LONDON climate change PARTNERSHIP

London's Commercial Building Stock and Climate Change Adaptation

Design, Finance and Legal Implications

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London Climate Change Partnership

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Any recommendations in this report reflect the views of the London Climate Change Partnership developed during the course of this study, and do not necessary reflect the views of the individual members of the Partnership. This document is intended only as a general discussion of the issues. It is not considered to be legal advice.

Contents

Foreword

The financial services industry, amongst others represented in London, is a global one. The impacts of climate change around the world will therefore affect London's businesses, people and the UK economy at large. We can either be forward thinking and well prepared and turn climate change into an opportunity to lead, or we can wait for risk levels to change, probably in unexpected ways and just react. Our view is that we must be proactive. We are making good progress, but there is more to do.

The current financial crisis, which with the benefit of hindsight will be a short term phenomenon, must not distract us from dealing with the major long term trends currently facing society, including population growth, urbanisation, ageing populations and of course climate change.

Adaptation and Mitigation in parallel – Reducing carbon emissions (mitigation) is essential; but adaptation is also critical. Some climate change is now inevitable and unless urgent, concerted global action is taken to reduce greenhouse gas emissions, further changes to our climate may become unavoidable. This means that preparing for and adapting to the changes is not an alternative strategy to reducing greenhouse gas emissions, but a parallel, complementary and highly necessary one.

From the **UK Climate Projections (UKCP09)**, London and the rest of the UK will experience hotter drier summers, and warmer wetter winters. This will include increased risk of extreme events such as flooding, heatwaves and water scarcity. There will always be some uncertainty in climate projections, but that should not be an excuse to adopt a "wait and see" attitude. Far from it; it illustrates how our future planning must include flexibility and options.

Our aim is to identify the major challenges and opportunities that a changing climate brings to the **key sectors** within the **commercial property industry**.

The **Planning, Design and Development** of "adaptive capacity" (i.e. flexibility and options for future change) must be built into our building's structures and systems. It is essential that London's building designs consider projected climate changes over the lifetime of a building. Using the recently launched UKCP09 projections, it is of key importance to consider a range of scenarios taking into account the building, its location and intended use, future climate and uncertainty within a risk assessment process. Therefore planners, architects and engineers should incorporate flexibility to respond to new climate knowledge or actual extreme events.

It is encouraging that there are low cost quick wins like green roofs and louvres, which will provide relief in the short term, for London's new and existing building stock.

Within London's **Valuation and Finance** sectors, levels of adaptation and sustainability are now starting to influence rental and sales, capitalisation rates and occupier retention. Such issues are beginning to affect property values in

some cases but this is not yet mainstream. This practice may become significantly more common in future. A well adapted property may hold its value, while mal-adapted and unsustainable properties may be less likely to secure market value rates. We are now calling on all property market stakeholders to consider these issues and risks.

Resilience to climate change also has a **Legal** consideration. Legislation relating to property is likely to increasingly focus on adaptation. Legal duties that are now allocated to public bodies such as local government, and statutory undertakers, will shift across to other sectors and stakeholders. Legal advisors cautioned that what is currently "guidance" or "soft law" can rapidly become formalised and this imposes a need to continually monitor developments.

We must seek opportunities to adapt through all commercial property audiences. For example, after an insurance claim, there is an opportunity for properties to be rebuilt sustainably with climate change adaptation in mind, though not beyond the finances allowed for in the premium rates. A more significant opportunity to adapt existing properties arises after a major event such as a windstorm or flood.

This has been recognised by the insurance industry. Leading insurers have pledged to "increase the proportion of repairs that are carried out in a sustainable way" through their membership in the ClimateWise initiative and the Association of British Insurers has been engaged in a range of activities to promote resilient repairs.

This document is intended to highlight the need for adaptation, to illustrate the business opportunities and encourage proactive dialogue and action within London's commercial property sectors. No single authority or organisation has direct control over the action necessary to prepare London or the financial sector for climate change. Partnership working will continue to be essential.

The principals raised in this document, also apply to financial sectors in other locations in the UK and abroad.

Adaptation to climate change should become embedded within decision making including: design, development, investment, operations and behaviours.

Gerry Acher
Chair, London Climate Change Partnership

Executive summary

The London Climate Change Partnership held a stakeholder event in April 2009 at City Hall, Greater London Authority, outlining the potential cost, value and legal implications of not adapting to climate change impacts, for London's commercial building stock.

Experts in all elements of the commercial building sector provided evidence and guidance on how London's future climate is likely to impact or benefit our commercial buildings and the organisations owning, designing, developing, valuing.

Case study evidence was given in sequence from the design and development, valuation, investment, insurance and legal liability. Each presenter highlighted the potential cost, value and legal benefits from improving the sustainability and adaptation to climate change impacts, for each stage in the commercial property sector.

The event was the first ever public analysis illustrating how each sector and organisation type can play a key role in improving London's business and asset resilience to inevitable climate change impacts. The Key Messages to London's commercial property sector are:

London's Future Climate

- London will experience hotter drier summers, and warmer wetter winters – with increased risk of extreme events such as surface water flooding from intense rainfall, and summer heatwaves.

Planning, Design and Development

- **Adaptation at the core of buildings and business:** Climate change adaptation is a key part of the sustainability agenda, and should be a fundamental consideration in the design and refurbishment of buildings and in business continuity planning.

- **Adaptive capacity:** Incorporate 'adaptive capacity' into building systems, facades and services, so that they have the ability to cope with the effects of current and projected changes in weather and climate over the buildings lifetime.

- **Mixed mode ventilation and cooling:** A mixed mode ventilation strategy is key. This enables low energy, low carbon, natural ventilation whenever possible, with the ability to switch to mechanical cooling when external temperatures are too high for natural ventilation systems to work effectively.

- **Refurbishment opportunities:** Consider low cost quick wins such as green roofs and louvres for existing buildings in the short term. Consider more strategic interventions such as changes to mixed mode ventilation and cooling systems and well insulated facades if major refurbishment or a move to new premises is planned.

- **Adaptation and mitigation in parallel:** Improvements made in water and energy efficiency will have a direct financial benefit to the business through reductions in both water and energy bills, plus the ability to report the associated carbon emission reduction from water heating savings – highlighting a dual benefit of tackling adaptation and mitigation agendas in parallel.

Valuation and Finance

- **Include adaptation in finance decision making** – there is a growing responsibility on all involved in the decision making process with regard to the charging of a property as security for a loan to ensure that reasonable and appropriate account is taken of climate risks. The definition of Market Value is clear, but so too are the responsibilities of valuers to reflect on such risks and, if not appropriate by way of a quantitative adjustment (ie. because the Market itself is not acting in such a way), to provide some form of qualitative comment. This should serve to improve the robustness of valuation advice and the manner in which it is used.

- **Consider adaptation in market value assessment** – It is equally important for the users of valuations to understand what Market Value represents. It is simply a reflection of the Market's sentiment at the time. Important decisions regarding financial instruments that will be in place over the medium to long term should not be taken based solely upon a measure of value that arguably has a limited shelf-life. Practices must evolve to take account of risks (climate-based or otherwise) that are conveyed and expressed qualitatively, alongside the purely financial measures.

- **Incorporate adaptation in post insurance rebuild** – Explore and take on opportunities to adapt through all possible mechanisms. For example, following an insurance claim, properties and assessors should seek opportunities to rebuild with climate change adaptation in mind (ie. increased flood resilience), though not beyond the finances allowed for in the premium rates. Policymakers should consider mandating resilient rebuilding to level the playing field for insurers and to encourage a more rapid and material outcome. A significant opportunity to adapt existing properties arises after a major event such as a windstorm or flood but this is likely to be missed without appropriate regulations.

- **Ensure adaptation is considered with legal and economic value** – It is important to realise that some policies cover legal defence costs, regardless of the outcome of the case; so insurers may face costs even if ultimately the case is defended successfully. Accordingly, clarity within Banks' commissioning letters may be one way out of this potential future litigation; but inclusion of a full climate discussion, even if not included in the final valuation, is also a sensible action from valuers. It is to be hoped that such forethought would encourage adaptation; the sooner this is seen to have an economic value, the more likely the decision to adapt will be made.

- **Consider and embed adaptation early** – Legal recourse is of course a measure of last resort – and rarely does it lead to a truly satisfactory conclusion. Should redress be sought from an advisor, they in turn will most probably seek recourse to their Errors & Omissions or Professional Indemnity insurer to cover their costs.

Legal

- **Adaptation has increasing relevance in commercial property law** – Climate change legislation in respect of commercial buildings is likely to focus more and more on adaptation issues. Legal duties imposed on local government and voluntary reports and initiatives in relation to adaptation are likely to be "pushed down" and entrenched. Guidance can rapidly become formalised and climate change legislation is likely to be increasingly "multi-tasking" and innovative. Companies are likely to become progressively more concerned with occupying well adapted buildings.

- **Embed adaptation in property sector contracts** – As climate change impacts become more apparent, in all aspects of building design, build, ownership and occupation, there will be amplified focus on where liability lies regarding failure to adapt or dealing with the resulting damage to buildings. As the financial consequences of such liability begin to be appreciated, we are likely to see increasing focus in contracts for the design, building and occupation of buildings on the need for adaptation.

1. London's Climate Change Projections

Some climate change is now inevitable. This means preparing for changes to our climate is not an alternative strategy to reducing greenhouse gas emissions, but a parallel and complementary one.

The UK Climate Impacts Programme (UKCIP) have reported that the UK is getting warmer by 0.4 – 0.9ºC since 1914, meaning 9 of the 12 warmest years since 1659 have occurred since 1990[1]. A separate analysis of London's climate record states that summer temperatures in London have risen at an average rate of 0.73ºC per decade over the last thirty years[2].

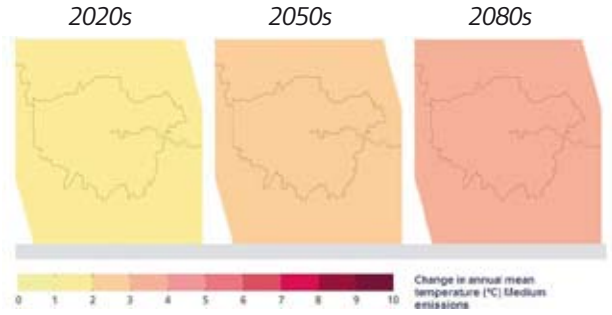
In June 2009, the government published the latest generation of climate projections, known as the UK Climate Projections 2009 (UKCP09). These projections update the UKCIP02 scenarios and represent the best climate projections in the world. The projections are available online[3].

UKCP09 represents the latest generation of climate projections, but cannot represent every potential climate outcome. We therefore advise that decision makers understand their vulnerability first and then apply the widest range of projections to understand their climate risks. By taking this approach, and understanding how UKCP09 can and should not be used, decision makers will be able to easily use improvements in climate modelling. However it is essential that decision makers assess all climate scenarios against current and future vulnerabilities.

