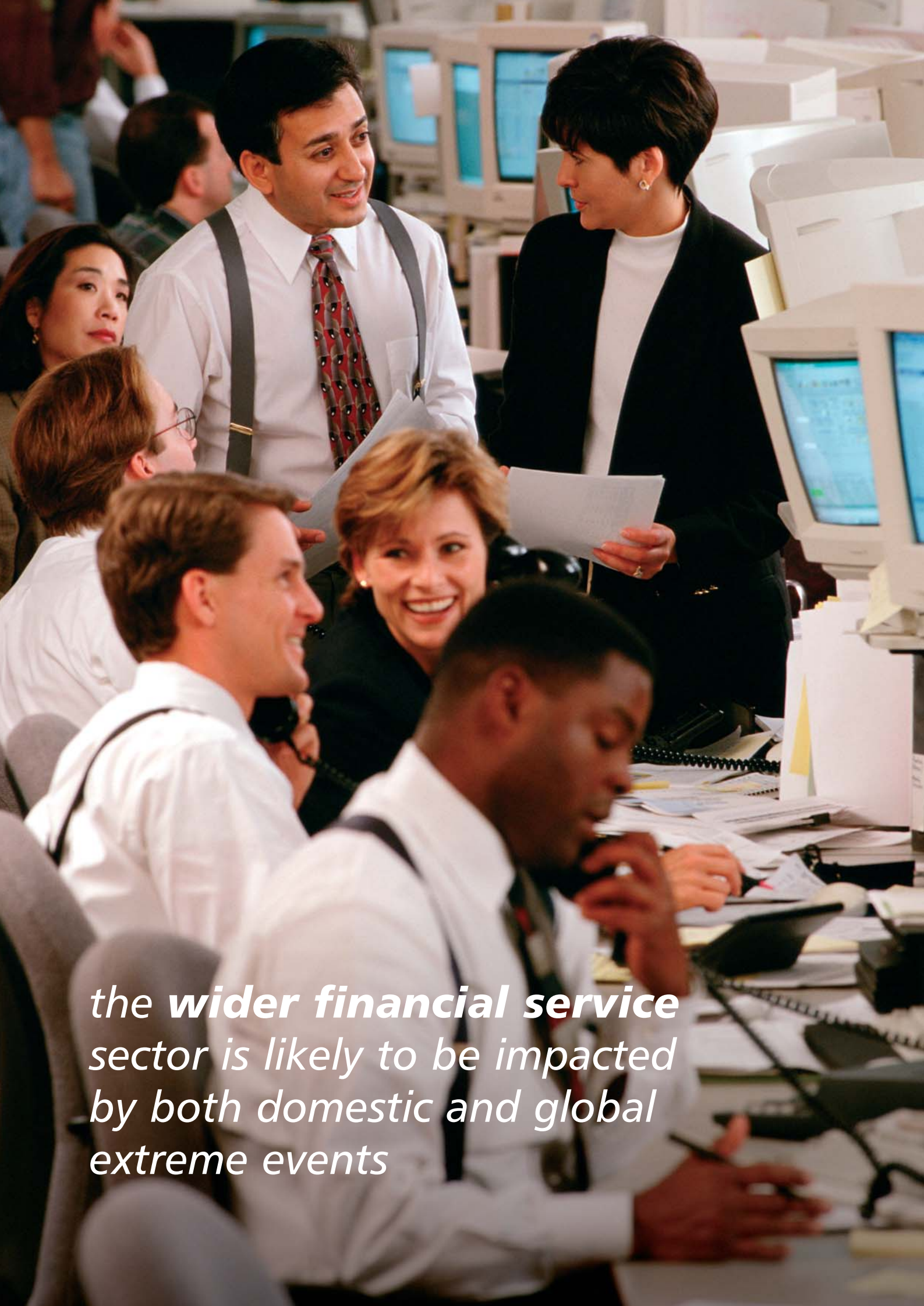


london'swarming

The Impacts of Climate Change on London

Summary Report





the wider financial service sector is likely to be impacted by both domestic and global extreme events

Foreword

Climate change is one of the most serious threats facing the human race this century. There is a need to reduce our contributions to global warming, and discussions continue internationally about this, principally around the Kyoto Protocol. As part of my vision for London as an exemplary sustainable world city, the capital must play its part in reducing greenhouse gases. My policies, especially those in the London Plan, the Transport Strategy and the Energy Strategy, will help to achieve this.

But however successful we are in slowing down global warming, some climate change is inevitable. Recent events such as the floods in eastern Europe and the closure of five rail terminuses here in London on 7 August this year due to flooding, remind us that extreme weather can occur at any time. Climate change means that such events will become more common.

The United Kingdom has taken a lead on the science of assessing climate change impacts. A number of regional studies have already been undertaken, but this study is the first for a major urban area and one of the first to use the UK Climate Impact Programme's latest scenarios of climate change produced in April this year.

The Greater London Authority is pleased to have taken the lead in the London Climate Change Partnership, a grouping of private, voluntary and public organisations, including national, regional and local government and agencies, which has funded and commissioned this first study.

The study sets out the type and extent of climate change which is now expected and the sorts of impacts this will have on Londoners. More work is needed to explore and quantify these impacts in more detail. More importantly we need to develop the responses to the threats and opportunities which this study sets out, in terms of policies, investment, technological and cultural change, while we have the time to plan ahead.

I encourage all Londoners to think about how the changes to the climate described in this report will affect them and the organisations to which they belong.

Ken Livingstone

Ken Livingstone

Mayor of London



Ken Livingstone

Photography

*Cover
Reuters/Russel Boyce*

*Above
Liane Harris*

*Opposite
Taxi Photo Library*



*London is exposed to
far **greater potential
damage from flooding**
than any other urban
area in the UK*

Introduction

This study is the first step in understanding what climate change could mean for London. This summary report is accompanied by a technical report that describes the study methodology and findings in detail. The London Climate Change Partnership (LCCP) will be taking forward the messages from the study, and building them in to decision-making in London.

