A Summary of Climate Change Risks for London

To coincide with the publication of the UK Climate Change Risk Assessment (CCRA) 2012

climate uk

Introduction

London, as a world city, a major transport hub and an international centre of finance, politics and culture, is crucial to the UK's resilience as a whole. However, it is one of the most vulnerable parts of the UK to climate change. This is because of a combination of factors: its population size and density; the ageing Victorian infrastructure that allows it to function; its sensitivity to the world economy; reliance on importing resources; its location in the already hotter drier South East, with much of the city situated on former estuarial marsh land; and its existing vulnerability to extreme weather.

The London Climate Change Partnership (LCCP) recognises these vulnerabilities and has been working to increase climate resilience within and between sectors in London for the last decade. The LCCP is comprised of public, private and voluntary sector organisations that have a role to play in preparing London for extreme weather today and climate change in the future. The Mayor of London is part of this partnership, and has played a major role in assessing the risks and increasing resilience to climate change in London.

In October 2011, he released a climate change adaptation strategy, which was produced in consultation with key players across London. This provides a framework for collective action, identifying where the Mayor is uniquely placed to act and where other organisations, and even Londoners themselves, can lead or join in action.

The UK Government's national Climate Change Risk Assessment (CCRA) provides a high-level appraisal of risk across the country, which provides a broader context for the Mayor's strategy for London. Using this work we are able to compare the risks faced by London with the rest of the UK. The national CCRA is the first step towards a National Adaptation Programme (NAP), which will set out recommended priority actions for increasing the UK's resilience. The actions set out in London's Climate Change Adaptation Strategy will be taken into account during the creation of the NAP. The Mayor and the London Climate Change Partnership will continue to work with Government as the NAP is developed to ensure that the unique needs and opportunities that London presents are fully taken into account.

UK Climate Change Risk Assessment

The UK Climate Change Risk Assessment (CCRA) is an independent research project, funded by UK Government and Devolved Governments that analyses the main risks and opportunities to the UK, arising from climate change over the coming years. It provides the underpinning evidence to inform discussions on adaptation action needed in such areas as infrastructure, health, environment and business. It will be updated every five years taking account of new climate observations and improved understanding of future climate change and risks.

The CCRA methodology is novel in that it has allows for comparison of over 100 risks (prioritised from an initial list of over 700) from a number of disparate sectors based on the magnitude of the impact and confidence in the evidence base. A key strength of the analysis is using a consistent method and set of climate projections to look at current and future risks and opportunities.

The CCRA methodology has been developed through a number of stages involving expert peer review. The approach developed is a tractable, repeatable methodology that is not dependent on changes in long term plans between the 5 year cycles of the CCRA.

The assessment considered population growth, where relevant, but did not quantify the impacts of other societal changes on future risks, for example due to economic growth, or developments in new technologies, or the full range of planned and potential future Government policies or private sector adaptation investment plans.

Excluding these factors from the analysis provides a more robust 'baseline' against which the effects of different plans and policies can be more easily assessed. However, when utilising the outputs of the CCRA, it is essential to consider that Government and key organisations are already taking action in many areas to minimise climate change risks and these interventions need to be considered when assessing where further action may be best directed or needed.

Key National Messages

Some key findings show why we must act now to prepare ourselves and our businesses for the future impact of climate change. The research reveals that without action we could see:-

- Increases in the frequency of flooding affecting people's homes and wellbeing, especially for vulnerable groups (e.g. those affected by poverty, older people, people in poor health and those with disabilities), and the operation of businesses and critical infrastructure systems. Annual damage to properties in England and Wales, due to flooding from rivers and the sea, rises from £1.2 billion to between £2.1 billion and £12 billion by the 2080s. Without action, a range of important infrastructure such as roads and railways may be affected by a significantly increased risk of flooding based on future population growth and if no adaptive action is taken.
- Summer overheating potentially contributing to heat-related health problems. Premature deaths due to hotter summers are projected to increase (e.g. by between 580 and 5900 by the 2050s). This is likely to place different burdens on National Health Service (NHS), public health and social care services. Other health risks that may increase include problems caused by ground-level ozone and by marine and freshwater pathogens.
- Reductions in water availability, particularly during the summer, leading to more frequent water use restrictions and, in the longer term, water shortages. The gap between demand and availability will potentially widen, impacting homes, businesses, schools and hospitals. By the 2050s, between 27 million and 59 million people in the UK may be living in areas affected by water supply-demand deficits (based on existing population levels). Adaptation action will be needed to increase water efficiency across all sectors and decrease levels of water abstraction in the summer months.

This pack was commissioned to coincide with the publication of the UK's first Climate Change Risk Assessment. While drawing on the CCRA where there is regional or local information (which at times is limited due to lack of data) this pack presents a local perspective of the CCRA risks and opportunities. The pack offers an illustration of what climate change means for people, businesses, community groups, local authorities, and other organisations across key sectors, at the local level, highlighting what is already happening and where there is a strong case for greater local action.

