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# Framework for assessing indicators of environmental impacts in the transport sector

*1. Define 'indicator'*

*2. Criteria for indicator assessment*

*3. Systematize environmental impacts*

*4. Assess some indicators*

# Introduction

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- Aims to contribute to the development of harmonised methods for building better environmental indicators relevant to transport
- Output of a collaboration among a network of 30 European ‘natural’, ‘policy’ and ‘planning’ scientists; a 5-year study
- Develops a framework for the construction, assessment and use of environmental indicators
- Partial synthesis of a book, available at <http://cost356.inrets.fr/>

# Definition of indicators

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- After in-depth literature review
- An *indicator* is a variable, based on measurements, representing as accurately as possible and necessary a phenomenon of interest
- An *indicator of environmental sustainability in transport* is a variable, based on measurements, which represents potential or actual impacts on the environment - or factors that may cause such impacts - due to transport, as accurately as possible and necessary

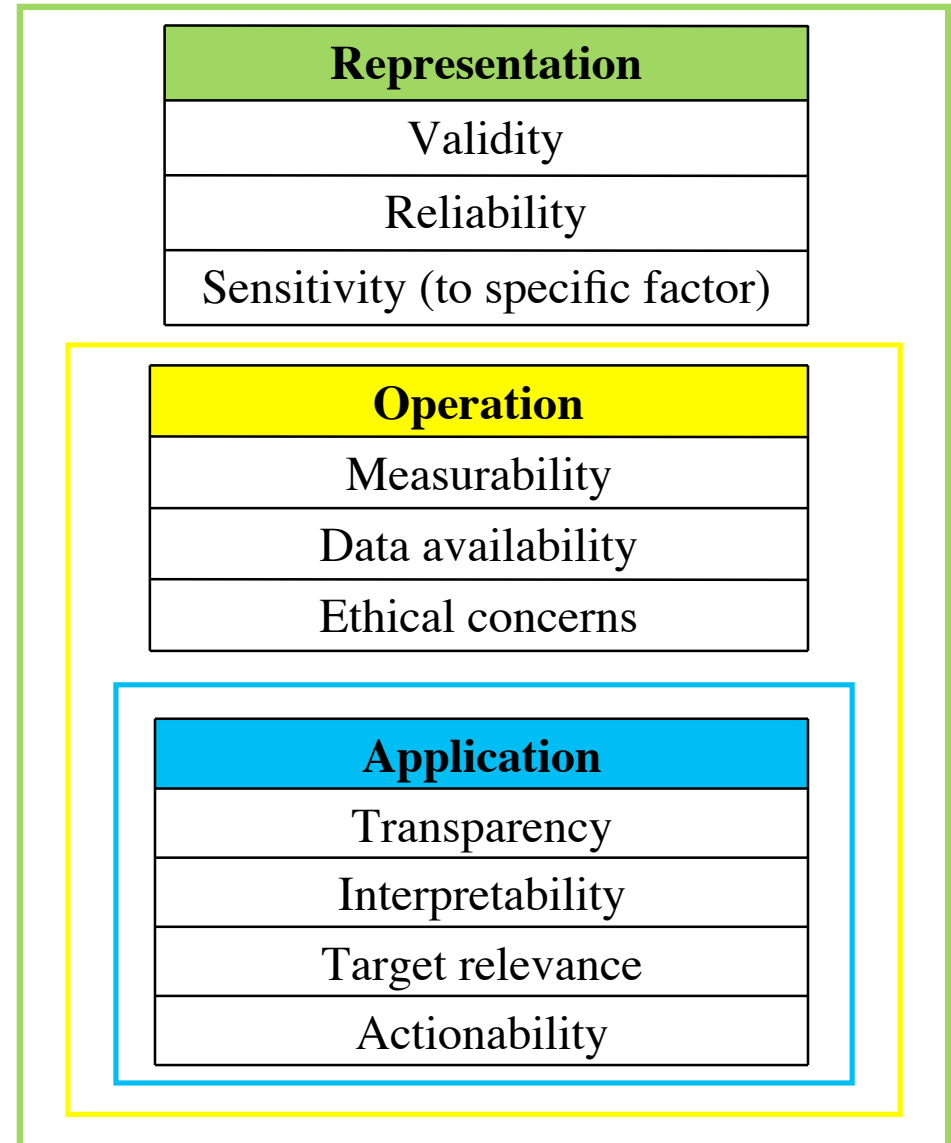
# Criteria for indicator assessment and selection