Key Messages

- **London may be particularly sensitive** to increases in temperature in the future because of the urban heat island effect¹. Models show progressive increases in both summer heat island intensity and frequency with climate change. This will have detrimental effects on air quality, summer electricity demand, and comfort in the city's buildings and transport network. By the 2080s, London's summer extreme temperatures could be comparable with those of present-day New York.
- **London is exposed** to far greater potential damage from flooding than any other urban area in the UK – due to the value of its assets and the fact that a significant proportion of London lies within the floodplain of the River Thames and its tributaries. Whilst flood protection levels are presently good, in the longer term, unless current action to increase investments in flood management measures is continued, the increased risk of flooding from climate change could lead to damage to buildings and property, and disruption of London's transport network. New developments to address the growing demand for housing will need adequate flood protection from all flood sources.
- **London is one of the driest capital cities** in the world, with available water resources per head of population similar to that of Israel. Climate change could reduce the amount of water available and increase demand in summer.
- **London is a major world city.** Climate change impacts globally will affect London. The inter-linking of international capital markets means that the wider financial service sector is likely to be impacted by both domestic and global extreme climate change events.
- **Climate change** could also present some important opportunities for London. For example, tourism and recreational industries could benefit considerably. It may also offer new opportunities for the financial sector.
- **Awareness of climate change issues** amongst stakeholders involved in this study was high and is accelerating. However, work needs to be done to begin to quantify the potential climate change impacts and adaptation options at the local level and to engage decision-makers effectively, whether householders, government or major corporations.

¹ **The Urban Heat Island Effect** is a term used to describe the fact that the temperature of London at its centre is several degrees higher than at its edges; this is because London is a fairly dense, urban settlement and heat emitted from buildings and the characteristics of the airflow contribute to this temperature profile.

Photograph
Rex Features/Nils Jorgensen

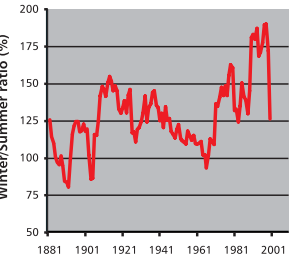


Figure 1 Changes in the ratio of winter to summer rainfall over the Thames region.

Note: the line is based on a 10-year moving average of the winter/summer rainfall ratio.

² **These scenarios were based** on climate models run by the UK Meteorological Office's Hadley Centre, and were produced by the Tyndall Centre in April 2002.

Source: UKCIP and the London climate change impacts study

Global Climate Change

An increasing body of weather observations shows nineteenth and twentieth century warming of the world as well as other changes in the climate system. Emissions of greenhouse gases and aerosols due to human activities, such as burning fossil fuels, are altering our climate. Natural phenomena, such as variations in solar radiation and volcanic activity have also been factors in the observed changes.

The Changing Climate in London

In the UK there has been a string of unusually warm and dry summers in 1976, 1983, 1984, 1989, 1990, 1994 and 1995 that has no modern close parallel. Winter rainfall has steadily increased, resulting in a greater contrast between winter and summer rainfall over the Thames region (Figure 1). There has also been a dramatic decline in the number and amount of snowfalls since the 1960s.

The future London climate will be different from today's. The UK Climate Impacts Programme (UKCIP) has recently published a set of scenarios of possible future climate change for the 2020s, 2050s and 2080s². The four "UKCIP02" scenarios (named Low, Medium-Low, Medium-High and High Emissions) reflect some of the uncertainty attached to future economic and social activity, and associated amounts of greenhouse gases released to the atmosphere. Other uncertainties include the future behaviour of global ocean circulation and land-surface cover. Different climate models produce different results depending on how these factors are accounted for.

Table 1 features some of the climate changes projected for south-east England by the 2050s and 2080s under the UKCIP02 scenarios, compared to the baseline period of 1961-90. Predictions for the south-east represent the best available modelled climate change data covering the Greater London area. Figures 2 and 3 show changes in average

annual, winter and summer temperature, and changes in precipitation for the 2020s, 2050s and 2080s under the Low Emissions and High Emissions scenarios respectively.

London is Different

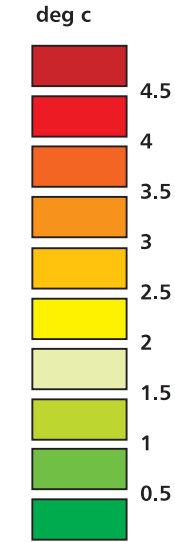
- This is the first** UK climate change impacts study with a distinctly urban focus. As a result, it has identified a number of climate change impacts that have received less attention in previous regional studies – such as impacts on air quality, transport infrastructure, buildings and the financial sector. As an increasing proportion of the world's population lives in cities, how the world's major cities are affected becomes increasingly important.
- London is not** only the capital of the UK but a major world city. Changes to the world's climate will affect all parts of our globe. This will fundamentally affect the environmental, economic, social and political drivers that influence London.
- The Urban Heat Island effect** exacerbates many impacts of climate change in London.
- Climate change impacts** on buildings and the built environment, water resources, transport, parks and gardens, air pollution and tourism, are all exacerbated in London compared to other UK cities and regions. A population density twice that of most other UK cities exerts strong pressures upon these resources, systems and sectors.
- London's population** has a diverse social structure and climate change will be likely to affect vulnerable social groups disproportionately (for example those on lower incomes may be more significantly affected).

"In central London, the urban heat island effect adds up to a further 5-6°C to summer night temperatures."

Table 1 Climate changes projected for the south-east by the 2050s and 2080s from the UKCIP02 scenarios	
Winters will become warmer by 1 to 2°C by the 2050s and by up to 3.5°C by the 2080s.	The number of storms each winter crossing the UK could increase from five (the 1961-90 average) to eight by the 2080s.
Summers in the 2050s will be 1.5 to 3.5°C hotter, and as much as 5°C hotter by the 2080s.	Summer cloud cover may decrease by as much as 18% by the 2080s.
Higher summer temperatures will become more frequent, and very cold winters will become increasingly rare. Daily maximum temperatures of 33°C, which currently occur about one day per summer in the south-east, could occur 10 days per summer by the 2080s (medium high emissions scenario).	Summer soil moisture may reduce by 50% or more by the 2080s.
In central London, the urban heat island effect currently adds up to a further 5 to 6°C to summer night temperatures, and will intensify in the future	Snowfall amounts will decrease by between 50 to 100%.
Winters will become wetter by between 10 to 20% by the 2050s and up to 30% by the 2080s. Summers may become drier by 20 to 40% in the 2050s and may be 50% drier by the 2080s.	Relative sea level in the Thames Estuary will continue to rise by between 26 and 86cm by the 2080s and will rise further in the future.
Heavy winter rainfall could occur twice as frequently by the 2080s.	Current extreme sea levels will be experienced more frequently.
Mean winter wind speeds may increase by as much as 10% by the 2080s, though this is very uncertain.	Within the next 100 years any cooling effect due to weakening of the Gulf Stream would be more than compensated for by increased temperatures resulting from climate change.

