Cities adaptation and mitigation issues

– why not yet (combined) but needed,
some how and who in the transport sector

Climate change and cities

- 2% of Earth surface occupied by large cities, about 3% by urban areas
- 50% of World population ‚urban dwellers' (3.3 billion; UN, 2007)
- Cities generate:
  30-40% of global CO2 em. (cities as production places),
  60-70% of global CO2 em. (consumed by city residents)(Satterthwaite, 08)

→ Cities/ Urban areas:
  → places of concentration of climate vulnerability and greenhouse gas (GHG) emissions
  → … important actors in climate initiatives (C20/40; ICLEI, Climate Alliance, Clinton Initiative)

  → … and with it: our greatest opportunity to tackle both, A&M

All figures: UN; Satterthwaite, 08

A&M: obstacles and needs for integration

- Different responsible and receiving actors involved in action and aftereffect
- Difference in time of action and aftereffect (delays)
- Difference in spatial source and effect of action
- Makes coordination difficult, entanglement necessary

- ***Mal*adaptations**:
  - Density of urban areas (increased profitability of public transport/ lower emissions – increased heat island effect)
  - Air conditioning (reduced heat stress – higher emissions)
  - Biofuels (fewer GHG emission – competition for land with possible implications for food security)
  - Flood defences (reduced flood risk – encouragement for new development and increase in vulnerability)

→ Need to coordinate adaptation and mitigation &
→ Potential to produce tradeoffs

A&M in transport: why transport?

Mitigation:

- 17.5% of global CO2 em. from transport (UN, 2007)
- 13% of CO2 em. for passenger traffic (Schafer, 1998)
- High-income countries: often only sector with positive growth rates in CO2 (increasing MIT, longer journeys, faster cars), e.g. in Berlin
- Low-income countries: increasing personal motorization, mostly fossil fuel driven

→ **High reduction potential**

Adaptation:

- Mobility/transport is a fundamental need of human beings
- CC: high potential for damages on infrastructure, reduction in service & injuries for passengers
- → Need for investigations in **impact reduction**

A&M in transport: why transport?

- Essential sector for multiple economic, public and private activities
- A **multitude of actors** involved,
  both from public and private sector

- Infrastructures particularly long-lasting, app.80-100a
  - Meet advanced stages of CC, resilience important
  - Fix solid material without easy possibilities for adjustments, e.g. new technologies

- **High reduction potential**
- **Highly sensitive to changes in climate and to extreme weather events in particular**

Methods

- Presentation of different studies:

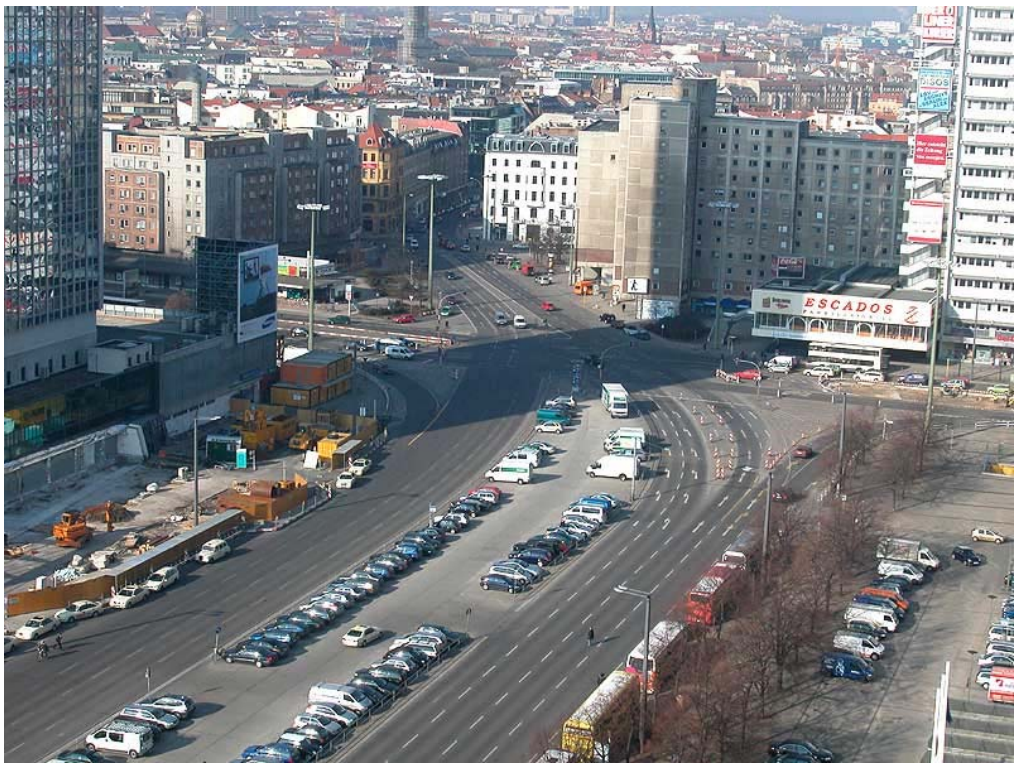
1. **Mitigation**: Statistical analysis, correlation and regression analyses to the contribution of settlement structure, traffic structure and income on personal CO2 emissions from road traffic in Berlin