Detailed results from the CCRA are presented in:

- An extensive and comprehensive UK CCRA Evidence Report;
- A suite of technical reports on 11 key sectors.
- The UK CCRA: Government Report, which highlights actions already in place to manage the risk identified in the CCRA, and outlines UK Government plans for the future.

To read these publications, please visit: http://www.defra.gov.uk/environment/climate/government/

Key Risks and Implications

Some Key Regional Climate Implications

Business

- London is a global centre for the financial sector, which means that impacts from global extreme weather events, as well as local events, are likely to affect its businesses. This provides opportunities as well as challenges for businesses.
- Tourism is expected to continue to increase in London, but its market share of UK tourism is expected reduce as more people visit the North of England and Scotland.

Health and Wellbeing

- London has a high concentration of vulnerable groups, which are likely to be disproportionately affected by the impacts of climate change.
- The impacts of climate change will not be equal or fair, and are likely to increase existing inequalities unless we take action.
- London is expected to see an increase in deaths due to heat during the summer months, but it is also likely to see a reduction in deaths due to cold in the winter.

Buildings and Infrastructure

- Many of London's vulnerabilities to climate impacts stem from its urbanisation, which can reinforce climate impacts; for example by preventing the city from cooling off on hot summer nights and increasing the rate of rainfall run-off, leading to flash flooding.
- A significant proportion of London's critical infrastructure is already at risk of flooding and/or overheating.

Agriculture and Forestry

- There is relatively little land in London used for commercial food production, although community food-growing schemes may be affected.
- London's tree stock is at risk from drought and higher summer temperatures, which could impact on the cooling effect it provides. Future climate should be considered in tree-planting schemes.
- More frequent summer droughts may reduce the success rate of newly planted trees and put mature trees under stress, potentially shortening the lifespan of many of London's mature street trees.

Natural Environment

- Hotter, drier summers and a growing population will put increasing pressure upon already limited water resources, potentially leading to more frequent drought management measures and negative impacts on the water environment.
- Increasing London's green space can help to cool the urban environment, improve air quality and help reduce surface water flood risk.
- London's habitats and biodiversity are expected to change as a result of climate impacts.

Key Risks and Implications

Key National Risks from the UK CCRA 2012

- Climate change represents a potentially significant issue for all UK business sectors.
- Main climate challenges to businesses include flooding and coastal erosion, increased competition for water, and disruption of transport and communication links.
- The degree to which individual organisations are affected depends upon their level of vulnerability and adaptive capacity.
- There are potentially significant commercial and competitive advantages to be gained for those businesses taking on the challenge.

Business

- Climate change could have significant implications for the health and wellbeing of the UK population.
- Implications affect public health, the continuity of health and social care services both within the NHS and beyond, the resilience of local emergency services, and the most socially vulnerable.
- There may be some welcome benefits, but these are likely to be outweighed by a range of negative effects.

Health and Wellbeing

- The built environment and infrastructure are already vulnerable to extreme weather such as flooding, storms, heatwaves, and droughts.
- Most of today's buildings were designed for the climate that existed when they were built and are not necessarily equipped to cope with current and future climates.
- Around 70% of buildings that will be in use in the 2050s already exist, but there may be opportunities for innovative building services and urban planning in the UK and overseas.
- The government has already prioritised the need to improve the long-term resilience of new and existing infrastructure networks in the energy, ICT, transport and water sectors.

Buildings and Infrastructure

- Agriculture and forestry are sensitive to climatic conditions; changes in climate have a profound impact on productivity and economic viability.
- Climate change may alter the impact that agriculture and forestry have on the natural environment and the value of the ecosystem services provided.
- Warmer temperatures and carbon fertilisation may present some opportunities to increase yields, in the short term.
- Low water availability in the summer, increased flooding and coastal erosion, increased prevalence of pests diseases, and frequent wildfires may limit opportunities in the longer term.

Agriculture and Forestry

- Climate change may exacerbate and/or alter the pressures placed on the natural environment, especially those caused by human activity.
- Heightened impacts may in turn affect the way humans are able to use the environment – for example growing crops or obtaining high quality drinking water.
- The natural environment is crucial to our ability to adapt, reducing flood risk, cooling cities and storing water.

Natural Environment

Buildings and Infrastructure

Many of London's vulnerabilities to climate impacts stem from its urbanisation, which can reinforce climate impacts; for example by preventing the city from cooling off on hot summer nights and increasing the rate of rainfall run-off, leading to flash flooding. Because it is densely populated and developed, London also needs to import a large percentage of its water, energy, workforce, food, and other consumables from outside of the city, making its supply chains more susceptible to disruption. Water supply, which is an important issue for London, is dealt with in more detail in the Natural Environment section.