Figure 2 Changes in south-east England average annual, winter and summer temperatures for the 2020s, 2050s and 2080s for the UKCIP02 Low Emissions and High Emissions scenarios.

Mean Temperature Change



Temperature

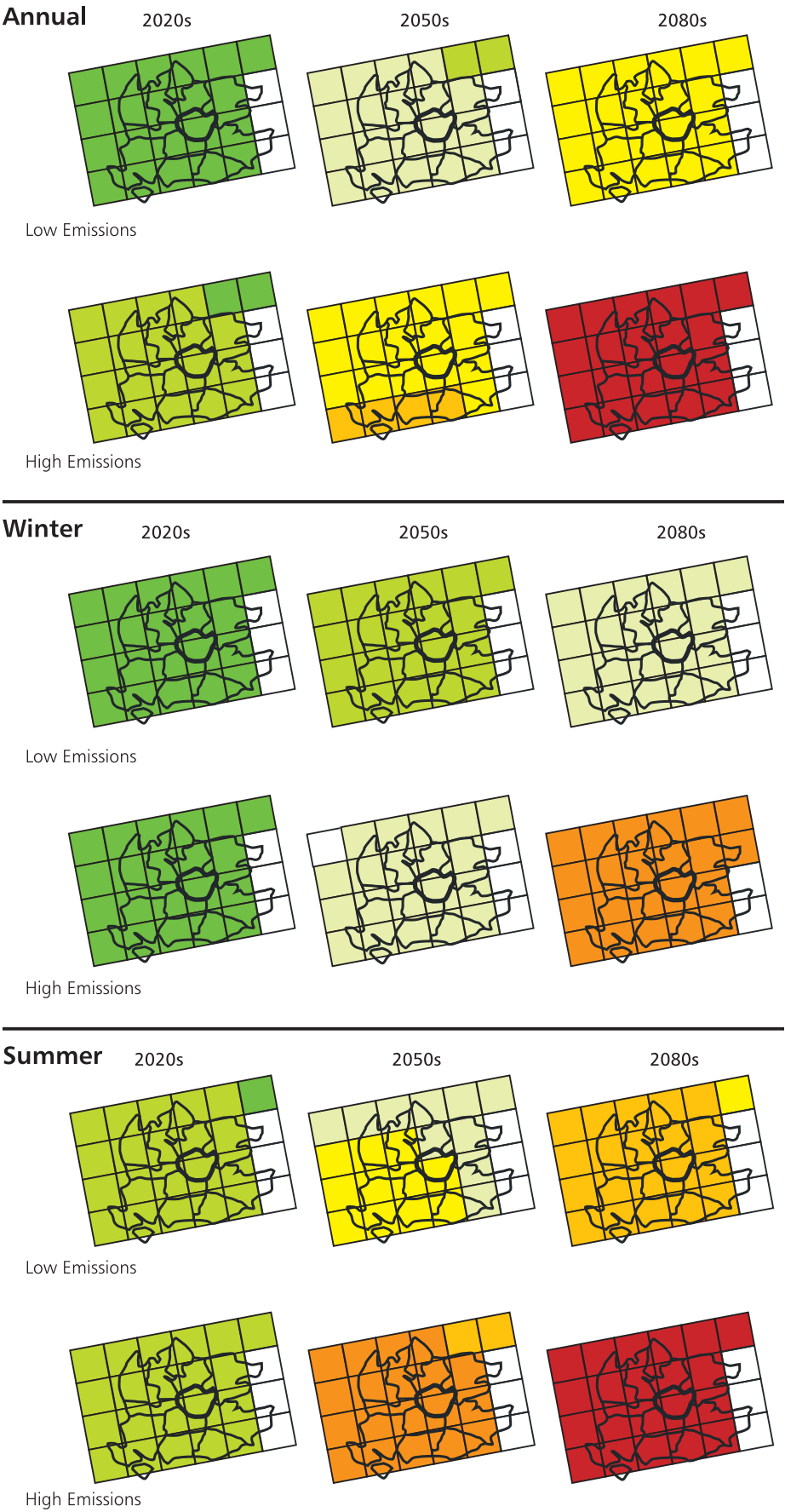
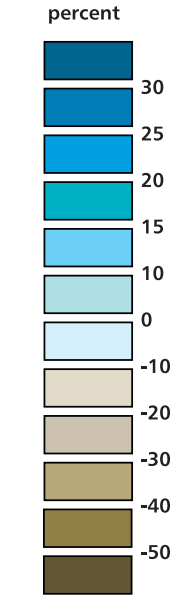
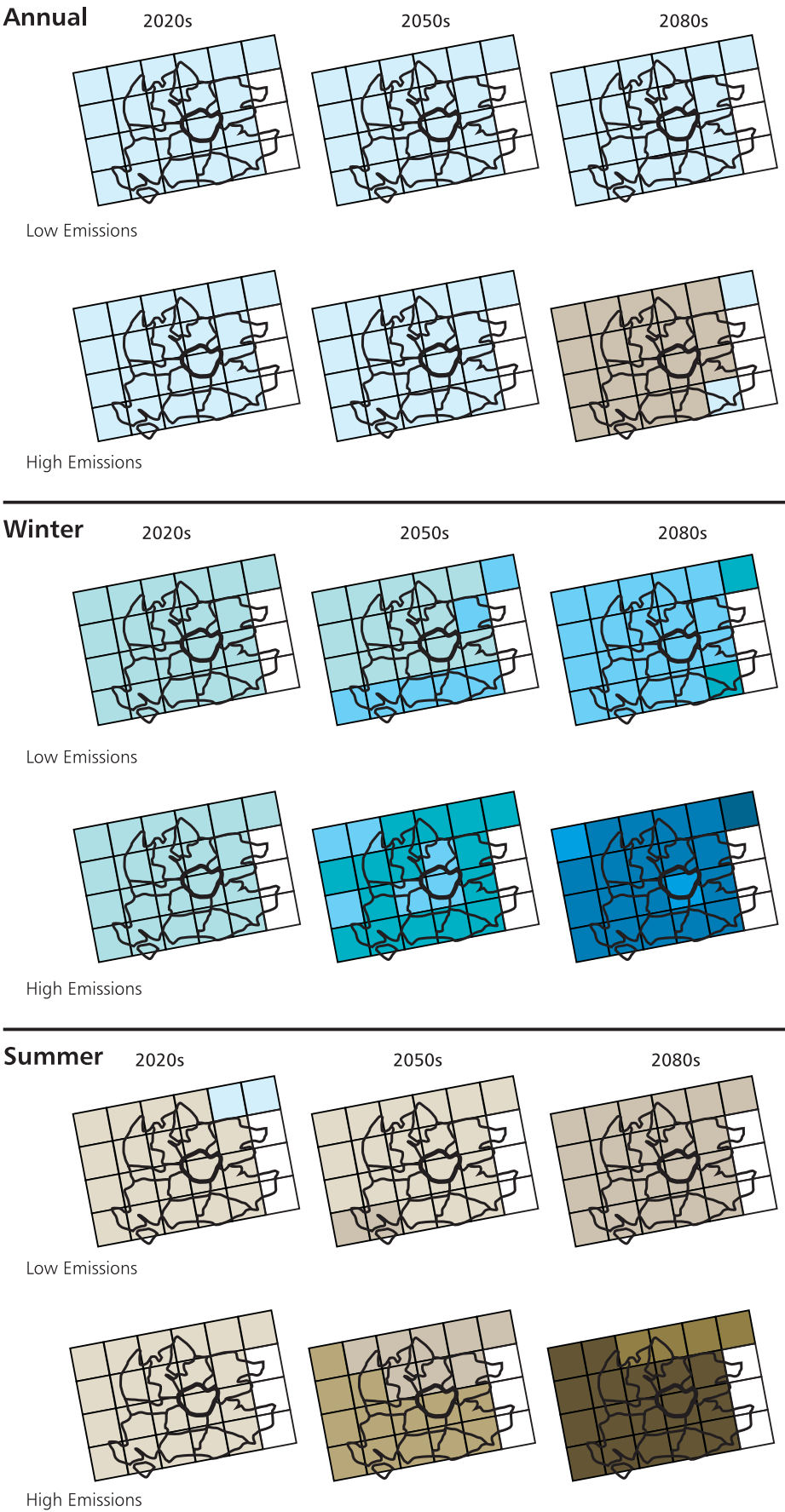


