Urban Heat Island Effect

The urban heat island effect is the term used to describe the way that hard-surfaced urban environments respond more quickly and more radically to temperature changes. In the summer this overheating leads to surges of electricity use as office air conditioning, refrigerators and electric fans are switched on as well as increases air pollution from gas-fired air conditioning and heat-pumps. Warm air can become trapped near to ground level and the resulting temperature rises increase the occurrence of heat stress–related mortality and illness (Rosenfeld et al. 1995; Nowak et al. 2000; Sailor et al. 2002; Hogrefe et al. 2004).

Summer Effects

Because of global warming, the danger of extreme summer over-heating is increasing. In the Europe-wide heatwave of August 2003, over 700 deaths were recorded in Paris. In London, where the temperatures were less extreme, 64 deaths have been directly attributed to heat-stress during that event. Climate change has increased the risk of a similar event occurring in London from 1 in 7 years, to 1 in 2.5 years (Mitchell et al. 2016).

Winter Effects

In the winter it is a temperature inversion that can cause the worst pollution. Hot air, rising from the city is trapped below a cushion of cold air. Because London lies within a natural valley, warm air cannot easily dissipate and instead the trapped air accumulates higher than acceptable levels of greenhouse gasses and pollutants. Those pollutants are caused by traffic, emissions and tyre residue as well as pollutants from domestic and commercial gas fired heating and air conditioning systems. Because traffic and emissions from gas fired heating are at their highest in the coldest months of the year this temperature inversion, exacerbated by winter over-heating, can be even more dangerous than summer over-heating. Unlike the old 'pea-soupers' caused by a very visible coal smoke smog, nitrous oxides and particulates are too small to be seen. So on a bright and ostensibly clear cold day, levels of pollution may be high, but the atmosphere may seem insidiously clear.

Statistics

Statistics on urban heat island effect and pollution in Central London are patchy.

Temperature: There are no met-office temperature recording stations in Central London. The one on the roof of the BBC was removed some years ago.

Weather Station	Location	Altitude
HAMPSTEAD	51.560, -0.178	137 m above mean sea level
LONDON, ST JAMES'S PARK	51.504, -0.129	5 m above mean sea level

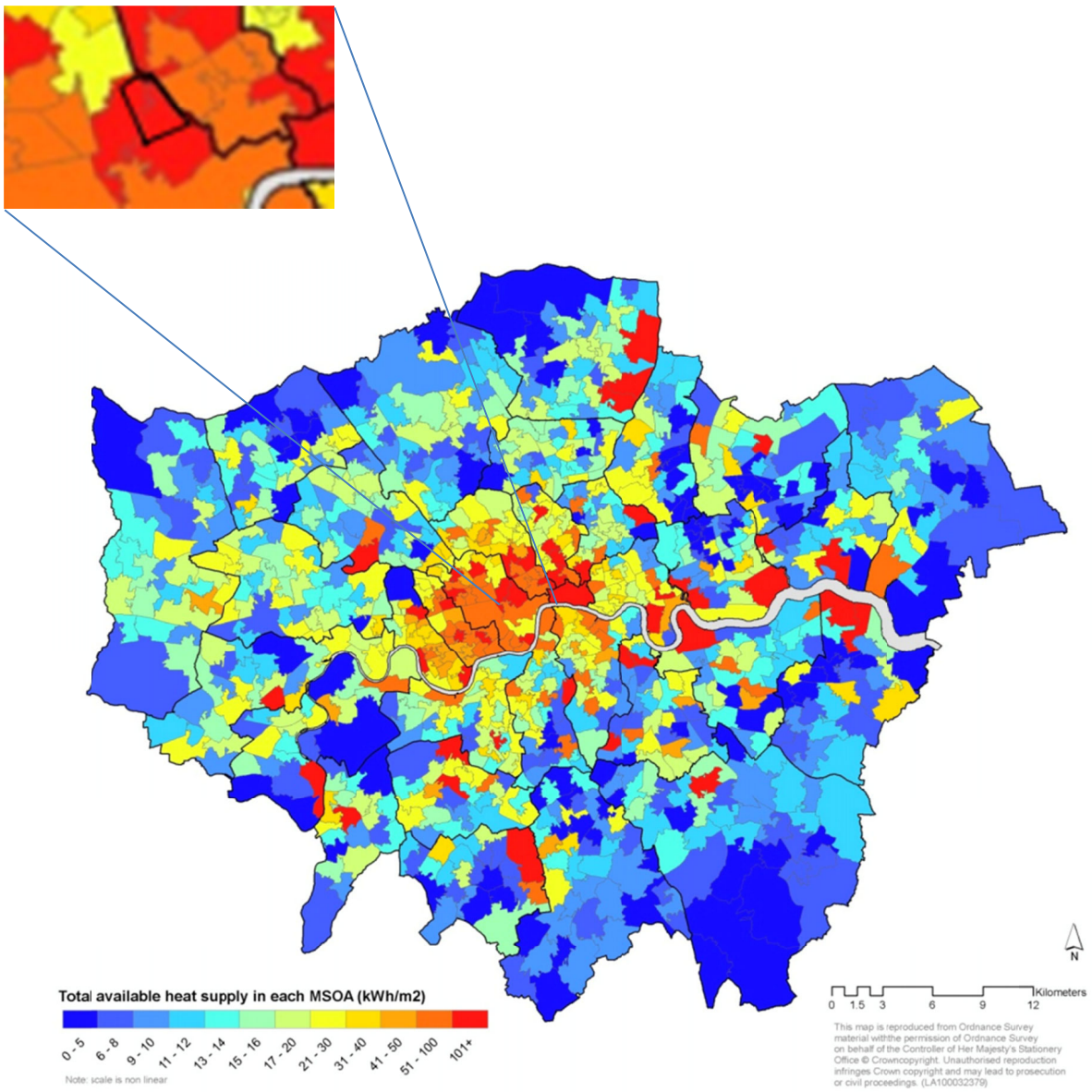
These stations can be monitored by the general public by reference to the following websites:

http://www.severe-weather-centre.co.uk/en/europe/united-kingdom/weather-london-st-jamess-park/details/S037700/

http://www.weathercast.co.uk/world-weather/weather-stations/obsid/3770.html

The records show that St James Park is consistently warmer than Hampstead, in spite of its park location (which might be considered to mitigate the impact).

Satellite imagery of London reveals similar data. The insert below shows the approximate location of Fitzrovia, against the boundary of the Borough of Camden which is Cleveland Street.



Above: Heat output of central London, overlaid on map of the borough and ward boundaries. Inset shows the approximate location of Fitzrovia, straddling West End and Marylebone High Street ward boundaries. Credit Chris Grainger of Buro Happold. You can download the data used to create them here

Source: http://mappinglondon.co.uk/2013/londons-wasted-heat/

Pollution: In the 2017 report by Kings College, *Pollution in London by* Mittal and Baker they cited Westminster Marylebone Road and Oxford Street as displaying annual mean levels above the national air quality standards for the presence of nitrogen dioxide (NO^2) as well as registering very high levels of nitrogen oxides (NO^x) equivalent to Ealing, Hangar Lane and Lambeth, Brixton Road. Emissions of nitrogen oxides are not covered by national air quality standards. According to this report, they main source in London of these pollutants is diesel traffic emissions.

Unfortunately measurements at Oxford Street do not record ozone, sulphur dioxide or particulate matter, even though these all registered as high on Marylebone Road. It should be noted that these measurement locations were chosen because of their significance as principal traffic corridors. Neither Westminster City Council, nor the Greater London Authority, has considered the 'double whammy' in densely urbanised areas such as Fitzrovia where the urban heat island effect contributes to pollution, reduces the dilution of greenhouse gasses and increases their negative effect due to temperature rises. Thus in central London we cannot assume that the direct relationship between pollution and traffic flows would be as marked. (Mittal & Baker, 2018).

Damian Carrington in The Guardian (2018) reported that air pollution from NO^2 causes an estimated 23,500 early deaths every year in the UK.

Responsibility

The GLA and the London boroughs have responsibilities for the management of air quality and must work towards the attainment of DEFRA's air quality (AQS) objectives for the UK. The principal methods by which they can manage air quality is via traffic management and town planning.

