
DLR
Strategic Environmental Indicators for Transport
and their Evaluation –
Qualitative decision aiding for SEA
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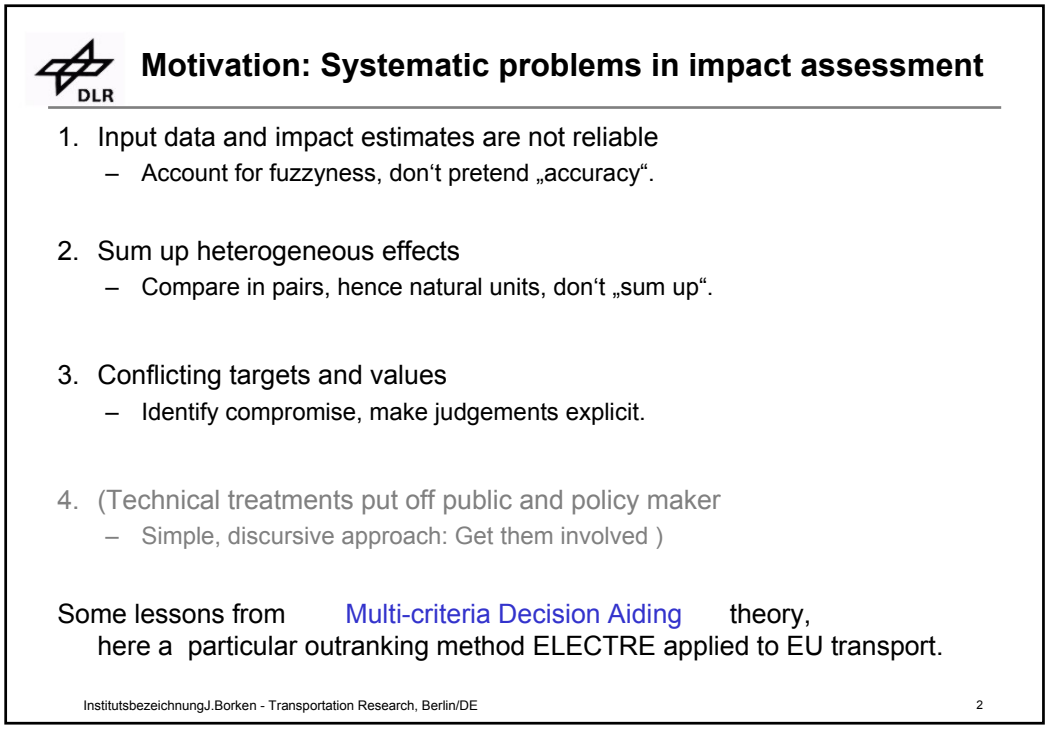
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Motivation: Systematic problems in impact assessment
1. Input data and impact estimates are not reliable
– Account for fuzzyness, don't pretend „accuracy".
2. Sum up heterogeneous effects
– Compare in pairs, hence natural units, don't „sum up".
3. Conflicting targets and values
– Identify compromise, make judgements explicit.
4. (Technical treatments put off public and policy maker
– Simple, discursive approach: Get them involved)
Some lessons from Multi-criteria Decision Aiding theory,
here a particular outranking method ELECTRE applied to EU transport.
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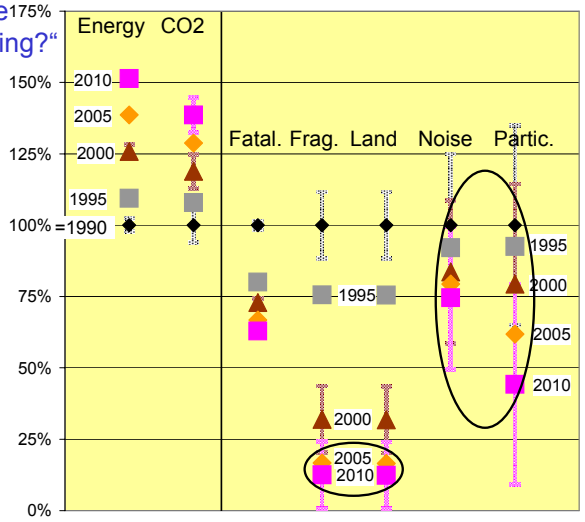
1. Vague data & knowledge demand general treatment

„Is the environmental performance of Europe's road transport improving?"