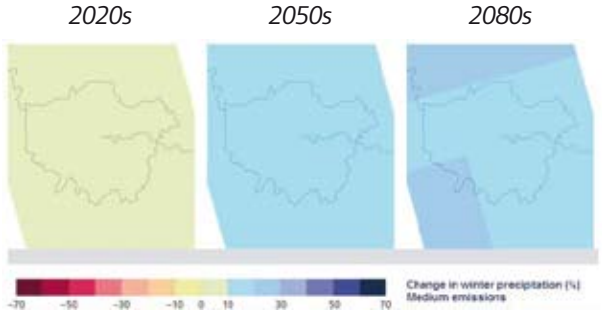
The table below summarises the UKCP09 projections for London, showing the changes to the key atmospheric variables for the middle of the century (2050s) under the medium emissions scenario compared to the 1961-1990 baseline period.

Temperatures	• Summers will be warmer, with the average summer day being 2.7°C warmer and very hot days 5.2°C warmer than the baseline. By the end of the century the hottest day of the year could increase by up to 10°C. • Winters will be warmer, with the average winter day being 2.2°C warmer and a very warm winter day 3.5°C above the baseline.
Rainfall	• Greater changes in seasonal rainfall. • Summers will be drier, with the average summer 18% drier and the driest summer 39% drier than the baseline. • Winters will be wetter, with the average winter 15% wetter and the wettest winter 33% wetter than the baseline.
Tidal surges (until end of the century)	• Tidal surges are not projected to increase in frequency, though the height of a one-in-fifty year tidal surge is projected to increase by up to 70cms by the end of the century.
Sea level rise (until end of the century)	• Sea levels are projected to rise between 96cms and 2 metres by the end of the century. *(These latest projections take account of ice-sheet modelling published after the IPCC Fourth Assessment report).*

Overheating Risk:
Change in London annual mean temperature (°C)
Medium emissions scenario (50% probability)



Flood Risk:
Change in London winter precipitation (%)
Medium emissions scenario (50% probability)[4]



London's Flood Risk

London is prone to flooding from five sources of floodwater:

- from the sea (tidal flooding)
- from the Thames and tributaries to the Thames (fluvial flooding)
- from heavy rainfall overcoming the drainage system (surface water flooding)
- from the sewers (sewer flooding)
- from rising groundwater (groundwater flooding).

It is possible for flooding from a combination of these flood sources to occur simultaneously.

Although nearly 15 percent of London lies on the former flood plains of the Thames and its tributaries, London currently has some of the highest standards of tidal flood defence in the world.

The Thames Tidal Defences, including the Thames Barrier, protect London and the Thames estuary from tidal surges and upstream flows from heavy rainfall by closing the barrier to provide additional space to protect London. They were designed to provide protection against a tidal surge that might statistically occur only once in every 2,000 years. The TE2100 project identified that the current defences provide a higher standard of protection than expected and that based on current projections, no major changes to London's tidal flood defences are required within the next 20 years and it is extremely unlikely that a new Thames Barrier would be required before 2070.

London's large areas of urban impermeable surfaces (roofs, pavements and roads) mean that the city relies upon storm drains to conduct rainwater away to prevent flooding. This means that London is highly vulnerable to surface water flooding (flash flooding), which is more difficult to map and protect against than tidal or fluvial flooding. Surface water flooding usually results from the drainage network being overwhelmed by heavy rainfall. This is because the storms that are usually responsible for heavy rainfall (for example, summer convective storms) tend to be very localised and extremely unpredictable, combined with London's drainage system, which is designed for high frequency, but low volume rainfall quantities.

Summary of London's Flood Risk

TIDAL flooding is the highest consequence, but lowest probability climate risk for London. London is (currently) well defended, but this standard of defence is decreasing with climate change – sea level rise, increased fluvial flows.

FLUVIAL flooding is a significant risk. 100,000 homes have low standards of protection, with little warning time and few management options. Currently, the risk analysis is patchy and un-coordinated and few funds are committed to managing the increasing risk.

SURFACE water flooding is not well understood. The risk has not been mapped, is less predictable than tidal, or fluvial flood risk, but could be the biggest flood risk to London's property.

London's Future Flood Risk

Flood risk in London is already significant because of the extensive population and assets located on the floodplain. Flood risk will increase due to climate change, but also due to further development in areas of flood risk, ageing flood defence infrastructure, the fact that much of the infrastructure was designed to meet lower flood standards, a low level of public flood risk awareness and their capacity to respond to a flood.

Increases in rainfall events due to projected climate change could raise peak river flows in the Thames by up to 40% by the end of the century. Ensuring that new development and refurbishment incorporates either set back defences or effective sustainable drainage systems will be vital in order to reduce or maintain future flood risk.

For the non-tidal Thames, more emphasis needs to be given to development control and land-use planning, as well as emergency planning and flood warning to help reduce the consequences of flooding.

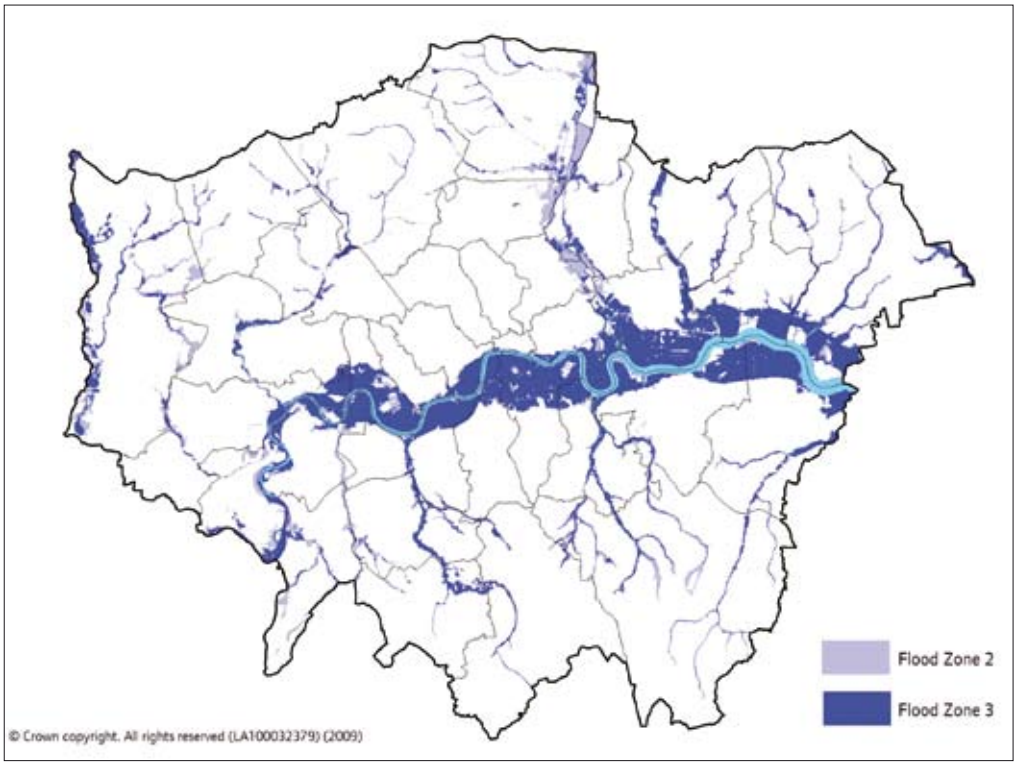


Figure 1 shows the areas susceptible to surface water flooding in London from a 1 in 50 year rainfall event[5]. As most drainage networks are designed for a maximum intensity of 1 in 30 year rainfall event, it is assumed that the drainage network has stopped performing and that rainwater is running to and collecting in low-lying areas.

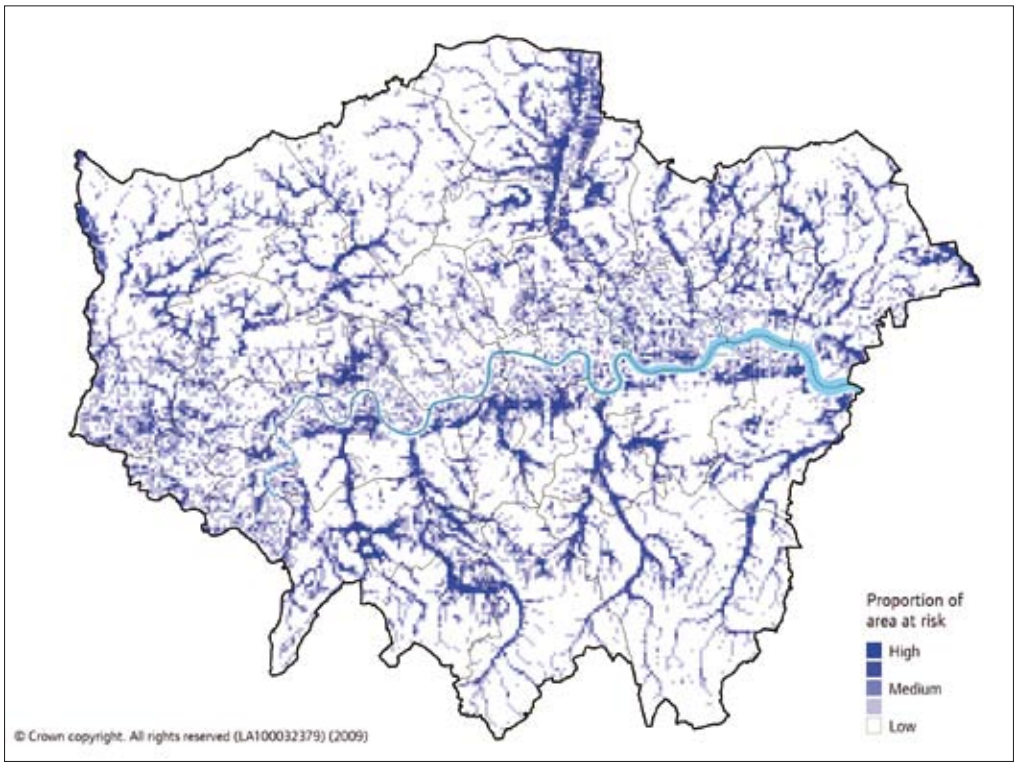


Figure 2 shows indicative areas at risk of surface water flooding from a single 1 in 200 year rainfall event. The map is indicative only and represents the proportion of a land unit (in this case a nominal 200m by 200m grid) which is covered by any area susceptible to surface water flooding from a 1 in 200 year rainfall event[6].

(Environment Agency)

London's Overheating Risk

High temperatures impact on London's infrastructure - buckling railway lines, melting road surfaces, making travel and office work in the capital uncomfortable, increasing water usage and energy demand for cooling.