Pollutant	Concentration	Measured as	To be achieved by (UK)	To be achieved by (EU)
Carbon Monoxide (CO)	10.0 mg m^{-3}	Maximum daily running 8-hour mean	31 December 2003	1 January 2005
Nitrogen Dioxide (NO_2)	200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	31 December 2005	1 January 2010
	40 µg m^{-3}	Annual mean	31 December 2005	1 January 2010
Sulphur dioxide (SO_2)	350 µg m^{-3}, not to be exceeded more than 24 times a year	1-hour mean	31 December 2005	n/a
	125 µg m^{-3}, not to be exceeded more than 3 times a year	24-hour mean	31 December 2004	1 January 2005
	266 µg m^{-3}, not to be exceeded more than 35 times a year	15-minute mean	31 December 2005	1 January 2005
Ozone (O_3)	100 µg m^{-3} not to be exceeded more than 10 times a year	8 hourly running or hourly mean	31 December 2005	n/a
Ozone (O_3)	Target of 120 µg/m3 not to be exceeded more than 25 times a year averaged over 3 years		n/a	31 December 2010
Particles (PM_{10}) (gravimetric)	50 µg m^{-3}, not to be exceeded more than 35 times a year	Daily mean	31 December 2004	1 January 2005
	40 µg m^{-3}	Annual mean	31 December 2004	1 January 2005
Particles ($PM_{2.5}$) (gravimetric)	25 µg m^{-3}	Annual mean	2020	1 January 2015
	20% cut in urban background exposure	Annual mean	2010 - 2020	2010 - 2020

Table 1: AQS Objectives and EU Limit Values.

Above: UK Measures of pollution and Air Quality Standards. From DEFRA (2008)

The issues in Fitzrovia

Measures for Fitzrovia can be grouped as follows in order of their local importance:

A Measures that directly reduce pollution and emissions of greenhouse gasses:

- Reduction of traffic
- Reduction of pollutants in vehicle fuels
- Reduction of gas-fired heating and air conditioning

B Measures that reduce heat gain from solar radiation:

- Tree planting
- Green rooves
- Reduction in surface albedo (reflectance)
- Pervious surfaces – grass, planting, gravel etc.

C Measures that reduce the carbon footprint of people living and working in the area: i.e. contribute to a reduction in global warming generally.

- Reducing the need to travel
- Increasing reliance on local and sustainable food sources
- Reducing waste, encouraging recycling

Studies have shown that the global effects on climate change by urbanisation, that changes the surface albedo (reflectance) may be comparable with that due to anthropogenic aerosols, solar variation and several of the greenhouse gases. Moreover, in regions of intensive human-caused land-use change such as North America, Europe and southeast Asia, the local radiative-forcing change caused by surface albedo may actually be greater than that due to all the well-mixed anthropogenic greenhouse gases together (IPCC2001) However it is generally consider that to reduce the urban heat island effect by any meaningful figure all measures found under B should be used.

High-albedo surfaces

Recent research is showing that the paler the surface, and the more reflective it is, the lower is the absorption of heat from sunlight. Rosenzweig, Solecki, Parshall et al (200) states,

> *High-albedo surfaces can reduce the absorption of radiation. For example, pavements can be made more reflective through the use of lighter-colored aggregate in asphalt or of other resurfacing material, or through substituting concrete for asphalt (Davis et al. 1992). A case study of Los Angeles showed that increasing citywide albedo by 15% could reduce surface air temperature in the downtown area by up to 2°C in the mid-afternoon (Taha et al. 1997)*

The Fitzrovia Design Guide (FitzWest 2017) explains how historically in Fitzrovia the prevailing surfaces are York stone paving and Portland stone facings. Victorian buildings are London brick with some soap-stone detailing. Edwardian buildings have more extensive soap-stone or Portland stone details, interspersed with red (Kentish) brick. White render can also be found as an equivalent of

Portland Stone facings. Black brick, or tarmac is neither historically in-keeping, nor appropriate for urban heat island mitigation. Reflective glass panels, tiles and faience all have historic precedents in Fitzrovia as well as a high albedo score.

The Checklist

Responding to the evidence above, the Fitzrovia Neighbourhood Forum has established a checklist that can be used by anyone wishing to scrutinise a design. This checklist has been set up to specifically address the Fitzrovia situation. Its purpose is as an aid-memoir when designing and for early pre-application discussion with officers. The aim should be to improve the score as the scheme comes closer to application stage.

NOTES

When reading the checklist please have regard to the following.

1. Measures to manage transport issues are generally part of a transport management study that should accompany any commercial or multi-housing application of size.

