GRaBS Summary and Policy Guidelines

adapting transport systems to climate change

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A Summary of the GRaBS Expert Paper and Policy Guidelines on Transport and Climate Change

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Adapting Transport Systems to Climate Change

GRaBS

The GRaBS (Green and Blue Space Adaptation for Urban Areas and Eco Towns) project is a network of leading pan-European organisations involved in integrating climate change adaptation into regional planning and development.

The 14 project partners, drawn from eight EU Member States, represent a broad spectrum of authorities and climate change challenges, all with varying degrees of strategic policy and experience. The GRaBS project partners are:

Austria:
- Provincial Government of Styria

Greece:
- Municipality of Kalamaria

Italy:
- Etnambiente SRL
- Province of Genoa
- University of Catania

Lithuania:
- Klaipeda University Coastal Research and Planning Institute

Netherlands:
- Nieuw-West City District of Amsterdam

Slovakia:
- Regional Environmental Centre for Central and Eastern Europe, Country Office Slovakia

Sweden:
- City of Malmö

UK:
- London Borough of Sutton
- Northwest Regional Development Agency
- Southampton City Council
- Town and Country Planning Association
- University of Manchester

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For further information about the GRaBS project, visit **http://www.grabs-eu.org**

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1
How climate change affects transport and travel

Evidence suggests that the Earth's atmosphere is warming owing to increases in human-made emissions of greenhouse gases (GHG), primarily carbon dioxide (CO_2). Atmospheric CO_2 concentrations have increased by almost 100 ppm (parts per million) since their pre-industrial level, reaching 379 ppm in 2005.[1] (IPCC, 2007). Global mean temperatures have risen by 0.74°C over the past century, with 0.4°C of this increase occurring since the 1970s.

Mitigation – that is, reducing the amount of GHG (greenhouse gas) emissions that we produce – is critical to tackling climate change (see Box 1, on page 2). However, it appears that some degree of climate change has already begun. Extreme weather in recent years has disrupted and damaged urban transport systems: flooding, heat waves and storms have all led to delays and increased costs.

An urgent task facing us is how we adapt existing transport planning, design, construction and maintenance – and decisions we make about how we travel – to climate change.

Road infrastructure

The Table 1, on page 3, sets out the key climate change impacts for road infrastructure (as reported by Eichhorst[2]).

Road vehicles and driving conditions

The most damaging impacts of a changing climate on road vehicles and driving conditions will be increases in temperature and more extreme rainfall. Increases in temperatures are likely to lead to: an increase in driver discomfort and exhaustion, leading in turn to a greater risk of accidents; use of more costly and more energy-intensive air conditioning systems; melting tyres or wearing tread; and overheating of equipment such as diesel engines. Increased instances of extreme rainfall (and consequent flooding) will result in more frequent occurrences of difficult driving conditions (and a higher risk of accidents), or circumstances where driving becomes impossible.

Rail infrastructure

Rail infrastructure is the transport sector that will be most able to cope with climate change. However, analysis suggests that railways may still have some significant vulnerabilities. For example, extreme hot weather can lead to buckling and moving of rails, which could cause major disruption.

Travel behaviour

Climate change will affect how people move around. Increasing temperatures may extend summer travel patterns, while changes in the amount of rainfall may influence how attractive walking or cycling becomes. Although these might be considered small adaptation responses, the knock-on effects may be significant because of the difficulty of getting people to choose more sustainable modes of transport. For example, a

1 *Fourth Assessment Report*. Intergovernmental Panel on Climate Change, 2007. **http://www.ipcc.ch/index.htm**
2 U. Eichhorst: 'Adapting urban transport to climate change'. In *Sustainable Transport: A Sourcebook for Policy Makers in Developing Cities*. GTZ, Germany, 2009.
http://www.sutp.org/index.php?option=com_docman&task=cat_view&gid=29&Itemid=54&lang=en

Box 1

Transport systems and mitigating climate change

How transport and travel contributes to climate change

In Europe, the EEA[3] estimates that transport accounts for almost a quarter (24%) of GHG emissions; road transport is responsible for more than 72% of transport-related CO_2 emissions.[4] Although the emission rates of most GHG sources are starting to plateau or decline, transport-related emission rates are still steadily on the increase. Transport energy use and carbon emissions are projected to be higher than current levels by 2030 as a result of continually rising demand.

