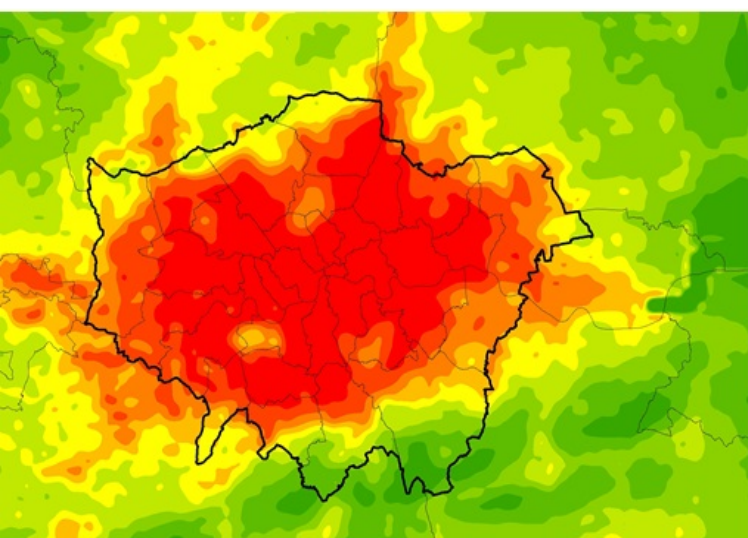


Come rain or shine

London's adaptation to the risks of severe weather

March 2015



Environment Committee Members

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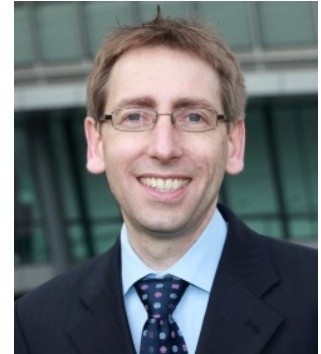
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Chair's foreword

It's often said that talking about the weather is a national pastime in the UK, but scratch beneath the surface and few of us have thought in detail about how our planet's shifting weather patterns are likely to affect our daily lives.



Just what are the risks of severe weather? What do the latest climate change projections tell us about the likely increase in different weather types, and how well prepared is London to meet these changes? These are just some of the questions we set out to answer.

During our investigation we took evidence from leading climate experts. Their message was clear: London's climate is changing, with summers expected to get hotter and drier, and winters milder but wetter. But within this trend the day to day temperature and rainfall is likely to be more unpredictable – with heatwaves, droughts, storms, flooding and cold snaps all set to become more regular features of London's climate.

This has major implications for how and where our homes are built. It's not just poorly insulated, older properties that are affected. We found that many new homes are susceptible to overheating in heatwaves, with premature deaths from overheating predicted to triple to 7,000 per year by the 2050s, as rising temperatures combine with an ageing population.

At the same time we heard that much of London's critical infrastructure is at risk from rainstorms and flooding. Accordingly, our recommendations are directed not just to the Mayor and central government, but also to those with responsibility for maintaining London's drainage system.

As our report notes, the risks associated with severe weather will never be completely eliminated, especially in a city like London, but we can do more to ensure that today's buildings and infrastructure are better designed, and better able to cope with tomorrow's climate.

A handwritten signature in blue ink, appearing to read 'Stephen Knight'.

Stephen Knight AM
Chair of the London Assembly Environment Committee

Executive summary

London has varied and unpredictable weather: we should be ready for heat waves and cold snaps, floods and droughts.

London is not very well adapted to its current climate. Many older homes are poorly insulated and difficult to keep warm; still more homes, even newer ones, are vulnerable to overheating in hot and sunny weather. The cityscape traps and emits heat, making London much warmer than the countryside on hot summer nights; London's built surfaces also shed water quickly to drains and watercourses, creating a risk of flash flooding in heavy rain.

London's climate is changing – summers are expected to get hotter and drier, winters milder but wetter, and the variability of temperature and rainfall may increase. This would mean that the risks of severe weather could increase, especially heatwaves and floods. The adaptation gap we already have is likely to get bigger.

Severe weather can have serious effects where the city is not adapted to it, and especially where there are vulnerable people. London sees thousands of excess deaths most winters, and hundreds can die in an exceptional summer heatwave. Floods damage property and also put life in danger: an extreme rainstorm could cause damage costing tens of billions, and would be likely to cause loss of life. Droughts and other severe weather can also be costly, disruptive and harmful.

So London needs to plan how it will be better adapted when the next severe weather events come. It needs to identify the weather it can expect to face in future, to assess how well adapted it now is to that weather, and to assess how much needs to be done and when, under different possible climate change scenarios. The pace of adaptation then needs to be monitored against the pace of climate change.

There need to be specific adaptation actions to keep homes cool in summer, and to keep them warm in winter; to prevent flooding, to be resilient to flooding where it may occur anyway, and also to be water-wise to cope with shortages of water supply.

Keeping homes warm is well-understood – the main factor is insulation and keeping out draughts. What is now needed is delivery of effective retrofit programmes for London's millions of hard-to-heat existing homes, by national government as well as the Mayor.

Keeping homes cool is less well-understood. New homes standards and retrofit work both need to better protect homes from overheating, keeping out the sun and other sources of unwelcome heat, and letting in cool air when there is any, as well as insulation. National standards need to embody the latest understanding of how to keep buildings cool.

As well as buildings, London's greenery and waterways play a crucial role in weather adaptation. They shade and cool the city, and soak up rainwater, preventing floods or providing safe floodable areas. Trees, green spaces and restored rivers form a crucial part of adaptation strategy, and the Mayor should show how much needs to be protected and delivered, and how that will reduce flood and heatwave risks.

Within built developments, there can also be places to store and soak away rainwater – sustainable urban drainage. Draft national standards for new developments need to be finalised, and retrofit programmes need to start to break through the vast proportion of London's area that is already impermeably paved over. In the shorter term, the design and maintenance standards for rainwater drains need to keep pace with changing patterns of rainfall.

Flood risk will never be completely eliminated, especially in a city like London, and buildings in flood-prone areas need to be resistant to the effects of flooding and quick to recover from it. In new buildings this need not be expensive, and building standards should stipulate easy adaptations that can make a huge difference. Water efficiency should also be built in to new developments, as well as fitted to existing homes.

To guide the delivery of all of these measures, the Mayor's Climate Change Adaptation Strategy needs an updated action plan. When the time comes to revise the Mayor's Environment Strategy and other major plans, they need to be based on a systematic analysis of the weather risks and adaptation needs that London faces.