2. Other important measures may also be are found in a design and access statement.

3. For full details of albedo levels refer to Davis, Martien, & Sampson, (1992)

4. All areas of Fitzrovia are well served by public transport. Therefore the need for a private vehicle is limited.
   May include a contribution to improved provision for public pedestrian, cycle and disabled access to and around building (including crossing points etc.)

5. Because of high land values there is good scope for higher than building regulations standards. Air conditioning is often justified because of higher than normal night time noise. However Fitzrovia does not possess this and other planning strategies should not allow night time noise to increase.
   The presumption should be in favour of solar panels, photovoltaics and/or passive ventilation and solar gain.

6. Green space is in short supply in Fitzrovia. So any space is welcome as a mitigate of the heat island effect, but also a refuge. Even a window box makes a contribution, as do private or shared residential balconies.

7. Generally the paler the surface and the more reflective the better. May include water and fountains.

8. Sustainable drainage schemes, including speed of run-off and destination for surface water should also be considered.

Climate Change/Urban Heat Island Checklist for Fitzrovia

Numbers refer to notes above.

SCHEME				DATE			ORIGINATOR	
	Issue	Measures to consider		CHECKPOINTS Tick as appropriate			Recommended modifications	
		Housing	Non-housing	Red	Orange	Green		
Reduction of pollution and emission of greenhouse gasses.								
1.	Reduction of traffic[1]	Reduced of on-site parking Cycle parking/ Ability to work at home/	Cycle parking/EV charging Deliveries/maintenance arrangements				4.	
2.	Reduction of pollutants in vehicle fuels[1]	EV charging available to residents	Transport reduction measures for staff					
3.	Reduction of gas-fired heating and air conditioning	No air conditioning. Passive house or low emissions/eco development. Opening windows Natural lighting – including in common parts.	No air conditioning. Opening widows Natural lighting. Electrical management system.				5.	
4.	Low energy building	Natural ventilation, natural lighting	Natural ventilation, natural lighting					
Measures that reduce heat gain from solar radiation								
1.	Tree planting	May include contribution to street planting	May include contribution to street planting					
2.	Green rooves and green space	Increase mark if greening is function, food growing, provides children's play or is accessible.	Increases if green roof is publically accessible				6	
3.	Albedo level[3]						7.	
4.	Percentage of impermeable surfaces						8.	
Measures that reduce the carbon footprint of people living and working in the area: i.e. contribute to a reduction in global warming generally.								

1.	Reducing the need to travel	High quality internet access. Consolidated delivery area	High quality delivery/collection systems				
2.	Increasing reliance on local and sustainable food sources	Contribution to local schemes can be included here.	Local applicants/local suppliers. Provision for small and local businesses. Provision for services for home workers.				
3.	Reducing waste, encouraging recycling	Recycling systems Waste sorting and storage	Recycling systems Waste sorting and storage				
Other issues							
1.							
2.							
3.							
Conspicuously wasteful							
1.	External patio heaters						
2.	Shop doors designed to be open all year around						
SCORE Add up number of ticks in each box.							
FURTHER COMMENTS							

Monitoring
Temperature and Humidity

Without a means of measuring temperature and humidity in Central London, there is no way of monitoring the situation.

Recommendation

That Westminster City Council invest in a central London Automatic Weather Station, cited to capture the prevailing conditions of the urban situation (i.e. not in a park).

Night Time Noise

The natural diurnal temperature flux of a building is normally adequate in temperate climates to cool the building down naturally overnight. However if windows or ventilators cannot be opened at night due to night time noise or adverse levels of pollution then passive systems cannot work. So accompanying such measures must be a commitment from Westminster City Council and the GLA to maintain the relatively quiet levels at night enjoyed in Fitzrovia which has the highest population of all West End Forums and the lowest number of night time activities. Thus deliveries, rubbish collections, late licenses etc. could seriously degrade the ability of the area to retain its sustainability.

Internet Access

The ability to work from home, to hold tele-conferences etc. is limited if internet access is poor. There are some improvements in the West End, but this also becomes and important point to monitor.

Raising Awareness

This is a little understood aspect of climate change that is extremely pertinent to planning applications and strategic policy making for Westminster in general and the West End in particular. FitzWest itself could take a longer term role in raising awareness of the issues and acting to scrutinise planning applications and policies.

FitzWest

Fitzrovia Neighbourhood Forum

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