Data too imprecise for
- noise + air pollution,
- fragmentation + land take

=> Qualitative, fuzzy judgement

„Does case A perform at least as good as case B for indicator x ?"
- Cannot say,
- maybe,
- definitely.



1990=100%, exemplatory error bars.
Data actually refer to TERM (EEA1999, 2001, 2004)

2. Compare heterogoneous impacts individually, don't sum up

Begin with performance table – **preference direction: The less, the better**.

Indicator	CO_2-Em.	Accident	Noise	Particle pot.	Fragmentg
unit	Mt CO_2-eq	fatalities	Exposure	kt PM_{10}-eq	Δ(-1%)
Case A	720	56000	High	High	1,20%
Case B	780	45000	High	A bit less	0,90%
Uncertainty	5%	1%	**HIGH**	**HIGH**	10%
part. concordance					
Case A at least as good as case B	Yes	No	**Cannot say**	**Maybe**	No

Judge the relative performance per indicator and its reliability for all cases in dialogue.

=> Construct a matrix of qualitative reliability judgements per indicator.

3. Identify values, conflicts and compromise in dialogue

Use value profiles to emulate different positions – derive from dialogue with stakeholders.

Overall objective	Protection of human health			Protection of structure and function of ecosystems		Protection of resources	
Impact category	Accidents	Noise	Air pollution	Biodiversity	Climate change	Energy resources	Land resources
a) Equal weights	33/3	33/3	33/3	33/2	33/2	33/2	33/2
b) Health dominant	50/3	50/3	50/3	25/2	25/2	25/2	25/2
c) Ecosystems dom.	25/3	25/3	25/3	50/2	50/2	25/2	25/2
d) Resources dom.	25/3	25/3	25/3	25/2	25/2	50/2	50/2

Values capture the - explicit and implicit – trade-offs

=> Make discussion transparent.

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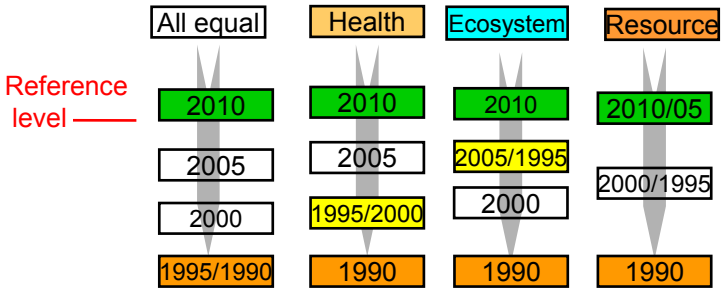
4. Overall ranking and compromise identification

ELECTRE, because compromise oriented:

Case A is globally prefered to case B IFF

- there are sufficiently strong criteria in favour of A AND
- there is no strong opposition or veto for single criteria.

This way, minority votes can be systematically integrated!



Sensitivity analysis:

Rank reversal IFF climate change and energy resources receive at least 60% of overall weight.

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Qualitative assessments can advance in vague contexts

- Qualitative relative assessments can structure and advance discussion
  - Accounts for fuzzyness
  - Treats heterogeneous data
  - Names conflict of values in clear language
  - Can open the door for participation
- Multi-criteria decesion aiding methods can help to identify compromise

Limits:

- Ordinal no cardinal evaluation => „distance“ not defined.
- Fuzzy input -> no precise output
- Compensation excluded
- Of course, the results depend on the method (Arrow‘s theorem)!

References on

ELECTRE / MCDA methods (French):

Roy & Bouyssou 1993: Aide Multicritère à la Décision : Méthodes et Cas. (ISBN 2-7178-2473-1).

MCDA methods (in English):

Figueira, Greco, Ehrgott 2005 (Ed.): Multiple Criteria Decision Analysis: State of the Art Surveys. Springer ISBN 0-387-23067-X, 1045+XXXVI pp.