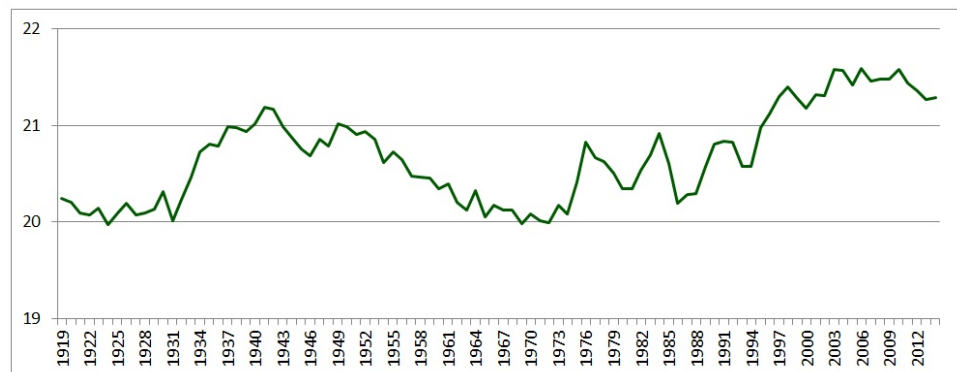
Introduction

London's current and future climate

London's climate is temperate. It does not experience such extreme weather as ice storms, hurricanes or widespread annual flooding. But it does have considerable variability overall, with a wide range of possible different weather types occurring, and unpredictability at medium timescales.¹ Londoners have to deal with heatwaves, cold snaps, rain storms and droughts.

We also have to deal with a changing climate. As shown in the graph below, average summer temperatures have risen: since about the 1990s they have been higher than in most of the 20th century. As daily temperature variability has also increased, typical high temperatures are already two degrees warmer than 30 or 40 years ago.²

South and south-east England summer temperature (ten-year moving average, °C)



Source: UK Met Office data

London's climate is likely to change further in decades to come. The most likely changes are that summers will be on average hotter and drier, and winters on average milder and wetter. This will increase the risk of winter floods and especially summer heatwaves. The average number of

¹ Specific weather forecasts can be made with a high degree of confidence a few days ahead, but as we look further ahead the specific weather is less and less predictable. The climate (statistical patterns in weather observed at different times of year) is known from records, but the actual weather experienced over a month or a season varies considerably from year to year.

² Evidence from Professor Martin Parry, Imperial College London, at the [Environment Committee's meeting of 3 June 2014](#)

heatwave days per year is projected to double by 2020 and continue to rise thereafter.³

Variability of temperature and rainfall may increase, so there will still be the potential for cold snaps, dry winters and wet summers. In particular, warm air can hold more water so even in a generally hot dry summer there will still be the potential for heavy rain storms, perhaps at a higher likelihood than currently.⁴

Therefore this report concentrates on the increasing risks of flood and heatwave. It also covers the continuing danger from very cold weather and, as London's population continues to grow, from the challenge to water supply in a drought.

These changes pose challenges for London and Londoners. Like people all over the world, we have to adapt to our climate, such as through our clothing and the design and construction of our buildings and cityscape. Cold is London's deadliest weather. As well as the health effects of the cold, lives can be lost in accidents caused by storms and frozen conditions. But very hot weather can also be dangerous, and London is not designed to keep us cool. London's transport passengers know how uncomfortable an overheated space can be, but for vulnerable people failure to keep cool in a heatwave can be serious or even fatal. If water supplies are also interrupted, the danger is greater.

There are also economic effects, such as property damage and disruption to business, transport and other activities. Floods can be the most costly events, but droughts, heatwaves and wintry weather also have these impacts.

We may feel at the mercy of the weather, but we can take steps to reduce its most adverse effects. As our climate changes and as London grows, it will be increasingly important that the Mayor, the government and other stakeholders take active measures to protect us.

³ These findings have come repeatedly from various studies and are summarised in the Mayor's [Climate Change Adaptation Strategy](#) (CCAS). They were also outlined at the [Environment Committee's June 2014 meeting](#)

⁴ Evidence from National Centre for Atmospheric Science and the Met Office at the [Environment Committee's June 2014 meeting](#)

The committee's work

In the course of this investigation, we took evidence from a range of experts (listed at Appendix 2) on the risks posed by severe weather and the necessary adaptations.

We also built on previous work, especially on flood risk and warm homes, including:⁵

- Flood risk in London (slide pack, 2014)
- Could do better: a report card on progress with Mayoral carbon reduction targets (2014)
- Water matters: efficient water management in London (2012)
- Fuel poverty in London (2012)
- For a rainy day: the Mayor's role in managing London's flood risk in case of severe rainfall (2011)
- The London climate hearing (2009)
- Response to the Mayor's draft Water Strategy (2009)
- Response to Draft Flood and Water Management Bill (2009)
- Lagging behind: insulating homes in London (2008)
- Chainsaw massacre: a review of London's street trees (2007)
- London's drought (2006)
- London under threat? Flooding risk in the Thames Gateway (2005)
- Crazy paving: the environmental importance of London's front gardens (2005)
- Down the drain: London's water supply and usage (2005)

⁵ All of the listed reports are accessible via the Assembly's environment and climate change [publications index](#). The reports are listed in chronological order so the dates of publication will assist in finding individual papers.

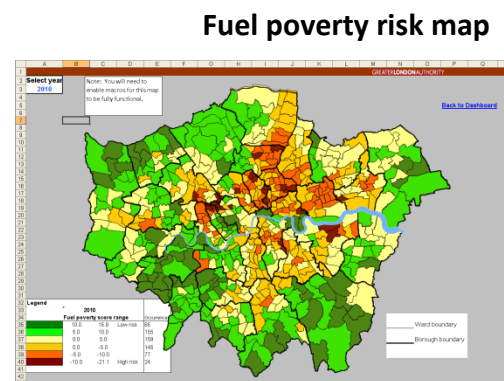
Heat and cold

The effects of extreme heat and cold are felt most acutely by older people and those in poor health. When the temperature drops, many people struggle to heat their homes, and their health can really suffer. And when a heatwave strikes, the same vulnerable groups are again put at more risk. The effects of cold and heat can be reduced by some of the same adaptation measures, such as building insulation. Improving building regulations, and retrofitting existing homes, would not only help deal with the health impacts of extreme temperature, it would also reduce the burden on health services and cut household energy bills and carbon emissions.

The risk and impact of heat and cold

Severe cold

There are thousands of excess winter deaths each year in London, with people over 75 most vulnerable.⁶ People also may find it hard to keep their homes warm for reasons including the state of the property and the cost of energy. The Assembly has found that over half a million Londoners are in fuel poverty, with a quarter of that number in severe fuel poverty, spending over a fifth of their income on fuel.⁷



London may not experience such low winter temperatures as some other parts of the country, but it has a high percentage of hard-to-heat properties such as those with solid walls. The expected future pattern of climate change is for milder average winter temperatures, so we might expect cold weather deaths to fall. However, continuing, possibly increasing, weather variability may still bring severe cold in some winters, for example if the shifting jet stream brings an arctic air mass to the UK.