Mitigating these effects

A reduction in driving is the best long-term action to take for climate mitigation, and this will involve a rethinking of urban development. Dalkmann and Brannigan[5] propose a combination of three different approaches to reduce CO_2 emissions from transport:

- **Avoid:** Reduce the number and the length of journeys.
- **Shift:** Transfer mobility towards low-carbon modes of transport.
- **Improve:** Reduce the emissions produced by motorised transport systems.

Examples of what this might look like in practice include:

- **Planning:** Increase the modal share of walking and cycling trips by planning high urban density with mixed land use close to public transport nodes.
- **Regulation:** Lower speed limits.
- **Economic interventions:** Road pricing, car parking charges and mobility credits or permits. Inner London's Congestion Charge zone came into effect in 2003 and has led to an estimated 19% reduction in traffic-related CO_2 emissions and a 20% reduction in fuel consumption.[6]
- **Information:** Raise awareness of and promote alternative transport options.
- **Technology:** Improve vehicle efficiency and develop cleaner fuels – for example, biofuels, natural gas and hydrogen.

study of commuters travelling by car in Brussels found that in adverse weather more than half made different decisions about their transport mode, route and departure time. This is a relatively unexplored area of research, and more work is needed to establish how weather influences the travel choices that people make.

2 Adapting transport and travel to the climate change effects

Policy-makers, planners, engineers, designers and others need to develop adaptation strategies for urban transport systems to prevent the negative impacts associated with a changing climate.

In general, a climate change adaptation strategy for a transport system should:

- identify the critical components of the transport system potentially at risk;
- monitor the changing climate conditions and relevant impacts on the transport system;
- set out how operating and maintenance practices need to change to take account of these risks and changing conditions;
- identify how standard design and procedures need to change; and
- relocate vulnerable infrastructure.

3 *Greenhouse Gas Emission Trends and Projections in Europe 2009. Report 9*. European Environment Agency, 2009. **http://www.eea.europa.eu**

4 *Action Plan for the Deployment of Intelligent Transport Systems in Europe*. COM(2008) 886 final. European Commission, 2008. **http://eur-lex.europa.eu/**

5 H. Dalkmann and C. Brannigan: 'Transport and climate change'. In *Sustainable Transport: A Sourcebook for Policy Makers in Developing Cities*. GTZ, Germany, 2009. **http://www.sutp.org/index.php?option=com_docman&task=cat_view&gid=29&Itemid=54&lang=en**

6 G. Jones, S. Pye and P. Watkiss: *London Congestion Charge*. AEA Technology, 2005

Table 1
Impact of climate change on road surfaces and other road infrastructure

Increased temperature and more heat waves	• Melting asphalt (dark surface). • Increased asphalt rutting due to material constraints under severe exposure to heat. • Thermal expansion on bridge expansion joints and paved surfaces, and damage to bridge structure material.
More frequent droughts (and less soil moisture)	• Degradation of road foundation due to increased variation in wet/dry spells and a decrease in available moisture.
Sea level rise and coastal erosion	• Risk of inundation of road infrastructure and flooding of underground tunnels. • Degradation of the road surface and base layers from salt penetration.
More extreme rainfall events and flooding	• More landslides and subsidence. • Higher waterways can submerge, undermine and wash away bridges. • Risk of dirt roads, and other roads with limited foundations and poor or no drainage, being washed away or scoured. • More rapid degradation of subgrade material underneath roads or pavements, leading to a loss of strength and bearing capacity.
More intensive and frequent storms	• Damage to bridges, flyovers, street lighting, signs and service stations. • Risk of inundation by the sea. • Blocked roads due to fallen trees, damaged buildings and vehicles.

- **Hazard:** The extent, severity and probability of the phenomenon which has the capacity to cause harm.
- **Vulnerability:** The susceptibility to damage of the elements at risk to a particular hazard
- **Exposure:** The degree to which elements at risk may come into contact with the hazard of interest.