Flood

London is currently very well protected against tidal flooding, but has a lower and much more variable standard of protection against river flooding and a relatively low standard of protection against surface water flooding. Both tidal and river flooding are considered in the CCRA, although a lack of suitable data meant that surface water flooding could not be analysed UK-wide. However, there has been work done in London to understand surface water flood risk. In the Thames Estuary, the tidal flood defences provide a higher level of protection than elsewhere in the country. The Thames Barrier has been operational since 1982 and has been closed over 100 times to protect London from flooding. In addition to stopping tidal surges from entering central London, closing the barrier can also 'keep out the tide' and provide additional space for high river flows after heavy rainfall in the upper Thames catchment to the west of London.

The Thames Estuary 2100 (TE2100) project was set up by the Environment Agency to tackle tidal flood risk in London and the Thames Estuary for the 21st century. It pioneered an approach to adaptation that assessed the thresholds for responding to different amounts of sea level rise. A large range of possible increases in extreme water levels were investigated and this led to the development of flexible response options or 'adaptation pathways'. The final plan is centred around the most likely scenario but can be adapted if the rate of sea level rise or linked factors change as the century progresses.

Fifteen per cent of the city's surface area lies on the floodplains of London's rivers, although much of it currently benefits from existing flood defences. This means that an estimated 1.25 million people are at risk from flooding and nearly half a million properties. It is important to note that over 80 per cent of these properties are at 'low' flood risk (0.5 per cent or less chance in any one year), but that there are over 83,000 properties at 'moderate' risk (between 0.5 and 1.3 per cent chance in one year) or 'significant' risk (more than 1.3 per cent chance in any one year).

There is also a substantial proportion of the capital's schools, transport network, and emergency services that are at risk from tidal and river flooding risk, although most are well protected.

The CCRA identifies the two main climate drivers for increased flooding in the UK as increases in rainfall and sea level rise. Changes in levels of rainfall are expected to impact on surface water flooding, sewer flooding and groundwater flooding. Surface water flooding occurs when heavy rainfall overcomes the drainage system. It is an area of climate risk which is particularly increased in urban areas such as London because development reduces the amount of permeable surfaces where rainwater can drain away. In London there are currently estimated to be more than 800,000 properties at risk of surface water flooding. The CCRA's rainfall analysis suggests that heavy rainfall events will increase in intensity in London and elsewhere and that this increase is most likely to occur in winter months. Further development due to population increase in London is projected to place an additional pressure on surface water drainage. London's Built Environment case study, Drain London, looks in more detail at how surface water flood risks for London have been assessed.

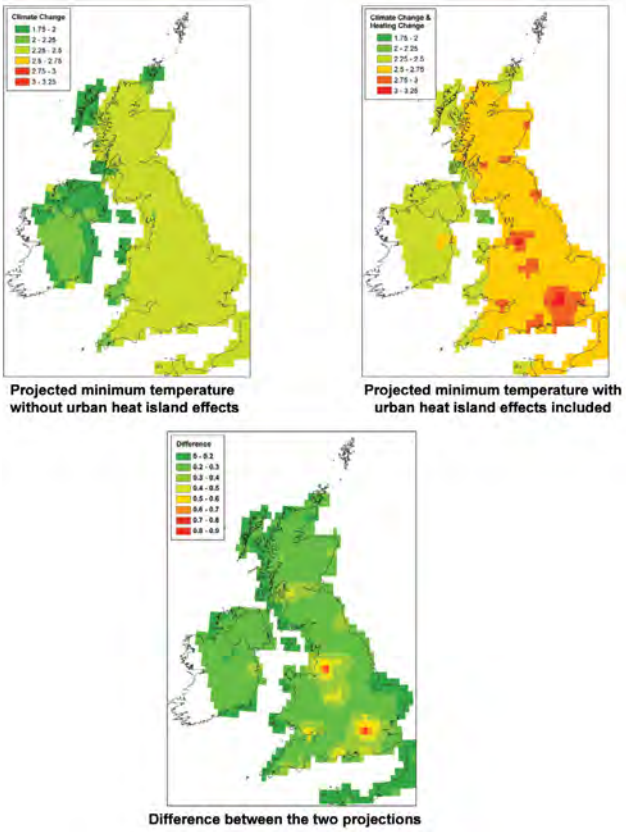
The results shown in Table 1 show the increase in frequency of storms that exceed three different thresholds (>20mm in 3 hours; >30mm in 6 hours; >40mm for the total storm). A value of 1.0 in the table means no change and a value of 2.0 means that the frequency has doubled. The results indicate that the frequency of heavy rainfall events could double by the 2080s leading to an increase in the frequency of surface water flooding, with London particularly affected by the >40mm for total storm events category.