London's summers are still comparatively mild enough for significant health impacts, but the city does experience extremely hot weather events such as heatwaves. However an analysis of climate in London over the past century revealed that summers are getting progressively warmer and that the temperatures of the hottest day in each year are rising even more quickly[7]. Nights are also getting hotter at a rate above the average rate of warming.

London's changing climate has seen an increase in average summer temperatures by 0.77ºC per decade over the last 30 years, with peak daytime temperatures increasing the fastest, at 1.66ºC per decade[8], In addition to climate change, the urban heat island effect further increases the risk of internal overheating.

The August 2003 heatwave demonstrated how vulnerable London is to heat, with at least 600 heat related deaths recorded. The reasons for this vulnerability are thought to be a combination of large elderly population, poor air quality and high night time temperatures due to the urban heat island effect.

Some of the consequences of prolonged high temperatures are:

- an increase in demand for energy intensive cooling, such as air conditioning
- a rise in the demand for water, increasing the pressure on limited water resources
- damage to temperature sensitive infrastructure (electrical systems, transport networks)
- an increased risk of blackouts due to increased demand for energy for cooling.

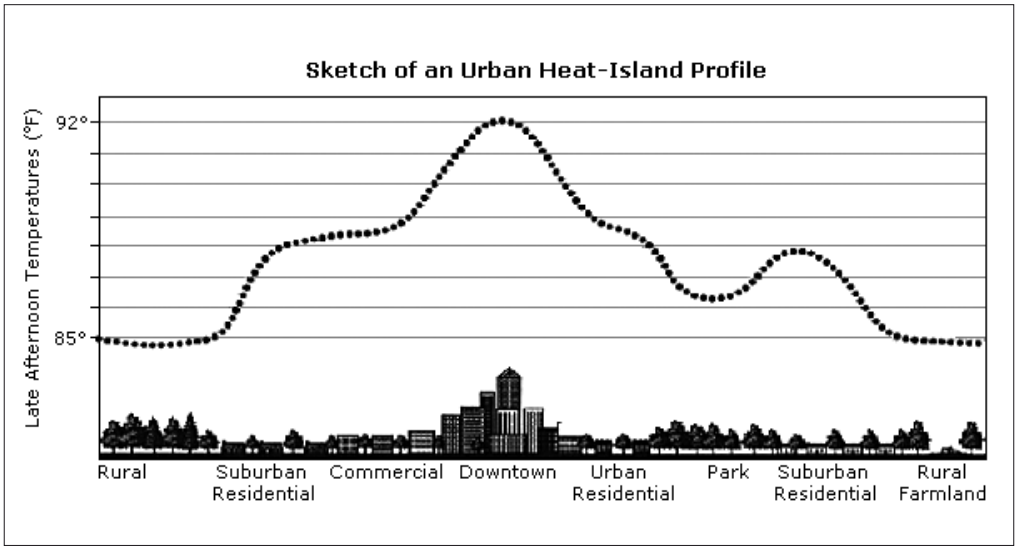


Figure 3. Typical temperature profile of an urban heat island.

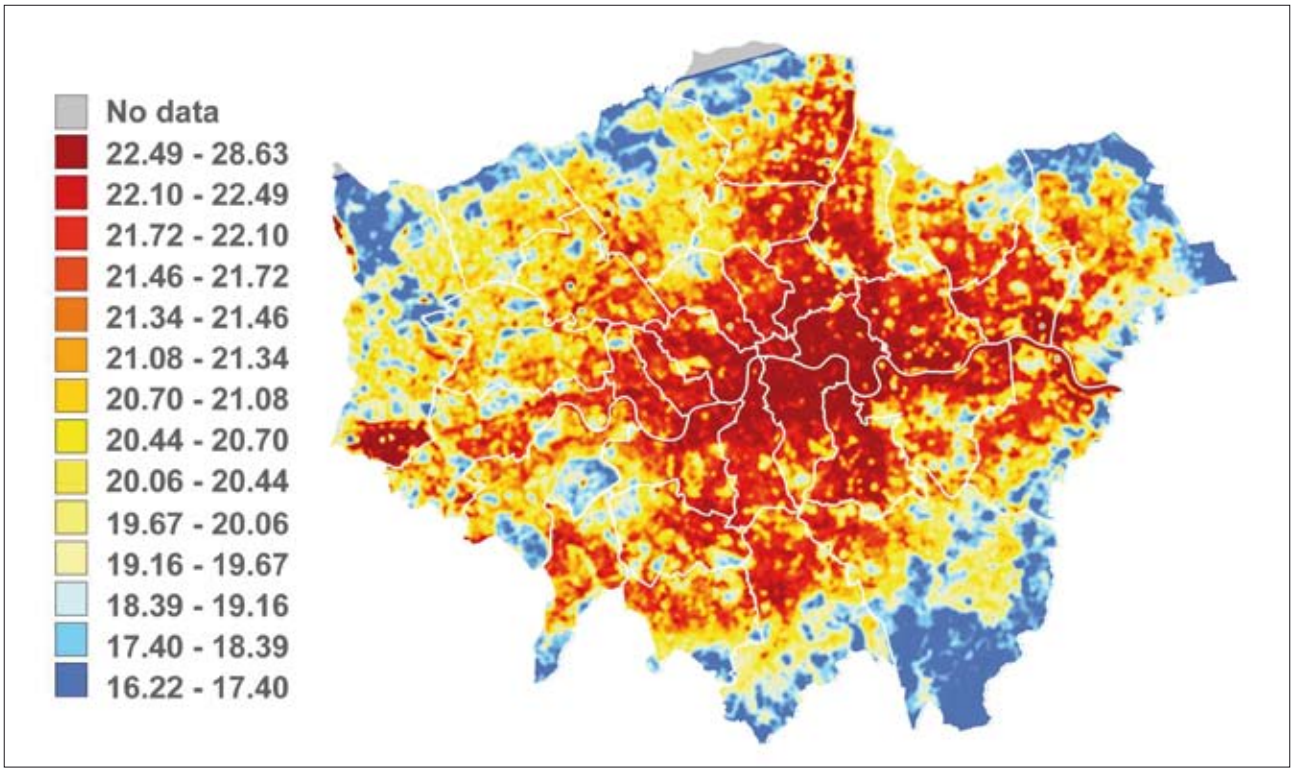


Figure 4. Surface temperature (°C) in London at 21.43 on 12 July 2006. *Source LUCID*[9]

The urban heat island

London suffers from an 'urban heat island' which describes the warmth of the surfaces and atmosphere that urban areas often experience in comparison to the surrounding rural areas.

Figure 3 shows the temperature profile of an urban heat island, highlighting how temperatures rise from the rural fringe towards the city centre. London was up to 10°C warmer than the surrounding greenbelt during the 2003 heatwave, highlighting the value of green infrastructure amongst London's built environment.

In some cities, the heat generated in the city by traffic, air conditioning systems and other energy uses adds to the heat being radiated from the buildings and roads, further raising temperatures. This 'anthropogenic' (man made) contribution to the urban heat island is likely to be minimal across the whole of London, but is significant in high-density areas in the centre of the city. If the use of air conditioning were to become widespread, the area affected by anthropogenic contribution would increase.

Figure 4 shows the surface temperature of London (°C) at a resolution of 90m on the night of 12th July 2006 as the heatwave was starting to build. It can be clearly seen that the surface temperature rise towards the centre of London, with surface temperature in the central London boroughs 5°C warmer than the suburbs.

London's Future Overheating Risk

London will experience an increasing risk of overheating due to:

- global warming-induced climate change
- the intensification of the Urban Heat Island (UHI) effect from:
  - climate change
  - increase in development density from London's growth
  - increase in man-made heat contributions as a response to higher temperatures (e.g. air conditioning) and London's growth
  - reduced evaporative cooling due to drier summers.

Over the next couple of decades, temperatures high enough to significantly affect health and business will be limited to extreme weather events, aggravated by the urban heat island effect. However, by mid-century, the increases in average summer temperatures will imply that most London summers will be the equivalent of 'heatwave' temperatures today, with new extreme high temperatures experienced.

The 2003 heatwave was 3.4°C above average summer temperatures. The UKCP09 projections show that by the 2050s (medium emissions scenario), average maximum summer temperatures will increase by 2.7°C, and a 10% probability of average temperatures exceeding 27°C (+6.5°C on top of baseline.). These projected increases are now almost unavoidable.

The climate models that produce the UKCP09 cannot model urban land cover and therefore assume a rural land cover for the whole of the UK. This means that urban feedbacks, such as the urban heat island effect are not represented in the model and therefore the models are likely to under-predict future urban temperatures.

Green spaces reduce the urban heat island by reflecting more of the incoming solar energy than urban materials, by absorbing energy through photosynthesis and providing cooling through evaporative transpiration.

London's Water Stress

Drought is caused by lack of sufficient rainfall. London already faces limited water resources and is currently vulnerable to drought. Dry periods can be short and sharp, as experienced in the hot summer of 2003 or prolonged, such as the two dry winters experienced in 2004-05 and 2005-06. In a dry year, Thames Water currently forecasts that its demand for water in its London resource zone (the red area in Figure 3.1) would be about 80 million litres per day greater than its available supply.[10]

In most years, there is sufficient water in the Thames, the River Lee and the aquifer to meet London's current demands, but sustained periods of low rainfall results in water being drawn from the reservoirs and to manage the remaining reserves, water companies can apply to government to initiate drought measures.

The probability of a drought affecting Londoners depends upon how much rain falls, how long periods of low rainfall last (particularly over winter), and how sensitive the supply-demand balance for the area in question is to drought.

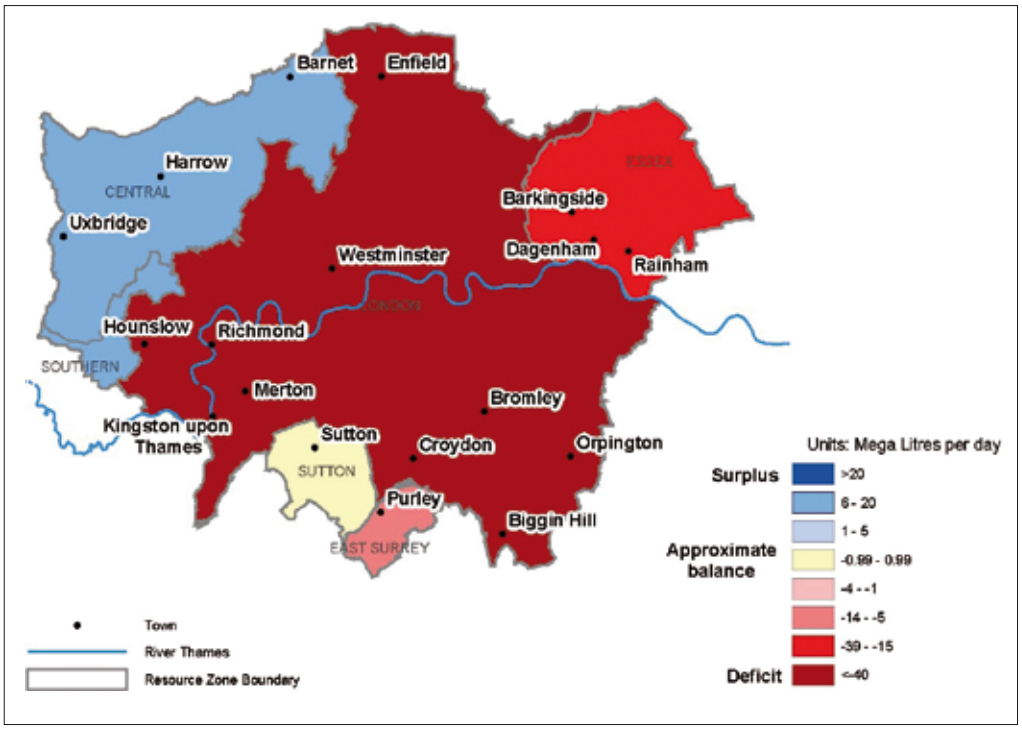


Figure 5. Estimated supply-demand balance (in a dry year) within Greater London for 2008/09.

