

Transport Planning Society

LOCAL TRANSPORT:

ADAPTING TO CLIMATE CHANGE

September 2009



Nottingham Declaration
Partnership

CONTENTS

Summary	1
1. Introduction	1
What is climate change adaptation?	2
National activities to support transport adaptation.....	2
Local transport authorities' new duty	3
Improving local performance.....	4
2. Understanding climate change in your area.....	4
The UK Climate projections	4
Local information	6
3. Understanding network vulnerability.....	8
Local Climate Impacts Profile.....	8
Checklist of issues to consider	8
4. Strengthening resilience	11
Managing severe weather and disruption.....	11
Low to medium cost measures	12
Major schemes.....	13
Supporting climate change mitigation.....	14
5. Transport asset management plans.....	14
6. Experience from London.....	15
7. Future research.....	16
8. Further information	17

Acknowledgements Thanks to the following for their contributions: Chris Baker, Joan Bennett, Catherine Duggan, Jo Hughes, Phil Killingley, Jamie Matthews, Laurie Newton, Ben Still, Richard Walker, Michelle Witton-Smith and Helen Woolston.

SUMMARY

Recent climate projections reveal that further climate change is now unavoidable, no matter how successful we are at reducing greenhouse gas emissions in future.

Climate change is expected to have a significant impact on local transport and the Local Transport Act 2008 placed a new duty on Local Transport Authorities (LTAs) to have regard to government policies and guidance on climate change adaptation.

This briefing note offers some initial ideas about how LTAs might respond, but our understanding of how to adapt to climate change is still in the very early stages and much further work is needed. It draws on discussions at a practitioner workshop held in June 2009.

This note discusses:-

- Work that is currently being undertaken for the UK Adapting to Climate Change Programme and other research that could in future provide valuable information for LTAs
- Sources of information on projected climate change and its consequences.
- A checklist of issues to consider for network vulnerability to climate change
- Ideas on possible measures to strengthen network resilience to climate change
- A summary of action by the London Climate Change Partnership to strengthen the resilience of London's transport network
- Issues for further research and case studies.

1. INTRODUCTION

Some climate change is now unavoidable, no matter how successful we are at reducing greenhouse gas emissions in future, because past emissions will continue to influence climate for at least several decades to come. Climate change is expected to have a significant impact on local transport and the Local Transport Act 2008 placed a new duty on Local Transport Authorities (LTAs) to have regard to government policies and guidance on climate change adaptation.

Our understanding of how to adapt to climate change is still in the very early stages and much further work is needed. This briefing note offers some initial ideas about how LTAs might respond. It was developed jointly by [The Transport Planning Society \(TPS\)](#), the [UK Climate Impacts Programme \(UKCIP\)](#) and the [Nottingham Declaration Partnership](#).

This project was funded by the [Local and Regional Adaptation Partnership Board \(LRAP\)](#), a collection of local and regional bodies supporting adaptation and supported by Defra. The LRAP board, established in 2008, aims to facilitate action on climate change adaptation at a local and regional level. The work on local transport forms part of a wider LRAP research and support programme.

While primarily aimed at local transport planners, this note may have some relevance for local highways authorities and public transport operators. It draws on:-

- Discussions at a practitioner workshop held in June 2009
- The experience of the London Climate Change Partnership in adapting London's transport
- Guidance published by the Department for Transport
- The UK Climate Projections 09

These are all covered in the document or links are provided under further information at the end.

WHAT IS CLIMATE CHANGE ADAPTATION?

Adaptation describes actions to reduce the negative consequences and enhance the beneficial consequences of weather and climate events. It implies strengthening resilience and maintaining business continuity in the face of a changing climate.

Adaptation = addressing the impacts of climate change
Mitigation = addressing the causes of climate change

The difference between weather and climate

Adaptation responses are required to address the impacts of both weather and climate, so it is important to recognise the difference.

Climate is the average weather in a locality over an extended period. Climate scientists normally use a thirty-year period which, in periods of stable climate, has been sufficient to provide a reliable average including the inevitable peaks and troughs of natural variability.

Weather describes what is happening at any point in time, be it torrential downpours of rain, exceptionally high temperatures, or thunderstorms.