Location	> 20mm Rainfall in 3 Hours			> 30mm Rainfall in 6 Hours			> 40mm Total Storm Rainfall		
	P10	P50	P90	P10	P50	P90	P10	P50	P90
London	0.9	1.2	1.5	1.6	2.0	2.1	3.0	2.1	2.4
Cardiff	1.0	1.2	1.3	1.8	1.5	1.7	1.6	1.8	2.1
Glasgow	1.3	1.4	1.7	3.5	3.0	2.2	1.9	1.9	2.0
Belfast	1.3	1.4	1.5	1.6	1.8	1.6	1.5	1.5	1.6
Average	**1.1**	**1.3**	**1.5**	**2.1**	**2.1**	**1.9**	**2.0**	**1.8**	**2.0**

Table 1 - Change in frequency of heavy rainfall events between 1961-90 and the 2080s. (UK CCRA 2012)

Social infrastructure	Total in London	Number at flood risk* (% of total)
Schools	3,049	441 (14%)
Hospitals	111	10 (9%)
Civil infrastructure		
Police stations	169	46 (27%)
Fire stations	111	20 (18%)
Ambulance stations	63	9 (19%)
Prisons	8	1 (12.5) - Belmarsh
Railway stations	324	49 (15%)
London Underground stations (including DLR)	291	75 (26%)
Bus depots	84	25 (29%)
Airports	2	1 (50%) – City Airport
*defined as Flood Zone 3 (> 0.5% per annum tidal flood risk or >1% per annum fluvial flood risk)		

Table 2 - Infrastructure in London at risk of tidal and river flooding (Greater London Authority, 2011)



Increase in minimum temperature in period 2041-2050 (UK CCRA 2012)

Areas of Shrink-Swell Clays in the UK (UK CCRA 2012)

Heat

The temperature at the centre of a large city can be several degrees higher at night than in the surrounding rural areas, which is known as the Urban Heat Island (UHI) effect. Several factors contribute to the development of this urban microclimate, including: greater absorption and storage of heat from the sun by the urban fabric during the day; surface water being drained away and therefore not available for evaporative cooling; and anthropogenic heat emissions, such as exhaust air from air-conditioning systems. The magnitude of the UHI effect is dependent upon the interplay of local conditions including land coverage, built form, wind patterns, cloud cover and relative humidity. In the case of London, the UHI effect on night-time temperatures can be up to 10°C. The Tyndall Centre's ARCADIA project suggests that:

- By the 2050s, one third of London's summer may exceed the Met Office current heat wave temperature threshold (Daytime temperature of 32°C and night-time temperature of 18°C).
- A threefold increase in anthropogenic heat emissions (e.g. from air conditioning) on top of climate change has a negligible impact on maximum daytime temperature, but would raise minimum night-time temperatures by about 0.5°C which would aggravate heat stress.

Overheating of commercial and other properties can arise due to a number of factors, but can be especially acute in modern highly insulated lightweight buildings and highly glazed buildings. The risk of overheating in buildings is likely to increase as outdoor temperatures increase. In London, the number of days per year when overheating could occur is projected to rise from 18 days to between 22 and 51 days by the 2020s (central estimate is 33 days).

London's climate change adaptation strategy aims to tackle overheating in the urban realm through four interrelated aims:

1. Limiting the intensification of hot weather by London's UHI (discussed further in the Natural Environment section).
2. Designing new, and adapting existing buildings and infrastructure to minimise the need for cooling as far as possible.
3. Ensuring that where cooling is still required, that low-carbon, energy-efficient methods are used
4. Enhancing the emergency response to heatwaves.

Energy Demand

The CCRA has found that the estimated number of days above the temperature threshold where cooling is required is projected to rise significantly, particularly in the South East and London, and especially in towards the end of the century. While currently residential properties do not contribute significantly to cooling demand, they may do so in future as we see hotter summers and more frequent heatwave events. However, other factors such as household income and future housing design are also expected to play a large part in the uptake of domestic air conditioning. Cooling demand from commercial properties is expected to continue to rise.

As well as contributing to the Urban Heat Island effect, the expected increase in use of air conditioning will have an impact on our summer energy use. The CCRA reports[1] that under a high climate scenario cooling energy demand is projected to rise from approximately 1.6TWh (Terrawatt-hours) in 2004 to 2.5TWh by 2030 in London, and under a low climate scenario it is projected to rise from approximately 1.6TWh to 2.2TWh, mostly driven by office cooling. (A terawatt hour is a million million Watt hours – equivalent to leaving on a small hairdryer in every home in Britain, continuously, for 1.6 days).[2] Using the current DECC guidance value of 6.8 pence/kWh, [3] this equates to additional annual costs of £40–60 million/year. London currently represents around 11 per cent of total UK cooling demand.

However, a positive aspect is that warmer winters are projected to reduce our winter energy demands across the UK. Heating degree days (HDD) are projected to decrease in step with changes in winter temperature with immediate impacts in the short term. The south of England, including London, will receive the greatest benefit from this effect. In the long term (2080s) HDD in southern England are projected to be 50 per cent lower than the 1961–90 period, compared to 30 per cent lower in Scotland.