Source: Environment Agency

Analysis suggests that peak demand in London in 2006 (a drought year) was nearly double that in 2007 (a comparatively cool and wet summer).[11] Non-domestic use accounts for 29 per cent of London's total water consumption, with the offices and other service buildings using around 337Ml/day.[12] This demand is projected to grow by 18 percent over the next 25 years.

All London offices are metered for water use, which provides a simple 'user pays' system for businesses and tenants. On-site water heating and use also contributes to the building's energy consumption and carbon emissions.

London's Future Water Stress

Climate change is expected to affect London's water availability by:

- reducing river flows
- reducing groundwater recharge
- increasing evaporation
- increasing risk from broken water mains due to increasing subsidence

Climate change is not projected to significantly alter the amount of rain that falls in a year, but it will affect when rain falls, and how heavily it falls. Summers will be drier, with the average summer 18% drier and the driest summer 39% drier than the baseline. London's winters will be wetter, with the average winter 15% wetter and the wettest winter 33% wetter than the baseline.

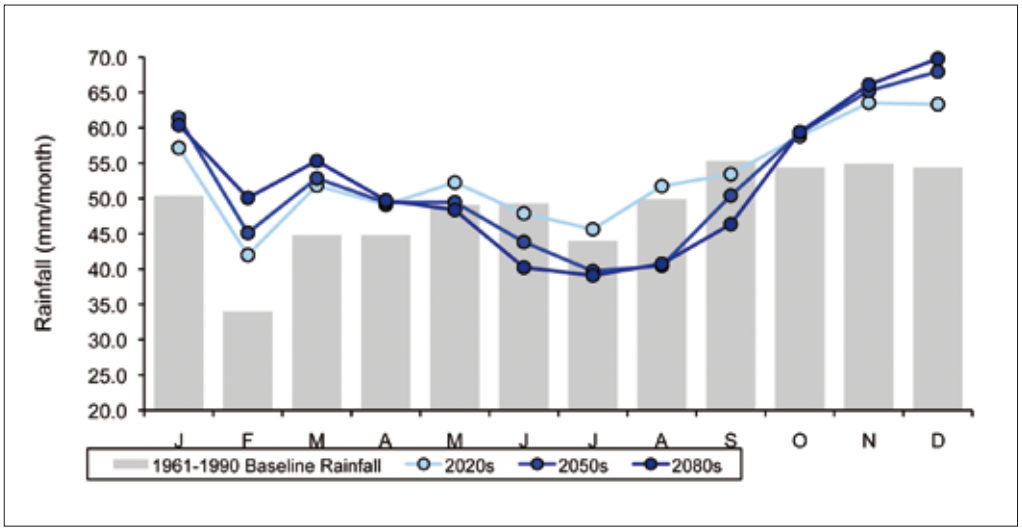


Figure 6. London's projected monthly rainfall for 2050s (2040-2069) for medium emission scenarios, against London's baseline rainfall records (1961-1990). Highlights the projected increase in London's winter rain and decrease in summer rain[13].

Drier summers will mean that rivers will receive a reduced contribution in the amount of rainfall that can prevent low flow rates. Heavier and more intense rainfall will mean that a greater proportion off the rain runs off the ground into water course, increasing flood risk and potentially altering the water available for long-term abstraction.

Much of London is built on clay which expands and shrinks according to its water content. Dry weather causes clay to shrink and land levels to fall, whereas wet clay expands and rises. More seasonal rainfall and hotter summers will cause soil moisture levels to fluctuate more dramatically, increasing the amount of subsidence and heave. For most of London this movement is minimal and unnoticed, but some buildings (e.g. those without foundations) and infrastructure (e.g. escalators and soil embankments) are more susceptible to this movement.

Windstorms

Evidence suggests that severe windstorms around the UK have become more frequent in the past few decades[14], however it is difficult to discern a trend from the windstorm record due to the low numbers of such storms. The south-east of England also has the highest building standards for wind resistance in England.

2. Planning, Design and Development

This section outlines how the projected changes in climate for London are likely to effect commercial buildings. It highlights some design and refurbishment options to address these impacts.

Key Issues and Risks

The three main climate change related impacts for all buildings in London will be[15]:

1. **Flooding** – property damage, valuation and insurance impact, lost business continuity
2. **Overheating** – reduced building and workforce performance
3. **Water Stress** – water shortage, subsidence and heave damage

Flood risk is increased by:

- The fact that London has a very high proportion of impermeable surfacing – roads, buildings, pavements and roofs. This reduces the opportunity for rain to soak into the ground, which then increases the risk of concentrated surface water flood risk. London also relies on a combined stormwater and sewer system built in the Victorian era which gets overwhelmed during times of heavy rain. This results in flood water backing up into the urban street environment.

Flood impact on buildings:

- Increased the risk of basement and ground floor flood inundation, as well as the risk of water ingress of facades and roofs. The majority of London's commercial properties currently use these basement areas for services and plant operations which increases the vulnerability of basic business operations resulting from rain and flooding events. This can have a negative affect on productivity and building valuation.

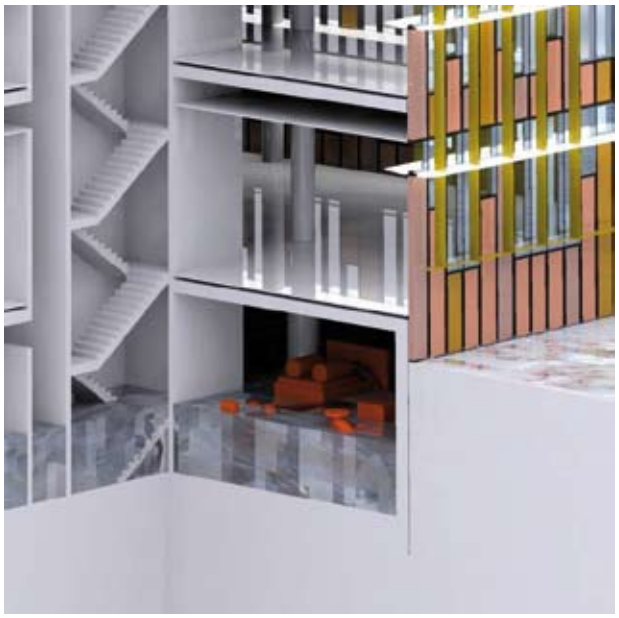


Figure 7. Services and plant located in the basement exposed to flood water impact.

Overheating risk is increased by:

- The widespread trend of using glass facades on 'sealed' buildings has increased both the risk of internal overheating and the reliance on energy intensive mechanical cooling systems in London's buildings.
- In addition to London's changing climate which has seen an increase in average summer temperatures of 0.73°C per decade over the past 30 years[16], the urban heat island effect further increases the risk of internal overheating[17]. The increasing density of London's built environment and hard non-absorbent surfaces, added to the lack of sufficient green space in the city's inner areas, amplifies the temperatures in street environments and internal workspaces.

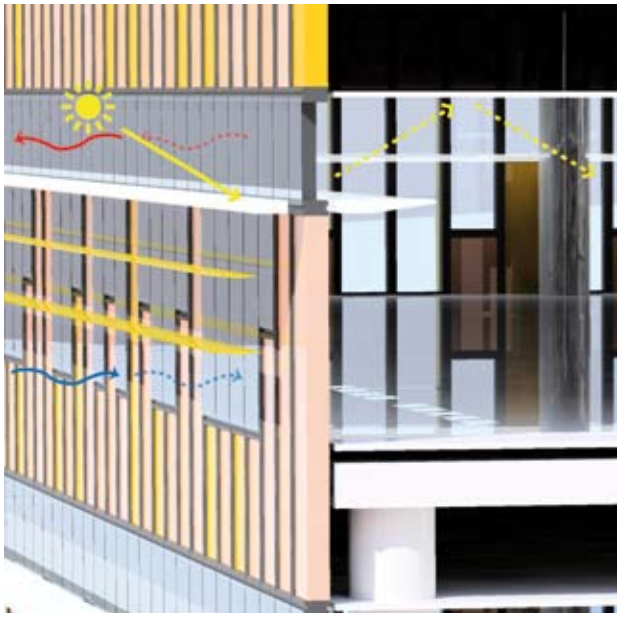


Figure 8. Illustration of several methods to minimise overheating risk and higher cooling and energy demands:
(a) Increases in solidity will improve the insulation of the façade.
(b) External louvres will minimise solar glare.
(c) Light shelves can increase daylight penetration into the building.
(d) Use natural ventilation where possible.

- Thermal discomfort thresholds for offices are considered as 25°C 'warm' and as 28ºC 'hot'. A building has technically 'overheated' if it exceeds the hot threshold for more than 1% of occupied hours. Heat stress risk for healthy adults is an indoor temperature above 35°C at 50% relative humidity[18]. The UKCP09 climate projections report that by 2050, London's average summer days will be 2.7°C warmer and very hot days possibly up 5.2°C warmer than the baseline[19].

Impacts on buildings:

- The projected increases in both average and extreme temperatures will make London's buildings more uncomfortable, more expensive to run through cooling energy costs and potentially dangerous to health as a result of high internal temperatures in poorly designed offices.
- These changes could result in productivity losses, the potential need for retrofitting mechanical ventilation systems, and negative property valuations.

Water stress risk is increased by:

- Londoners currently use more water than the national average (161L/person/day versus 150L)[20]. In London, non-domestic use accounts for 29 per cent of water consumption. The Office of Government Commerce set a best practice benchmark for water use in office establishments of 6.4 m^3 [21] per full time employee per year. Environment Agency and water company forecasts estimate that overall commercial demand for water will grow over the next 25 years by around 8%[22]. London's future climate is projected to increase the risk of water stress during summer months.
- The increasing ranges in rainfall and subsequent soil moisture levels, means that London Clay soils are particularly susceptible to shrinkage and swelling which can lead to subsidence issues in buildings and damage to water supply pipes within London's urban areas.

