Green Infrastructure
GI4AQ
(Does it all add up?)
Churchman Landscape Architects
Birmingham Institute For Forest Research (BIFOR)
50,000 Preventable Deaths Per Year in UK Due to Pollution
Leading cause of mortality worldwide

Worldwide 3 million premature deaths per year
Total NOx emissions fell by 37% between 1990 and 2000 and were expected to fall a further 49% between 1999 and 2010. Air Quality Expert Group-Draft Report on Nitrogen Dioxide. UK emissions of NOx fell by 19% between 2010 and 2015. DEFRA: Improving Air Quality in UK May 2017. Government objective is for every car and van to be zero emission by 2050.
Air pollution in London passes levels in Beijing... and wood burners are making problem worse

By Sarah Newton, science reporter
23 January 2016 12:35 GMT

London breaches air pollution limits for 2018

London breaches air pollution limits for the whole year, just 31 days into 2018.

Westminster breached the limit on 3 January, Lambeth on 31 January. Under EU rules, a limit of 200 micrograms per cubic metre of nitrogen dioxide for the whole year was exceeded, with six days during January hitting 400 micrograms per cubic metre.

Academics claimed this week that Oxford Street has the worst nitrogen dioxide pollution in the world. Today the European Court of Justice is hearing evidence in a case against UK’s consistent breaches of EU air standards. With your help, Karl Mathiesen investigates how bad things are.

Does London have the worst NO2 pollution on Earth?

Karl Mathiesen freelance@theguardian.com or tweet @karlmathiesen

Sadiq Khan triggers alert for high air pollution in London

Capital is given emergency warning as polluted air from the continent combines with toxic air at home

Revealed: every Londoner breathing dangerous levels of toxic air particle

Exclusive: Every area of the capital breaches global standards for PM2.5 pollution particles, with most areas exceeding levels by at least 50%
Figure 3: UK national average NOx roadside concentration apportioned by source of NOx emissions, 2015

Source: PCM modelling provided by Ricardo Energy & Environment (2017)

Note: ‘Local road traffic’ in the large pie chart is the estimate of the proportion of local NOx roadside concentrations contributed by traffic on that road and is shown in greater detail in the smaller pie chart. ‘Road traffic background’ is the estimate of NOx concentrations contributed by traffic on other roads.

* Other (petrol) is made up of petrol vans and motorcycles.

HGVs = Heavy Goods Vehicles.
Pollution events are site and time specific.
Schools located in areas where pollution levels exceed recommended thresholds are mostly in Inner London, 86% of the primary schools and 88% of the secondary schools.
Growing claims that GI can help to mitigate pollution

“Trees Can reduce pollution by 40% NOx and 60% Particulates”

Source: *Environmental Science and Technology*: 2012
More than £1bn saved in health costs in one year thanks to pollution removal by plants

Statisticians have estimated that more than £1 billion was saved on health costs in the UK in 2015 thanks to plants removing pollution from the environment.

The figure is based on an estimated 5,800 fewer respiratory hospital admissions, 1,300 fewer cardiovascular hospital admissions, 27,000 fewer life years lost and 1,900 fewer premature deaths in the UK in 2015 because of the role vegetation plays in removing pollution. In 2015, UK vegetation was estimated to have removed 1,354k tonnes of the particulates PM2.5, SO2, NO2 and O3 from the atmosphere.

The Office of National Statistics (ONS) commissioned the Centre for Ecology and Hydrology, the Economics for the Environment Consultancy and EMRC to conduct a natural capital analysis of the effect of vegetation on pollution.

Healthy Design, Healthy Places
Mayor offers £1 million green grants to improve air quality

30 August 2017

The Mayor of London, Sadiq Khan today visited the Royal Botanic Gardens Kew, in Richmond, as he encouraged community groups to apply for his £1 million Greener City Fund to help deliver more air quality improving trees, plants and green play areas in every neighbourhood.

Trees and plants play an essential part in reducing London’s dangerously polluted air, as well as being a vital part of our landscape. The Mayor wants to protect London’s Green Belt and help make the capital the world’s first National Park City. His £1 million Greener City community fund is part of his wider £9 million funding to help schools, boroughs and local groups improve their local environments.

The end of parklife as we know it? The battle for Britain’s green spaces

09 July 2017

Britain’s parks are in crisis. With councils such as Bristol cutting spending to zero, and land being lost to developers, what’s happening to our public gardens?

We can expect, now that cracks are appearing in the government’s commitment to austerity, calls for many deserving causes to be released from their starvation diets. Of these, Britain’s parks and green spaces have been among the most viciously cut. They cost little in relation to their benefits. They are also assets for the long term, representing years and decades of investment that will be lost if they are degraded or, as is happening in some cases, sold off or built over. If, as David Cameron says, the point of austerity is to give future generations protection against future hard times, it makes no sense to throw away things of lasting capital value. Once gone, they won’t come back.
Specify your interests and start searching for arboreal plants from which you can get more benefits.