Transport

Heat stress and thermal comfort are likely to become increasingly important issues as our climate changes, particularly during times of heatwave. For much of the transport infrastructure, the impact on passengers is expected to be minimal because air conditioning units are already becoming standard across modes. However, one notable exception is the London Underground system. Even in our present climate the Underground network can be uncomfortably hot in the summer, and during hot weather some sections of the network can reach temperatures that may affect the wellbeing of vulnerable passengers.

As most of the London Underground was built before air-conditioning was invented, and the tunnels were designed with just enough room for the trains, cooling the London Underground network is a highly complex engineering problem. In addition, London Underground is preparing to meet the rising demand by increasing passenger transport capacity on the network by 300,000 passengers a day by 2016, with longer and more frequent trains. Together these will increase temperatures in the network. London Underground has a cooling strategy for the network in place, which involves a mix of measures. A programme of retrofitting existing buses with white painted roofs and automatic ventilation system is also underway to keep passengers cool.

The likelihood of delays arising from rail buckling is projected to increase somewhat, with the largest increase in numbers in London and the North West of England. Allthough this is only predicted to be a low magnitude impact up until the 2080s, of all of the impacts considered in the transport sector, rail buckling is one area where there are limited options available to users in an event to minimise delay.

Subsidence

In the UK, large numbers of properties are at risk of subsidence. In 2009 there were about 30,000 notified domestic subsidence claims, with a total value of £175m.

In particular, clay soils with high shrink-swell potential underlie much of the densely populated areas of London and the South East of England. Changes to the present shrink-swell pattern may occur due to higher temperatures and changes in rainfall patterns. This may also have a knock on effect on water supply leakage due to damage to pipes, exacerbating water shortage issues (see Natural Environment section). However, the range in the projections is wide, reflecting the uncertainty in the projected changes in summer rainfall.

1 - Citing Day et al, 2009.

2 - DECC, 2011.

3 - 2010 commercial costs, expressed in 2009 prices.

Natural Environment

Whilst containing a densely populated urban area, London enjoys a remarkable amount of space for nature with two-thirds of its area occupied by green spaces or water. Of this about a third is made up of private gardens, a third parks or sports grounds and the remaining third a variety of habitats, including grassland, woodland and rivers.

As discussed in the Built Environment section, London is more vulnerable to heat than its surrounding areas due to the Urban Heat Island effect. There is evidence that green space reduces the urban heat island impacts as evaporation and transpiration from plants, and their shading effects, can cool the atmosphere. In London, monitoring of the urban heat island suggests that large parkland areas are typically 1˚C cooler than surrounding built up areas. This issue is already being tackled through the Mayor's plans to enhance 1,000ha of green space in London by 2012, and to increase green cover in central London by five per cent by 2030 and a further five per cent by 2050.

City	Rainfall (mm/year)
London	**590**
Jerusalem	597
Istanbul	629
Mexico City	662
Edinburgh	664
Thames Region	**690**
Newcastle	700
Dublin	740
Rome	791
Manchester	809
England and Wales	**897**
Sydney	1226

Table 3 - City rainfall data compiled by Waterwise from relevant country MET office websites.

Biodiversity

Climate change in London could affect biodiversity in two distinct ways: direct effects, such as changes in species composition due to higher temperatures; and 'knock-on' effects resulting from climate change adaptation actions. These changes are likely to include:

- Lack of water to irrigate sites of nature conservation importance and other green spaces.
- Change in species composition due to more frequent drought conditions and higher temperatures.
- Increased pressures on biodiversity from people using open spaces for recreation in hot weather.
- Increase in the area of natural or vegetated surfaces in the urban environment due to climate change adaptation actions, which will provide with considerable flexibility to deliver biodiverse 'greenery'.
- Increased pollution of watercourses due to flooding of sewers and Combined Sewerage Overflow spills during intense rainfall events.
- Increased pollution of watercourses from wastewater discharges due to low river flows.
- Change in habitats due to managed retreat and restoration of functional floodplains.
- Increase in algal blooms, some of which may be harmful to either biodiversity or humans if the food chain is affected.
- Colonisation by new species from southern England and continental Europe. However, London's habitats are highly fragmented; it may be the case that otherwise suitable habitats cannot be colonised by new species because they are not able to disperse to or through London.

Water Supply

London is already in an area of Serious Water Stress. The large population in the South East of England combined with the relatively low level of rainfall means that the amount of water available per person is strikingly low in comparison to many hotter, drier countries.

And while supply is short, demand is also disproportionately high. Londoners now consume an average of 167 litres per day, compared to the national average of less than 150 litres per person per day. This increased consumption is primarily linked to affluence (more water consuming devices per home) and lower occupancy rates (smaller household units, such as flats, each with water consuming devices). An additional factor is that only one in four households in London has a water meter, and thus the majority have no incentive to save water and no opportunity to save money on their water bills.