2. **Action theory of adaptation** and **semi-quantitative assessment** (SQA) : structured review to adaptation to CC, rooted in “action frame of reference” (Parsons 1937), DPSIR- Framework (OECD 1993): Entanglement of actors (& their aims); Expert judgements, literature review, impact matrix (SQA)

3. **Implications** for adaptation and mitigation and their integration from the research project ADAM

1. CO2 emissions from road traffic in Berlin

- What factors influence variations in CO_2 em. from road traffic in Berlin?
- Aim: Implications for urban planning to CO_2 em.
- Focussing on one actor: the consumer



Photos: Philipp Eder

1. CO2 emissions from road traffic in Berlin

Study outline:

- Focus on Berlin
- 23 records according to the municipal districts
- Database available only for the year 1995
- CO2 emissions are calculated from traffic surveys (cars, lorries and buses on roads and on parking lots were counted) and multiplied with emission factors
- Correlation and regression analysis to settlement structure, traffic structure and income

1. CO2 emissions from road traffic in Berlin

CO2 emissions from traffic (tons/year) and the relationship to settlement structure, transport structure and income (N = 23 = all districts) except for the districts with motorways (N = 10)

	Correlation		Regression			
	Coefficient	Significance p	*B*	Beta	Constant	R^2
Settlement structure						
Density						
Resident population (31 December 1995)	0.670	0.000	0.306	0.294		
Number of jobs	0.635	0.001	0.822	0.531		
Number of jobs in industry	0.670	0.000	—	—		
Total built area [ha]	0.564	0.005	0.215	0.376	20 796.511	0.747
Mix of land uses						
Area: mixed uses [ha]	0.235	0.280	—	—		
Area: residential use [ha]	0.313	0.146	—	—		
Area: business use [ha]	0.224	0.304	—	—		
Transport structure						
Traffic area [ha]	0.785	0.000	79.726	0.400		
Street length [m]	0.546	0.007	—	—		
Length of highways [m]	0.192	0.595	—	—	22 051.158	0.714
Total number of vehicles	0.806	0.000	1.429	0.496		
Income						
Total net income/month (average income/person * number of residents)	0.720	0.000	—	—		
Number of residents with net income < 700€/month	0.449	0.031	—	—		
Number of residents with net income 700– < 1250€/month	0.414	0.050	—	—		
Number of residents with net income >1250€/month	0.862	0.000	2.078	0.843	46 407.839	0.711
Number of household with net income <1250 €/month	0.488	0.018	—	—		
Number of household with net income 1250–2000 €/month	0.679	0.001	—	—		
Number of household with net income >2000 €	0.761	0.000	—	—		
Combined analysis						
Resident population (31 December 1995)	0.670	0.000	—	—		
Number of jobs	0.635	0.001	0.512	0.331		
Total built area [ha]	0.564	0.005	—	—		
Traffic area [ha]	0.785	0.000	—	—	16 328.883	0.834
Total number of vehicles	0.806	0.000	—	—		
Number of residents with net income >1250€/month	0.862	0.000	1.757	0.723		

Source: Reckien et al. (2007), Urban Studies 44/2

1. CO2 emissions from road traffic in Berlin

Conclusion:

- **Nr. of jobs** & share of high income households explain most CO2 em.
- **Income** has the highest power of explanation

Planning:

- Traffic area is also important, not the length of highways
- all other factors not of influence to planners

Politics:

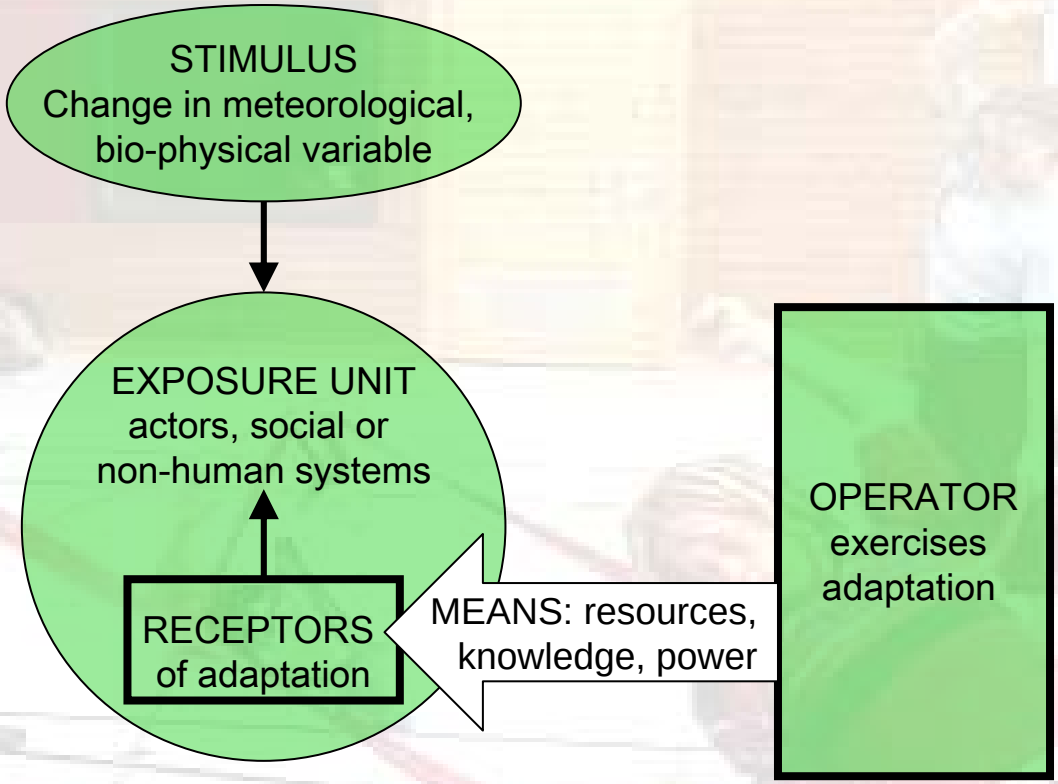
- Which incentives successful: rising fuel or lowering public transport prices?
  - Stronger neg. relation between CO_2 and low income parts (stronger than pos. relation between CO_2 and rich parts)
  - People emit less CO_2 when budget is limited
  - But: poor people less mobile or use more CO_2 saving transport modes?
  - Others have shown: improvements in public transport result often in a modechange of cycling and walking people than a change of drivers

→ **Rising the fuel prices could be more effective, but hits the poorer inh. most**

Source: Reckien et al. (2007), Urban Studies 44/2

2. Adaptation

- Action theory
- A lot of actors involved,
- Blurrs the picture and has to be entangled



- Crucial actors: transport users, transport service and infrastructure providers (as exposure units, operators or receptors), politics & planning as operators
- High degree of actor-interdependency in adaptation

Source: Reckien et al. (2008), ISEE-conference paper

2. Action theory of Adaptation: review results

- 9 reviews included: **1** (2004), **2** (2005), **1** (2006), **2** (2007), **3** (2008); 4 reports commissioned by governments (US, Canada, EU, Germany), 2 focus on businesses (Germany, UK)

  - Papers discuss stimuli in more detail than adaptation measures
  - Operator is mentioned in most cases, receptor in about 66% of the measures, an exposure unit in 28%

  - 3 papers hardly address any actors
  - Papers do not distinguish between different roles of actors
  - 5 papers address private sector or businesses as operators

  - **Little adaptation** so far under way, although **awareness rises**
  - **Few** actions from **private actors** visible
  - Little concrete options suggested: **change in transportation modes** referred to by 3 documents