These differences are important because of the different impacts that can be expected and therefore the different responses that are required. Local transport authorities will need to consider the impact of both changes in seasonal averages and severe weather events.

NATIONAL ACTIVITIES TO SUPPORT TRANSPORT ADAPTATION

THE UK ADAPTING TO CLIMATE CHANGE PROGRAMME

The Department for Transport (DfT) is closely involved in the government's [Adapting to Climate Change Programme](#). Along with other government departments, DfT will produce a high level adaptation strategy in spring 2010.

The Climate Change Act (2008) gives the Government the power to direct reporting authorities (public sector bodies and statutory undertakers) to report to Parliament on the predicted impacts of climate change on their organisation and their proposals for adapting to build resilience to the identified risks. Selected transport operators and organisations will be asked to report with the final list being agreed and presented to Parliament in November. The first reports are expected in January 2012.

In the case of local transport and highway authorities, reporting on adaptation will be via National Indicator 188 'Planning to Adapt to Climate Change' (see below).

RESEARCH BY TRANSPORT ORGANISATIONS

A significant amount of adaptation work is already underway on adapting the strategic road and rail networks. The Highways Agency for example, will soon publish their [Climate Change Adaptation Strategy](#) which analyses predicted climate change impacts and how they might affect the strategic road network. It also looks at possible measures that could be implemented to minimise the impacts of extreme weather. This Strategy could be used as a reference tool by local authorities, but with the caveat that local networks' structure and usage are very different to that of the Highways Agency's motorways and trunk roads. The rail industry has an extensive research programme in place to analyse the possible impacts of climate change on its network. It is looking to identify adaptation measures that could be implemented to build resilience to impacts such as higher temperatures and increased rainfall.

FUTURENET

A consortium led by the University of Birmingham been awarded funding for a major four year, £1.5million research project (Future Resilient Transport Networks) to examine how to make the UK's transport systems resilient to climate change. The project will identify what the UK's transport system will look like in 2050 and investigate how to ensure that it will be able to cope with the effects of climate change.

To assess the resilience of the transport network in 2050, FUTURENET will take into account likely future changes in technology and infrastructure, as well as changes in climate and extreme weather events. It will attempt to answer questions such as: what will be the critical thresholds of extreme weather that cause disruption or accidents; how susceptible are different modes to extreme events; and what are the likely implications for maintenance and renewal costs? The project is due to be completed in 2013.

LOCAL TRANSPORT AUTHORITIES' NEW DUTY

At the local level, the Local Transport Act 2008 placed a new duty on LTAs to have regard to the government's adaptation policies and guidance in their Local Transport Plans (LTPs). This is reinforced in the DfT's LTP Guidance (chapter 3 paragraph 12), which states:

In addition to measures to reduce greenhouse gas emissions, it is important that local authorities put in place measures to improve the resilience of local transport to the

impacts of climate change, such as flooding and the deterioration of roads, in line with the Government's Adapting to Climate Change Programme, NI188 (Planning to adapt to Climate Change) and the UK Climate Projections.

IMPROVING LOCAL PERFORMANCE

Local areas' performance on climate change adaptation is coming under increasing scrutiny and efforts by LTAs' to adapt local transport will help local areas' to demonstrate that they are taking climate change seriously:-

- All local authorities must report their performance against national indicator NI 188 (planning to adapt to climate change)
- 56 local areas have agreed NI 188 improvement targets in their Local Area Agreements
- The joint inspectorates will consider how well local areas are adapting to climate change within Comprehensive Area Assessments (CAA)

2. UNDERSTANDING CLIMATE CHANGE IN YOUR AREA

DfT's Local Transport Plan Guidance encourages LTAs to *identify problems and priorities on the basis of clear evidence and data*. Evidence on future climate change for your area is important for understanding the vulnerabilities of your network as well as setting standards and choosing locations for new schemes.

Although Local Transport Plans may only have a 10 to 15 year timeframe, many of the proposal contained in the plans, including locations, infrastructure and equipment, will last for much longer. Therefore longer term climate change needs to be considered.