⁶ Excess winter deaths can be caused by a number of factors, including cold weather and also seasonal patterns in infectious diseases like influenza. Since 2000, London's excess winter deaths estimate has varied between 1,700 and 3,700. See [Office for National Statistics Excess Winter Mortality in England and Wales, 2013/14 \(Provisional\) and 2012/13 \(Final\) data](#)

⁷ See the 2012 report by the Assembly's Health and Public Services Committee, [In from the cold](#)



Source: London Remade

Heatwave

Very hot weather also affects people's health, causing increased illness, hospital admissions and deaths. Health statistics show these effects at temperatures as low as 25 degrees Celsius (again, especially for older and other vulnerable people); as the temperature increases, the problems get more severe. The 2003 heatwave was responsible for 600 deaths in London and the number of 'casualties' – illness and hospital admissions – is estimated at about ten times this figure. In a more normal year, the number of heat-related deaths in Greater London is about 200. Heatwaves also cause a costly loss of productivity across the working population, though the size of this effect is not well known.⁸

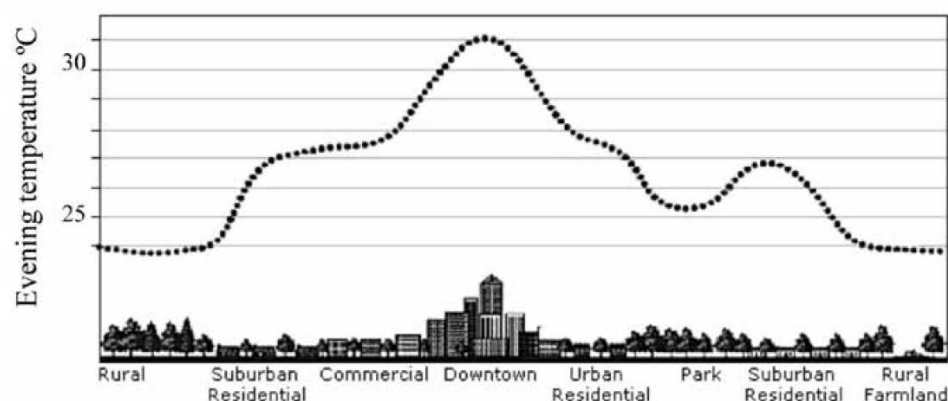
London is particularly vulnerable to heatwaves: the 'urban heat island' effect increases temperatures towards the centre of large cities. The heat island is created by the concentration of heat sources in urban areas (such as vehicle engines, electrical appliances, and building cooling and lighting systems, and powered infrastructure), by the ability of paved and built surfaces to absorb the sun's heat and release it later, and by the lack of vegetation and water to cool by evaporation. The heat island is strongest at night in hot summer weather, as the re-release of stored

⁸ Evidence from Oxford University research, the London Risk Register, and the [Environment Committee's June 2014 meeting](#)

solar heat is greatest. The heat island effect varies locally with factors like tree cover, green space, water, building facings and other design features.

Urban Heat Island

Figure 5.2 Simplified temperature profile of a typical urban heat island



Source: GLA – Climate Change Adaptation Strategy

Summer temperatures have increased and are expected to increase further, leading to more, and more severe, health effects. Records show that London previously saw an average of 14 days of excessive heat (over 26 degrees Celsius) per year. That number is now 18, and is projected to rise, to an estimated 33 days per year by the 2020s.⁹ By the 2060s, it is expected that summer temperatures like those of the 2003 heatwave will be normal, occurring or being exceeded on average every other year.

Such temperatures are still no hotter than those experienced by some other cities already – for example around the Mediterranean. People adapt to these temperatures, but do so with different building design and behaviour. London will likewise need to adapt its built environment and way of life, perhaps following such examples.¹⁰

Adapting to the risks of heat and cold

The greatest risks from extreme temperatures, especially for vulnerable people, tend to come in the home. To protect against extreme cold, homes need proper insulation and effective heating. Although new homes are built with high standards of insulation, many of London's older

⁹ Based on research by the Chartered Institute of Building Service Engineers, reported by Professor Martin Parry at the [Environment Committee's June 2014 meeting](#). For an online written presentation see [Defra Technical Report: Climate Change Risk Assessment for the Built Environment sector](#)

¹⁰ Evidence from Professor Martin Parry and others at the [Environment Committee's June 2014 meeting](#)

properties do not have enough; there are a number of programmes underway to retrofit this to existing homes.

Keeping homes cool is less well-understood. Insulation can help keep out the heat as well as the cold, but other measures are necessary. Homes need to be protected against the sun's heat, especially at windows, and people need to be able to control internal sources like appliances and hot water pipes. When there is cooler air outside, sufficient ventilation is the most effective cooler.

Regulations and standards for new buildings

London needs a steady supply of new housing to accommodate its growing population over the coming decades. All new homes are subject to strict building regulations and there are standards for good design to keep them at the right temperature. Standards for insulation and preventing heat loss in new buildings are increasingly strict, working towards the 'zero carbon' standard for homes.¹¹ People living in new build properties therefore experience much higher levels of comfort in the colder months. The issues of preventing heat gain and encouraging cooling in hot weather are, however, less well addressed.

Though the London Plan sets out sustainable cooling principles¹², the national statutory standards to keep buildings cool are out of date and poorly-suited to a modern urban environment. They are based on heatwave expectations from earlier in the 20th century, not the greater prevalence of high temperatures today or the still-hotter conditions expected in decades to come. Also, they are based on simplistic assumptions, for instance that windows are open at night to let in cool air. In reality, there may be many situations that prevent this, such as urban noise, air pollution or security fears.¹³ And in an urban heatwave, even the night air may not be very cool.

The regulations and standards for new building design and construction therefore need to be updated and made more relevant to modern, urban

¹¹ In line with national policy, the [Mayor's Climate Change Mitigation and Energy Strategy](#) (p167) calls for a 'zero carbon' standard for new homes by 2016, though national policy has been subject to some delay in the progress towards this. The national Code for Sustainable Homes is now voluntary and it is not yet clear exactly how or when building regulations will embody the zero carbon standard. See [information from the UK Green Building Council](#). There are also other non-statutory standards for very energy-efficient homes such as [Passivhaus](#) and the top ratings under the [Building Research Establishment Environmental Assessment Methodology](#)

¹² [London Plan, policy 5.9](#)

¹³ Evidence from the [Environment Committee's June 2014 meeting](#)

contexts. As well as applying sufficiently high standards in established measures such as insulation, there is scope to encourage more innovative solutions such as providing channels for through-draught ventilation in single-aspect flats.

It will also be necessary to ensure that the standards are enforced, at the design stage and through building as well as in the completed structures.

Recommendation 1

The Government should update, and keep up to date, building standards and regulations regarding climate adaptation issues, including keeping cool as well as keeping warm. To address urban issues, there should be special standards applicable in urban areas.

The Mayor should lobby for these better regulations, making the case for, and helping to develop, standards that are fit for London's current and future climate. The Mayor should work as necessary with others such as the London Climate Change Partnership, the Core Cities, the Zero Carbon Hub, the Environment Agency, and the Committee on Climate Change.

The Mayor should report to this committee by the end of 2015 how this case has been presented and what the response has been. This report should also cover actions pursuant to recommendations 7 and 8.