Source: Reckien et al. (2008), ISEE-conference paper

2. Adaptation in the transport sector

- Change of modal split:
  - Smallest efforts for the transport users
  - Under their direct influence
  - Useful for short as well as long-term adaptation
  - Preferences in modal split of high importance for transport service and infrastructure providers
  - Initiating a change in modal split, also gives indications for other actors involved
- Actor: transport users

- Theoretically, adaptation measures relate to indicators of mobility:
  1. the modal split: the kind (e.g. car, rail, ship, bicycle) and the number of the means of transportation used
  2. number of ways per person (specific traffic volume)
  3. the duration of all ways per person (time expenditure)
  4. the distance of all ways per person (specific transport performance)
  5. and the kind and fraction of each transport purpose/intention as a function of all ways (Ahrens 2005)

2. Adaptation in the transport sector: SQA

Approximation: high adaptation need for those modes where impacts are high

Impacts

- IN: 3-PARITE SCALE (high, medium, low) and
- ON: Transport parameters (passenger safety, transport reliability, comfort) with differing importance
- FROM: Different stimuli (storms, torrential rain and flooding, heat waves)
- WITH: weighing factors for likelihood of occurrence
- Exemplary Region: Berlin (Modell WETTREG, Spekat et al. 2007)

→ Exact change of stimuli is not needed

2. Adaptation in the transport sector: SQA

Passenger safety, transport reliability, and comfort under **storm events** (high figures represent low impacts)

Distances travelled	Means of transportation	Parameter: Passenger safety	Parameter: Transport reliability	Parameter: Comfort	Sum
Inter city, long distances	Passenger rail	3	0	2	5 (12)
	Plane	3	0	1	4 (12)
	Ship	3	0	0	3 (12)
	Car/ Bus	3	2	1	6 (12)
Sum (Max), Respective %		12 (24) 50.0 %	2 (16) 12.5 %	4 (8) 50.0 %	18 (48) 37.5 %
City wide transport,	Underground	6	4	2	12 (12)
	Tram	6	2	2	10 (12)
	Car/ Bus	3	2	1	6 (12)
	Bi-/ Motorcycle	0	2	0	2 (12)
	On Foot	3	2	1	6 (12)
Sum (Max), Respective %		18 (30) 60.0 %	12 (20) 60.0 %	6 (10) 60.0 %	36 (60) 60.0 %

Red: high impacts; Orange: medium impacts, Green: low impacts.

Source: Reckien et al.(2008), ERKLIM-Report; Reckien et al. (2008), ISEE-conference paper

2. Adaptation in the transport sector: SQA

Passenger safety, transport reliability, and comfort under **heat waves** (high figures represent low impacts)

Distances travelled	Means of transportation	Parameter: Passenger safety	Parameter: Transport reliability	Parameter: Comfort	Sum
Inter city,	Passenger rail	3	2	1	6 (12)
	Plane	6	4	2	12 (12)
	Ship	6	2	2	10 (12)
	Car/ Bus	3	2	1	6 (12)
Sum (Max), Respective %		18 (24) 75.0 %	10 (16) 62.5 %	6 (8) 75.0 %	34 (48) 70.8 %
City wide transport,	Underground	3	2	0	5 (12)
	Tram	6	2	1	9 (12)
	Car/ Bus	3	2	1	6 (12)
	Bi-/ Motorcycle	6	4	2	12 (12)
	On Foot	6	4	2	12 (12)
Sum (Max), Respective %		24 (30) 80.0 %	14 (20) 70.0 %	6 (10) 60.0 %	44 (60) 73.3 %

Red: high impacts; Orange: medium impacts, Green: low impacts.