Another reason for London's increasing shortage of water is that nearly 600 million litres a day, a quarter of all the water distributed to London customers, is lost in leakage. This is the equivalent to an additional person's demand in every home in London. This is because: much of London's mains water network dates back to the Victorian era; subsidence and heave cause the pipes and joints to break (the climate change projections for this are discussed further in the Built Environment section); and London clay is particularly corrosive and weakens the pipes.

Climate change is expected to affect water availability by:

- Reducing river flows.
- Reducing groundwater replenishment ('recharge')
- Increasing evaporation.
- Increasing loss from broken water mains due to increasing subsidence.
- Increasing demand for water from people and wildlife.

In the long term (2080s), estimates of the supply-demand deficit are very large (several times the total supply of the UK's largest water company), indicating that major demand and supply-side measures could be required to maintain supplies in London at today's level of risk.

The Mayor has developed a Water Strategy to tackle the issues that London faces with managing water. One of the measures already being implemented to help Londoners save water is a city-wide programme called RE:NEW. The Greater London Authority is working with the Boroughs, London Councils and the Energy Saving Trust to improve the water and energy efficiency of Londoners' homes with a free package of measures, such as loft insulation and aerator showerheads, being installed into people's homes.

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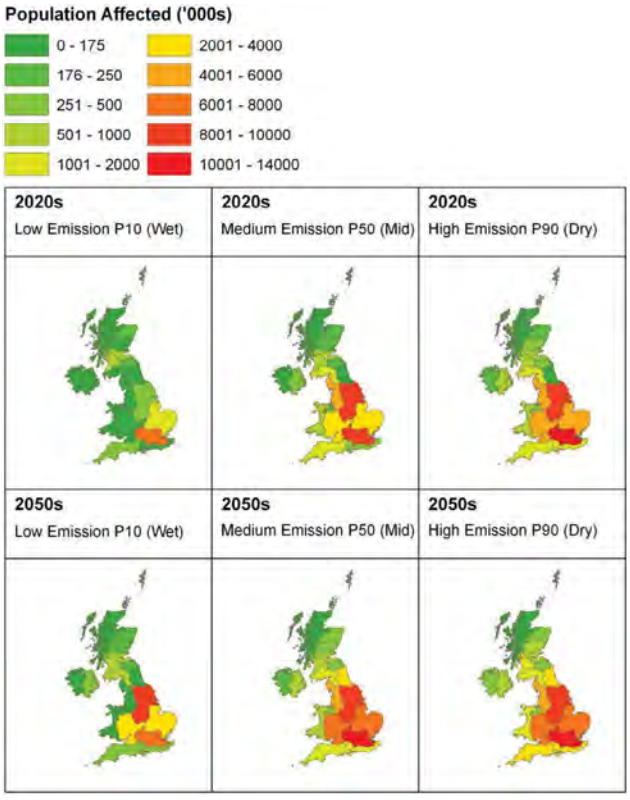

Population affected by a supply-demand deficit due to climate change (UK CCRA 2012)

Agriculture and Forestry

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Climate change impacts, both positive due to warmer weather and negative due to drought and flood, are likely to have only small impacts on agriculture within London itself, mainly due to the fact that there is relatively little land in London used for commercial food production. More noticeably for Londoners, prolonged climate change impacts felt outside London (in the UK and internationally) could have an impact on the price of food consumed in London.

There is potential for community urban growing projects in London to be affected adversely by extreme weather, but a warmer climate may also provide opportunities for them to grow new crops.

The main impacts in the case of flooding are likely to be disruption to the logistics of transporting and distributing food in the capital. London's supply chains operate in a highly complex way, which means that they are vulnerable to interruption.

Climate change is recognised as a serious threat to the presence of trees in urban areas in London. In particular, drought may influence the health, growth and productivity of London's tree stock. This can ultimately cause tree mortality, often when in combination with other stresses such as pests and pathogens, which may also increase.

More frequent summer droughts may reduce the success rate of newly planted trees and put mature trees under stress, potentially shortening the lifespan of many of London's mature street trees. This may have an adverse impact on the cooling effect of urban tree-planting programmes if drought resistant types are not used.

The changing climate could mean that London's green space becomes suitable for different tree species. The Mayor of London produced the Right Trees in a Changing Climate tool, which was designed to aid decision-making in planting regimes by incorporating projected climate change. This tool is currently being transferred to the Forestry Commission's Forest Research website, where users will be able to find it from early 2012.

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Trees in the right place, like other vegetation, intercept rainwater and reduce the rate and scale of eventual run-off. As a consequence, this reduces the risk of localised storm water flooding. The sponginess of leaf litter beneath broadleaved woodland can also improve water retention and infiltration.

The role of trees in soil shrinkage and subsidence, and the adequacy or otherwise of building foundations, needs to be further understood and addressed, particularly given the shrinkable nature of London Clay soils (which is discussed further in the Built Environment and Infrastructure section).

The CCRA reports that risk of wildfire is also expected to increase due to hotter, drier summers, particularly towards the end of the century, and especially in the south of the UK.