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- Literature provides *lists* of 4-30 criteria for use in the selection of indicators
- Broad consensus about many criteria across domains (health, agriculture, transport...)
- Limited agreement on specific definitions of criteria (often only a headline)
- Considerable overlap among definitions
- *Very low agreement of an overall categorisation => no common logic as to purpose of each criterion*

# Ten criteria for indicator assessment and selection

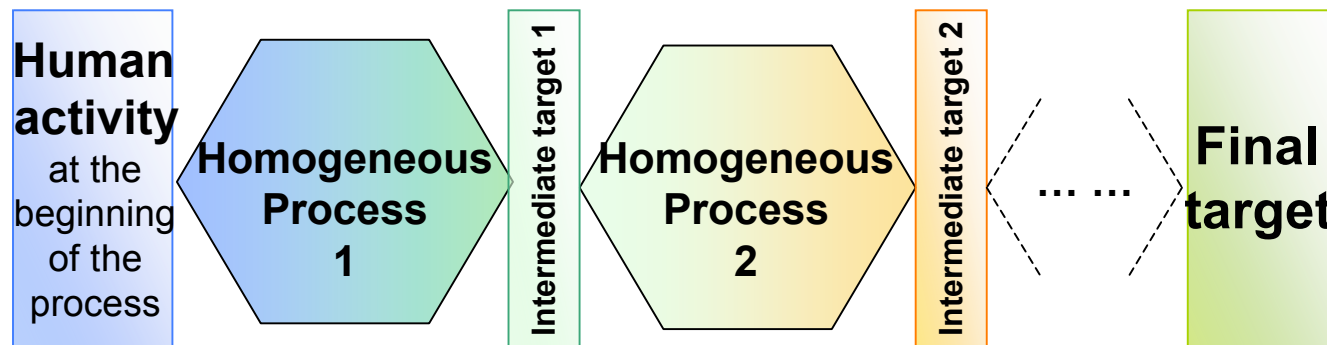
- **Measurement** related criteria:  
Indicators assessed with regard to accurate representation of an impact (as accurate as possible and necessary)
- **Monitoring** related criteria: Indicators assessed with regard to how operational they are for practical and continued monitoring
- **Management** related criteria:  
Indicators assessed for their pertinence to and usefulness for policy and decision making





# Concept of 'Chain of causalities'

- Impact lists often *heterogeneous* in literature => *systemic* approach
- Chain of causalities = homogeneous process or series of homogeneous processes between the transport system and a final target of the impacts on the environment



- Homogeneous process defined by a scientific discipline, linearity, reversibility, distance and time scale, ...
- Final target: resources, ecosystem, human health, human well-being, man-made heritage, the Earth
- Chains independent, encompass all the relevant impacts found in the literature

# 49 chains, 27 aggregated chains

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## ■ Noise and vibrations

- Noise (4 chains)
- Vibration (1 chain)

## ■ Safety

- Traffic Safety (1 chain)
- Biota collision (1 chain)

## ■ Air pollution

- Sensitive air pollution (3 chains)
- Direct toxicity of air pollutants (2 chains)
- Photo-chemical pollution (4 chains)
- Acidification (2 chains)
- Eutrophication (1 chain)
- Dimming (1 chain)
- Ozone depletion (2 chains)

## ■ Soil and water pollution

- Pollution of soil, surface water, groundwater (3)
- Maritime pollution (3 chains)
- Hydraulic changes and risks (2 chains)

## ■ Impacts on land

- Land take (4 chains)
- Habitat fragmentation (2 chains)
- Soil erosion (1 chain)
- Visual qualities of land / townscape (1 ch.)