Figure 3 Changes in south-east England average annual, winter and summer precipitation for the 2020s, 2050s and 2080s for the UKCIP02 Low Emissions and High Emissions scenarios.

Precipitation Change



Precipitation





*climate change could
reduce the amount of
water available and
increase demand in summer*

Possible Consequences for London

Keeping Our Cool

Future warming will be most noticeable during summer nights, so there will be less relief from higher day-time temperatures. Increasing temperatures on the London Underground will lead to reduced passenger comfort.

Increased temperatures could also reduce comfort of occupants in domestic, commercial and public buildings and lead to business disruption. Much of London's building stock will still be in place in 50 years time and will have to cope with more very hot summer days. Building simulations of a small commercial, non air conditioned property in London for possible climate change conditions in the 2050s found that temperatures would be outside established "comfort levels" for 23% of working hours. A conventional response to this would be to install more air conditioning (AC) in buildings. Air conditioning, however, is electricity-guzzling, and will increase carbon dioxide emissions, unless the electricity comes from renewable energy sources (such as photovoltaic cladding of high-value buildings). Even then, AC increases the quantity of waste heat in the urban environment, making life less pleasant for those who do not have AC. There is no simple answer to this problem but better building design can certainly help reduce it, e.g. by encouraging use of 'natural ventilation' and novel ideas such as using the cool water below ground to chill buildings.

Domestic buildings are somewhat less vulnerable to very hot summer days because there is less 'heat gain' from equipment and because there are usually more opportunities for cooling, e.g. by opening windows.

The higher temperatures expected under climate change could lead to significant changes in London's demand for energy. On the one hand, there will be an increase in the demand for cooling, primarily in the summer. For a typical air conditioned office building in London the increase in cooling energy compared to 1961-2000 has been estimated at over 10% by the 2050s, and around 20% by the 2080s. On the other hand, there will be a reduction in the demand for space heating. However, energy for heating in the winter is provided mostly by gas, whilst traditional air conditioning runs off electricity. Hence, the provision of summer cooling could contribute disproportionately to global warming.

"In the 2050s temperatures would be outside established 'comfort levels' for 23% of working hours."

Water, Water Everywhere

London is exposed to far greater potential damage from flooding than any other urban area in the UK, due to the value of its assets and the fact that a significant proportion of the city lies within the floodplain of the River Thames and its tributaries. Government estimates suggest that the value of protected land and property within the Thames region tidal Thames flood risk area is £80 billion giving a flood damage estimate of the order of £30 billion.

London is vulnerable to three types of flooding: the inundation of floodplains by river water, local flooding when the drainage network is overwhelmed by intense rain storms, and by tidal surges in the Thames. Climate change could adversely affect all three by: increasing the intensity of rainstorms leading to flash floods from tributaries and the drainage system; bringing more frequent intense winter rainfall leading to a higher and more frequent threat of flooding from the Thames and its tributaries; and by raising sea levels and potentially increasing winter storminess leading to more frequent closures of the Thames Barrier.

*Photograph
Thames Water*

“New development is needed to address the demands of a growing population. These developments will need adequate protection from all sources of flooding.”