Water Stress impact on buildings:

- Prolonged periods of water shortage have the potential to result in water restrictions.
- Increasing soil shrinking and swelling movement could increase the risk of damage to mains and on-site water pipes, resulting in higher leakage rates. This would increase water costs to the business and could result in damage to building structure and services.
- Increasing subsidence and heave movement in London clays could increase the potential damage to building foundations and facades.
- Structural or services damage could affect property or business valuations and future insurance premiums.
- On-site water heating and use also contributes to the building's energy consumption and carbon emissions. All London offices are metered for water use, which provides a simple 'user pays' system for businesses and tenants. Therefore improvements made in water efficiency and on-site leakage reduction will have a direct financial benefit to the business through reductions in both water and energy bills, plus the ability to report the associated carbon emission reduction from water heating savings.

Drivers for adaptation of commercial buildings

There is an increasing focus on adaptation through:

1. **Planning policy** – National, regional and local planning policy is evolving to embed climate change adaptation throughout existing regulation and guidance, plus through the development of new adaptation specific requirements. Planning Policy Statement 1 (PPS 1)[23] sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system. The London Plan (2008)[24] establishes London specific targets and requirements on climate change adaptation and mitigation agendas within the spatial and built environment. Local Development Plan Documents (DPD) such as core strategies, local development frameworks and area action plans, must show general conformity with the London Plan and deliver on-ground resilience and sustainability for each planning application.

2. **Building regulations** – Building regulations are progressively revised every three years with the next revisions due in 2010, 2013 and 2016. Part L of the Building regulations currently focuses on energy efficiency and carbon emissions ie climate change mitigation. But they are moving to include adaptation measures in the future, such as water efficiency, flood risk and overheating criteria. Energy Performance Certificates and Display Performance Certificates are now required for all public and commercial buildings. As well as energy efficiency, certificates may in the future also need to show how adapted and resilient to water stress, flooding and overheating a building is.

3. **Government strategies** – Government recognises the need to mitigate and adapt to climate change in parallel. This is reflected by a chapter on each issue in the 2008 UK Sustainable Construction Strategy[25], the focus

on adaptation in the Climate Change Act 2008[26], the cross-government Adapting to Climate Change Programme[27], the Adaptation Sub-Committee of the statutory Climate Change Committee[28], the UK-wide Climate Change Risk Assessment proposal[29] and a new reporting power to require statutory undertakers, including water, energy and sewage companies, to report on addressing climate change risks.

4. **Professional industry guidance** – The Chartered Institute of Building Services Engineers (CIBSE) suggests the use of future climate change scenarios in building design[30], and CIBSE and the GLA are intending to release new design guidance specifically for London later this year based on an analysis of future climate change trends scenarios[31].

   The Association of British Insurers (ABI) urges property developers to design and build new developments in a climate-aware way to secure future insurability[32]. Climate change impacts may make certain buildings uninsurable. Insurers will only be able to insure buildings if climate change risk is managed to acceptable levels. If insurance is not provided, buildings may not be sellable. Insurance losses relating to buildings are expected to increase significantly as the climate becomes more volatile.

Risks for companies and property owners of not adapting commercial buildings to climate change

Climate change adaptation is becoming an increasingly vital part of the sustainability agenda for companies and their property assets. A lack of thinking about adaptation and incorporation of resilience into business planning can lead to the following risks:

1. **Operational** – Higher running costs due to increased cooling loads in hot summers, resultant increase in energy use, and higher energy prices. Higher costs of repair after extreme weather events.

2. **Increased insurance premiums** – Difficulty or additional expense in insuring buildings in flood risk zones or areas prone to the Urban Heat Island effect if resilience measures are not put in place. If risks are ignored this could also lead to increased insurance excess or ultimately to un-insurability.

3. **Occupant dissatisfaction with office temperatures** – Providing a comfortable indoor climate for occupants in as energy and cost efficient way as possible is a fundamental objective of building design and management[33]. However, most buildings are not being designed or managed to cope with increased variability in a warming

climate against increasingly stringent energy and carbon targets. Thermal discomfort thresholds for offices are considered as 25ºC 'warm' and as 28ºC 'hot'. There is no upper limit on acceptable building temperatures currently specified in health and safety guidance in the UK, but guidance from the US[34] recommends that 35ºc is the dangerous heat stress threshold for healthy adults when relative humidity is 50%. Increased thermal discomfort, occupant dissatisfaction and heat related health risks are likely to be increasing problems as these temperature thresholds are reached more frequently. Occupant dissatisfaction with office environments is generally caused by people being too warm or cold, or by unwanted heating or cooling of particular parts of the office. Building standards specify environmental ranges or 'comfort zones' in which at least 80% of occupants regard the environment as comfortable. If 20% or more of occupants are dissatisfied with their office environment, this is likely to impact on staff productivity levels, building usability, business continuity and could lead to possible litigation.

4. **Lending** – Lending amounts for purchase or refurbishment will be assessed and made available as to a percentage of the property's valuation. If the valuation figure is lower than market value due to poor resilience or sustainability performance, then this may reduce the owner's ability to secure the required loan. Further lending issues are outlined in Chapter 3.

5. **Liability and responsibility** – Construction warranties generally expire approximately 12 years from completion. If a building is conceived now and completed in 2013 the liabilities will expire by 2025. Responsibility for picking up the costs of refurbishing, modifying and upgrading a mal-adapted building will shift from professional advisers and designers towards the landlord, tenant and insurers as contractual warranties have expired. Failure to anticipate future building design requirements as a consequence of climate change now, may result in more expensive retrofitting and remedial measures taken later. Therefore it is in the financial and legal interest of developers, owners, and tenants of commercial buildings to make sure adaptation issues are considered and addressed in both design and fit out briefs, and in contractual warranties. Further legal issues are reviewed in detail in Chapter 4.

6. **Reputational risks** – A building which frequently floods or overheats during extreme weather events will be perceived negatively by occupants, employees, and competitors alike. Whilst committing capital and revenue funding to implement adaptation strategies may seem like a corporate risk, the risks of not doing so are very likely to be higher.

Opportunities for companies and property owners who adapt commercial buildings to climate change

1. **Economic** – Potential to provide long-term economic benefit to property owners and tenants in the form of: property values; reduced insurance premiums; improved

corporate social responsibility; reduced energy costs, and business continuity following significant climate event. Properties easier to sell or let at market value if well designed and protected from climate risks as clients are attracted to well designed, better performing buildings that are resilient to climate change risks.

2. **Market differentiation** – Can position a company as a market leader on climate adapted buildings and highlight an organisation's 'sustainability credentials' to clients, staff and lenders. Investors with climate vulnerable assets may start to seek to improve them or remove them from their portfolio, investing in more sought after climate proofed assets instead.

3. **Staff retention** – Higher staff retention and productivity due to more comfortable working conditions. Greater awareness of and support for sustainability and adaptation strategies from staff who are taking an increasing interest in green and ethical issues.

4. **Better risk management** – Reduced potential economic and legal risks and liabilities. Embedding resilience to extreme weather events into a building continuity plan, will improve the ability to continue operating during extreme weather events related to climate change eg floods and heatwaves.

5. **Green Leases** – Essentially a 'Green Lease' is a lease which has additional provisions set out within it whereby the Landlord and the Tenant undertake specific responsibilities/obligations

with regards to the sustainable operation of the property[35] (eg. energy efficiency, waste reduction/management and water efficiency).

Currently, landlords and investors are often unwilling to incur capital expenditure to improve energy and water efficiency beyond normal building requirements, as in many cases the financial benefits will be gained by the Tenant through lower energy and water bills, without any corresponding ability to recoup the cost of these improvement works through the service charge. The payback period on sustainability and resilience improvements can take many years to filter through and as shorter leases are increasingly common, a tenant may have little incentive to actively incur capital expenditure on a building.

The development of Green Leases is a way of overcoming these obstacles by setting out clearly each party's obligations with regards to sustainability and resilience issues, and even supporting them with financial incentives or

penalties. A green lease provider may also attract additional custom through achieving better market value[36].

Possible adaptation solutions for existing commercial buildings

Climate change adaptation design options are as relevant to existing buildings as they are to new developments. Existing building comprise most of the commercial building stock in London. In the current economic climate there are fewer new buildings being commissioned and built. Companies are making the most of their existing buildings. Below are some possible solutions for adapting existing commercial buildings to climate change.

1. When **retrofitting and refurbishing** buildings, consider those options which are relevant to existing buildings as well as new developments[37]. Consider the orientation of the building as this will determine which retrofit options are most appropriate.

2. Install a **mixed mode ventilation and cooling strategy**. This combines an automated natural ventilation system with an automated mechanical cooling system. The idea is that natural ventilation should be adequate for the majority of the year, with low-carbon mechanical cooling kicking in when temperatures are too high for the natural ventilation system to cope with.

3. **Optimise solidity** in the elevation to reduce the amount of heat getting into the building, and improve thermal performance of the building during the heating season.

4. **Reduce solar gain and prevent solar glare** through external louvres, or internal blinds which just prevent solar glare.

5. **Optimise daylight control** by adding light shelves, which even out the diffusion of daylight into the room, and can increase the penetration of daylight into more central areas. This reduces the need for artificial light in deeper plan office space.

6. **Assess and alter total glazed area** of the facade, then minimal external and internal shading is required. Ensure standard quantities of daylight reach the perimeter area of office space up to 4m from façade of office depth. Office space beyond that should have enough daylight for perception only, with very low energy, controlled task lighting where required.

7. Vegetate the building with **green roofs, green walls, trees and green spaces**. This helps to keep the building and surrounding air cool and increases thermal insulation. US studies have shown that the typical temperature of a green roof on a 'hot day' is 23°C while that of a tarmac roof can reach 66°C[38]. Trees and

Figure 9. Thermal imaging demonstrating the insulation and heat reflection properties of green roofs – areas with green roofs are cooler on the surface and better insulated.

Structure	From 50 to over 200 years: A building's structure can last for up to 200 years or more – just think of some of the 18th and 19th century buildings still serving us in London.
Facade	Between 25 and 45 years: Depends on materials and the effect of local climate and environmental conditions.
Services	Approximately 15-20 years: Most HVAC systems are replaced on a 15 year typical turn-around related to refitting for new leases, not the 20 year typical potential life of the distributed plant. If you replace the suspended ceiling then you tend to replace HVAC above it at the same time. Some centre plant items (and drainage) may have a longer life because they tend not to impact on let-ability perception of new occupied spaces. Depending on the design specification of services they may or may not be able to cope with the extreme weather events we are likely to see.
Fit out	Between 10 and 15 years: Ceilings, floors, partitions and furniture tend to be a bit more flexible. But again when fitting out office space, consideration is required as to whether there is enough contingency space in the cavities for additional cooling and ventilation systems which may be necessary in the future.

vegetation at ground level also help with storm water attenuation, preventing critical services from flooding.