Adapting existing buildings

Many existing homes are hard or expensive to keep warm: insulation and draught-proofing standards were lower in the past. Eighty per cent of London's pre-2010 homes will still be in use in 2050.¹⁴

Though it initially exceeded the target for homes reached, work to make existing homes warmer now appears to be behind schedule. There are London and national retrofit programmes for energy efficiency, as well as efficiency ratings on heating appliances. The Mayor's retrofit progress milestone for 2012 was to reach 200,000 homes; in fact by then around 400,000 were retrofitted, a quarter of them under the Mayor's RE:NEW programme. However, the Mayor's evidence to us implies that the programme is currently running behind, with an estimate of 1.1 million

¹⁴ [Mayor's Climate Change Mitigation and Energy Strategy](#), p168

homes by 2017, compared to the strategy's milestone of 1.2 million by this year, 2015.¹⁵

Existing properties vary in their ability to resist overheating. Those with a thicker and heavier construction that is slow to heat up ('thermal mass'), and with smaller windows that let in less sunlight, can stay cool on hot days. However others are more vulnerable. Fitted adaptations can help, such as blinds and shutters, external insulation, white paint or other light exteriors, and loft and wall insulation.

Recommendation 2

The Mayor, in the next progress report on the Climate Change Mitigation and Energy Strategy, should show how he will meet retrofit targets. If he will not meet them, he should show current and anticipated retrofit performance and its implications for climate adaptation and carbon emissions.

The retrofit programmes are designed to reduce carbon emissions and keep homes warm. The GLA environment team has been providing input to the retrofit programmes to ensure that the nature of works does not increase problems with overheating and if possible reduces it. When making direct contact with households, the retrofit programmes should also offer advice or low-cost measures specifically to keep homes cool.

Recommendation 3

The Mayor should ensure that retrofit programmes take account of the need to keep properties cool (especially in homes where occupant and building are both at increased risk of harm from overheating). Progress should also be reported in the next update to the Climate Change Mitigation and Energy Strategy.

Air-conditioning

Installing air-conditioning is one way of tackling excessive heat in buildings, but – from a city-wide perspective – is the least preferable way of doing so. The energy required for air-conditioning systems not only increases carbon emissions, it also increases the overall heat of the local environment (the heat removed from the building, plus additional heat generated by the energy use). The London Plan sets out a cooling

¹⁵ See this Committee's 2014 report card on Mayoral carbon reduction targets, [Could do better](#)

hierarchy in terms of sustainability, with avoiding heat gain being most preferable, followed by natural ventilation, powered ventilation and with active cooling at the bottom. Air-conditioning is still rare across the housing stock, but rising temperatures may encourage its further spread¹⁶ (and may encourage the use of portable air-conditioning units, which are especially energy-inefficient¹⁷). In the US, where most homes have air-conditioning, it adds around one-fifth to the already high home electricity consumption.¹⁸ A study in Paris suggested that increased air-conditioning could add two degrees to the urban heat island there, with the greatest heating at night when excess heat has the greatest health effects.¹⁹

Green infrastructure

‘Green infrastructure’ describes the living elements of the urban environment – plants, soil, waterways and so on – that perform a useful function for city dwellers. These functions include cooling the urban environment. Trees especially provide shade, and vegetation and waterways allow cooling evaporation – reducing the factors leading to the ‘urban heat island’. It has been estimated that a ten per cent increase in tree cover could reduce temperatures in London by 3-4 degrees Celsius.²⁰ As green infrastructure is important in managing excess rainfall, green infrastructure policy is discussed further in the next chapter, but because of the cooling effect the findings of that section, and particularly recommendation 6, are also of great importance for London’s ability to cope with future heatwaves.

¹⁶ BRE on behalf of the Department of Energy and Climate Change (2013): [Energy Follow-up Survey 2011: Report 9 – domestic appliances, cooking and cooling equipment](#). See also RES-H Policy (2009): [Current state of heating and cooling markets in UK](#)

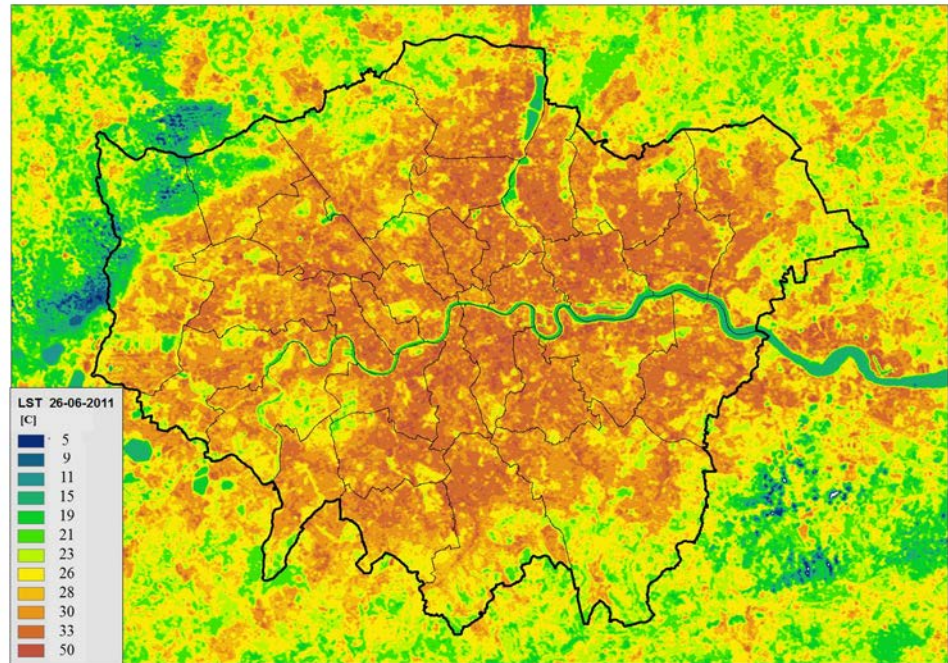
¹⁷ A. Pathan, A. Young and T. Oreszczyn: [‘UK Domestic Air Conditioning: A study of occupant use and energy efficiency’](#)

¹⁸ The Independent, 2010, [‘Air conditioning: Cold comfort’](#)

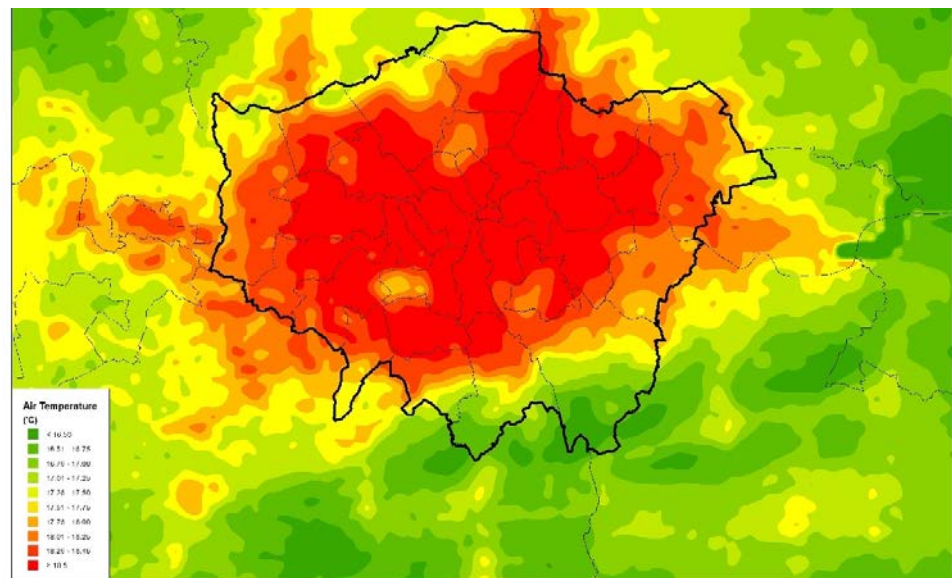
¹⁹ Munck et al., 2013, [‘How much can air conditioning increase air temperatures for a city like Paris, France?’](#). See also Munck et al., 2010, [‘The influence of air conditioning on street temperatures in the city of Paris’](#).