London is protected from major flooding by a combination of tidal defences (the Thames Barrier and associated sea defence system), and river defences upstream of the Barrier. The current flood defence standard for the tidal defences is estimated to be about a 2000 to 1 chance of flooding in any year or 0.05% risk of flooding, declining to its original design standard of 1000 to 1 chance, or 0.1% risk of flooding, as sea level rises, by 2030. Thereafter, if improvements are not made the defence standard will continue to fall. The defences are being reviewed, in the light of expected climate changes. Preliminary estimates of the cost of providing a 0.1% standard to the year 2100 show that a major investment in the flood defences infrastructure of the order of £4 billion may be required within the next 40 years.

The Thames river defences through central London have an indicative standard of 0.1% risk of flooding – however the standards of protection to some limited Thames-side areas and on many of the tributary rivers are lower. The likely trend of increases in incidence and severity in floods within the Thames catchment will further increase the flood risk to these reaches. This will require enhanced levels of flood risk management.

New development is needed to address the demands of a growing population. These developments, such as in the Thames Gateway or in other low-lying parts of London will need adequate protection from all sources of flooding.

But Not Enough To Drink

Londoners use (per capita, as supplied by Thames Water) approximately 155 litres of water per day, compared to the average for England of 149 litres (based on information provided by water companies to Ofwat). But available water resources per head of population in London are by far the lowest in the UK and lower than in most capital cities. Climate change could reduce the amount of water available and increase demand in summer. Currently most of the city’s water needs are met by river water stored in reservoirs and by water from the underground chalk aquifer. Higher summer temperatures and lower rainfall will reduce soil moisture and the chance to replenish groundwater supplies despite more winter rainfall. There is some uncertainty in quantifying this impact. River flows are likely to be lower in summer, which will raise water temperatures and aggravate water quality problems in the Thames and its tributaries, especially following heavy summer storms when urban run-off will be washed into rivers from the drainage system.

A Healthy Environment

Air pollution is already at unacceptable levels in many parts of London. Air quality is worse at certain times of the year and under certain weather conditions (such as still, sunny days in summer). Projected increases in dry, sunny weather in summer over the south-east will therefore favour the production of higher amounts of street level air pollutants. Any decline in air quality could pose serious health problems for asthmatics as well as causing damage to London’s plants and buildings.

Increased extreme temperatures could lead to higher levels of mortality related to heat stress. It has been estimated that the heat waves in 1976 and 1995 were associated with a 15% increase in mortality in Greater London, especially among the sick and elderly. Flooding can result in short and long-term illness, including stress-related conditions within vulnerable communities such as children, the elderly and the less abled.

Rises in average winter temperatures would result in the reduction of wintertime deaths. A recent Department of Health report has estimated that by the 2050s up to 20,000 fewer deaths might occur in the UK as a whole as a consequence of climate change.

Poor health in London is closely correlated with the uneven distribution of wealth and resources. This includes wide disparities in the quality of housing, levels of crime, educational achievements and wealth. Such inequalities mean that the adverse health impacts of climate change will be felt disproportionately by those who are already worse off.

Nature Watch

London is a remarkably green city with a rich heritage of native and exotic species. The most serious threats to wildlife include the degradation and loss of habitats, the introduction and spread of problem species, water stress and poor water quality, unsympathetic management, and encroachment of inappropriate development. Climate change could add to these problems through competition from exotic species such as the Chinese Mitten Crab (which out-competes the native species), spread of disease and pests affecting both fauna and flora, increased summer drought stress for wetlands and beech woodland, and sea level rise threatening rare inter-tidal habitats such as salt marshes. We may also find that we are committed to preserving protected habitats and species when these species can no longer live in the new climate and may vanish. Earlier springs, longer frost-free seasons, and reduced snowfall could further affect the dates of egg-laying, as well as the emergence, first flowering and health of leafing or flowering plants. However, small birds, like the wren, and naturalised species such as the collared dove and ring-necked parakeet could thrive in the warmer winters.

Climate Change and the Building Industry: Benefit or Burden?

London has ambitious plans to build more offices and homes. The draft London Plan includes a minimum target of 459,000 new dwellings by 2016. This will have significant implications for the building industry. The industry will benefit from an increased number of available construction days; in summer, due to fewer rainy days and in winter due to fewer frosts, (although there may be an increased risk of waterlogging). However, higher winds, if they occur, would affect the safe use of construction equipment such as cranes and scaffolding and higher temperatures would affect the health and safety of construction workers. Subsidence due to drying out of clay soils is expected to worsen, as soil moisture decreases in summer and autumn and this may affect underground pipes and cables.

There are significant opportunities for improving the design of new buildings so that they can cope more effectively with very hot summer weather. This includes the use of natural ventilation, heat exchanges with cooler water below ground or in waterways, and use of chillers connected to energy-efficient combined heat and power systems. Renewable energy sources to power cooling systems could also be employed, including photovoltaic (PV) cladding on high quality buildings. Retrofitting existing buildings to cope with climate change poses more challenges; this is an area where innovation is required, though much can be achieved by encouraging behavioural change to limit energy demand.

There will, in summary, be opportunities for building designers to devise innovative alternatives to more conventional air conditioning and to take account of future potential water constraints through the use of grey water³ recycling and other water conservation practices.

“There are significant opportunities for improving the design of new buildings so that they can cope more effectively with very hot weather.”

³**Grey water:** domestic wastewater excluding toilet waste that may include wastewater arising from a hand basin, kitchen, bath, shower and laundry.

“The intensive rainfall event of 7th August 2002 led to five of the capital’s mainline train stations being closed due to floods.”

Keep on Moving

London’s transport system, and the dense network of road, rail and airports that link the city with the rest of the UK and the world, are vulnerable to disruption from flooding and other extreme weather events that are expected to increase in frequency and intensity with climate change. Examples (Box 1) of the type of disruption to be expected in future, based on recent heavy rainfall, illustrate the extent of this vulnerability.

Box 1

The intensive rainfall event of 7th August 2002, when over an inch (25mm) of rain fell on London in one-half an hour period in the early evening, led to five of the capital’s mainline train stations being closed due to floods. Similarly, a number of the tunnels in the underground rail system were inundated and closure of stations including Chalk Farm, Kentish Town and Belsize Park resulted. This has significant costs – in terms of lost productivity and late delivery of supplies.

