



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

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Climate Adaptation Futures

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30.06.2010



# 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

interdisciplinary research group in Social-Ecological Research (SÖF)  
funded by the German Federal Ministry of Education and Research, 2008-2013  
in cooperation with partners from business and politics

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# Vulnerability of the Transport Sector

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- 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

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- 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

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- 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

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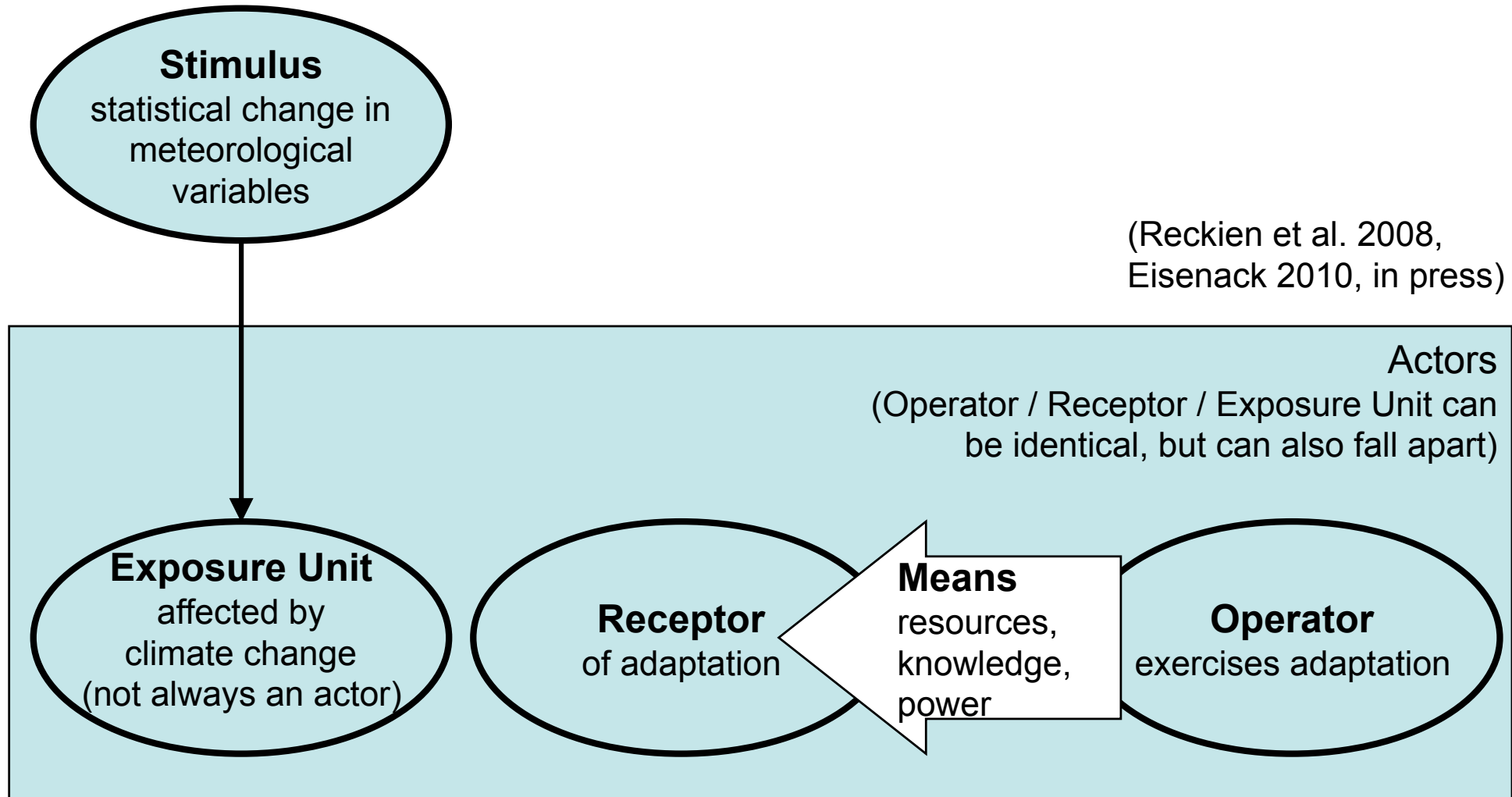
- Overall 30 papers in 23 peer reviewed journals
- Contributions to books: 14
- Grey literature: 15
  
- Only 19 papers in 13 journals explicitly consider adaptations
  
- Literature is scattered: no journal with more than 2 contributions
- From 2005-2009: no significant pattern in the number of papers, 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

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- About 200 adaptations indentified 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



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

# Modes and Means

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- 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

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- 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

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- 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

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- 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

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- 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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