NB. All of these options will be building and site specific therefore professional design advice is required to ensure the most appropriate solution.

Design life of buildings

Different elements of a building have different design lives. These are listed in the table above. An understanding of these design lives can help you plan your building adaptation strategy.

The right time to implement a climate change adaptation strategy for your building is:[39]

Before:

- A significant gap emerges between the rents achieved in your property and those in the same or equivalent locations
- Your building loses a major tenant or multiple tenants and there are prolonged periods of vacancy
- A major tenant's lease renewal is approaching – climate change resilient refurbishment offers a incentive to stay
- Major plant is due for refurbishment

When:

- You want to add value to your property
- You have just bought an undervalued building
- You want to make your portfolio work harder
- You have to comply with recent or upcoming legislation
- You want to strengthen your brand and reputation
- You want to improve your corporate and social responsibility
- Carbon disclosure and carbon constraints are unavoidable
- You want to differentiate your building portfolio against the competition

Theoretical commercial building case studies

1960-1970s office building

Buildings constructed during the 1960-1970 period make up around 15% of the London's city offices[40].

Main common features

- Opening windows.
- Poorly insulated facade.

Strengths and weaknesses under climate change

- Decreased efficiency of staff due to heat stress.
- Increased sick days.
- Increased reliance on mechanical cooling.
- More frequent mechanical breakdowns.
- Portable cooling devices are less efficient, create more heat and use more energy.
- The requirement to keep existing equipment cool and operational.
- Increased energy consumption for cooling.
- Increased carbon emissions.
- Electricity brownouts and blackouts during hot weather.

1980-1990s office building

Approximately 40% of office buildings in the City of London area were built during the 1980-90s. This period of building stock also makes up approximately 15% of the West End and mid-town buildings.

Main common features

- A sealed glass box.
- High performance glazing relying solely on mechanical ventilation.
- No relationship to orientation.
- Deep floor plan relying on artificial lighting.

Strengths and weaknesses under climate change

- Increased running costs.
- More frequent mechanical breakdowns with no back up natural ventilation option.
- Increased maintenance regimes.

Real commercial building refurbishment and adaptation case studies

Unilever House, Victoria Embankment, London by Arup

- Unilever House was refurbished by adding high performance insulation and double glazing to the existing facade so it meets the requirements for a new building under the current building regulations Part L2.
- The small 'punch hole' windows in the façade of the original building were retained resulting in less solar gain and better resilience to over heating under future climate change.
- The roof was designed to be a useable roof garden with considerable amounts of vegetation, which is good for thermal lag, keeping the building cool in hot weather, increasing biodiversity and providing a staff amenity.
- The heating system used does not generate excess heat emissions, therefore does not contribute to the urban heat island effect or exacerbate poor air quality.

55 Baker Street, London by Make

- The original structure was retained. The existing building had a very low floor to ceiling height therefore the soffits were exposed and chilled beams installed.
- The services were relocated to the perimeter which means they can be easily accessed for future upgrades without interrupting the floor plate. This builds in flexibility and means individual tenants can upgrade specific floors at a time, not the whole building.
- Strategically placed solidity in elevation reduces solar gain and overheating.
- The building is not currently suitable for natural ventilation due to surrounding traffic noise and pollution. However, smoke vents in the elevation could be changed for natural ventilation if in the future more electric cars result in less noise and pollution.
- It has excellent daylight penetration of 95%.
- Consideration has been given to future uses such as a residential block or a hotel.

Key Messages

- **Adaptation at the core of buildings and business:** Climate change adaptation is a key part of the sustainability agenda, and should be a fundamental consideration in the design and refurbishment of buildings and in business continuity planning.

- **Adaptive capacity:** Incorporate 'adaptive capacity' into building systems, facades and services, so that they have the ability to cope with the effects of current and projected changes in weather and climate over the buildings lifetime.

- **Mixed mode ventilation and cooling:** A mixed mode ventilation strategy is key. This enables low energy, low carbon, natural ventilation whenever possible, with the ability to switch to mechanical cooling when external temperatures are too high for natural ventilation systems to work effectively.

- **Refurbishment opportunities:** Consider low cost quick wins such as green roofs and louvres for existing buildings in the short term. Consider more strategic interventions such as changes to mixed mode ventilation and cooling systems and well insulated facades if major refurbishment or a move to new premises is planned.

- **Adaptation and mitigation in parallel:** Improvements made in water and energy efficiency will have a direct financial benefit to the business through reductions in both water and energy bills, plus the ability to report the associated carbon emission reduction from water heating savings – highlighting a dual benefit of tackling adaptation and mitigation agendas in parallel.

3. Valuation and Financing: assessing a market value

Property valuation and climate risk

London is a global financial centre, with lenders and insurers involved in projects around the world; they are subject to a wide variety of legal systems and climate perils.

Current valuation regulation stipulates that Market Value is the required basis of valuation for situations where a property is being charged as security for a loan. The definition of Market Value is firmly grounded in the perceived realities of the market, mimicking the views of willing purchasers and willing sellers to arrive at a 'proxy for price'.

Valuation is an opinion of market value for a specific site at a given date. This assessment is being made against the backdrop of evolving environmental issues, which need to be continually added to valuation consideration. Adaptation to climate future climate impact has typically been included in valuation in the form of flood risk only, with tidal and fluvial flood risk information being the predominant information available. Impacts such as overheating, water shortage and surface water flood risk, are key climate risks as stated in the UKCP09 and the Climate Change Act 2008, and are becoming fundamental building blocks to the 'sustainability' agenda, and will need to be given greater weight in future valuation assessments.

If property valuers do not consider the Market is acknowledging Sustainability in the form of a pricing differential, then there they, in turn, will not seek to make a quantitative adjustment to the value they report. From a 'numbers' perspective, there is absolutely no place for personal prejudice in the definition of Market Value. However, this definition of value, which is being relied upon by Banks as a key ingredient to a financial decision, is arguably failing to reflect or highlight a material risk (ie. lack of sustainability or resilience to climate impact) that may well manifest itself over the term of the commitment.

This highlights a possible mismatch between the intended use and the actual use to which such valuations are put. Banks see valuers as experts in their field; they will typically accept valuations at face value and the quantum largely determines their appetite to lend. In so doing, Banks assume that the valuer has considered all relevant factors when carrying out their research and analysis. To date, whilst some may seek to reflect potential degradation of value arising from known environmental issues such as land contamination, only rarely will they make any adjustment themselves to reflect climate risk – and even then this will most probably be limited to a perceived flooding risk.

As we have seen, increasing levels of climate risk (flooding, overheating, subsidence, windstorms) are now likely, at some locations, at some point in the future. It therefore seems reasonable to assume that, in due course, the property market will include climate risk amongst its concerns. When this happens, property values may, for maladapted properties, fall in value. Given valuations are based on market sentiment this could happen suddenly, either based on new scientific information or after a catastrophic event which highlights the risk. We have seen this clearly in New Orleans after hurricane

Katrina, where some neighbourhoods have not been rebuilt at all.

Banks lend money, exchanging cash assets on their balance sheet for an advance, which, for property lendings are likely to be secured against the property itself. Provided the property maintains its value, and the borrower continues to generate sufficient cash, the balance sheet remains strong, as repayment can be assumed in full.

If however a property is de-valued to a level less than the outstanding loan, the bank may write down the value of the debt and their balance sheet will be correspondingly weakened. If there were to be material financial losses to the banks, which arose due to reasonably foreseeable climate impacts being given greater significance in the property market, then it is possible that the Banks would seek recourse against their professional advisers.

Unless such challenges were settled bilaterally, it might be for the courts to decide what risks were foreseeable and whether the professional advisers had acted with reasonable care and skill in their assessment of those risks - and the manner in which that was communicated to the Bank. In so doing they would have to comment on what knowledge was "state of the art" at the time. If they found against the valuation firms the financial costs could be significant; particularly in some jurisdictions where some courts award punitive damages in excess of the pure financial loss.

Valuers are clear that the provision of an opinion of Market Value is provided at a specific valuation date. As time elapses and market trends evolve, the ability to rely on a valuation figure provided some time in the past, at a future date, wanes. Some valuers may also add that, unless their clients ask them specifically to include a comment on such risks, then they do not opine on their financial impact. In some cases banks have specifically requested that specific environmental risks are taken into account. For example most commissioning letters for valuation reports on top-end and mid corporate properties now require valuation firms to consider "propensity to flood". This came about following the 2000 floods and illustrates how a single event can change market practice suddenly and permanently. This may have set a precedent, i.e. "when banks are interested they will ask", but it may be unwise for valuation firms to assume this would work as a legal defence. Furthermore, the RICS' publication in September 2009 of a Valuation Information Paper (No. 13) on the implications of Sustainability on Commercial Property Valuation, clearly places a responsibility on valuers to appreciate such risks, reflect upon them in drawing their conclusions on value and, where appropriate, to provide a qualitative comment.

Over the past two years we have seen dramatically how write-downs in the value of assets on a bank's balance sheet can have global economic effects. It is illuminating to consider some scenarios of how this could work with climate risk.

Property Lender's perspective on climate risk

Typically in financing the acquisition of a commercial building the lender will look to finance up to a percentage of the valuation of the property (or of forecast building costs if it is a new building project). In buoyant financial conditions, for state of the art buildings, the percentage may have approached 75% or even 80% of the value; but more recently this has been lower reflecting the economic downturn and concerns over property demand in future. Loans to commercial property companies are rarely on an amortising basis (i.e. they are not repaid gradually over the term like a "repayment mortgage"), but are on a "bullet repayment" after 5 or maybe 7 years. This financing structure increases the risk to the lender.

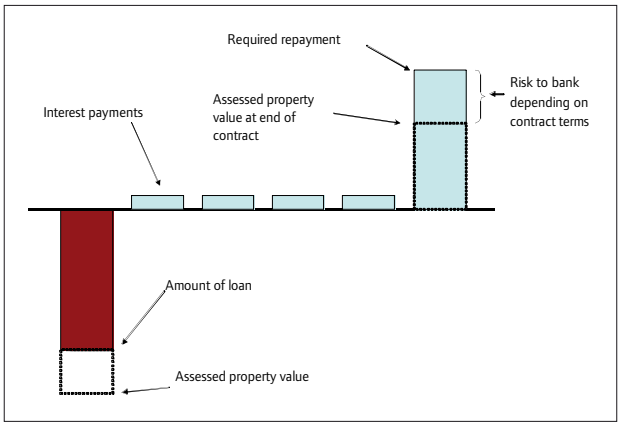


Figure 10. Illustrative bullet repayment scheme.