²⁰ According to research by Manchester University, as [cited by the Forestry Commission](#).

Land surface temperature is affected by local ground cover



Air temperature is affected by land surface temperature



Source: Both images © Arup

Flood and drought

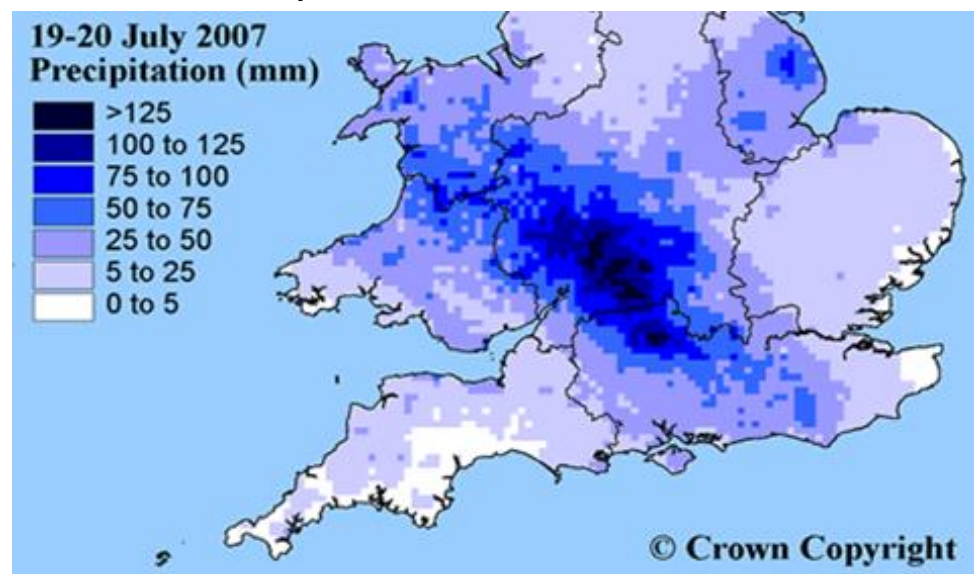
London's rainfall is expected to become more concentrated in the winter and potentially more variable, so the dangers of both very heavy rain and of drought are expected to continue and may increase. Flood deaths in the UK are fortunately few, and the health effects of drought are generally bound up with those of heatwave. This section considers mainly the economic and property impacts of flood and drought.

Risks and impacts

Heavy rain

An episode of extremely heavy rain presents a serious risk of surface water flooding in London. Should a rainstorm strike London like the one that affected southern England in July 2007, the water would run off paved surfaces and quickly overwhelm the drainage network. Hundreds of thousands of properties in London are vulnerable to this kind of surface water flooding. Low-lying streets and ground-floor and basement properties could flood within minutes, likely leading to loss of life, and causing property damage in the order of tens of billions of pounds.²¹

Extreme rain narrowly missed London in 2007



Map source: Met Office publication. Contains public sector information licensed under the Open Government Licence v1.0

²¹ See the 2011 report [For a rainy day](#)

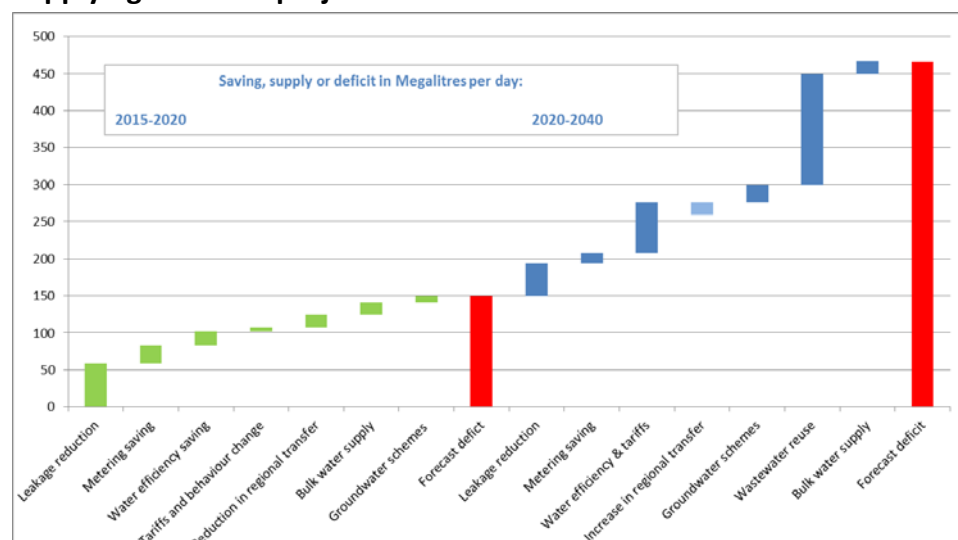
Drought

London begins to experience pressure on its water supplies after two consecutive dry winters. London's water comes from the environment – either water stored deep in the ground or from rivers partly fed by groundwater. As summer rain tends to evaporate again, winter is the time that groundwater reserves can be naturally replenished. When there are two consecutive dry winters (as in 2004-06 and 2010-12), water from the environment is scarce and, in water supply terms, there are drought conditions, leading to restrictions on non-essential water uses ('hosepipe bans'), with economic costs and impacts on normal life.

A sequence of three consecutive dry winters could leave ground water critically low and might result in more severe restrictions, such as supply to homes being limited, and the use of standpipes. Vulnerable people's well-being could be threatened. Three-dry-winter sequences of varying severity have occurred on average every 20 to 25 years.²²

London's population is set to grow (by around 700,000 just by 2021), but the water available in the environment is not. This will increase pressure on water supplies: Thames Water forecasts that its London supply area will, without further action, face a deficit of 133 million litres a day by 2020, rising to 416 million by 2040 – equivalent to the water needed by several million people.²³

Supplying London's projected water deficit



Source: Thames Water

²² Six in the past 140 years, according to the Met Office at the [Environment Committee's June 2014 meeting](#)

²³ [Thames Water: Water Resources Management Plan 2014](#)

Adaptation to heavy rain

A city like London has a multi-layered system for coping with heavy rain. Rainfall runs off, is held by, or soaks into the built and green surfaces of the city. Runoff is channelled into drains and in normal circumstances safely removed to watercourses. And new buildings can be designed and built to cope with flood events and recover quickly in the aftermath.

The GLA has a strategy for tackling surface water flood risk, including the Drain London programme. This has produced risk assessments and management plans for each London Borough and is now helping some boroughs investigate and tackle their areas of highest risk. Interventions can be made across the areas discussed below.