Evidence about the anticipated changes in your area's climate and its potential impacts may be gained from:-

- The UK Climate Projections 09 (UKCP09)
- Flood and shoreline plans and information
- Regional Climate Change Studies

THE UK CLIMATE PROJECTIONS

KEY FINDINGS FROM THE UK CLIMATE PROJECTIONS

New UK Climate Projections 09 (UKCP09) were launched in June 2009. The table below summarises the key changes that are expected.

Summary of projected climate change in the UK

Long-term / seasonal averages

- Warmer, drier summers
- Milder, wetter winters
- Rising sea levels

Extremes

- More very hot days
- More heatwaves especially in the south and east
- More rain on the wettest days of the year
- Fewer frost nights

Climate changes are likely to be most pronounced in the south of the country due to the proximity to the continental landmass, and less so in the north due to the thermal buffering of the Atlantic Ocean.

WHAT IS AND IS NOT INCLUDED IN UKCP09?

UKCP09 presents information on temperatures, precipitation (rain, hail and snow), cloud, humidity, sea level rise, storm surges, waves and sub-surface changes. It does not interpret how these changes might feed through into other impacts that will be crucial for transport planning such as floods, storms, high winds and coastal erosion / inundation. Research is now underway to use the new projections in impacts studies. In the meantime evidence on some of these may be obtained from other sources (see below).

EMISSIONS SCENARIOS AND PROBABILITIES

Climate change projections are inherently uncertain due to uncertainty about the course of future emissions; limitations in our ability to model the climate precisely (model error); and the effects of natural variability (year to year fluctuations in the overall trend).

Because we cannot be certain about future emissions, UKCP09 uses three emissions scenarios (based on the IPCC's¹ Special Report on Emissions Scenarios) – high, medium and low. As a result of the lag in how the climate responds to emissions, the alternative scenarios do not result in a significant variation in the projections up to 2040, but after 2040 the projections start to diverge noticeably.

All of the projections in UKCP09 are representative of thirty year periods - for example the period 2070-2099, which is known as “the 2080’s”. The first time period is 2010-2039. As the results are a thirty year average, UKCP09 does not give information on very near term climate.

For the first time, UKCP09 also gives a measure of the uncertainty from modelling and natural variability by assigning probabilities to different outcomes. These probabilities should be seen as a measure of the strength of evidence for different future climates based on expert judgement. The

¹ The UN's [Intergovernmental Panel on Climate Change](#)

probabilities do not include all possible sources of uncertainty, but they go far beyond previous scenarios that only used a single “best guess” estimate.

The probabilities allow decision makers to use the Projections by assessing their attitude to risk. For example, if expensive and critical infrastructure is at risk, they may want to take a very risk averse approach and focus on planning adaptive strategies that protect against low probability, high impact events (such as very high levels of sea level rise).

This inevitably raises the question of which emissions scenario and probabilities to use for transport infrastructure that may continue to function for many decades. Although planning for the most extreme ranges (high emissions scenario and fairly low probability of occurring) may be the safest bet, it may also be the most expensive. For major schemes with a long life span, scheme appraisals may need to weigh the costs of planning for alternative scenarios and probabilities. (See section 4.)

LOCAL INFORMATION

LOCAL PROJECTIONS AVAILABLE FROM UKCP09

The [technical UKCP09](#) site presents overview information such as:-

- Key findings for the whole of the UK and for administrative regions
- UK maps of how seasonal mean precipitation and temperatures are likely to change

Users can also use the *Customisable output* available from the user interface to view projections for their locality and generate maps and graphs. As well as seasonal and annual means, the *Weather Generator* tool gives statistics of extremes that occur at a daily scale, such as hot days and dry days. This could be important when considering performance thresholds for transport infrastructure.

GENERATING LOCAL PROJECTIONS

Before interrogating the UKCP09 data, check if any other part of the local authority or the LSP is already analysing the data, perhaps for a Climate Change Plan, NI 188 Improvement Plan, Local Development Documents or other purpose. Most councils have one or more officers who lead on climate change. Speak to them first.

REGIONAL CLIMATE CHANGE STUDIES

Many [Regional Climate Change Partnerships](#) have published Regional Climate Change studies and / or strategies. These may contain useful evidence and consider the indirect impacts of climate change, such as changes in work, immigration or tourism patterns.