The floods of Autumn 2000 affected many parts of the UK and had many knock on effects on London. One example of this is the time lost due to flooding at Stroud’s Bridge, on the rail link between Oxford and London between 13th and 18th December, 2000. The financial loss to Railtrack due to time delay penalties as a result of this one disruption has been estimated to be at least £1.2m. Other economic costs associated with the disruption were the value of lost time suffered by train passengers and the repair costs to the rail infrastructure.

A general increase in temperature, and a higher frequency of hot summers, are likely to result in an increase in damage to elements of transport infrastructure, including buckled rails and rutted roads, with their attendant disruption and repair costs.

At the same time, less salting and gritting is likely to be needed on the capital’s roads in winter, resulting in cost savings for local authorities. Similarly, there may be fewer instances of points freezing in the rail network in, and surrounding, the capital and less disruption from snowfalls that are predicted to decline in frequency.

Water transport may be more favoured as temperatures in the city increase. The air moving along the Thames can be 0.6°C less than the surrounding streets, and the river passes by many of London’s commercial, retail, leisure and tourist destinations.

Financial Forecasts and Weather Forecasts

The London insurance industry, as one of the three largest global insurance centres, is particularly exposed to an increased volume of claims from business and domestic customers that are likely to occur in the event of higher and more extreme wind storms and flood events. Since UK insurers offer greater insurance protection for weather-related

damage than their competitors elsewhere, they are, consequentially, more exposed to climate change effects. As well as claims that may be made by those who have suffered damages to assets in London, there is a significant threat from claims that may be made by those in other parts of the world who are vulnerable to extreme climate change events (e.g. typhoons in South Asia).

Historical examples of the size of such damages and associated claims are presented in Box 2.

Box 2

The October 1987 storm cost insurers £1,500m at 1987 prices for UK damage alone. Overall, including continental European losses, the economic loss was £2,310m of which the insured loss was £1,940m. Two further such storms in England in January and February 1990 (“Daria” and “Vivian”) caused insured losses in England of £2,400m (at 1990 prices). The overall European economic losses were £6,500m of which insured losses (at 1990 prices) were £4,500m. Three big storms in December 1999 (“Anatol”, “Lothar”, and “Martin”) did not affect England seriously, but devastated large areas of Northern and Western Europe, causing economic losses of £8000 m of which insured losses were £3,875m.

Catastrophic storms such as the 1987 windstorm can force insurance companies to sell some of their equity holdings including stocks and shares and property. This could lead to a fall in value of this equity, with a consequent deflationary effect on the economy. The inter-linking of international insurance and capital markets means that the wider financial service sector is likely to be impacted by both domestic and global extreme climate change events.

A further problem is that many households do not have adequate insurance cover, and this is more acute for those on lower incomes. This means the effects of flooding fall disproportionately upon these households, which increases inequality still further.

However, there are significant business opportunities to the financial services sector arising from climate change for example, in the development of markets for catastrophe bonds and weather-related trading in the international financial markets. There are also opportunities from mitigation of greenhouse gas emissions, for example, in carbon emissions trading, energy auditing and verification consultancy. These opportunities are likely to be enhanced as the recognition of potential climate change impacts, e.g. flood risk to London, stir a greater regulatory response from national governments.

These types of future risk changes are already being considered in the development of the global market strategies within the London insurance industry. In the UK, the insurance industry is engaged with sectors such as property, transport and regulatory authorities to develop effective and equitable adaptation strategies.

“There are significant business opportunities to the financial services sector arising from climate change.”

“The effects of flooding fall disproportionately upon those households on lower incomes.”

higher summer temperatures will become more frequent, and very cold winters will become increasingly rare

Wish You Were Here

The effect of climate change on London's tourist industry is highly uncertain. On the one hand there may be a beneficial effect on the industry if southern Europe and other destinations become less attractive. Climate change impact studies for southern Spain, for example, suggest a possible re-emergence of malaria in the area and an increased incidence of flash floods and forest fires that might deter potential visitors. More summer holidays could therefore be taken domestically, with time spent in London being one component of such a holiday. On the other hand heat waves might deter visitors to London (though it does not currently appear to deter visitors to New York, Tokyo, Rome, Madrid and other hotter cities). Increased numbers of visitors to London will have knock-on effects such as increased demand for water from this transient population.

London's attractiveness as a destination for short-breaks from across the UK and internationally is unlikely to decrease under climate change, and might even increase.

It is likely that summer heat-waves in London and the heat island effect will encourage London residents to leave the city for short recreational trips in greater number – other things being equal. Theme Parks and similar out-of-town excursion destinations may benefit. At the same time, sports and recreational fishing could suffer in dry summers as rivers and canals have less water.

Patios, BBQs and Café Society: Passing Fad or Cultural Shift?

Lifestyles will adjust to climate change by more outdoors living, both at home and for recreation. This could include more pavement cafes, outdoor music and theatre entertainment, alfresco dining such as barbeques and picnics, more sporting events and more visitors. Some members of society may be less able to take advantage of more outdoors living due to lack of facilities locally or because of fear of crime or other forms of social exclusion. Others may find that such social shifts bring unwanted noise and disturbance. Society will adjust to new lifestyle patterns, but it may not always do so harmoniously. The market will adjust over time to these changes but there will be a role for planners in designing urban areas so that they can cater for such new demands and increased use of green spaces.

"There will be a role for planners in designing urban areas so that they can cater for increased use of green spaces."

Photograph
Atkinson Duckett

Where to Now?

Making Choices

We are already experiencing human induced climate change, and there would still be further changes in the climate even if we stopped using fossil fuels tomorrow. We will have to learn to live with some level of climate change. Certain aspects of climate change may seem attractive. Higher temperatures and more sunshine in London could lead to a more outdoor lifestyle as described above. This could lead to a feeling that London is an even more vibrant city. But if climate change impacts are not addressed effectively, they could lead to uncomfortably hot living, working and travelling conditions, water shortages, increased risk of flooding and adverse health impacts through poorer air quality. This could lead to a feeling that London is a city beset by periodic disruption. London’s ability to address climate change issues effectively and people’s experience of these positive and negative impacts, will determine the general view of the attractiveness of London as a place in which to work, live and visit.