In the report you will get a list of the most used tree species for urban greening, arranged according to a score [0-10] expressing the degree of compliance with shared requirements. Climatic and site requirements are measured (if you specify the location), the correspondence to the possible required height and the value of the potential environmental benefits of species weighted according to the specified scale of Importance from 0 to 10 (*). In the report there are reported indicative benefit estimates for single adult plant (or m²), too, if required to display them.
<table>
<thead>
<tr>
<th>London's Urban Forest - Key Statistics</th>
<th>Inner London</th>
<th>Outer London</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Trees</td>
<td>1,587,000</td>
<td>6,834,000</td>
<td>8,421,000</td>
</tr>
<tr>
<td>Tree Cover</td>
<td>13%</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>Canopy Cover</td>
<td>18%</td>
<td>21%</td>
<td>21%</td>
</tr>
<tr>
<td>Most Common Species</td>
<td>Birch, Lime, Apple</td>
<td>Sycamore, Oak, Hawthorn</td>
<td></td>
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<tr>
<td>Pollution Removal (per annum)</td>
<td>561 tonnes</td>
<td>1,680 tonnes</td>
<td>£126.1 Million</td>
</tr>
<tr>
<td>Stormwater Alleviation (per annum)</td>
<td>705,000m³</td>
<td>2,705,000m³</td>
<td>£2.8 Million</td>
</tr>
<tr>
<td>Carbon Storage (whole value)</td>
<td>490,000 tonnes</td>
<td>1,868,000 tonnes</td>
<td>£146.9 Million</td>
</tr>
<tr>
<td>Carbon Sequestration (per annum)</td>
<td>15,000 tonnes</td>
<td>61,300 tonnes</td>
<td>£4.79 Million</td>
</tr>
<tr>
<td>Building Energy Savings (per annum)</td>
<td>£223,000</td>
<td>£37,600</td>
<td>£260,600.00</td>
</tr>
<tr>
<td>Building Avoided Carbon Emissions (per annum)</td>
<td>£23,600</td>
<td>£31,000</td>
<td>£54,600</td>
</tr>
<tr>
<td>Replacement Cost (whole value)</td>
<td>£1.35 Billion</td>
<td>£4.77 Billion</td>
<td>£6.12 Billion</td>
</tr>
<tr>
<td>Amenity Value (CAVAT) (whole value)</td>
<td>£17.6 Billion</td>
<td>£25.7 Billion</td>
<td>£43.3 Billion</td>
</tr>
<tr>
<td>TOTAL ANNUAL BENEFITS</td>
<td>£59.54 Million</td>
<td>£73.16 Million</td>
<td>£132.7 Million</td>
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</table>
Problems in accurately defining level of mitigation offered

• Too many variables
• Every condition is different
• Conditions are dynamic
• Cannot set up a control

Orientation, elevation, urban pattern, density of buildings, relationship to open space, relationship to natural corridors, rivers etc, relationship to natural topographic features, aspect, Spatial parameters (height to width), Wind direction, wind speed, turbulence, adjacent activities, down wind activities, shading, growth rate of trees, maturity, height and state of existing vegetation, in ground conditions, fertility of soils.
How as designers might we reduce effects of pollution?

- How does pollution enter the atmosphere?
- What happens once pollutants are in the atmosphere?
- How are pollutants absorbed by plants?
- Can pedestrians be removed from source?
- Are there good and bad practices which mitigate/exacerbate pollution effects?
Principal Pollutants  NOx  and PM10s

Resulting From vehicle emissions in London

NOx  =  50%

PM10s  =  80%
Ozone Good

NOX + Sunlight = OZONE

Ozone Bad
Cities morphology

Hong-Kong

London
Where are plants likely to be most effective in reducing levels of pollution?

- Where concentration is highest
- Where air mixing is greatest
- Where residence time of pollution is longest
- Where there is greatest separation between source and receptor
- At locations of greatest sensitivity e.g. schools, hospitals
Effectiveness of Planting in absorption of pollutants

<table>
<thead>
<tr>
<th>Efficiency</th>
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<tbody>
<tr>
<td>Site Specific Planting</td>
</tr>
<tr>
<td>1e</td>
</tr>
<tr>
<td>1b</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3e</td>
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<tr>
<td>3d</td>
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<td>4</td>
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<td>5</td>
</tr>
</tbody>
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Are there good and bad trees to plant for improving air quality?
Are there good and bad trees to plant for improving air quality?
Circumstances where planting exacerbates effects of pollution
Are there optimal and suboptimal arrangements of planting?
Worst Development Scenarios: Street Canyons
Can trees naturally worsen the effects of pollution?
All plants synthesise reactive VOCs and release to atmosphere

- All trees release biogenic VOCs
- Isoprene C5H8 191, 2-methyl-1,3butadiene
- Produced by biogenic (trees) and anthropogenic (cars) sources
- In London 50% of Isoprene is due to vegetation on warm days
- Biogenic VOCs produce Ozone
- This is a delayed reaction so effect can be downwind
- Biogenic VOCs account for 10% of ozone concentrations within and downwind of urban areas
- Ozone production increases with temp so global warming will exacerbate problem
Do plants have the Ability to deal with extreme pollution events
Methods of Assessing Acceptable Thresholds of Gaseous Pollution

• Hourly Objective: Concentration of NO2 in the air. Max allowable = 200ugm-3 with no more than 18 exceedences per year

• Annual objective: Concentration of NO2 averaged over a period of a year = 40ugm-3

• Incidence of extreme winter events is increasing while summer exceedences are diminishing

Source: Air Quality Expert Group: Nitrogen Dioxide in the United Kingdom
EXTREME EVENTS
Conclusions

• Most effective means of tackling air quality is by reducing output from primary source
• Trees / vegetation can have a positive effect on mitigating pollution
• Worst effects are localised, i.e. roadside and in street canyons
• The level of mitigation offered can be increased through choice of plant and by careful selection of correct planting position.
Dealing with problem at source, future of cars