FLOOD AND SHORELINE INFORMATION

Two plans that will provide information on flood and coastal erosion are:

- [Catchment Flood Management Plans](#) (to be published shortly). These analyse flood risk in catchment areas now and in the future.

- [Shoreline Management Plans](#) (second generation SMP plans are currently in production) provide similar insights into anticipated coastal flooding and erosion.

Both plans recommend the best ways of managing future risks over the next 50 to 100 years. They will help with identifying the locations most at risk of flooding and coastal erosion and if these risks may be reduced by future management measures or if, for example, coastal retreat is proposed.

Strategic Flood Risk Assessments (SFRA) may also contain useful information on areas at risk from flooding. They are produced by Local Planning Authorities to inform their Local Development Documents (LDDs). The SFRA will evaluate the effects of climate change on all sources of flooding and consider appropriate policies for development in or adjacent to flood risk areas.

DIFFERENT TYPES OF FLOODING

River flooding occurs when a watercourse cannot cope with the water draining into it from the surrounding land. This can happen, for example, when heavy rain falls on an already waterlogged catchment.

Coastal flooding results from a combination of high tides and stormy conditions. If low atmospheric pressure coincides with a high tide, a tidal surge may happen which can cause serious flooding.

Surface water flooding occurs when heavy rainfall overwhelms the drainage capacity of the local area. It is difficult to predict and pinpoint, much more so than river or coastal flooding.

Sewer flooding occurs when sewers are overwhelmed by heavy rainfall or when they become blocked. The likelihood of flooding depends on the capacity of the local sewerage system. Land and property can be flooded with water contaminated with raw sewage as a result. Rivers can also become polluted by sewer overflows.

Groundwater flooding that occurs when water levels in the ground rise above surface levels. It is most likely to occur in areas underlain by permeable rocks, called aquifers. These can be extensive regional aquifers, such as chalk or sandstone, or may be more local sand or river gravels in valley bottoms underlain by less permeable rocks.

The Environment Agency has recently provided data to local authorities on [Areas susceptible to flooding from surface water](#).

Locations considered to be at highest risk from surface water flooding will be undertaking Surface Water Management Plans over the next few years. In priority areas local authorities will lead on the development of the plans that will assess the local flood risk from surface water, ground water and smaller watercourses and consider actions for managing this risk. As they develop, these plans will be a valuable source of information.

WIND AND STORMS

As yet there are no projections available for changes in wind speed and storms.

3. UNDERSTANDING NETWORK VULNERABILITY

There was broad consensus at the June 2009 Practitioner workshop that a crucial first step in adapting local transport will be to assess the current resilience of transport networks to climate change. This might involve research in a number of areas, including:

- identifying areas of the transport system most vulnerable to different types of flooding
- establishing the whereabouts, ownership and condition of drainage systems
- assessing the impact of hot weather on the comfort and technical performance of networks
- investigating the behaviour of pedestrians, cyclists, and passengers during hot weather
- assessing the impact of high winds on bridges and street furniture
- understanding the vulnerability of distribution systems (especially food) to network disruption

LOCAL CLIMATE IMPACTS PROFILE

Local Climate Impacts Profiles (LCLIPs) can provide a useful insight into how local transport networks are currently coping with severe weather and may help you to think through the consequences and possible costs of changes to the climate and severe weather.

Many local authorities have undertaken LCLIPs using information from the media and council records. These identify vulnerability to recent weather and climate events, how these events were dealt with and the costs. Check whether an LCLIP has already been completed for your area or consider undertaking an LCLIP if one is not available. [Guidance on undertaking an LCLIP](#) is available on UKCIP's website.

CHECKLIST OF ISSUES TO CONSIDER

The table on the following pages suggests some issues to consider when assessing the vulnerability of local transport networks to the types of events that are expected to become more frequent with climate change.

The checklist covers all aspects of the local network, not just those that are the direct responsibility of local authorities.

These suggestions are derived from a number of sources including: DfT guidance; the practitioner workshop held in June; LCLIPs; and other research. *But* this is still a new area of work and it is probable that some issues have been missed.