Application of ELECTRE to Transport EIA (in German):

Borken 2005: „Umweltindikatoren als ein Instrument der Technikfolgenabschätzung – Selektion, Aggregation und multi-kriterielle Bewertung am Beispiel des Verkehrs“
http://www.freidok.uni-freiburg.de/volltexte/1938/

Indicators for environmental impacts

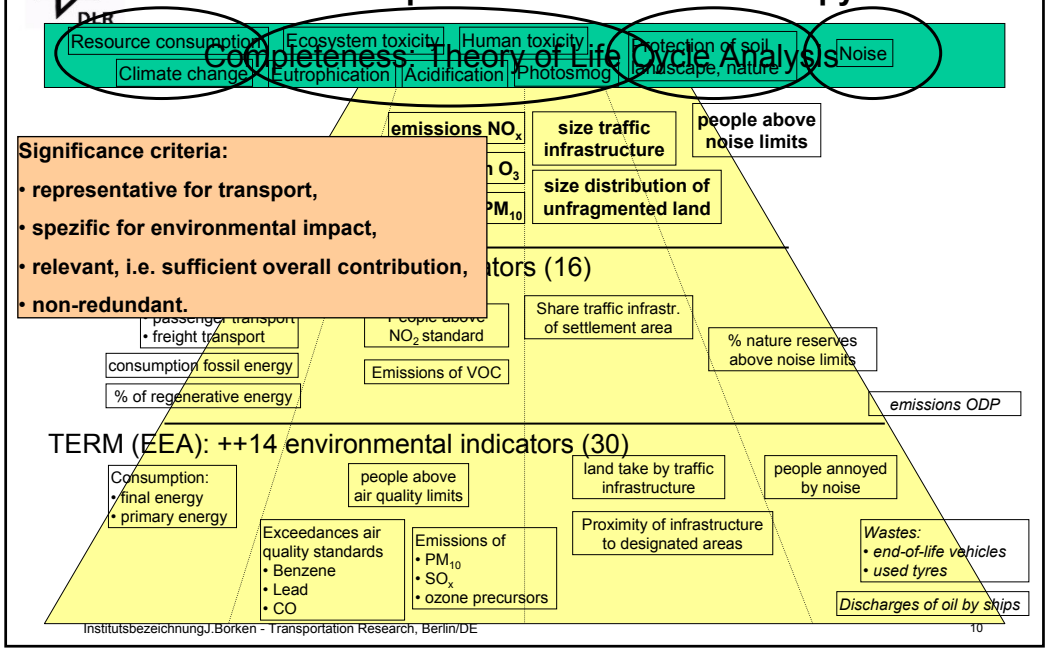
- Start with 24 real-world indicators, here TERM indicators of EU Environ. Agency
- Reduce to 7 key indicators for road transport:
  - Representative,
  - pertinent,
  - relevant,
  - non-redundant

Completeness and significance from LCA theory

	Protection of human health			Protection of ecosystems		Ressource protection	
Impact category	**Acci-dents**	**Noise**	**Air pol-lution**	**Bio-diversity**	**Climate change**	**Energy ressources**	**Land ressources**
Indicator	Traffic fatalities	Population exp. >65dB(A)	Particles (pot.)	Fragmenta-tion	CO_2-emissions	Energy con-sumption	Land take
	Assign relative importance to the various targets / impact categories						

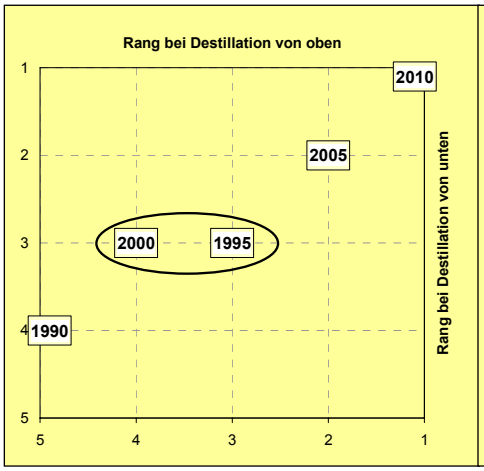
- But data are incomplete, imprecise, not homogeneous.