The London Climate Change Partnership (LCCP) has taken the first step in commissioning this study so that we can begin to understand the many ways in which changes to the climate will affect our lives in London. The next step is to ensure that climate change is built into decision-making for London, so that the city is prepared for its impacts, and can take advantage of the opportunities.

However, ever-increasing climate change is not inevitable. The severity of climate change over the coming century will be determined by the choices we make now about emissions of the greenhouse gases that contribute to climate change. Such choices could, for example, include less resource and energy use and more efficient use of water.

“London’s ability to address climate change issues effectively will determine the general view of the attractiveness of London as a place in which to work, live and visit.”

Living with Change

Climate change is not the only change that will affect London in the next century. The city will experience many social, economic and environmental changes. For instance, the Mayor’s draft London Plan indicates that the population and the economy will both grow significantly, bringing with them the need for many more homes, offices and jobs along with the infrastructure needed to support this (transport, communications, water, waste management, energy, recreation and social services). This increased density of development in London needs to be planned and implemented in ways that take account of the possible impacts of climate change so that we can ensure that climate change does not cause widespread disruption to our social, economic and environmental systems.

There are a number of ways in which we could adapt to the impacts of climate change and some of the options are outlined in Table 2 below. It should be pointed out that this table is indicative of possible future adaptation strategies and is not intended to be fully comprehensive. Detailed examination of possible adaptation options will be considered within further studies. Consideration of these and other appropriate adaptation options needs to be built into London’s plans for the future.

Including Climate Change in London’s Plans

The United Kingdom is at the forefront of understanding of climate change. With this study and the other processes listed below, London is beginning to prepare for climate change.

- **The Environment Agency** is developing Catchment Flood Management Strategies for all London’s fluvial rivers and the Thames tributaries.

“The increased density of development in London needs to be planned and implemented in ways that take account of the possible impacts of climate change.”

Table 2 Examples of possible adaptation options

Higher Temperatures	<ul style="list-style-type: none">• Design buildings with balconies, shading and efficient cooling systems including wider use of natural ventilation.• Use of the cool groundwater under London for cooling (the new GLA building uses a borehole groundwater cooling system).	Biodiversity	<ul style="list-style-type: none">• Use of softer engineering solutions to flood defence e.g. use of waterside buffer zones.• Protection of green and open spaces.• Development of green corridors to facilitate migration of climate sensitive species.
Flooding	<ul style="list-style-type: none">• Improved flood risk identification forecasting, awareness and warning.• Promotion of flood proofing of buildings at increased risk from flooding.• Accelerated investment in flood management programmes.• Not developing in areas at risk of flooding without carrying out a detailed risk assessment and ensuring that adequate flood protection is in place.	Transport	<ul style="list-style-type: none">• Possible use of cool groundwater under London for cooling the London Underground.• Change in winter strategy (less frequent snow and ice) by road maintenance departments and rail operators.• Increased use of water transport.
Water resources	<ul style="list-style-type: none">• Development and deployment of more innovative water resource options in conjunction with more conventional options such as reservoirs.• Wider use of water-efficient saving devices.• Sustainable leakage control.• Restrictions on some water uses.• Increasing awareness amongst the population to use water wisely.	Infrastructure	<ul style="list-style-type: none">• Contingency planning for dealing with potential damage to existing infrastructure (such as water and gas supply pipes, electricity and telecommunication cables).• Taking possible climate change impacts into account when designing new infrastructure.
Air quality	<ul style="list-style-type: none">• Air pollution warning services.• New fiscal and voluntary measures to control emissions.• Improved public transport.• Traffic restrictions.	Energy	<ul style="list-style-type: none">• Increased use of renewable energy generation systems e.g. solar photo-voltaics with increased sunshine.
		Emergency Planning	<ul style="list-style-type: none">• Co-ordinated approach to climate related emergencies by appropriate services

“Adaptation options need to be built into London’s plans for the future.”

“More work needs to be done to understand the potential impacts of climate change and the level of resources needed to address them.”

- **The Environment Agency** is working with the Thames Estuary Partnership to develop a strategy for flood risk management in the Thames Estuary for the next 100 years.
- **The Environment Agency’s** water resources strategy for London has included some consideration of climate change. This sets the framework for water company planning.
- **Water companies** are examining the impacts of climate change on water availability, water quality and the capacity of sewers to cope with severe rainfall episodes.
- **The Greater London Authority** (GLA) has included a range of policies in the draft London Plan that begin to address aspects of climate change.
- **London’s local authorities** have a key role as community leaders and service providers. Many have already started to address climate change issues in their Unitary Development Plans as well as in their community and Local Agenda 21 strategies.
- **The London Biodiversity Partnership** has included some assessment of the impact of climate change on some species and habitats in London.

This is a good start, but much of this work is of a preliminary nature and more work needs to be done to understand the potential impacts of climate change and the level of resources needed to address them in more detail. The LCCP will encourage future plans to include strategies for adapting to climate change.

Improving Our Understanding

There is still much uncertainty surrounding how climate change could affect London. There is a need to improve our understanding in order to ensure that we can plan effectively for the future and measure whether our plans are being effective. The technical report accompanying this summary contains a preliminary assessment of many of these issues but more work needs to be done to quantify the potential impacts in more detail. The LCCP will promote further work on:

- **Improved monitoring** of climate variables such as temperature (including the urban heat island and temperatures in the underground system), rainfall, river flows, wind speeds, storms, sea level rise and air pollution.
- **More detailed assessment** of the potential impacts of climate change in London including how it could affect specific developments. Some key questions are outlined below:
 - How can new buildings and infrastructure be designed and built with potential climate change in mind in order to ensure comfortable living, working and travelling conditions?
 - Where will there be increased risk of flooding, and what should be done about it?
 - How could climate change affect London’s water availability?
 - How will it affect the health of Londoners?

