Tool nutzen?

- nationale & supra-nationale policy maker (z.B. EC)
- Unternehmen
- Forscher

Warum soll es genutzt werden?

- **Proaktiv**
  - strategische Konkurrenzfähigkeit der EU Industrie
  - Wettbewerbsvorteile von „biobased industries“ (Holzsektor)
- **Reaktiv**
  - auf Druck von legistischen Massnahmen
  - halten des Status Quo im Vergleich mit Mitbewerbern
- **Folgenabschätzung von Politikmassnahmen**
Alternative FWCs in BW

Module 2
Forest management

- natural regeneration
- natural regeneration
- planting

Module 3
Forest to industry

- motor-manual harvesting
- semi-mechanized harvesting
- fully-mechanized harvesting

- long logs
- short logs
- short logs

Module 4
Industry

- small local sawmill
- large regional sawmill
- large regional sawmill

- (log frame)
- (sawline)
- (sawline)
some feedback ...
The used set of indicators was sufficient to evaluate the sustainability of FWCs

The set of indicators to assess sustainability impacts has to be „complete“ & balanced
The presented alternative FWCs are relevant examples for Baden-Württemberg

questionnaire

- clear definitions of system boundaries must be communicated for any evaluation procedure
Applying MCA-methods in sustainability assessment is a useful approach.

Questionnaire:

- Strongly agree: [Bar]
- Agree: [Bar]
- Disagree: [Bar]
- Strongly disagree: [Bar]

Number of participants: [0, 2, 4, 6, 8, 10, 12]

Utilizing the full potential of MCA for SIA of FWCs requires a guided process.
The software appears user-friendly and easy to use

questionnaire

feedback of group results is perceived as valuable asset

... provide (semantic) guidance in the process of preference elicitation

![Bar chart showing responses to questionnaire questions.]

- Strongly agree: 10 participants
- Agree: 2 participants
- Disagree: 0 participants
- Strongly disagree: 0 participants

Number of participants: 0, 2, 4, 6, 8, 10, 12
Aufbereitung & Analyse

multi-kriterielle Bewertung:

- Transformation von Indikatorwerten mithilfe v. Präferenzfunktionen
- Gewichtung von Indikatoren
- Aggregation von Indikatoren
- Reihung von Alternativen

...importance of indicators
The role of people in EFORWOOD MCA
...and of stakeholders in particular

**stakeholders**
- judgments on importance of indicators
- judgments on importance of indicator values

(a) inclusion of extended knowledge about uncertain issues
(b) inclusion of multiple perspectives, values and interests
(c) increase legitimacy
indicators for the BW spruce test chains

- production cost
- employment
- salaries & wages
- occupational safety & health
- GHG emissions
- energy use (non-renewable)
- transport distance
Objectives of the workshop

- **testing** MCA methods & software
- getting **feedback**
- **learning** about stakeholder perceptions
- **developing** the approach and the tool further

- with an informed audience
- in a real-life context
  - FWCs from Baden-Württemberg
MCA - Why should we do it...

- We will see all sorts of impacts across alternatives, cf. the indicator list

- We must be able to compare alternatives and evaluate e.g. a difference between two optional FWCs (a, b) like:

  \[ d(a,b) = 10\text{€} + 1\text{kg CO2} + 15 \text{ FTE employment} \]

- …enabling a consistent and transparent comparison among alternatives
methods, methods ...