CHECKLIST OF ISSUES TO CONSIDER FOR NETWORK VULNERABILITY TO CLIMATE CHANGE

Weather / climate & its impacts	Roads / pavements	Cycling / walking	Buses / trains / trams	Structures
Coastal erosion & storm surges	<ul style="list-style-type: none"> • Realignment of routes • Collapse of cliffs taking down infrastructure • Temporary or permanent inundation of infrastructure • Communities and/or services cut off e.g. homes, hotels, roads, beach access routes, ports and harbours 			
Heatwaves – increase in extreme temperatures	<ul style="list-style-type: none"> • Surface damage such as melting tarmac • Subsidence and heave 	<ul style="list-style-type: none"> • Surface damage such as melting tarmac • Overheating of paths and discomfort • Modal shift away from walking and cycling due to discomfort. 	<ul style="list-style-type: none"> • Buckling rails, speed restrictions & emergency timetables • Overheating and discomfort / health risks for passengers (especially underground) • Modal shift to cars due to discomfort 	<ul style="list-style-type: none"> • Surface and structural damage
Increases in average daily temperatures	<ul style="list-style-type: none"> • Longer growing seasons and increased verge / embankment maintenance. • Drought and lower water tables causing ground shrinkage, unstable ground, subsidence, landslides etc 			
Heavy rainfall and flooding	<ul style="list-style-type: none"> • Landslips • Damage to pavements 	<ul style="list-style-type: none"> • Pedestrian subways more likely to flood and take longer to clear. 	<ul style="list-style-type: none"> • Higher risk for underground networks. • Flooding of train / tram power sources 	<ul style="list-style-type: none"> • Embankments unsafe or collapse • Landslides bringing down structures • Bridges damaged or washed away

Weather / climate & its impacts	Roads / pavements	Cycling / walking	Buses / trains / trams	Structures
High winds and storms	<ul style="list-style-type: none"> • Unsafe buildings and consequent transport diversions • Fallen trees and associated debris - blocking routes / safety risk 			<ul style="list-style-type: none"> • Vulnerability of / danger from movement of lightweight structures (traffic signs, lighting, street furniture). • Vulnerability of exposed structures / bridges.
		<ul style="list-style-type: none"> • Modal shift to cars & public transport 	<ul style="list-style-type: none"> • Damage to overhead power lines 	
Severe weather generally	<ul style="list-style-type: none"> • Disruption to normal traffic flows with people unable to travel, confused about what networks are running, or marooned en route • Risks to passenger safety • Impact on outdoor workforce and public transport staff • Failures of “just in time” supply chains, most importantly food supplies 			
Indirect impacts	<ul style="list-style-type: none"> • Increase in tourist visitors from overseas and UK visitors staying in UK • Changes in visitor travel patterns – especially to coastal locations • Population movements away from urban heat islands and locations that suffer frequent floods • Changes in economic sectors / employment patterns • Inward migration from countries that are suffering more severe climate change 			

4. STRENGTHENING RESILIENCE

Measures to strengthen the resilience of local transport to climate change have been divided into:-

- Managing severe weather and disruption
- Low cost interventions and maintenance
- Major schemes

But as mentioned in the introduction, our understanding of how to adapt to climate change is still in the very early stages, and these are just initial ideas. Other options may well occur to you.

MANAGING SEVERE WEATHER AND DISRUPTION

The prohibitive cost of fully adapting transport networks to cater for increasingly severe weather could make it increasingly impractical to accommodate expectations that transport networks will function whatever the weather. While it should be possible to introduce many adaptation measures, people and businesses may have to come to accept that some disruption is inevitable and that they also need to take personal responsibility for their safety if they choose to travel.