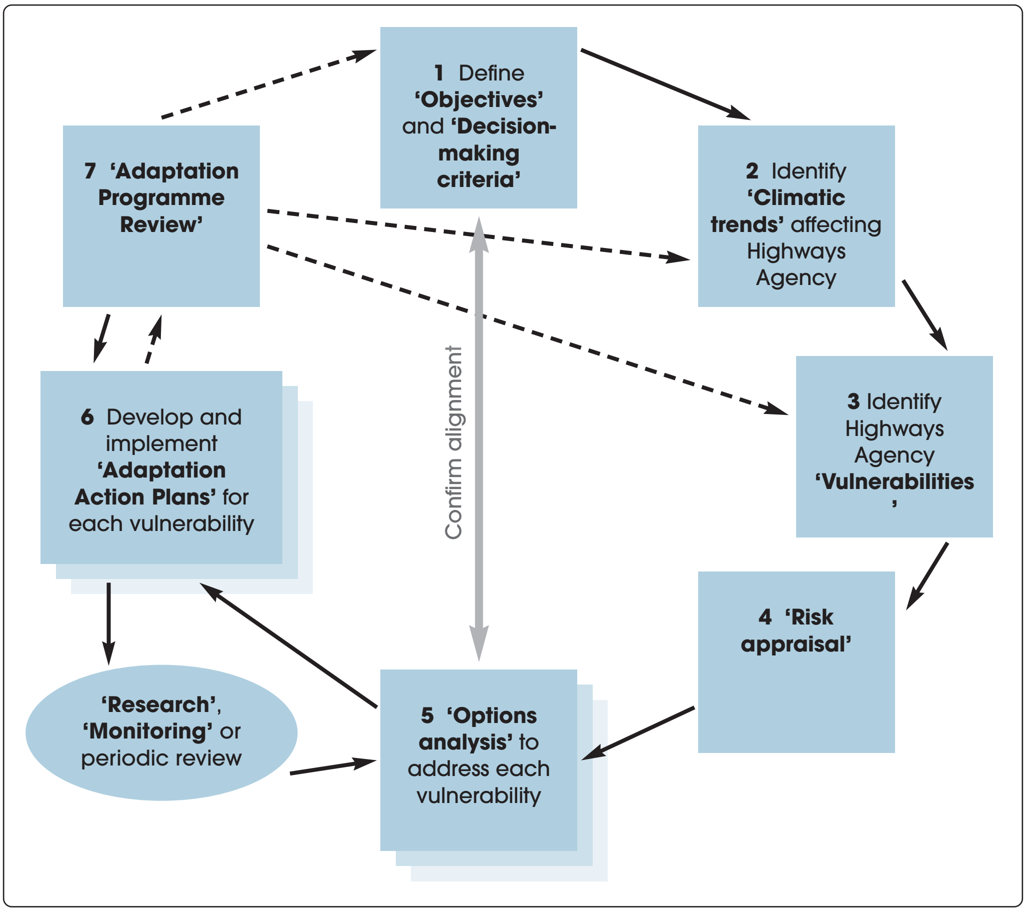
Fig. 1 Crichton's risk triangle, illustrating how hazard, vulnerability and exposure combine to influence overall risk

The GRaBS approach

The GRaBS project defines risks for urban transport systems using three components: hazard, exposure and vulnerability (after Crichton's risk triangle – see Fig. 1). Once transport planners have identified the risks, they can then devise actions to help adapt transport systems to adapt:

- **Retreating actions:** Reduce the hazard of a potentially dangerous climate event and its extent, severity and probability.
- **Protecting actions:** Reduce the exposure of people, infrastructure and other resources at risk.
- **Accommodating actions:** Reduce vulnerability – that is, the extent to which people or infrastructure are likely to be damaged.

GRaBS is focusing mainly on the last two approaches and raising awareness of the vital role that green and blue (for example, sustainable drainage systems) infrastructure has in moderating the increase in summer temperatures expected with climate change. Currently this role is not sufficiently recognised or integrated into mainstream planning. GRaBS has developed good practice Adaptation Action Plans in each partner country to co-ordinate the delivery of urban greening and adaptation strategies, based on an innovative and user-friendly risk and vulnerabilities assessment tool.



Left: Fig. 2 Diagram illustrating the Climate Change Adaptation Framework adopted by the UK Highways Agency

3 Adaptation responses

Road infrastructure

The UK Highways Agency has developed an adaptation strategy[7] linked to its core investment and work programme, including design, construction, maintenance and operations. Fig. 2 shows the Agency's Climate Change Adaptation Framework, which it developed to identify specific risks and determine the most appropriate management options. The *Street Design Manual* of New York's Department of Transport[8] suggests using:

- asphalt roadway composed of light-coloured aggregate and/or binder producing high solar reflectance index (SRI) values in order to reduce the heat it generates; and
- porous asphalt, which is standard asphalt concrete mixed without fine particles and with low binder content to leave space for water to drain through to an open-graded stone bed (see the illustration above) – this reduces run-off into the sewer system and the likelihood of puddles or slick or icy surface conditions.