First result: 7 top indicators in information pyramide

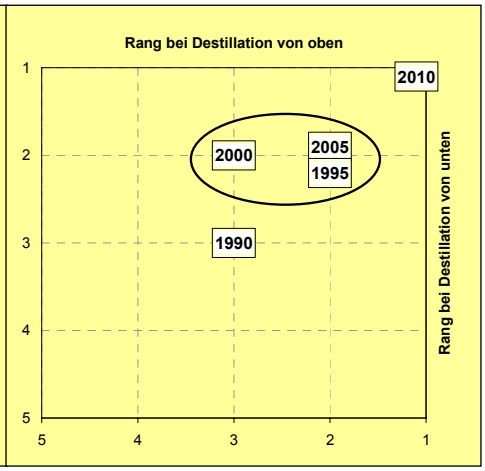


Ranking results for different value profiles

when HEALTH most important:
Safety + noise + air poll.: 50% weight

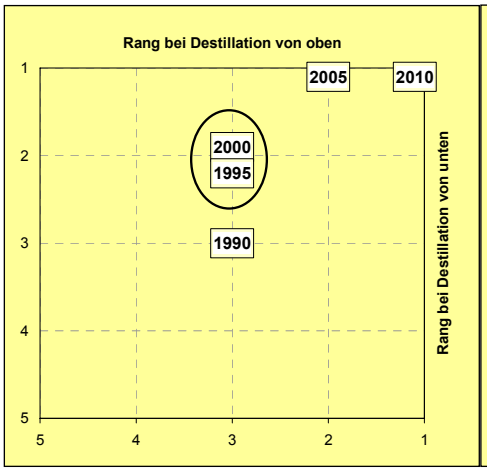


when ECOSYSTEMS most important:
Biodiversity + climate: 50% weight

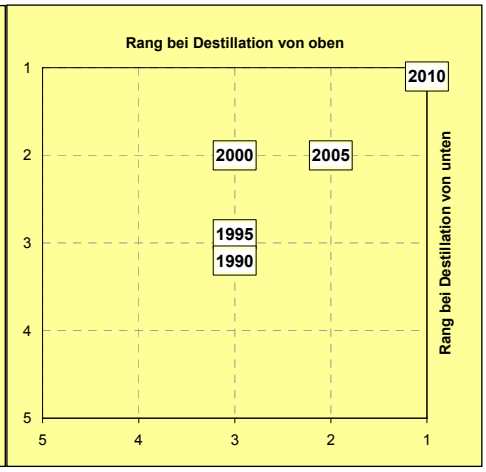


Evaluation (4): Different assessment profiles

when RESOURCES most important:
Land + energy: 50% weight

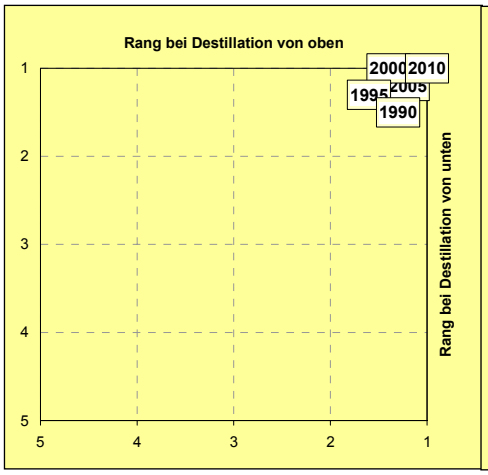


when ALL EQUAL:

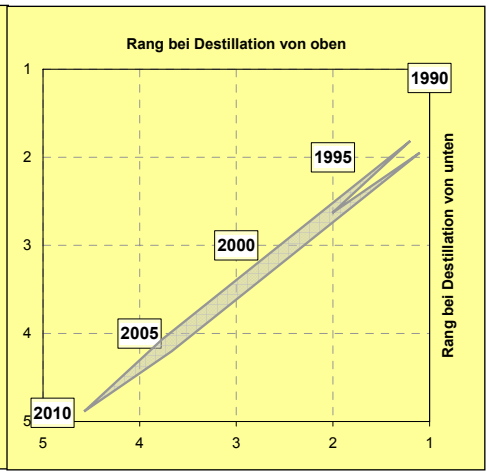


Evaluation (4): Different assessment profiles

Ranking impossible:
CO2 and energy > 40% weight.



Rank reversal:
CO2 and energy > 60% weight.



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Summary (1): Focus on common points

Given TERM's simple data structure

- Other parameters do not influence the order, but its resolution.
- Common assessment:
  Less environmental stress in future from EU road transport

  2010 >> 2005 > (2000/1995) >> 1990
- Other ranking IF AND ONLY IF
  - Single criterion receives a dominant weight,
  - Veto, or
  - Different future development.

- KEY indicators (= relevant + precise + decisive):
  - CO2 emission + energy consumption -> fossil fuel consumption,
  - Land take + fragmentation -> road construction.

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