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Health and Well-being

The impact of climate change on health can be looked at under three headings:

1. Direct impacts on health and health inequalities (positive and negative)
2. Indirect impacts on health, affecting the wider determinants of health (positive and negative) and health inequalities
3. Direct effects on the delivery of health and social care services (including those people working within the health and social care sector, and also the buildings and infrastructure required to deliver these services).

This report selects some examples from the first category of impacts for London. For a more detailed look at how climate change is expected to impact on the health of Londoners, you can refer to the London Climate Change Partnership's report London's Changing Climate: In Sickness and in Health and the health section of the Mayor's Climate Change Adaptation Strategy.

Climate change will have both positive and negative effects on the health of Londoners. However, these impacts will not be distributed evenly, and are likely to increase existing inequalities. In Table 1, some of the known health effects of weather are set out, which are expected to be affected by climate change. [1]

Heat-related mortality currently accounts for around 1,100 premature deaths (or deaths brought forward) per year in the UK, with London, followed by the South East, being the area worst affected. In our future climate (without taking adaptation into account), heat-related mortality and morbidity may increase more in large urban areas. This is partly as a result of the urban heat island effect.

Heat is also estimated to cause over 100,000 patient-days in hospital per year. However, these figures can increase noticeably for exceptionally hot years such as was experienced in 2003 and 2006, which may be the norm by the 2050s.

Premature deaths in London and the South East accounted for approximately one third of the total number of premature deaths caused by heat in all of the scenarios that were considered by the CCRA. The differences are partially related to higher densities

Health Outcome	Known Effects of Weather/Climate
Heat stress, cold stress	Deaths from heart- and lung-related diseases increase with hotter and colder temperatures. Heat-related illnesses (heat cramps, heat exhaustion and heat stroke) and death increase during heatwaves.
Air pollution related morbidity and mortality	Weather affects air pollution concentrations. Weather affects the distribution, seasonality and production of air-transported allergens.
Morbidity and mortality resulting from weather disasters	Floods and windstorms cause direct effects (deaths and injuries), infectious diseases, long-term mental health problems, and indirect effects (temporary limitations on access to health and social care services).
Vector-borne diseases	Higher temperatures shorten the development time of pathogens in vectors and increase the potential transmission to humans.
Water- and food-borne diseases	Risk of bacterial pathogens increases with rising temperature. Increases in drought conditions may affect water availability and water quality due to extreme low flows. Extreme rainfall can affect transport of disease organisms into water supply.
Cataracts, skin cancers and sunburn	More cloud-free days and higher temperatures may encourage potential risk of over-exposure to UV radiation.

Table 4 - Health effects of weather/climate 2011 (LCCP/GLA)

of population in the south, although the main difference relates to generally higher temperatures in the more southern regions. Relative to population size, the mortality rate for London is approximately twice that of the North East.

The London Climate Change Partnership has been working to tackle these issues through engaging with London's health and social care sector on the issue of adaptation, and the Mayor is implementing a strategy to cool the city through urban greening (discussed further in the Natural Environment section). Retrofitting of existing buildings and heat-sensitive design of new buildings will also be an important element in tackling the health impacts of rising temperatures in London.

A positive aspect of climate change is that warmer winters are expected to cause reductions in cold-related mortality and morbidity. These reductions are projected to be greatest in the South West and South East of England, followed by London.

Air Quality

Climate change may reduce winter air pollution levels but may increase summer air pollution. Wetter winters will 'wash' the pollutants from the atmosphere. Higher summer temperatures, less rainfall and less cloud cover are projected to increase the formation of ground level ozone, and periods of little or no wind usually associated with heatwaves may mean that pollution in the city – including particulate matter which is particularly harmful to health – will be less easily dispersed.

Higher concentrations of ground-level ozone are produced during summer photochemical smog episodes, which are caused by the interaction of oxides of nitrogen (NOx) and volatile organic compounds in the presence of sunlight. These can have detrimental effects on human health, leading to an increase in hospital admissions and premature deaths.

London has lower ground-level ozone concentrations and related health impacts compared to its surrounding regions. This is because rural and suburban areas usually experience higher concentrations of ozone than city centres. But despite lower levels of ozone in London, a report by the Greater London Authority estimated that in 2008, around 4,300 deaths in London were partly attributable to exposure to air pollution from other sources, an effect which is exacerbated by heat. In December 2010, the Mayor published an Air Quality Strategy to cut emissions from London's transport network, homes and workplaces. These measures will significantly improve air quality in London.

The CCRA reports that annual mean ozone concentrations in central London are expected to more than double within the 2000-2050 period, mainly due to reductions in projected NOx emissions. It is unclear what net effect this is likely to have on mortality and morbidity.

UV exposure

The CCRA reports that there is evidence that an increase in UVB radiation flux associated with climate change, and potentially the incidence of skin cancers, may be largest in southern England, with an increase in melanoma of up to 20 per cent possible by the 2080s.