Urban street design

To avoid the reductions in urban density that would result from creating large green spaces, designers should encourage walking and cycling by providing a green infrastructure network, which is a set of connected green spaces. This kind of network should link residential areas to public open spaces and natural green corridors through a 'bioclimatic approach' to urban design. The aim would be to provide effective climate resilience and a more comfortable environment for people using these spaces for active transport modes. This approach could play a vital role in improving conditions for walking and cycling in extremely hot (and potentially wet) weather. But more research is needed to better understand how sunlight,

7 *Climate Change Adaptation Strategy and Framework*. Highways Agency. Department for Transport, 2009. **http://www.highways.gov.uk/aboutus/24180.aspx**
8 *Street Design Manual*. New York City Department of Transportation, 2009. **http://www.nyc.gov/dot**

Table 2
Selecting mitigation and adaptation actions to complement and reinforce each other

Strategic approach	Main opportunities for synergies	Mitigation	Adaptation
Avoid/reduce	• Sound land use planning for compact and transit-oriented cities with sufficient green spaces • Climate-proofed design standards for infrastructure	• Short distances reduce land conversion, travel demand and related emissions • Reliable and high-quality public transport, walking and cycling infrastructure	• Parks and green roads provide cooling • Short distances favour walking and cycling • Resilient infrastructure
Shift/maintain	• High-quality public transport (combined with transport demand management measures – TDM) • Climate-proofed design standards for infrastructure • High-quality pedestrian and bicycle infrastructure • TDM measures that provide disincentives to private motorised vehicle use	• High-quality public transport attracts more customers and reduces car trips • Less road space • Less CO_2 emissions per passenger-kilometre	• High-quality public transport is necessary to maintain mobility of those without access to a car • Reliable public transport is vital for disaster management/ evacuation
Improve	• Procurement of efficient and resilient vehicles • Vehicle standards	• Energy-efficient vehicles reduce carbon emissions per kilometre	• Resilient vehicles necessary to maintain mode share (reliable and comfortable public transport) • Air conditioning should be based on CO_2 (lower warming potential than HFC)

temperature, humidity and wind combine to affect comfort for pedestrians and cyclists, and how these microclimatic factors affect mobility choices and behaviour.

Rail infrastructure

Successful adaptation for rail infrastructure is likely to include:

- improvements in flood defences along some lengths of coastline and selected reaches of rivers;
- restrictions on development in areas prone to flooding;
- use of more durable materials such as more corrosion-resistant metals;
- an increase in the stability of pylons and other structures prone to wind loading;
- better drainage systems; and
- planting low-maintenance vegetation to act as buffer zones for high winds.

Comfort for public transport users

In 2006 London Underground began trialling a groundwater cooling system at Victoria station to reduce the temperature of the subterranean platforms (which can be more than 10°C above the ambient temperature at ground level). The trial reduced platform temperatures and provided an environmentally-friendly solution as it made use of groundwater that was already being pumped out of the station. Transport for London has also published a list of suggested measures that can be used to reduce the temperature for bus passengers, including:

- thermostatically controlled air cooling systems fitted on the upper deck as standard;
- better windows, with opening windows on all full-sized window bays;
- white roofs on all new buses and buses going for repainting to reflect heat;
- insulated roof and side panels, and tinted side glass, on new buses to reflect heat; and
- thermostatically controlled heating systems on new buses, rather than systems where the temperature is set by the driver or garage engineers.

4
Integrating adaptation and mitigation

There are compelling reasons for ensuring that there is integration between adaptation and mitigation strategies for transport planning. Even if mitigation measures were able to radically reduce the amount of GHG emissions now, we would still need adaptation strategies because of the climate change that is already with us. However, these adaptation responses must not lead to a further increase in GHG emissions. For example, installing air conditioning on public transport is one response to higher temperatures, but this will lead to increased GHG emissions and undermine other mitigation measures.

In contrast, other adaptation measures could contribute to reducing GHG emissions. For example, creating green and shaded spaces in urban areas that people can use for walking and cycling commuting instead of driving could both cool cities and reduce carbon emissions through a reduction in driving and the use of air conditioning.

In fact, any reduction in driving is a 'win-win' solution: it contributes to mitigation, and it helps adaptation by reducing the amount of heat that vehicles contribute to urban areas (two-thirds of the fuel burnt by car engines is emitted as heat) and by reducing demand for impermeable and heat-absorbing car parks and other paved areas.

The aim should therefore be to 'green urban transport', both in the sense of favouring the shift towards sustainable modes of transport for climate mitigation and in the sense of supporting the development and use of green spaces for climate adaptation (see Table 2, on page 5).

The GRaBS Project
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