Some contracts are written so that, the lender relies for repayment exclusively on the cash flow and/or the asset value of the property being financed. At the time of repayment, this means that the Banks would receive the lesser of the outstanding loan or the property value. If the property is valued at less than the outstanding loan then the banks do not receive full repayment. In such a case they have no call on the other assets of the entity borrowing the money.

In other contract types the outstanding debt would fall to the borrower, so the Banks have an additional layer of protection provided the borrower was still solvent. It is likely the borrower would also have relied on the advice of a valuer before deciding to acquire the property; in which case, particularly if they have a large debt to repay, they may seek financial recourse. In times of economic stress it is quite typical to see an increase in legislation as claimants go in search of deep financial pockets.

We have seen that there are two types of event that can lead to a loss in property value:

1. A physical event like: a flood which may damage the property, or gradually increasing average temperatures which require expensive retrofits (air conditioning, cladding, shutters etc); and

2. A "knowledge" event where our understanding of a hazard may change due to new scientific research, or perhaps due to a physical event elsewhere. Such events could also be caused by regulatory or political change; for example if policymakers announce they will not be increasing spending on flood defences in a region.

Arguably owner-occupiers may, depending on their business model, be less affected by the second type. There will be physical impacts to

deal with, but provided they can continue to carry out their business they may be able to bear increased risk for a period. Developing a business continuity plan with consideration to extreme weather event adaptation is vital for all businesses and properties, as 80% of SME businesses affected by a major incident are reported to either not re-open or close within 18 months[41].

Property investors and banks are subject to both types of risk. This is because their business model relies on the current value of the properties in their portfolio. Knowledge events are just as likely to cause a sudden and material change in market values as are real physical events. It is important to realise that such knowledge events can precede observed changes in the actual peril by many years. For example; if new scientific evidence suggests a much faster pace of sea level rise than expected coastal properties may lose value. Impacts in the future will be discounted for the real time value of money which tends to reduce their financial impact.

Key Messages

- **Include adaptation in finance decision making** – there is a growing responsibility on all involved in the decision making process with regard to the charging of a property as security for a loan to ensure that reasonable and appropriate account is taken of climate risks. The definition of Market Value is clear, but so too are the responsibilities of valuers to reflect on such risks and, if not appropriate by way of a quantitative adjustment (ie. because the Market itself is not acting in such a way), to provide some form of qualitative comment. This should serve to improve the robustness of valuation advice and the manner in which it is used.

- **Consider adaptation in market value assessment** – It is equally important for the users of valuations to understand what Market Value represents. It is simply a reflection of the Market's sentiment at the time. Important decisions regarding financial instruments that will be in place over the medium to long term should not be taken based solely upon a measure of value that arguably has a limited shelf-life. Practices must evolve to take account of risks (climate-based or otherwise) that are conveyed and expressed qualitatively, alongside the purely financial measures.

- **Incorporate adaptation in post insurance rebuild** – Explore and take on opportunities to adapt through all possible mechanisms. For example, following an insurance claim, properties and assessors should seek opportunities to rebuild with climate change adaptation in mind (ie. increased flood resilience), though not beyond the finances allowed for in the premium rates. A more significant opportunity to adapt existing properties arises after a major event such as a windstorm or flood.

- **Ensure adaptation is considered from legal point of view** – It is important to realise that some policies cover legal defence costs, regardless of the outcome of the case; so insurers may face costs even if ultimately the case is defended successfully. Accordingly, clarity within Banks' commissioning letters may be one way out of this potential future litigation; but inclusion of a full climate discussion, even if not included in the final valuation, is also a sensible action from valuers. It is to be hoped that such forethought would encourage adaptation; the sooner this is seen to have an economic value, the more likely the decision to adapt will be made.

- **Consider and embed adaptation early** – Legal recourse is of course a measure of last resort – and rarely does it lead to a truly satisfactory conclusion. Should redress be sought from an advisor, they in turn will most probably seek recourse to their Errors & Omissions or Professional Indemnity insurer to cover their costs.

4. Legal: Regulatory and policy issues

Adaptation is likely to rise up the agenda as the consequences of failing to design and build with adaptation in mind become more widely appreciated.

Are the effects of climate change 'reasonably foreseeable'?[42]

Climate change attains legal significance when the phenomenon (and its effects) can be considered 'reasonably foreseeable'. In the United Kingdom there is, to date, no judicial authority clearly stating that climate change impacts are reasonably foreseeable. However, it is essential to remember that a court ruling does not make something 'reasonably foreseeable'. Rather, it is a finding that as a matter of fact, based on expert evidence where appropriate, the event or effect was reasonably foreseeable at the date of the act or omission that gave rise to a claim.

In Arscott v Coal Authority [2004] EWCA Civ 892, Laws LJ said: "an event may be reasonably foreseeable even though the precise mechanics of its causation are not… But reasonable foreseeability must imply some understanding of the chain of events which is putatively foreseen; otherwise we are… looking at… divination…

There is an extremely strong argument that climate change has moved beyond 'divination' and meets the test described by Laws LJ. The Stern Report on the Economics of Climate Change commissioned by the UK Treasury and addressed to the Chancellor of the Exchequer and the Prime Minister opened with: "The scientific evidence is now overwhelming: climate change presents very serious global risks, and it demands an urgent global response."

Stern's premise reflects the increasing, and increasingly detailed and sophisticated range of climate change models and the concerted efforts of researchers operating across the globe, and reflected in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report ('4AR'). Previously, in 2006, the Carbon Disclosure Project issued its report on the 'Adaptation tipping point'. Its premise was:

> *'Our climate is changing, and we are faced with many years of continuing unavoidable change. Even if we make a significant reduction in greenhouse gas emissions tomorrow, the lag in the climate system means that we will need to cope with a changing climate for the next 40 plus years, due to emissions we have already put into the atmosphere. Businesses and the financial markets need to grasp the reality we face – that we have to both reduce our emissions, and adapt to inevitable climate change. There is no choice between mitigation and adaptation – we have to pursue complementary actions on both.'*

That body of evidence, and the tools to interpret it, has been greatly enhanced by publication of the new UK Climate Impacts Programme (UKCIP) projections. Building on the already world-leading UKCIP02 scenarios, the UKCP09 projections provide the tools to assess climate change impacts on a geographically specific basis, moving emphatically beyond 'divination' and into a robust probabilistic analysis.

Expert evidence and the court

In reaching their conclusions bodies such as the IPCC rely on scientific evidence, the sophistication and complexity of which requires a significant level of specialist expertise and experience. In approaching an issue of that type, the court must have due regard to expert evidence.

A court does not have to act in accordance with an expert's approach to a subject. However, a judge who decides to reject a coherent and reasoned opinion must give a coherent and reasoned explanation for doing so, and for accepting any opposing evidence[43]. The consensus identified by 4AR and by Stern, and the robust probabilistic analysis underpinning UKCP09, would make it extremely difficult for a judge to reject expert evidence on climate change.

In the United States the Ninth Circuit explicitly accepted, and summarised the findings of bodies including the IPCC as follows[44]:

- Carbon dioxide concentrations increasing over the 21st century are virtually certain to be mainly due to fossil-fuel emissions
- The average earth surface temperature has increased by about 0.6 degrees
- There have been severe impacts in the Arctic due to warming, including sea ice
- Global warming will affect plants, animals, and ecosystems around the world.
- Some scientists predict that it will cause 15 to 37 percent of species in certain
- Global warming will cause serious consequences for human health, including the spread of infections and respiratory diseases
- Climate change is associated with increasing variability and heightened intensity of storm such as hurricanes
- Climate change may be non-linear, meaning there are positive feedback mechanisms that may push global warming past a dangerous threshold (the "tipping point")

The court accepted that these findings indicate that greenhouse gases from combustion of fossil fuels substantially contribute to climate change, and that climate change is expected to result in widespread adverse environmental impacts.

Climate change – cause or impact?

Courts might be called upon to consider climate change in two main and distinct contexts:

1. Claims that there is a causal link between particular emissions (eg from aviation or extractive industries) and climate change, or
2. Claims that the reasonably foreseeable impact of climate change was not taken into account when designing, building or operating a building or asset

Courts in a number of jurisdictions have encountered difficulty with the first category. Cases within that category generally seek either to prevent a development that will arguably increase emissions and contribute to climate change[45], or to attribute fault for historic emissions. In such cases, establishing specific causal links can be extremely difficult, and the particular question to be addressed by the court will often preclude a finding that global climate change is a legally relevant issue.

Cases in the second category ought not to face such difficulties. If a building or asset is located, designed, built or operated in a way that has no, or insufficient, regard to the reasonably anticipated impacts of climate change in the relevant area, then there must be scope for claims in contract or tort based on that failure.

Liability of designers/contractors[46]

Those designing and building buildings will usually have express or implied contractual obligations to use reasonable skill and care and to comply with performance specifications. Standards of reasonable skill and care are assessed on available knowledge at the time of the contract. We are reaching or have reached a point where "available knowledge" includes knowledge of the impacts of climate change and appropriate adaptation measures. In addition where contractual obligations fall short there may be liability in negligence (although damages for "pure economic loss" caused by negligence are not recoverable). Liability in negligence will depend on whether the loss was reasonably foreseeable. We have reached or are reaching a point where the impacts of climate change can be said to be reasonably foreseeable. However, limitation periods of six or twelve years from the date of breach of contract may restrict liability where the consequences of a failure to build in adaptation measures is not appreciated within this period.

We are likely to see increasing legislation (e.g. revised Building Regulations) requiring adaptation measures and more specific contractual requirements to deal with adaptation measures, with perhaps contractually extended limitation periods and a wider use of indemnities to deal with the inadequacies of ensuring liability rests with designers and contractors for failures to build in adaptation measures where the consequences of the omissions are not apparent until after limitation periods have expired

Landowners' liability to neighbours

Landowners are liable in nuisance for the reasonably foreseeable consequences of non-natural use of land or for the natural use of land which the owner knows or should know will cause damage. If an owner's land is prone to cause damage to his neighbours when the, now arguably foreseeable, impacts of climate change occur there is a potential liability to his neighbours. If so, an owner has a limited duty of care to "abate" the potential nuisance which could include a duty to carry out reasonable adaptation works.

Landlords and tenants

The obligations of landlords and tenants to carry out any adaptation works are likely to depend on the extent of any repairing obligations in their lease. Generally speaking, adaptation will constitute "improvements" which will not fall within repairing obligations. However, even if neither party can be obliged to carry out adaptation works, it is relatively clear that the remedy of physical damage caused by climate change impacts would constitute "repair". Currently damage caused by "nature" (e.g. storm, flood etc) would be carved out of the parties' repairing obligations and would be insured under the insurance obligations in a lease. It is clear that the AIB is concerned about

the insurance industry's ability to continue to cover such damage where it becomes more common and extensive as a result of climate change. This may lead either to greater use of "reasonable precautions" provisions in policies or even to uninsurable losses arising. In this event, the lease may need to cover the issue of liability of the parties to "repair" the damage caused by climate change impacts.