LTA's might consider how best to manage the disruption caused by severe weather, for example:-

- **Build resilience to severe weather**
 - **Personal resilience:** e.g. raise awareness of: how to find about transport disruption and alternatives; safety during heatwaves; what to do if marooned by landslips, floods or storms; not attempting to travel during severe disruption and working from home where possible.
 - **Business resilience:** e.g. encourage contingency planning by retailers and other businesses for disruptions to deliveries - particularly for essential food items.
- **Know when severe weather is expected:**
 - Register for the Environment Agency's [Floodline Warning Direct Service](#).
 - Ask your Emergency Planning Team to keep you informed of heatwave warnings. Under the Heatwave Plan for England the Met Office will inform emergency planning teams when heatwaves are predicted. Emergency planning teams are required to cascade this to priority services such as adult care and childrens' services, but at the moment local transport is not specified.
- **Be fully prepared to give advice during the disruption** across a range of media – online, radio, phone. Advice might cover messages about personal resilience in severe weather as well as travel options. Plan for the possibility that contact centre staff may not be able to travel to work and may need to work from home or another location.

LOW TO MEDIUM COST MEASURES

The table below suggests a range of low to medium cost measures that might be considered.

POSSIBLE LOW TO MEDIUM COST MEASURES	
Weather	Measures
Heatwaves	<ul style="list-style-type: none"> • Paint roofs of buses / trains white, tinted windows • Natural ventilation of public transport vehicles and interchanges and underground routes (windows that open, through carriages, unblocking ventilation shafts) • Provide shade for footpaths, cycle routes and public transport waiting areas (see advice in the Heatwave Plan & from CABE), while ensuring that security is included in the design to avoid any potential for crime / fear of crime. • Resurface roads / pavements with more heat resistant materials
Increases in average daily temperatures	<ul style="list-style-type: none"> • Increased cutting of verges and other vegetation, but taking into consideration biodiversity impacts.
Heavy rainfall and flooding	<ul style="list-style-type: none"> • Identify location of drains and their condition • Improved maintenance of drains and culverts • Strengthen embankments • Prepare a surface water management plan
High winds and storms	<ul style="list-style-type: none"> • Risk assessment and replacement of trees and lightweight structures

APPRAISING OPTIONS

Naturally the cost and benefits of different adaptation measures will need to be weighed against each other as well as against other spending proposals. It may not be feasible to implement all of the desirable options and the desirability of measures will depend on their cost and the likelihood of network failures if not implemented.

The final Local Transport Plan Guidance (Chapter 4) encourages local transport authorities to appraise options and DfT has published [Advice on the Prioritisation of Smaller Transport Schemes](#).

The assessment criteria could include the likelihood and severity of climate change impacts if the options are not implemented. Likelihood estimates may need to consider alternative emissions scenario and probabilities, but for measures with a relatively short life-span this will be less crucial as the UK climate projections do not diverge greatly under different emission scenarios up to 2040.

It may also be helpful to involve the Local Strategic Partnership (LSP) in decisions about the priority to be given to adaptation responses.

MAJOR SCHEMES

Major schemes may be divided into:-

- Those that are commissioned with the primary aim of strengthening resilience
- Other major schemes which incorporate new design standards to strengthen resilience

Schemes with the primary aim of strengthening resilience to climate change might include: realignment of routes; elevating routes; major drainage improvements; improvements to ventilation of underground routes; new road and path surfaces; bridge redesign; re-siting of power sources; re-engineering of embankments; groundsource cooling systems.

Major investments that might need to include new design standards to cope with severe weather include:

- Buses, trains and trams: improved ventilation for staff and passengers; greater resilience of engines, power sources and track.
- Roads and paths: design to strengthen resilience to floods and heatwaves

The standards needed will of course depend on the expected life of the scheme and the extent of climate change which is projected over this period. The Department for Transport has issued some guidance on standards for roads and pavements (see section 8), but as yet there is little other published advice available on scheme standards to prepare for climate change.

The Environment Agency can provide advice on reducing flood risk and should be involved early on in the development and design of all major schemes.

SCHEME APPRAISAL

DfT's *Guidance for Local Authorities seeking Government funding for major transport schemes*, says that A Major Scheme Business Case should include a Value for Money (VfM) assessment. Ideally VfM assessments would place a monetised value on benefits, but for adaptation measures there is as yet no easy way of placing a monetary value on travel disruption, injury and health risks. It may be possible to place a monetary value on potential damage to infrastructure if adaptation measures are not introduced.

