Climate Resilient Cities
A Primer on Reducing Vulnerabilities to Disasters

I/ CITY DESCRIPTION

London has a population of 7,512,400 within the boundaries of Greater London (2006 data), and the metropolitan area is estimated to have a total population of between 12 and 14 million; it is the most populous municipality in the European Union. Greater London covers an area of 609 square miles (1,579 square kilometers), making it the 37th largest urban area in the world. Its primary geographical feature is the Thames, a navigable river that crosses the city from the southwest to the east.

Recent studies show London’s ecological footprint—an estimate of the city’s impact on the planet in terms of resource consumption—to be more than twice the size of Great Britain and about the size of Spain.

In 1995, the ecologist Herbert Girardet estimated London’s footprint to be 125 times the size of the city itself, which meant that London required an area the size of the entire productive land surface of the UK in order to function in terms of its resource use and disposal of pollutants and waste. In 2000 the City Limits project recalculated London’s footprint, and in 2003, the Greater London Authority (GLA) Economics published a review of the ecological footprinting methodology (GLA 2003).

Key findings from the GLA study showed that in the year 2000 Londoners:

- Consumed 154,407 GWh hours of energy, or 13,276,000 tons of oil equivalent, which is about the same as Greece and Portugal (British Council 2004), and produced 41 million tons of CO$_2$;
- Consumed 6.9 million tons of food;
- Consumed 866 billion liters of water, of which 28 percent was leakage;
- Traveled 64 billion passenger kilometers, of which 69 percent was by car; and
- Produced over 26 million tons of waste.

This translated into an ecological footprint for London of 49 million global hectares (gha), which is 42 times its biocapacity and 293 times its geographical area (roughly twice the size of the UK). This represents around 6.6 global hectares per London resident. For Londoners to be ecologically sustainable by 2050, a 33 percent reduction of their ecological footprint by 2020 and an 80 percent reduction by 2050 will be needed. The GLA emphasized that while London’s ecological footprint is high, the city’s CO$_2$ emissions per capita are the lowest in the UK.
The Barrier across the Thames at Woolwich was closed 72 times to protect London from tidal flooding between 1983 and 2007.

II/ PRIORITY HAZARDS/VULNERABILITIES

The British Council and the UK Climate Impacts Program (UKCIP) London’s Warming have found that London is potentially exposed to a far greater risk from flooding than any other urban area in the UK, primarily because of the value of its assets and its geographic location within the floodplain of the Thames River. The draft London Climate Change Adaptation Strategy (GLA 2008) states that London is vulnerable to climate change increasing the risks of floods, drought, and heat waves. London, the studies show, is an “urban heat island.” The center of London, where densely packed buildings absorb solar energy during the day and radiate it at night, is several degrees warmer than the green and rural areas surrounding the city. (City centers create heat, too, although this is thought to be less of a factor for London.) During prolonged heat waves, the difference in temperature can be as much as up to 9 degrees Celsius. This will contribute to detrimental effects on air quality and will increase the amount of electricity used for cooling in the summer months.

Water is also a key issue. London is one of the driest capital cities in the world and climate change could further reduce the amount of water available. London’s catchments and aquifers are already “over-licensed” or “overabstracted” and Londoners use more water than the national average (163 versus 150 liters per day) and only 19 percent of London households are metered (versus 26 percent nationally). Awareness of climate change is increasing, but much work needs to be done to quantify the potential climate change impacts and adaptation options at the local level and to engage decision-makers and stakeholders from householders to government to major private corporations.

The Thames is a tidal river, which makes London vulnerable to flooding (Figure 1). The Thames was once a much broader, shallower river with extensive marshlands; at high tide, its shores reached five times their present width. Since the Victorian era, it has been extensively embanked, and many of its London tributaries now flow underground. London is also vulnerable to flooding from the tributaries to the Thames and heavy rainfall, both of which are predicted to increase under climate change. The threat of flooding has increased over time due to a slow but continuous rise in high water level by the slow “tilting” of Britain (up in the north and down in the south) caused by post-glacial rebound.

In estuaries, flooding can occur as a result of surges caused by the combined effects of atmospheric pressure, high tides, and high winds. In addition, sea levels around the United Kingdom are about 10 centimeters higher than they were in 1900.

It is possible to control the frequency, extent, and size of flooding to some degree. In 1974, a decade of work to deal with the threat began with the construction of the Thames Barrier across the Thames at Woolwich, which protects 150 square kilometers of London that lies below the high tide level. The expected level of protection provided by the Barrier will decline after 2030 unless action is taken, so concepts for its future enlargement or redesign are already being discussed. The Barrier was closed 72 times to protect London from tidal flooding between 1983 and 2007 (Figure 2). The Barrier can also be used to reduce flood risk from high rainfall upstream. In these cases it closes against the tide to keep water levels low in the downstream portion of the Thames so that increased water volume from upstream has somewhere to go.