## ■ Non-renewable resource use and waste handling

- Non-renewable resource use (1 chain)
- Non-recyclable waste (1 chain)
- Direct waste from vehicles (1 chain)

## ■ Greenhouse effect (1 chain)

## ■ Other impacts

- Electromagnetic pollution (2 chains)
- Light pollution (1 chain)
- Introduction of invasive alien species (1)
- Introduction of illnesses (1 chain)
- Fire risk (1 chain)
- Technological hazards (1 chain)

# Typology of the chains of causalities

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- Typology for presentation: 27 aggregated chains, 8 macro-chains
- Aggregate the 49 chains according to typical global or top-down classifications gives *heterogeneous* aggregates
  - quality of life / resources
  - short / long term
  - reversible / irreversible
  - local / global
- Top-down approaches of the environment through simple and discrete classifications seem not to correspond to the reality of the impacts



# Assessment of indicators of 7 impacts

- 7 chains of causalities out of 49 chosen:
  - noise as annoyance, direct toxicity of air pollutants, loss of cultural heritage due to land take, natural habitat fragmentation, non renewable resource use, waste, greenhouse effect -> 90 indicators
- 90 indicators assessed / 10 criteria above, by one or several experts

x=poor  
xx=limited  
xxx=good  
xxxx=excellent

- Example:*  
chain  
'non-renewable  
resource use'

Indicators based on ...	Representation			Operation			Application			
	Validity	Reliability	Sensitivity	Measurability	Data availability	Ethical concerns	Transparency	Interpretability	Target relevance	Actionability
... energy and mass	x	xx	x	xxx	xxx	xxxx	n.a.	xx	x	x
... relationship between use and deposits	xx	xx	xx	xx	xxx	xxxx	n.a.	xx	x	x
... future consequences of resource extractions	xxx	xx	xxx	xx	xxx	xxxx	n.a.	xx	x	x
... exergy consumption and entropy production	xx	xx	xx	xx	xxx	xxxx	n.a.	x	x	x
... marginal increase in costs due to the extraction of a resource	xx	xx	xx	xx	xxx	xxxx	n.a.	xx	x	x

# Assessment of indicators of 7 impacts

Representation	
Validity	Low scores often given
Reliability	High scores often given
Sensitivity	Poor to excellent

Operation	
Measurability	Low scores often given
Data availability	Low scores often given
Ethical concerns	For all but one chain, all indicators excellent

Policy application	
Transparency	High scores often given
Interpretability	High scores often given
Target relevance	Low scores often given
Actionability	Low scores often given

# Assessment of composite indicators

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- Same assessment made for 7 aggregate or composite indicators of overall environmental sustainability
  - Ecological Scarcity (for Switzerland)
  - ReCiPe (for Europe)
  - Ecological Footprint
  - Material Input per Service-unit MIPS
  - Economic approaches
    - stated preferences
    - revealed preferences
    - damage oriented

# Assessment of composite indicators

Representation	
Validity	All but 2 indicators poor or limited
Reliability	All but 2 indicators poor or limited
Sensitivity	All but 2 indicators good or excellent

Operation	
Measurability	All but 2 indicators good or excellent
Data availability	All but 2 indicators poor or limited
Ethical concerns	All indicators excellent

Policy application	
Transparency	All but 2 indicators poor or limited
Interpretability	Poor or limited
Target relevance	All but 2 indicators poor or limited
Actionability	Mostly poor

## Conclusions (1/2)

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- The concept of chains of causalities is a useful methodology and gives us new tools in order to evaluate the impacts of transport on the natural environment, on humans (health and well being), on man made heritage and more globally on the Earth
- We derived 10 criteria for the assessment and selection of environmentally sustainable transport indicators
- Indicators of environmental impact or environmental sustainability vary greatly in quality as assessed against the 10 criteria

## Conclusions (2/2)

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- Further scientific work needed to derive indicators for impacts little studied or emerging environmental issues
- Need to review potential indicators
  - with extended panels for the 7 impacts assessed here
  - for other environmental impacts
  - for typical applications of indicators in transport assessment
- Often inter- or trans-disciplinary work
- Similar approaches to be done
  - for impacts of transport on economic or social outcomes
  - for environmental impacts from other sources than transport





*Thank you for your attention*

Claude Monet