The DfT guidance recognises that in many cases it will be difficult to place a monetary value on the benefits of major schemes, but notes that the VfM should account for all impacts of the investment proposal, not just those impacts that can be presented in monetary terms (paragraph 2.6.3). Adaptation benefits should therefore be included within VfM assessments even if they cannot be monetised.

Many major schemes would be expected to last well beyond 2050, and therefore the appraisal may need to consider a range of likelihoods of severe weather occurring under different UKCP09 emission scenarios and probabilities.

It may also be worth considering a flexible design which allows adaptation measures to be strengthened over time as climate change trends become clearer.

Defra and HM Treasury have recently published a supplement to the Treasury's Green Book - [Accounting for the Effects of Climate Change](#) (2009) which may be useful for major scheme appraisals, especially chapter 3 on *Appraising and Evaluation of Policies, Programmes and Projects*.

NEW DEVELOPMENTS

New transport developments are often driven by new housing, education and business developments. Transport and land use planners need to work together to avoid development in areas of high flood risk and / or developments that might add to flood risk. Local Transport Plans therefore need to be closely aligned with the Local Development Framework and Single Regional Strategies.

LEARNING FROM OTHER COUNTRIES

There are opportunities to learn from practice in other countries that already experience, for example, higher temperatures and heavier downpours. Partnerships such as Eurocities and UITP (International Association of Public Transport) might be able to help with contacts.

SUPPORTING CLIMATE CHANGE MITIGATION

Climate change mitigation remains a top priority for local transport and every effort needs to be made to ensure that adaptation measures also support mitigation. For example:

- Put in place measures to minimise modal shift away from walking, cycling and public transport in severe weather such as: shading of footpaths, cycle routes and waiting areas; adaptations to keep buses, trains and trams comfortable during heatwaves; improved drainage in pedestrian sub-ways - or replace with surface routes.
- Consider low energy / resource solutions first, e.g. passive as opposed to mechanical ventilation, and avoid major engineering works where less resource intensive alternatives are available.

5. TRANSPORT ASSET MANAGEMENT PLANS

Local authorities control 98% of highways in England and Wales. In many authorities these roads are the most valuable assets they own, worth hundreds of billions of pounds. DfT therefore recommend that local authorities give serious consideration to integrating their Transport Asset Management Plan (TAMP) with their LTPs. As TAMPs identify asset condition they are an important first step to

setting out an adaptation strategy that would make road networks more resilient to climate change. The DfT has allocated £32m to help English highway authorities to improve asset inventory capabilities, and those allocated the largest sums are required to spread best practice.

6. EXPERIENCE FROM LONDON

The London Climate Change Partnership's work to adapt London's transport was outlined at the June practitioner workshop by Helen Woolston, environment and climate change co-ordinator at Transport for London's Sustainability Unit. These initiatives were devised in response to the Partnership's 2005 report *Climate Change and London's Transport Systems*.

THE LONDON CLIMATE CHANGE PARTNERSHIP (LCCP) is a stakeholder group of over 30 organisations co-ordinated by the Greater London Authority. These include national, regional and local government, the Environment Agency, the UK Climate Impacts Programme, emergency services, residential and commercial developers, transport providers, financial institutions, and the health, utility and voluntary sectors.

Flood

Helen explained that over the past year LCCP has been preparing an inventory of London's drainage infrastructure, including information on who owns drains, their location, capacity, and condition. The "Drain London" project has involved liaising with boroughs and water authorities to draw up the first complete survey of the capital's drainage system. Initially it was a slow process even finding the right people at the boroughs to talk to. Another major obstacle was the water company's initial view that the location of its drains was commercially confidential.

After a year of hard work by the Drain London partnership, involving Thames Water and other bodies, an adequate picture of the data available on the capital's drainage systems has now been drawn up. "It took many tiny steps to achieve, but for the first time, all boroughs in London have been asked for information on where their drains are," Helen said.

The next stage is to test whether the systems are adequate and whether the drains are well maintained. The London Borough of Richmond is trialling development of a Surface Water Management Plan.

Flood risk is also being addressed through a range of other initiatives including identifying which assets are most vulnerable and where action needs to be targeted. "On London Underground our most valuable at risk asset – the tube's electrical bulk supply points – is not really transport equipment as such," Helen said. "We need to protect them at all costs to make sure people can be safely evacuated from tube trains."