III/ ADAPTATION MEASURES: ENHANCING RESILIENCE TO CLIMATE CHANGE IMPACTS

London is already beginning to be affected by the impacts of climate change. With more intense rainfall and rising sea levels, the threat of flooding is now acute. Sum-
FIGURE 1. Flood Levels in England and Wales, 1923 to 2007

The data shown are the number of peaks in a year over a threshold that is specified for each river. The threshold is the level which is exceeded on average three times a year over the period 1981 to 2000.

Source: UK Environment Agency.
The London Climate Change Partnership was established to coordinate London’s response in adapting to unavoidable climate change. The Partnership is a stakeholder group coordinated by the Mayor of London, consisting of over 30 key organizations with representation from government, climate scientific community, domestic and commercial development, transport, finance, health, environment, and media.

Some major international cities are already preparing for climate change, and some are dealing with climatic conditions today that London will experience in the coming decades. In early 2006, the London Climate Change Partnership commissioned a review of how other major international cities are managing climate risks (LCCP 2006). The review provided the Partnership with international case studies for climate change adaptation and informed them on forming climate adaptation planning policies for London, especially the Further Alterations to the London Plan. The London Climate Change Partnership wants to ensure that London can learn from good practice in these cities on how to cope with climate risks.

The review examined 18 cities to understand how they are addressing flooding, high temperatures, and limited water resources, the risks that are expected to intensify in London over the coming decades due to climate change. The primary audiences for this report are the members of the London Climate Change Partnership, the Mayor of London, the Greater London Authority, government departments, London Boroughs, developers, utilities and their regulators, and other policymakers and decision-makers in London and other cities.

In August 2008, the Mayor of London published a draft of the London Climate Change Adaptation Strategy (GLA 2008) to identify the key vulnerabilities from climate change and to develop the key actions that the GLA, working with stakeholders, will undertake to protect London. This strategy is the first of its kind in a world city.

The draft strategy proposes several actions and measures that will be adopted by London, including:

- urban greening to reduce flood risk and offset the urban heat island;
London is a leading member of the C40 Large Cities Climate Leadership Group, which is working in a partnership with the Clinton Climate Initiative to reduce emissions across the world. The C40 Group, working with the Tokyo Metropolitan Government and the Great London Authority, held a major conference on adaptation in Tokyo for major cities. The conference resulted in 13 joint actions between these cities to work together on adaptation.

The Association of British Insurers (ABI) is funding researchers and evaluation programs to examine the effectiveness of the Thames Barriers system. ABI also investigated flood risks associated with developments in particular areas of the city and found that the damage expected from flood risk could increase by 5 percent unless sensible flood risk management steps are taken.\textsuperscript{10}

\section*{IV/ Mitigation Measures}

The London Climate Change Action Plan released in February 2007 established the path for turning London into a low-carbon city. The Plan makes it clear that to tackle climate change, Londoners do not have to reduce their quality of life but do have to change the way they live. The Plan sets ambitious targets to reduce carbon dioxide (CO$\textsubscript{2}$) emissions—down 20 percent in 2016 and then down to 60 percent in 2025, both relative to 1990 levels.

Without more rigorous national and international action, including introducing widespread carbon pricing, London’s emissions level in 2025 will only have stabilized at just 30 percent below 1990 levels, half the target.

Data from the London Energy and Greenhouse Gas Inventory (LEGGI) was recently published for 2005. In that year, London emitted a total of 45,868,290 tons of CO$\textsubscript{2}$e (equivalent) of greenhouse gases. Of this, 45,385,360 tons (98.9\%) were CO$\textsubscript{2}$. The London Climate Change Action Plan estimated that these emissions would increase 15 percent by 2025 if nothing is done to reduce them. Since energy supply is the primary cause of climate change, the Plan sets a target to enable 25 percent of London’s energy supply to be moved off reliance on the grid and onto local decentralized energy systems by 2025, with more than 50 percent of London’s energy being supplied this way by 2050.

The London Energy Strategy,\textsuperscript{11} released in 2003, set a target to install at least 7,000 (or 15 megawatt peak capacity) domestic photovoltaic installations, 250 (or 12 megawatt peak capacity) photovoltaic applications on commercial and public buildings, and 500 small wind generators associated with public or private sector buildings. In terms of economic development, the London Development Agency projected that a potential sustainable energy sector (generated as a direct result of deploying technologies as set out in the London Energy Strategy) could be worth around £3.35 billion and could employ between 5,000 and 7,500 people. Renewable energy is part of the suite of measures needed to deliver London’s targets, and building integrated renewable energy (primarily solar and wind energy) is a key part of the renewable energy measures that will need to be implemented in and around London to achieve its ambitious targets (LDA 2003).

A key component of this work is, in fact, to ensure that new buildings in London also contribute to reducing CO$\textsubscript{2}$. This is done through asking developers to follow an “energy hierarchy” of sustainability (adopting sustainable design and construction measures), efficiency (prioritizing decentralized energy generation), and finally renewability (looking at the use of renewable energy).

