Adaptation to Climate Change in the Transport Sector
-- a Literature Review

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Adapting Utilities to Climate Change
Analysing and Developing Private and Public Action

key topics
- vulnerability analysis of energy and transport sector
- strategic instruments for companies
- requirements for governmental regulation
- compatibility analysis of public and private action
- archetypical barriers of adaptation

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Vulnerability of the Transport Sector

- Transport infrastructure is affected by extreme weather...
  - e.g. flooding of roads and railways, passenger safety during heatwaves, delays due to storms
- ...and by continuous climate change
  - e.g. permafrost melting (roads in the arctic), concrete degradation
- Transport delays and interruptions have high social costs
- Transport needs a long-lasting infrastructure (up to 100 years), such that anticipatory adaptation is indeed needed
  - e.g. bridges, railway lines, roads, airports, seaports
- Transport infrastructure and services are often highly regulated, so that early institutional adaptation may be needed
Literature Survey

- **Objective**
  - Assess the state of the art in research on adaptation in transport
  - Identify proposed or exercised adaptations
  - Identify the actors involved in adapting the transport sector

- **Document selection: sources**
  - Peer-reviewed journals (95 in total) from the following scientific fields:
    - Climate Change and Environment (Interdisciplinary, Economics, Political Science, Modelling)
    - Transport, Engineering
    - Disaster Studies, Planning, Law
  - Contributions to edited scientific volumes that are cited in scientific sources
  - “Grey literature” reports if they are cited in scientific sources and commissioned by public bodies
Document Selection

- Peer reviewed papers: appeared between 2005 and 2009
- Books and grey literature: cited between 2005 and 2009
- Search keywords
  - Transport
  - Infrastructure
  - Impacts
  - Adaptation
  - Climate change
- Subsequent elimination of documents that do not consider adaptation or impacts in the transport sector
  - (many of them mostly related to mitigation)
Document Selection: Results

- Overall 30 papers in 23 peer reviewed journals
- Contributions to books: 14
- Grey literature: 15

- Only 19 papers in 13 journals explicitly consider adaptations

- Literature is scattered: no journal with more than 2 contributions
- From 2005-2009: no significant pattern in the number of papers, but probably an increasing trend
- No outstanding authors (overall 89 authors in papers, one author with 3 contributions: A. Fisher; 7 authors with 2 contributions: W. Anderson, J. van den Bergh, J. Birkmann, P. Kirshen, P. Rietveld, M. Ruth, B. Yarnal)
Coding of Adaptations

- About 200 adaptations identified and coded
- Mode of transportation considered
- Technical or physical units involved
- Type of action
  - ... means employed for adaptation
- Actors involved
  - ... as Operators, Receptors or Exposure Units
The Action Theory of Adaptation

Stimulus
statistical change in meteorological variables

Exposure Unit
affected by climate change (not always an actor)

Receptor
of adaptation
Means
resources, knowledge, power
Operator
exercises adaptation

Actors
(Operator / Receptor / Exposure Unit can be identical, but can also fall apart)

(Reckien et al. 2008, Eisenack 2010, in press)
Modes and Means

- Majority of adaptations that explicitly address transport modes
  - road and water transport
- Much less adaptations for rail and air transport
- ...but by far the most adaptations are unspecific about the mode they address

- Means proposed for adaptation are also scattered or unspecific, but large groups of adaptations relate to
  - technological/physical solutions
  - (public and private) planning frameworks
  - monitoring, information provision, education, research etc.
  - specific investment proposals for new or changed infrastructure

- There are some, but very little proposals for
  - policy instruments (except spatial planning)
Operators

- Most operators are public actors, e.g.
  - Department of transport, national government, regulators, water agencies, planning authorities, ...
- ...or entities responsible for transport (public or private), in particular
  - Transport operators (about 1/3) and infrastructure providers (about 2/3)
- There are some, but far less adaptations to be operated by private companies, e.g.
  - Logistic industry, insurance, some specific production industries
- A very little number considers private households and scientific/educational organizations
- Another large group of adaptations mentions staff or managers of above organizations as operators
Receptors

- Nearly all mentioned receptors of adaptation are actors
  - Exceptions are:
    - Physical units that are also mentioned as exposure unit
    - Protective structures for an exposure unit, e.g. drainage systems
    - Physical or technical units that are a pre-requisite for exposed transport systems, e.g. water streets

- Receptors of proposed adaptations are quite diverse:
  - There appear many public and private actors, households and transport providers
  - There is a slight emphasis on
    - infrastructure providers
    - transport users
    - technical/physical units
Exposure Units

- About 55% of mentioned exposure units are technical or physical units, while 45% are actors of different type

- Physical/technical exposure units:
  - In most cases: parts of transportation infrastructure, often not specified concretely
  - The largest group of specific adaptations considers road infrastructure, e.g. bridges, road embankment, drainage

- Actors as exposure units
  - For most adaptations: private transport users
  - Some role for transport providers and private companies as being exposed
  - Little number of public actors mentioned
Conclusions

- Research on adapting transport to climate change is in a stage of infancy
- For proposed adaptations there is a gap between overly unspecific action (e.g. “relocation of vital assets”) and very specific action (e.g. “air conditioning in vehicles”)
  - Typical unspecific adaptations relate to planning and to information /education/research
  - Typical very specific adaptations relate to technical solutions
- Most adaptations proposed in the grey literature (in particular studies commissioned by public bodies)
- Bias for adaptations with a top-down-pattern, e.g.
  - Operator = public, Receptor = transport provider,
  Exposure Unit = transport user
- However: little concrete instruments for public policy
Thank you for your attention

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