- How could it affect London’s biodiversity and green spaces?
- Can existing buildings be adapted to cope with climate change?
- How could climate change affect London’s existing and planned infrastructure e.g. road, rail, airports, telecommunications, power lines, dams, water and sewerage pipes and drainage systems?
- How could it affect London’s economy?
- How are London’s competitor cities approaching climate change?
- How could it affect London’s cultural assets eg archaeological and historic sites?
- Will climate change bring the expected benefits to London’s tourist industry?
- How can the responses to climate change take account of difference in impacts on different social groups.
- How can the LCCP co-operate with the South East and other Regional bodies.

Engaging the Public

Both the media and the general public are already beginning to make the link between severe weather events and climate change such as the heavy rainfall and flooding in the winter of 2000. It is impossible to say whether individual events like these are caused as a direct result of human induced climate change but they are consistent with results from climate models. A well planned approach to communication is needed to present the public with well-founded, appropriate and accessible information. They need to know what the issues are and what to do.

It is particularly important that the public understands what they can do in emergencies that may be related to climate change such as extensive flooding, poor air quality episodes and intense hot spells that could directly affect their health and safety. The needs of vulnerable groups such as the elderly, those whose first language is not English and people with disabilities should also be identified and addressed.

Education (both formal and informal) should be used to engage the public. Climate change can be an interesting topic for learning in schools and other less formal methods due to its multi-disciplinary nature. Many schools are already using climate change as a teaching and learning topic.

A Co-ordinated Approach

Climate change will be a significant issue for London, so it is important that an effectively planned and appropriately resourced strategic approach is taken to climate change. The LCCP is committed to continuing to examine, understand and respond to the potential impacts of climate change in London.

The results of this study show that climate change will affect all organisations and households in London. There is much work to do to avoid the worst effects and to take advantage of the opportunities. The London Climate Change Partnership comprises a number of organisations who have worked together on this first stage. We welcome other organisations who have a part to play in preparing for climate change to join the Partnership for the next stages.

“A well planned approach to communication is needed to present the public with well-founded, appropriate and accessible information.”

“The London Climate Change Partnership welcomes other organisations .. to join the Partnership.”

Summary of Climate Change Impacts

Issue	Main Points
Higher temperatures	<ul style="list-style-type: none">There is likely to be an increase in the demand for cooling and thus for electricity in summer.Against this, there will be a reduction in demand for winter heating providing a financial advantage for bill payers and reducing incidences of fuel poverty.
Flooding	<ul style="list-style-type: none">Increased risk of flooding is expected for many parts of London.More frequent intense winter rainfalls are expected to increase the likelihood of flooding by rivers and flash flooding when urban drainage systems become overwhelmed.Rising sea levels and possible increased winter storminess would require more closures of the Thames Barrier.
Water Resources	<ul style="list-style-type: none">Water demand will be heightened during hot, dry summers.Longer summers with higher temperatures and lower rainfall will reduce soil moisture and the chance to replenish groundwater supplies.River flows are likely to be lower in summer and higher in winter.Lower river flows in summer will raise water temperatures and aggravate water quality problems in the Thames and its tributaries, especially following heavy summer storms.
Health	<ul style="list-style-type: none">Poorer air quality poses health problems for asthmatics as well as causing damage to plants and buildings.Higher levels of mortality related to summer heat stress are expected.Higher winter temperatures would be likely to lead to a reduction in winter cold spell related mortality.
Biodiversity	<ul style="list-style-type: none">Warmer weather would favour conditions for increased competition from exotic species as well as the spread of disease and pests, affecting both fauna and flora.Rising sea levels will threaten rare saltmarsh habitats.Increased summer drought will cause stress to wetlands and beech woodland.Earlier springs, longer frost-free seasons and reduced snowfall could affect dates of bird egg-laying, as well as the emergence, first flowering and health of leafing or flowering plants.
Built Environment	<ul style="list-style-type: none">The building industry will be likely to benefit from an increased number of available construction days.Subsidence will worsen as clay soils dry out in summer and autumn.Alternate wetting of clays in winter and drying of clays in summer may cause increased ground movement resulting in increased potential for damage to underground pipes and cables.Increased temperatures will reduce comfort of occupants in domestic, commercial and public buildings, and could lead to business disruption.
Transport	<ul style="list-style-type: none">London's transport system and ancillary services are vulnerable to disruption from flooding and other extreme weather events that are expected to increase in frequency and intensity.Increased temperatures on the London Underground, exacerbated by the urban heat island effect, will lead to passenger discomfort.Hotter summers may damage elements of transport infrastructure, causing buckled rails and rutted roads, with their attendant disruption and repair costs.Higher temperatures will lead to a reduction in cold weather-related disruption.
Business and Finance	<ul style="list-style-type: none">The London insurance industry could be exposed to an increased volume of claims from wind storms and flood events.Lower income households may find it more difficult to access adequate insurance cover in the face of increased flood riskThe risk management of potential climate change impacts may provide significant opportunities for London businesses.
Tourism	<ul style="list-style-type: none">Increased temperatures could attract more visitors to London, benefiting the tourist sector.Leisure and recreational facilities and tourist attractions will need to be able to cope with climate change by providing a pleasant environment for visitors.High temperatures could lead to residents leaving London in search of a more comfortable environment on holidays or breaks.
Lifestyle	<ul style="list-style-type: none">Outdoor living may be more favoured, although some members of society may be less able to take advantage of this due to lack of facilities locally, fear of crime or other forms of social exclusion.Green and open spaces will be used more intensively.



Partners

GREATER LONDON AUTHORITY



Consultants

Entec

Tyndall°Centre
for Climate Change Research

Metroeconomica
Economic and Environmental Consultants

This study was commissioned by the London Climate Change Partnership.

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www.thames-gateway.org.uk

This is one of a number of studies conducted under the umbrella of the UK Climate Impacts Programme (UKCIP). Based at the University of Oxford, UKCIP was set up by the Government in 1997, to provide a framework for an integrated assessment of climate impacts and to help organisations assess how they might be affected by climate change, so they can prepare.

This report and the more detailed technical report of the study can be found at www.ukcip.org.uk/london/london.html

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More information on climate change can be found at:

www.defra.gov.uk/environment/climatechange/

www.metoffice.gov.uk/research/hadleycentre/

www.ipcc.ch/

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