But despite solar UVB exposure associated with climate change being linked to melanoma skin cancer incidence and mortality, the relationship between future incidence of skin cancer and environmental conditions is an extremely complex issue. Changes in social behaviour, and changes in the stratospheric ozone layer, are also determinants of the level of risk.

Flooding

London's increase in flood risk will also have health impacts. The long-lasting health impacts of flooding, including psychological stress, are well-documented and can be very severe, especially when those affected are displaced from their homes for long periods of time. [2] For people living in areas of high flood risk, there are also likely to be social and economic impacts, which can negatively affect the wider determinants of health.

1 - London Climate Change Partnership, 2010 and London Climate Change Adaptation Strategy, 2011.

2 - London Climate Change Partnership, 2010.

Business

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The main threats to business activity within London are likely to be flooding and heat. Water shortage may also affect the running of businesses reliant on making industrial water abstractions or discharges. Extreme weather is likely to cause disruption to supply chains, staff availability, increased damage to commercial property and business continuity. As well as these local impacts, London's businesses are also likely to be affected by global extreme weather events because it is a global centre for the financial sector. This provides opportunities as well as challenges for businesses.

Loss of Productivity

As indicated in the figure on p17, London's businesses are likely to be particularly impacted by loss of productivity due to overheating. London's businesses are also expected to face the greatest increase in energy costs for cooling as they try to counteract this trend (as discussed in the Built Environment section).

1 - London and Partners, Key Visitor Statistics, 2010.

2 - Hamilton and Tol, 2007.

Flooding Impact on Mortgage Market

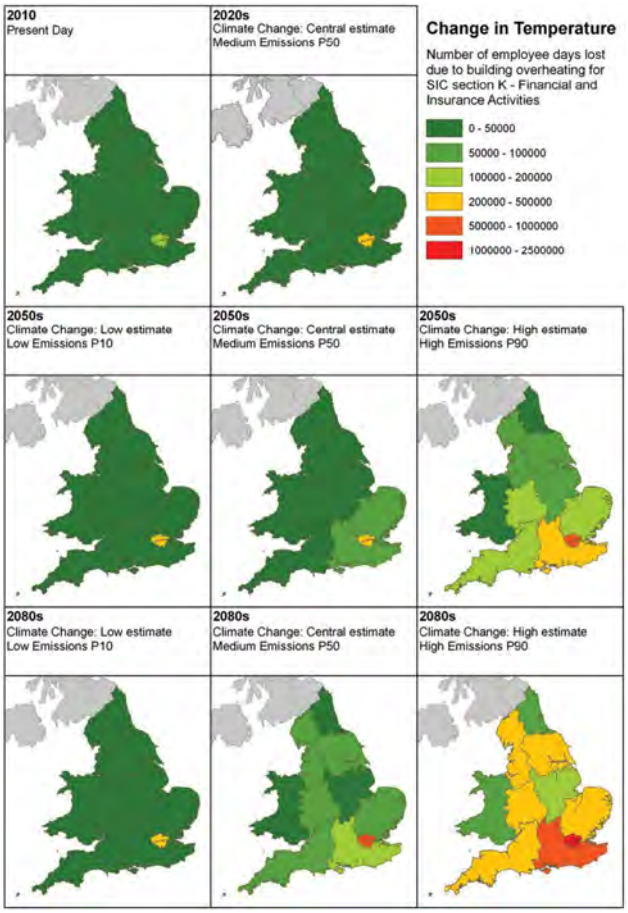
Climate change is expected to cause an increase in likelihood of flooding to properties throughout the UK from all sources. As the probability of flooding increases, insurance for properties that flood relatively frequently may be increasingly difficult or expensive to obtain.

If mortgage holders were unable to renew their buildings insurance due to an increase in flood risk, it would leave both lender and borrower exposed to an increased risk of loss and potential invalidation of the mortgage. Whether affordable flooding cover can be retained as a standard aspect of buildings insurance is, therefore, extremely important to the working of the mortgage market and the wider housing market.

The Community Resilience to Extreme Weather (CREW) project has also projected that an increase in flood risk due to climate change could have a negative impact on property prices. This may mean an increase in the incidence of people in negative equity in areas that have been badly flooded.

Tourism

London is a world tourism destination, which sees 26 million visitors annually, worth £11.2 billion to its economy [1] (London & Partners, 2010). The CCRA cites modelling[2] which projects that increasing temperatures may cause a shift in the regional distribution of tourists (from both the UK and internationally) under future climate change projections. By 2080, the general pattern for both domestic and international tourists is that the south of England will have a reduced market share, whilst Scotland, the north of England and Wales will have an increased market share. In the high scenario, the drop in market share is disproportionately high for London, compared to other UK regions. In absolute terms, however, all regions are expected have increasing numbers of tourists during the 21st century.



Regional Variation of the lost productivity due to overheating (UK CCRA 2012)

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