Main drains

The standard for drainage networks is to design them to cope with rainfall events up to a level that is only expected to be exceeded about once in 30 years (on average in any given location). In London, this is taken to be about 45mm of rain in a day. However, rainfall this heavy is now around five times more frequent, so that rainstorms that could overwhelm local drains are now expected more like once in six years.²⁴

Recommendation 4

Thames Water should provide the committee with an assessment of its drainage network's ability to deal with heavy rainfall events in London, and its plans to ensure its network keeps pace with the potentially increasing risk of these events in future. A risk-based approach, as described in the conclusion of this report, should be taken.

Sustainable drainage

Sustainable drainage slows or stops water from reaching the drainage network in the first place, and helps reduce the risk of the network being overwhelmed during heavy rain. Sustainable drainage measures include green roofs or walls and holding tanks or ponds to retain water, and permeable areas and soak-aways to allow water to penetrate into the soil. The GLA is currently drafting a Sustainable Drainage Action Plan that will map the potential for retrofitting sustainable drainage across London. This should help inform decisions about new investment, and potentially reduce the need for costly hard drainage infrastructure. Sustainable drainage in existing development will be important to addressing London's vulnerability to surface water flooding, and should be assessed

²⁴ Loyd's: East London Extreme Rainfall: Importance of granular data, cited in the Mayor's Climate Change Adaptation Strategy

and planned in the next Environment Strategy (see recommendation 10). We hope to review the action plan when it is available.

Sustainable drainage is still not well known to some developers and planners in this country: more guidance is needed to change the culture. There are good policies on new developments in the London Plan²⁵, but the Government has not yet published national standards (provided for by the Flood and Water Management Act 2010 and first consulted on in 2011).²⁶ Guidance is particularly needed now that local authorities are to handle sustainable drainage through the ordinary planning system rather than through previously-planned new specialist bodies. Firm standards would enable and encourage developers to choose and fit sustainable drainage solutions. Planning authorities will then need to apply these standards as required by their local flood risk situation.

Recommendation 5

The Government should publish the final version of the national sustainable drainage standards for new developments. In response to this report, it should set out when it intends to do so.

Sustainable drainage



Source: Susdrain

²⁵ [London Plan, policy 5.13](#)

²⁶ New Civil Engineer, 10 January 2014: [Delays dog sustainable drainage standards](#). See more recently Department for Environment, Food and Rural Affairs (2013): [Delivering sustainable drainage systems](#), specifically paragraph 2.7 and Annex

Green infrastructure

As well as helping to cool the environment, green infrastructure has a major role to play in adapting to rainfall. Vegetation catches rain in its leaves before it hits the ground, slowing runoff and keeping a portion of the water until it re-evaporates. Unpaved surfaces and natural watercourses allow water to soak into the ground rather than causing flooding.

Watercourses can be designed to manage the impact of heavy flows caused by intense rainfall. Straight channels with hard edges encourage the water to flow downstream, often creating bigger floods there; irregular, vegetated edges, unpaved surfaces and adjacent floodable land can hold excess flows higher in the watercourse where they do little damage. Most of London's rivers are in a hard channel or even completely covered and built over. Opening them out and putting back vegetation and unpaved surfaces is known as river restoration and has many benefits as well as reducing flood risk.²⁷ The Mayor has a target to restore 15km of rivers by 2015 and a further 10km by 2020. So far, at least 14 km of rivers have been restored through the Mayor's programmes: it seems that the 2015 target has been met, but the London Rivers Action Plan setting out this target and where the opportunities for restoration are is several years old and in need of updating.

Trees have an important role to play. The Mayor has a target to increase London's tree cover from a baseline of 20 per cent to 25 per cent by 2025 and 30 per cent by 2050; by 2025, he wishes for 2 million extra trees. The Mayor has several tree-planting programmes with targets of 10,000 to 20,000 trees each, which have so far led to the planting of more than 100,000 trees.²⁸ Since this represents a relatively small proportion of the planned London-wide increase, progress will therefore have to be achieved mainly through other means.

New planting is only part of the solution. New trees take a long time to reach maturity and deliver their full benefits. Also in urban areas trees are often subject to removal or reduction for many reasons. A significant determinant of green infrastructure benefits in the short to medium term is the protection and well-being of existing trees and green spaces.²⁹

²⁷ See the Committee's 2011 report [For a rainy day](#)

²⁸ The tree target is the Mayor's own. Sources on Mayoral tree targets and work include the [London Plan policy 5.10](#), the web page on the [RE:LEAF programme](#) and this [2014 Mayoral press release](#)

²⁹ From the London Tree Officers Association and others at the [Environment Committee's October 2014 meeting](#)

Problems that green infrastructure can help with, such as overheating and rapid runoff, can be most severe in the most urbanised areas. However, the easiest and lowest-cost places to deliver new trees, waterways and other green infrastructure are in less intensively-developed areas such as the suburbs. In central London there is a need to make long-term space for mature trees, as well as on-building green infrastructure such as green roofs and walls. Redevelopment offers opportunities. The London Plan sets out this need clearly, and sets a target to increase the amount of green surface in central London by five per cent by 2030 and another five per cent by 2050.³⁰ This goal and its delivery will need to be supported as part of the next Environment Strategy (see recommendation 10)

Recommendation 6

The Mayor should demonstrate, with quantified contributions from different actions as in the Climate Change Mitigation and Energy Strategy, how and where his green infrastructure goals (including for tree cover and river restoration) will be met.

Among the contributing actions will need to be better protection and enhancement of existing green infrastructure. The Mayor, with local government, should agree and implement appropriate measures to secure this.

Flood resistant buildings

Buildings can be constructed so as to be more resistant to flood damage – for example by using materials on the ground floor that are not damaged by water, and by routing wiring further from the ground. In new buildings these adaptations are not much more expensive than standard construction, but they can enable much quicker and cheaper recovery from a flood. Buildings can also be designed to keep water out, for example with entrances above ground level, as they are on key buildings such as metro stations in cities such as Singapore.³¹

³⁰ [London Plan, policy 5.10](#)

³¹ Evidence given at the [Environment Committee's October 2014 meeting](#)

Recommendation 7

The Mayor should press for standards and regulations to promote flood-resistant buildings in flood-prone areas (and those becoming flood-prone in future), especially those identified in London by recent work such as Drain London.

Adaptation to drought

Thames Water and the GLA are taking a strategic approach to relieving this pressure, projecting need and exploring options to reduce it or meet it. Current work includes reducing leakage and encouraging water efficiency.

At the moment, about a quarter of London's treated water supply is lost to leakage, significantly more than in other parts of the UK or other world cities. However, replacing water mains is very costly and Thames Water's planned leakage reduction is comparatively small – 16 per cent of current leakage by 2030.

Demand for water is primarily going to be managed by greater water metering. Thames Water aims to install metering for the majority of its London customers by 2020, rising to three-quarters by 2030. It is rolling this out by borough, and alongside it is piloting a programme of home visits to provide efficiency advice and fit water-saving devices, to enable customers to minimise their water use. However, some customers, especially larger households in smaller properties, could see bills rise and potentially face difficulty paying. It is important that social tariffs for vulnerable customers are introduced as metering is rolled out.³²

As well as encouraging efficiency, water metering helps to find leaks. The GLA, and this committee, hope to see full metering across London as soon as possible.