Faced with this prospect, a landlord or tenant may choose to carry out adaptation works even if there is no obligation to do so. Leases commonly contain restrictions on a tenant's ability to carry out alterations and only limited, if any, rights for the landlord to carry out improvement works to the demised property or to recover all or any part of the cost of such works from tenants. Given the parties may face the cost of "repairs" for the damage caused by the impacts of climate change, it might be sensible for them to consider building in to lease drafting, rights to carry out adaptation works and reasonable cost sharing for such works.

Legal framework for climate change[47]

Buildings contribute to 50% of the UK's CO2 emissions and about 75% of these emissions come from non-residential buildings. The legal framework surrounding the issue of commercial buildings and climate change is very broad.

Governments have adopted legally binding obligations to reduce GHG levels. These are enshrined in Annex B to the Kyoto Protocol to the UN Framework Convention on Climate Change, in the EU's legally binding target to reduce emissions by 20% by 2020 (or by 30% should an international climate change agreement be reached) and the UK's domestic commitment to and 80% reduction in GHG levels against 1990 levels by 2050.

However, the legislative response in respect of improving the performance of commercial building stock has been relatively weak. This is starting to change. The EU's Energy Performance of Buildings Directive[48] marked a turning point. It requires, for example, minimum energy performance requirements for buildings to be set, energy performance certificates (EPCs) to be made available and display energy certificates to be displayed in large buildings occupied by public bodies. The Energy Performance of Buildings Directive will be revised shortly and is likely to impose requirements in relation to "net zero energy" buildings.

Climate change accepted by Parliament

Parliament has explicitly accepted the validity and implications of evidence on climate change. The UKCP09 projections, along with the advice of the Committee on Climate Change, are a key evidential base for the reports to Parliament required by section 56 Climate Change Act 2008, in which the Secretary of State must give an assessment of the risks for the United Kingdom of the current and predicted impact of climate change. Those reports, and guidance to 'reporting authorities' issued under section 61 Climate Change Act 2008, are designed to allow reporting authorities to meet their obligations to prepare:

- An assessment of the current and predicted impact of climate change in relation to the authority's functions, and
- A statement of the authority's proposals and policies for adapting to climate change in the exercise of its functions, and the time-scales for introducing those proposals and policies.

These new statutory obligations add to the already extensive range of tools available to contracting authorities, including the UKCIP Risk, Uncertainty and Decision Making Framework and the Nottingham Declaration Action Pack, which was specifically designed for local authorities. Taken together, these freely available tools amount to an extremely compelling basis for concluding that it is at least legitimate, and arguably necessary, to take account of climate change impacts projected during the period covered by the contract, or during the reasonably anticipated lifespan of the asset.

UK policy implementation

At a UK level, a number of policy initiatives that respond to the threat of climate change have been implemented. "Planning and Climate Change – Supplement to Planning Policy Statement 1" sets out a number of ways in which the planning system can be used to combat climate change

The Carbon Reduction Commitment will require all users of more than approximately £500,000 per year of electricity to take part in a "cap and trade" scheme with respect to their total energy use[49]. This will have a significant effect on the information that a number of owners, occupiers and managers of buildings will have about the energy use of their properties, as well as provide an incentive for emissions reductions to be made. The Government has also announced a number of ambitious targets, including that all new non-domestic buildings to be "zero carbon" by 2019[50].

A focus on mitigation

Though these legislative developments are encouraging, it is clear that the legislative response for the commercial building sector has been less intense then that in respect of, for example, installations regulated under the EU emissions trading scheme. Both the EU and UK remain in the initial stages of developing a full legislative response to the mitigation of emissions. Further, very few legislative responses to date have focussed on adaptation to climate change.

The increasing priority of adaptation

However, it seems clear that the extent to which mitigation measures can exist without regard to adaptation is being revisited. Unlike mitigation policies, in respect of which the most significant initiatives have been driven "top-down", many initiatives in relation to adaptation have been driven by entities advancing local agendas or "bottom up" from interested sector organisations.

As far back as 2000, local authorities signed up to the Nottingham Declaration, committing both to reduce emissions and work on adaptation. The London Plan sets out a number of important obligations in relation to adaptation to climate change, including a requirement that

the Mayor and other agencies promote and support the most effective adaptation to climate change, including minimising overheating and contribution to heat island effects.

The London Climate Change Partnership has published a number of reports on adaptation issues in London[51]. The "City of London Corporation's Climate Change Adaptation Strategy, 2007" notes the importance of a number of factors for the adaptation of London's buildings. These include the relocation of IT and archives from flood-sensitive areas, installation of green roofs and green walls, creation of spaces for flood water storage, increasing flood resilience, harvesting of water and use of low water planting, creation of green spaces and making available cooled public building for public use when temperatures are high.

Moving outside of London, central government has published "NI188 Adapting to Climate Change performance Indicator for local authorities, 2008". This is a matrix which helps local authorities ensure that they assess the risks and opportunities, take action in any identified priority areas and develop an adaptation strategy and action plan. Defra has also published central government's response to adaptation in "Adapting to Climate Change in England: a framework for action, 2008", which highlights a number of important adaptation issues for the UK, including resilience of buildings. The EU is also addressing the adaptation agenda with the release of the White Paper on adaptation, Living with climate change in Europe.

What is the future for adaptation?

It seems clear that central government will put local government under increasing pressure to implement and report on implementation of their adaptation agenda. Local policy will be strengthened in relation to adaptation and elements from planning documents such as the London Plan, will be replicated throughout the UK.

It also seems likely that local authorities will require enhanced technical analysis of buildings' performance in relation to adaptation and that this may form an element of the environmental impact assessment made of major developments. Planning conditions and planning obligations are likely to be imposed in order to respond to the adaptation agenda. Both public and private sector developments will be subject to increased levels of scrutiny. Buildings regulations and planning policy and guidance will be strengthened in that same way as has already begun to be implemented in respect of mitigation.

Finally, as the need for buildings to be better adapted to climate change becomes more accepted, it is likely that there will be further "bottom up" growth in demand for better adapted buildings which are, for example, resistant to flash flooding as companies seek to occupy buildings that are built in accordance with the most up to date architectural practices and which are most consistent with the corporate images that they seek to portray.

Key Messages

- **Adaptation has increasing relevance in commercial property law** – Climate change legislation in respect of commercial buildings is likely to focus more and more on adaptation issues. Legal duties imposed on local government and voluntary reports and initiatives in relation to adaptation are likely to be "pushed down" and entrenched. Guidance can rapidly become formalised and climate change legislation is likely to be increasingly "multi-tasking" and innovative. Companies are likely to become progressively more concerned with occupying well adapted buildings.

- **Embed adaptation in property sector contracts** – As climate change impacts become more apparent, in all aspects of building design, build, ownership and occupation, there will be amplified focus on where liability lies regarding failure to adapt or dealing with the resulting damage to buildings. As the financial consequences of such liability begin to be appreciated, we are likely to see increasing focus in contracts for the design, building and occupation of buildings on the need for adaptation.

5. Summary and Conclusions

- London will experience **hotter drier summers, and warmer wetter winters** – with increased risk of extreme events such as surface water flooding from intense rainfall, and summer heatwaves.

- No single organisation has direct control over all the actions necessary to prepare London for the projected impacts of climate change. Adapting London to the changing climate will require national, regional and local government, government agencies, the private sector and London's communities to all work together. **Every commercial property sector has a key role to play** in improving our adaptation to climate impacts.

- **Adaptation is a core part of your business planning**. Adaptation and Mitigation should be addressed in parallel – we have to pursue complementary action on both.

- **Climate change adaptation is now a key part of the sustainability agenda**. It will become essential to integrate climate risk and adaptation into your decision-making processes, design, development, investment, operation and overall behavioural practices.

- **Physical design and build**. Seek designs and technologies to improve sustainability properties in buildings - mixed mode ventilation and cooling; facade design and solidity; external louvres; light shelves.

- Include adaptation to future climate risk into **valuation assessments, all finance decision making and post-event repairs.**

- Ensure that adaptation is considered early in the decision making process, with **legal and economic value impacts** in mind.

- Ensure that adaptation to climate change is considered and assessed when undertaking decisions and investments that have **relevance to commercial property and contract law.**

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Hindi

यदि आप इस दस्तावेज की प्रति अपनी भाषा में चाहते हैं, तो कृपया निम्नलिखित नंबर पर फोन करें अथवा नीचे दिये गये पते पर संपर्क करें

Vietnamese

Nếu bạn muốn có văn bản tài liệu này bằng ngôn ngữ của mình, hãy liên hệ theo số điện thoại hoặc địa chỉ dưới đây.

Bengali

আপনি যদি আপনার ভাষায় এই দলিলের প্রতিলিপি (কপি) চান, তা হলে নীচের ফোন্ নম্বরে বা ঠিকানায় অনুগ্রহ করে যোগাযোগ করুন।

Greek

Αν θέλετε να αποκτήσετε αντίγραφο του παρόντος εγγράφου στη δική σας γλώσσα, παρακαλείστε να επικοινωνήσετε τηλεφωνικά στον αριθμό αυτό ή ταχυδρομικά στην παρακάτω διεύθυνση.

Urdu

اگر آپ اِس دستاویز کی نقل اپنی زبان میں چاھتے ھیں، تو براہ کرم نیچے دئے گئے نمبر پر فون کریں یا دیئے گئے پتے پر رابطہ کریں

Turkish

Bu belgenin kendi dilinizde hazırlanmış bir nüshasını edinmek için, lütfen aşağıdaki telefon numarasını arayınız veya adrese başvurunuz.

Arabic

إذا أردت نسخة من هذه الوثيقة بلغتك، يرجى الاتصال برقم الهاتف أو مراسلة العنوان أدناه

Punjabi

ਜੇ ਤੁਹਾਨੂੰ ਇਸ ਦਸਤਾਵੇਜ਼ ਦੀ ਕਾਪੀ ਤੁਹਾਡੀ ਆਪਣੀ ਭਾਸ਼ਾ ਵਿਚ ਚਾਹੀਦੀ ਹੈ, ਤਾਂ ਹੇਠ ਲਿਖੇ ਨੰਬਰ 'ਤੇ ਫ਼ੋਨ ਕਰੋ ਜਾਂ ਹੇਠ ਲਿਖੇ ਪਤੇ 'ਤੇ ਰਾਬਤਾ ਕਰੋ:

Gujarati

જો તમને આ દસ્તાવેજની નકલ તમારી ભાષામાં જોઈતી હોય તો, કૃપા કરી આપેલ નંબર ઉપર ફોન કરો અથવા નીચેના સરનામે સંપર્ક સાધો.

MoL/Sept09/MR D&P/GLA1360