London’s renewable energy target aims to generate at least enough power for 100,000 homes by 2010 from sources ranging from large wind turbines to domestic photovoltaic installations and domestic solar water heating schemes. Improving energy efficiency in buildings is a key challenge for London, and a number of innovative housing developments such as BedZED in Sutton are combining energy-efficient design with renewable energy production, to deliver zero-carbon-emission buildings even in attractive living environments.\textsuperscript{12} As also stated in the LCCAS, the Mayor of London has also announced that he will work with the GLA to reduce London’s emissions by 80 percent by 2050 (GLA 2008).
The Climate Change Action Plan has several new programs targeting London’s housing. Key areas of focus include retrofitting existing buildings (domestic and commercial) and behavioral change:

- **Supply side:** promoting decentralized energy (i.e. combined heat and power, micro-renewable) and investing in the grid mix;
- **Housing energy:** promoting thermal efficiency of existing housing stock; implementing the New Housing Strategy, which includes renewable energy mix, take up on energy efficiency versions—i.e., for lighting and appliances—upgrade insulation potential, etc.
- **Behavioral change:** implementing awareness campaigns, smart metering trials, etc.

The London Energy Partnership is another innovative and useful program in London’s response to the challenges of climate change, security of energy supply, and fuel poverty. Its role is to bring together a range of sectors and organizations to deliver energy action more effectively. The London Hydrogen Partnership is working to make this technology a reality in the capital and improve air quality, reduce greenhouse gases, reduce noise, improve energy security, and support London’s green economy.

In its fight against air pollution by motor vehicles, London is recognized for its pioneer program called the London Low Emission Zone (LEZ), which is a charging scheme designed to discourage the most polluting heavy vehicles from entering London. Vehicles are defined by their emissions, and those that exceed predetermined levels are charged a fee to enter Greater London. The Low Emission Zone started operating in February 2008 for the heaviest trucks. There is a planned phased introduction of an increasingly stricter regime up to 2012 when it will be fully operational. The scheme is administered

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**FIGURE 3. Central London Congestion Charging Zone**

Source: Central London Congestion Charging Zone reproduced with kind permission of Transport for London. © TfL.
by the Transport for London executive agency within the Greater London Authority. Like the congestion charge, the Low Emission Zone is monitored using automatic number-plate-reading cameras to record license plate numbers. Vehicles entering or moving around the zone are checked against the records of the Driver and Vehicle Licensing Agency to enable traffic enforcement to pursue vehicles that have not paid. This Low Emission Zone built on the Congestion Charging scheme that London launched in 2001 as part of a wider, comprehensive transport strategy (Figure 3).

Notes
This “City Profile” is part of Climate Resilient Cities: A Primer on Reducing Vulnerabilities to Disasters, published by the World Bank. The analysis presented here is based on data available at the time of writing. For the latest information related to the Primer and associated materials, including the City Profiles, please visit www.worldbank.org/eap/climatecities. Suggestions for updating these profiles may be sent to climatecities@worldbank.org.

1 Data from wwwodemographia.com/dm-lonarea.htm.

2 The City Limits report on London Footprint is available online at www.citylimitslondon.com/download.htm.

3 The ecological footprint of London tourists was estimated by the same study at 2.4 million gha, which equates to an additional 0.32 gha per Londoner.


5 The Department for Environment, Food and Rural Affairs (formerly DETR) commissioned a consortium to evaluate the impact of climate change on the demand for water in England and Wales. The project began in June 2000 and produced the final report in February 2003. The report, “Climate Change and Demand for Water,” is available at www.sei.ac.uk/oxford/ccdew/index.html.

6 Thames Water loses 23 percent (609Ml/d) of water through leakage.

7 Data and information on flooding are from the Environment Agency at the following web site: www.environment-agency.gov.uk/yourem/cfe/1190084/natural_forces/flooding/?version=1&lang=en.

8 For example, the Environment Agency reports that between New Year’s Day and 8 January 2003, high rainfall upstream and high spring tides increased London’s flood risk. During this period the Barrier was closed a record 14 times. This is double the previous record of 7 consecutive closures during the floods of October 2000.

9 The London Climate Change Agency has been established with the support of the following founders: BP, Lafarge, Legal & General, Sir Robert McAlpine, Johnson Matthey, and the City of London Corporation. The Agency is also being supported by the Rockefeller Brothers’ Trust, KPMG, Greenpeace, the Climate Group, the Carbon Trust, and the Energy Saving Trust.

10 Association of British Insurers. See www.abi.org.uk.

11 The London Energy Strategy will be superseded by the GLA Climate Change Mitigation and Energy Strategy which is currently being developed. The targets quoted here are to be reviewed.


14 For more detail see: www.tfl.gov.uk/roadusers/lez/default.aspx.

15 For information on the congestion charging scheme, see www.tfl.gov.uk/roadusers/congestioncharging/default.aspx.

References