Thames Water anticipates that measures to reduce demand will need to be complemented by increases in usable water supplies. One technique is to treat waste water from sewage works to a much higher standard before adding it to river supplies, from where water can be extracted again for use. Another option is to use rivers or canals to move water around the country, if neighbouring regions have surplus water to offer. Building a new reservoir would enable more water to be taken out of

³² Evidence given at the [Environment Committee's February 2015 meeting](#)

rivers when flow is high in winter, and stored for use in summer when demand is high but river flow is low.³³

Urban rainwater is another potential resource. When it falls it is very clean, so harvesting the runoff from surfaces like roofs can provide water that requires little treatment, compared to water that has been through the drainage system. It may be usable directly for non-drinking uses, and so can reduce the demand for mains water and reduce bills for customers. This is in addition to the flood risk benefits of reducing runoff from buildings, and can form part of a sustainable drainage system.³⁴

The water supply strategy for London should continue to examine all available options, and should also include a climate monitoring element, with strategic linkages between observed climate trends and the expected need for measures on water supply and demand. Therefore recommendation 10 below is also directed at Thames Water and other water supply companies.

Measures relating to both drought and heavy rain

Regulations and standards for new building

New building and development presents opportunities to put in place water management measures such as sustainable drainage, rainwater harvesting, dual water systems, and flood-resistant electrical installations. As these features are deeply embedded into sites and buildings, it is often much easier and cheaper to install in new buildings, compared to retrofitting. Priority should therefore be given to encouraging best practice water management techniques in all new buildings.

Recommendation 8

The Mayor should seek to ensure that building standards and regulations promote sustainable drainage, water efficiency and flood resistance.

The Mayor should also ensure that these elements are part of developments that he supports through programmes such as Housing Zones, the Outer London Fund and the Estate Regeneration Fund.

³³ Evidence given at the [Environment Committee's February 2015 meeting](#)

³⁴ Evidence in this section from [the Environment Committee's October 2014 meeting](#) and written evidence from Thames Water

Adapting existing buildings

Since so much of London is already built and rebuilding affects only a small portion each year, retrofitting is also vital. The GLA's energy efficiency and warm homes retrofit programmes have been discussed above. There is an aim to address other issues at the same time, such as water efficiency, which we fully support. These programmes offer an opportunity to work in homes and other buildings, and more could be done to secure a full range of climate adaptation benefits.

Resources within the GLA's retrofit programmes are limited, but there are ways to enable this kind of work. Sustainable drainage measures in certain catchments can be funded through flood prevention budgets – as at Counters Creek in the boroughs of Hammersmith & Fulham and Kensington & Chelsea. Funding for some water efficiency measures may be available in partnership with Thames Water or other suppliers; some measures are very low-cost and are readily provided free of charge by water companies. There have also been calls for water efficiency to be included in the national Green Deal energy efficiency programme, which is funded largely out of the savings it enables on energy bills.³⁵

Recommendation 9

The Mayor should include a wider range of climate adaptation measures in his retrofit programmes, including

- sustainable drainage and efficient water management
- (in areas of high flood risk) flood resistance and recovery

³⁵ Edie.net, 2015: [‘Green Deal should be extended to include water efficiency, says Green Alliance’](#)

Conclusion: the need for risk-based adaptation strategies

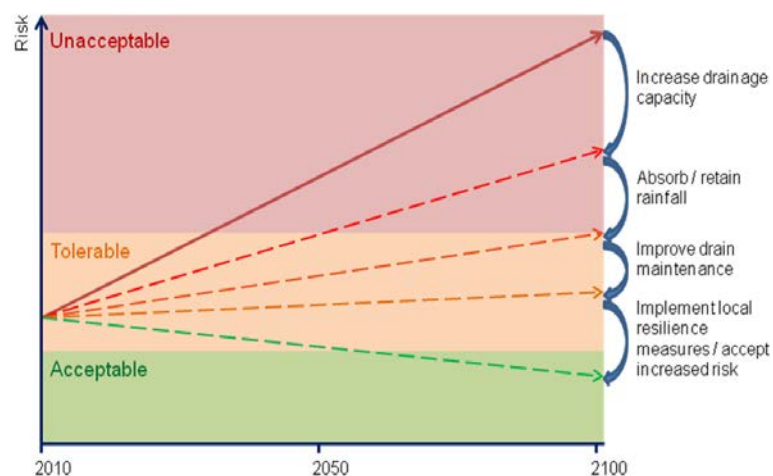
An effective strategy for adaptation to severe weather will be based on risk assessment and climate monitoring, and may need to use a 'pathway' approach – explained below.

Previous approaches, including the Mayor's Climate Change Adaptation Strategy – agreed in 2011, followed a different methodology based more on existing policies.

Formulating a risk-based adaptation strategy

- Assess all major climate risks
 - Assess current resilience to the risks
 - Identify the 'adaptation gap' between the assessed risks and current resilience
 - Formulate options for adaptation, grouped where appropriate into 'pathways' of linked adaptations in progressive sequence
 - Quantify the adaptation needed to a given degree of climate change
 - Monitor climate change indicators
 - Make timely decisions on adaptation actions, informed by the pathways map and the observed climate changes
 - Continue to monitor the progress of adaptation programmes and adaptation gaps
-

Assessing the adaptation gap and planning to close it

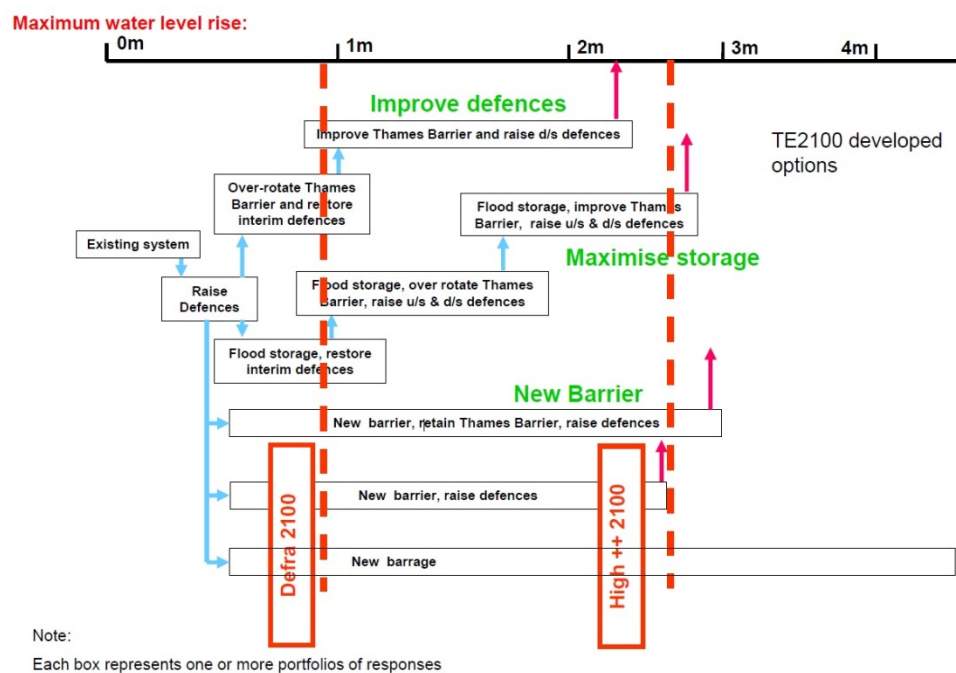


Source: GLA

The benefits of the risk-based approach include that it can highlight which issues most need tackling, and help to prioritise as well as inform action, thus avoiding both failure to adapt sufficiently and wasting resources on actions beyond what is necessary. Tracking progress also maintains awareness of whether the ongoing action is appropriate to the developing climate. An example of this approach is the Thames Estuary 2100 plan – illustrated below.