Source: Reckien et al.(2008), ERKLIM-Report; Reckien et al. (2008), ISEE-conference paper

2. Adaptation in the transport sector: SQA

Analysis with respect to **passenger safety** (high figures represent low impacts)

		Passenger safety under certain weather events			
		Storm	Torrential rain and flooding	Heat wave	**Sum**
	Weighting the frequency of occurrence	* 1	* 1	* 3	
Inter city,	Passenger rail	3	3	3	15 (30)
	Plane	3	3	6	24 (30)
	Ship	3	6	6	27 (30)
	Car/ Bus	3	3	3	15 (30)
Sum (Max), Respective %		12 (24) 50.0 %	15 (24) 62.5 %	54 (72) 75.0 %	81 (120) 67.5 %
City wide	Underground	6	3	3	18 (30)
	Tram	6	6	6	36 (30)
	Car/ Bus	3	3	3	15 (30)
	Bi-/ Motorcycle	0	0	6	18 (30)
	On Foot	3	3	6	24 (30)
Sum (Max), Respective %		18 (30) 60.0 %	15 (30) 50.0 %	24 (30) 80.0 %	111 (150) 74.0 %

Red: high impacts; Orange: medium impacts, Green: low impacts.

Exemplary region: Berlin (WETTREG, Spekat et al., app.2050)

Source: Reckien et al.(2008), ERKLIM-Report; Reckien et al. (2008), ISEE-conference paper

2. Adaptation in the transport sector: SQA

Summary analysis including passenger safety, transport reliability and comfort

		Entire performance under certain weather event			
		Storm	Torrential rain and flooding	Heat wave	**Sum**
	Weighting the frequency of occurrence	* 1	* 1	* 3	
Inter city,	Passenger rail	5 (12)	7 (12)	6 (12)	30 (60)
	Plane	4 (12)	7 (12)	12 (12)	47 (60)
	Ship	3 (12)	10 (12)	10 (12)	43 (60)
	Car/ Bus	6 (12)	6 (12)	6 (12)	30 (60)
Sum (Max), Respective %		18 (48) 37.5 %	30 (48) 62.5 %	34 (48) 70.8 %	150 (240) 62.5 %
City wide	Underground	12 (12)	7 (12)	5 (12)	34 (60)
	Tram	10 (12)	10 (12)	9 (12)	47 (60)
	Car/ Bus	6 (12)	6 (12)	6 (12)	30 (60)
	Bi-/ Motorcycle	2 (12)	2 (12)	12 (12)	40 (60)
	On Foot	6 (12)	5 (12)	12 (12)	47 (60)
Sum (Max), Respective %		36 (60) 60.0 %	30 (60) 50.0 %	44 (60) 73.3 %	198 (300) 66.0 %

Source: Reckien et al.(2008), ERKLIM-Report; Reckien et al. (2008), ISEE-conference paper

2. Adaptation in the transport sector

- Conclusion:
  - Gap between awareness & action
  - Scientific knowledge needs better structured analysis to be useful for target audiences → **operator, receptor & exposure unit**
- Large amount of actors involved in transport adaptation efforts
- Multiple modes affected

→ Effects of adaptation on different receptors strongly coupled,

→ Complex interdependencies strong barrier to adaptation

Adaptation without knowing exact impacts

→ Invest in least vulnerable modes (tram lines), promote walking in urban areas

→ Strong adaptation of rail system for long distances, air-based traffic is highly controversial with respect to mitigation

3. Conclusion on A&M and their integration

- What does this tell us about A&M integration?
  - Entangle actor constellations
  - Responsible and receiving actors should be the same or different ones be brought together
  - Actions have to be felt, e.g. in higher/lower burden of commuting
  - CO2 intensive transport has to cost more
  - Communicate about stimulus, exposure unit, receptor, means and operator; educate all

- Search for actors who feel their own actions, with high sensitivity and means to act (California!)

3. Findings on A&M and their integration

- ADAM (Adaptation and Mitigation to inform European Climate Policy)
- 5 metaphors to phrase the CC problem more differently & away from established directions of thought to lead to more efficient policy responses:

Turn off the tap with one hand, and start mopping with the other

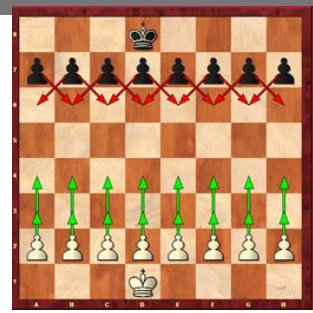
- The two can start at once, but activities are essentially separate
- Impossible to find an optimal mix, even if both are to start immediately (because it needs a global aggregate measure of well-being with welfare impacts on people living in different places and at different points in time; side effects are not all known: bigger mob but water already leaking through the neighbours ceiling?)