Heat

With temperatures in London as much as six degrees Celsius higher than outside, a large body of work has centred on cooling public transport. Initiatives that have been implemented include specifying new buses that are more resistant to heat through painting the roofs white, installing tinted windows that open rather than being sealed, and putting air conditioning in the drivers' cab.

On the London Underground, action has included specifying new designs for trains being built for the sub-surface lines (Metropolitan, Circle and District). These trains will be in the form of one long articulated "snakelike" carriage. This will improve air circulation and help to keep vehicles feeling cooler. For the deep tube lines, maintenance and unblocking of ventilation shafts is important.

The work has also looked at using natural assets to better effect. Groundwater which is pumped out of the system is being used in a 'groundwater cooling through heat exchange plant' at Victoria station. The equipment uses the water to cool air and circulate it into the station.

Infrastructure

New infrastructure has been designed to take account of climate change, with the technical standards of bridges, such as the new Acton roadbridge, adapted to be more resistant to heat and high winds.

7. FUTURE RESEARCH

Participants at the June practitioner workshop identified a number of areas which they believed would benefit from further research and case studies:-

1. Using the UKCP09 projections to understand network vulnerabilities and in investment appraisals.
2. Managing severe weather and disruption - building personal resilience and changing expectations
3. Adapting network maintenance
4. Understanding thresholds, e.g. impacts when temperature, rainfall and windspeed cross certain thresholds
5. New design criteria for all aspects of the network
6. Building adaptation into Transport Asset Management Plans
7. Vulnerability of distribution systems (especially food) to network disruption and the role LTAs could play in supporting the supermarket industry to improve system resilience.
8. Planning for the indirect impacts on migration and tourism

9. Harmonising adaptation and mitigation measures, e.g. research into the comparative mitigation impacts of air conditioning on public transport versus modal shift to private cars in hot weather

8. FURTHER INFORMATION

1. Local Transport Adapting to Climate Change: A practitioner workshop, June 2009
 - a. [Workshop summary](#)
 - b. [Presentation by Helen Woolston, London Climate Change Partnership](#)
2. [UK Adapting to Climate Change Programme](#), Defra.
3. UK Climate Projections 09
 - a. [Summary site](#)
 - b. [Technical site](#)
4. Maintaining pavements in a changing climate
 - a. [Maintaining Pavements in a Changing Climate, TSO](#) (Guidance from DfT)
 - b. [The Effects of Climate Change on Highway Pavements and how to minimise them](#), TRL (Technical research which informed the DfT guidance).
5. [Local Transport Plan Guidance](#), DfT 2009.
6. [Climate change section](#) of the Local Transport Plan Policies and Good Practice Handbook, DfT.
7. [Climate Change and London's Transport Systems](#), London Climate Change Partnership 2005.
8. [The Effects of climate change on highways policy](#), 3CAP - The Three Counties Alliance (3CAP) is a partnership between Derbyshire, Leicestershire and Nottinghamshire
9. [The Scottish Road Network Climate Change Study](#), Scottish Executive 2005.
10. [Advice on the Prioritisation of Smaller Transport Schemes](#), DfT 2008.
11. [Guidance for Local Authorities seeking Government funding for major transport schemes](#), DfT.
12. [Accounting for the Effects of Climate Change](#), Defra & HM Treasury, 2009.
13. [Sustainable drainage systems](#), Environment Agency.
14. [Changing Work in a Changing Climate](#) TUC 2009, considers among other things: indoor and outdoor working conditions including workplace temperatures and equipment, clothing and shift patterns.
15. [Heatwave Plan for England](#), Department of Health 2008. This has information on heat related illnesses and protective advice for the public during heatwaves.

16. [Risks to premises](#) from climate change and designing [new premises](#) / [retrofitting premises](#) to cope with climate change.
17. [Adapting public spaces to climate change](#), Commission for Architecture and the Built Environment (CABE)
18. British Geological Survey:-
 - [Climate change web pages](#)
 - [Landslide information and case studies](#)
19. [Eurocities mobility](#)
20. [UITP – International Association of Public Transport](#)