Thames Estuary 2100

Thames Estuary 2100 'decisions pathway': flood defence options vs sea level rise



Source: Environment Agency

The Thames Estuary 2100 plan sets out options for improving London's tidal flood defences against different degrees of sea level rise. The full plan lays out how long each would take to build, so that timely decisions can be taken on which to go ahead with, based on the observed pace of sea level rise.

These principles are endorsed by the experts we consulted, including the Environment Agency, the GLA and climate governance experts at Oxford University. Policy makers say it should be applied it more widely. However, the Mayor's Climate Change Adaptation Strategy does not fully apply this approach. It was drawn up before detailed assessments of many climate risks were available, and so its focus is led by the policy priorities at the time. Though some quantified targets were set for action, the contributions of those actions to meeting adaptation needs

were not always identified. Future updates to the Mayor's Climate Change Adaptation Strategy, and any new Environment Strategy,³⁶ need to be created through the risk-based approach.

Recommendation 10

The Mayor should produce an action plan update to the Climate Change Adaptation Strategy, setting out actions in response to the recommendations of this report, especially 1-3, and 6-9.

When next issuing or revising the Environment Strategy, the Mayor should take a risk-based strategic approach to climate change adaptation.

This approach should also inform the development of other relevant policies, including the Water Strategy, the London Plan and the Infrastructure Plan, and the work of other bodies such as the Environment Agency and Thames Water.

³⁶ The current [Climate Change Adaptation Strategy](#), and other Mayoral environmental strategies including the [Climate Change Mitigation and Energy Strategy](#), were produced under previous legislation which required six separate environmental strategies. The [Localism Act 2011](#) changed this requirement so that there must be an Environment Strategy, to include coverage of the same six areas. Currently, the existing strategies are taken as fulfilling this requirement in what is effectively a six-volume Environment Strategy. The [Water Strategy](#) covers some of the same ground as the [Climate Change Adaptation Strategy](#), bringing in other work as well, but is not a statutory requirement.

Appendix 1 Recommendations

Recommendation 1

The Government should update, and keep up to date, building standards and regulations regarding climate adaptation issues, including keeping cool as well as keeping warm. To address urban issues, there should be special standards applicable in urban areas.

The Mayor should lobby for these better regulations, making the case for, and helping to develop, standards that are fit for London's current and future climate. The Mayor should work as necessary with others such as the London Climate Change Partnership, the Core Cities, the Zero Carbon Hub, the Environment Agency, and the Committee on Climate Change. The Mayor should report to this committee by the end of 2015 how this case has been presented and what the response has been. This report should also cover actions pursuant to recommendations 7 and 8.

Recommendation 2

The Mayor, in the next progress report on the Climate Change Mitigation and Energy Strategy, should show how he will meet retrofit targets. If he will not meet them, he should show current and anticipated retrofit performance and its implications for climate adaptation and carbon emissions.

Recommendation 3

The Mayor should ensure that retrofit programmes take account of the need to keep properties cool (especially in homes where occupant and building are both at increased risk of harm from overheating). Progress should also be reported in the next update to the Climate Change Mitigation and Energy Strategy.

Recommendation 4

Thames Water should provide the committee with an assessment of its drainage network's ability to deal with heavy rainfall events in London, and its plans to ensure its network keeps pace with the potentially increasing risk of these events in future. A risk-based approach, as described in the conclusion of this report, should be taken.

Recommendation 5

The Government should publish the final version of the national sustainable drainage standards for new developments. In response to this report, it should set out when it intends to do so.

Recommendation 6

The Mayor should demonstrate, with quantified contributions from different actions as in the Climate Change Mitigation and Energy Strategy, how and where his green infrastructure goals (including for tree cover and river restoration) will be met.

Among the contributing actions will need to be better protection and enhancement of existing green infrastructure. The Mayor, with local government, should agree and implement appropriate measures to secure this.

Recommendation 7

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Recommendation 8

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The Mayor should also ensure that these elements are part of developments that he supports through programmes such as Housing Zones, the Outer London Fund and the Estate Regeneration Fund.

Recommendation 9

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Recommendation 10

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When next issuing or revising the Environment Strategy, the Mayor should take a risk-based strategic approach to climate change adaptation. This approach should also inform the development of other relevant policies, including the Water Strategy, the London Plan and the Infrastructure Plan, and the work of other bodies such as the Environment Agency and Thames Water.

Appendix 2 Contributors to the investigation

We held two meetings specifically to hear views and information for this investigation, and the report is also informed by the findings of a third meeting. The meeting dates and guests were:

3 June 2014

- Dr Emily Black, Senior Research Fellow, University of Reading and National Centre for Atmospheric Science, Climate division.
- Dr Matt Huddleston, Met Office Climate Scientist and representative on the London Climate Change Partnership
- Simon Hughes, Deputy Director for London, Environment Agency
- Alex Nickson, Policy & Programmes Manager (climate change adaptation), GLA
- Professor Martin Parry OBE, visiting professor at Imperial College; member of the Adaptation Sub-committee of the UK Committee on Climate Change; senior contributor to the Inter-Governmental Panel on Climate Change.

9 October 2014

- Professor David Balmforth, President-elect, Institution of Civil Engineers; Visiting Professor, Imperial College London; Executive Technical Director, MWH civil engineers
- Ashley Kingsborough, researcher, University of Oxford
- John Kolm-Murray, Seasonal Health and Affordable Warmth Co-ordinator, Islington Council
- David Lofthouse, London Borough of Merton representative to the London Tree Officers Association
- Alex Nickson, GLA
- Nicola O'Connor, Project Manager, Zero Carbon Hub
- John Parker, Transport for London representative to the London Tree Officers Association

3 February 2015

- Richard Aylard, External Affairs and Sustainability Director, Thames Water
- Alex Nickson, GLA
- Sir Tony Redmond, Chair, London and South East Region, Consumer Council for Water
- Kevin Reid, Principal Programme Manager, GLA

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Hindi

यदि आपको इस दस्तावेज़ का सारांश अपनी भाषा में चाहिए तो उपर दिये हुए नंबर पर फोन करें या उपर दिये गये डाक पते या ई मेल पते पर हम से संपर्क करें।

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Arabic

الحصول على ملخص لهذا المستند بلغة،
فرجاء الاتصال بـرقم الهاتف أو الاتصال على
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Gujarati

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