Biggest difference seems that A&M most effective at different governance levels (globally biggest emitters vs. national to local adaptation): **is that right???**

Synergies are good but don‘t garantuee the most cost-effective technologies → the two hands shouldn‘t get in the way of each other

Wealthier & better organised societies will do better (prob.) in A&M

Source: Patt, Reckien, et al., (2009): in M. Hulme, H. Neufeldt (Eds) Making climate change work for us – ADAM synthesis book, Cambridge University Press.



3. Findings on A&M and their integration

Move your pawns forward:

- Gasparov‘s aggressiv style of playing: pawns forward, develop new opportunities, keep options open; if a pawn makes a queen, it‘s often decisive in winning
- Induced technological change, first movers will win
- Relates to learning by doing: aggressive reduction policies also enable faster learning by doing, drives down the costs of the dominant technology the fastest
- Costs of reducing emissions drastically is rather low (below 2% of GDP for 50-80% reduction, Stern Report), stabilisation about 1% or lower (model comparison; Knopf et.al., 2008; Edenhofer, Bauer & Kriegler, 2005) & lower than inaction but you have to start now
- Turn off the tap: stimulating investment to use alternative energy source(s) to become less expensive than fossil fuels, rather than simply reducing the use of fossil fuels by small incremental amounts

Source: Patt, Reckien, et al., (2009): in M. Hulme, H. Neufeldt (Eds) Making climate change work for us – ADAM synthesis book, Cambridge University Press.

3. Findings on A&M and their integration

Burn the right bridges:

- Decision under uncertainty: don‘t burn the one that give way to valuable opportunities later – but burn those that allow to retreat to formerly unsuccessful path
- Very little progress reducing the uncertainty about climate sensitivity (ever) possible
- Climate proofing required mostly in developing countries, scarcity of historical weather records makes validation of downscaled climate models difficult (at spatial scales where adaptations occur)

- Governments have to uphold climate policies into the future: need to burn the bridges behind them, leading to high CO2 emissions
- Adaptation remains a task of keeping as many bridges as possible passable, adaptation is a learning process
- Social process of adaptation is so poorly understood; helping people to change behaviour in response to evolving climate risks

Source: Patt, Reckien, et al., (2009): in M. Hulme, H. Neufeldt (Eds) Making climate change work for us – ADAM synthesis book, Cambridge University Press.

3. Findings on A&M and their integration


Painting: Richard Johnson

Build the ladder

- No big benefits from low hanging fruit
- Reduction in CO2 globally by about 100% until 2100 necessary, Europe by 80% until 2050 to avoid dangerous climate change
- 2020 goals in Europe can be met at low cost by combining energy efficiency, e.g. with ETS, with substitution towards gas and renewables, and some downscaling of energy intensive manufacturing
- BUT never take us to goals for 2050 or 2100
- Price on carbon, either in the form of a tax or a tradable emissions permit, creating incentives for all economic actors to explore least cost ways for reduction & stimulate long-term investment in renewable energy
- Renewable support schemes, e.g. quotas, feed-in tariffs, clearly necessary

Source: Patt, Reckien, et al., (2009): in M. Hulme, H. Neufeldt (Eds) Making climate change work for us – ADAM synthesis book, Cambridge University Press.

3. Findings on A&M and their integration

It takes at least two to tango

- Europe needs to transform its energy system completely within the next two to four decades
- What is it holding back?: many winners and loosers, e.g. large employers with high political influence
- Seek policy solutions that will diffuse political opposition, rather than polarize it, building alliances between today's carbon intensive industries and climate protection advocates

Source: Patt, Reckien, et al., (2009): in M. Hulme, H. Neufeldt (Eds) Making climate change work for us – ADAM synthesis book, Cambridge University Press.

Conclusion and further research needs

- Optimum level of each depending on the other cannot be determined yet
- Challenge of mitigation is the fast introduction of low emission technologies
- Keep alternative ways open: allow for learning
- Least cost ways do not eliminate CO2 eq. emissions
- Entrenched principles in internat. climate policy (e.g. polluter pays) may stand in way for rapid agreement and change

- Investigate also *mal*mitigation, e.g. with respect to the construction of underground railway systems
- Adaptation indicators
- Social process of adaptation & behavioural change poorly understood, research on instruments to promote cultural change for mitigation / sustainable behavior needed

Thank you.