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App for 'Clean Air in Cities Index'

This App reports the health impact of long-term exposure to dangerous airborne particles ($PM_{2.5}$) for the population in a local area, region and England as a whole. It does not measure or display the number of actual deaths from air pollution or the risk for an individual.

Ambient or outdoor air pollution comprises particles and gases. The particles, which can comprise anything from tiny droplets to diesel soot and tyre and brake wear, are called 'dangerous airborne particles' or 'particulate matter' and are classified by their aerodynamic diameter in microns (one-millionth of a metre (μm) which is about one-hundredth of the thickness of a human hair) e.g. $PM_{2.5}$ and PM_{10}. Concentrations of $PM_{2.5}$ in ambient (or outdoor) air are measured in micrograms per cubic metre ($\mu g/m^3$). Air pollution that is 'human-made' is described as 'anthropogenic' with total air pollution being the sum of anthropogenic and non-anthropogenic (e.g. Sahara sand or volcanic dust). The World Health Organisation (WHO) has found no safe level for human exposure to $PM_{2.5}$.
The gases, which can coalesce and become particles, are mainly nitrogen dioxide (NO_2), ozone (O_3) and sulphur dioxide (SO_2). NO_2 is the only 'modern' molecule within the whole gaseous component of air pollution subject to WHO guidelines and legal limits. Whereas the particle component of air pollution is regulated by its total mass concentration, gases other than NO_2 are largely ignored. It is vital therefore that levels of NO_2 are reduced to avoid: its direct health effects and those of other toxic pollutants from combustion; and its contribution with nitrogen monoxide (also known as nitric oxide) as a precursor to the formation of deadly particles. SO_2, which is also regulated, has been largely eliminated as a problem by the use of ultra low sulphur fuels.

The Department of Health (DoH) has estimated that during the Great Smog of December 1952 there were 4,075 deaths in London attributable to short-term exposure to 'visible' air pollution. Scientists did not know about the effects of long-term exposure to air pollution until they began in the 1990s to study large cohorts of the population (i.e. one group of people as they aged) living in cities with different levels of air pollution.

It was only in 2010 that scientists published estimates of the number of deaths attributable to long-term exposure to $PM_{2.5}$ in the UK. Mayor Johnson estimated 4,267 deaths in London in 2008 attributable to long-term exposure to total $PM_{2.5}$. The Committee on the Medical Effects of Air Pollution (COMEAP) lead the way nationally by estimating, using the language used for alcoholism, obesity and smoking, 29,000 deaths in the UK in 2008 attributable to long-term exposure to anthropogenic $PM_{2.5}$ at an average loss of life for these people of about 11.5 years.

COMEAP and the Mayor's estimates were calculated after eliminating the effect of dozens of other possible risk factors (e.g. smoking and educational status as a surrogate for income) to produce a pure number assuming air pollution is the sole cause of those deaths. In Clean Air in London's (CAL's) view, these estimates are much more meaningful to members of the public than 'years of life lost' or an 'average loss of life of six months for everyone in the UK' favoured by the Government.

The estimates of 4,267 and 29,000 extra or excess deaths are good ones for comparing the effects of air pollution with the effects of other causes such as alcohol, active or passive smoking, obesity, diet etc which are calculated in the same way. However, COMEAP has shown us that because, in practice, individuals experience multiple risks, including air pollution, almost certainly air pollution

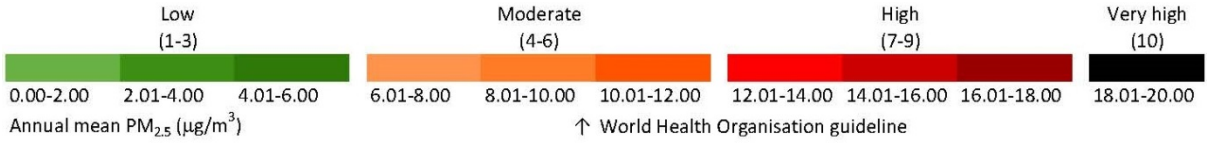
played some part in shortening the life of a much larger number of individuals. It is not possible to estimate that number but, given that much of the impact of air pollution on mortality is linked to cardiovascular deaths, it is reasonable to consider that air pollution may have contributed to all 200,000 deaths due to cardiovascular causes in the UK in 2008 (i.e. one in three of all deaths) at an average additional loss of life for these people of about two years (at typical ages for cardiovascular deaths e.g. 15% of which are before age 65).

The DoH now includes an indicator for 'Air Pollution' in the 'Health protection' section of the 'Public Health Outcomes Framework' provided to Directors of Public Health and Health and Wellbeing Boards in every local area in England. COMEAP recommended the Government include estimates for: the number of deaths attributable to long-term exposure to $PM_{2.5}$; the attributable fraction, which is the fraction of all-cause adult mortality attributable to anthropogenic $PM_{2.5}$; and the total years of life lost which equates to the number of attributable deaths times the average additional loss of life of about 11.5 years.

This App displays population-weighted annual mean concentrations of total $PM_{2.5}$ (i.e. the sum of anthropogenic and non-anthropogenic) and the fraction (in percentage terms) and pro rata number of deaths attributable to long-term exposure to anthropogenic $PM_{2.5}$ for local areas, regions and England as a whole in 2010. CAL has taken the DoH's published estimates for attributable fraction and the DoH has provided to CAL the estimates of anthropogenic, non-anthropogenic and total $PM_{2.5}$. CAL has calculated the number of attributable deaths in 2010 based on its understanding of the methodology recommended by COMEAP.

The Apps displays a pro rata number of attributable deaths for the calendar year to date for local areas, regions and England as a whole. The App also estimates the time to the next pro rata attributable death and uses a 'clock' to illustrate the time to the next pro rata attributable death for England, local areas and/or regions e.g. if the timer has moved two-thirds of the 'clock' it means two-thirds of the time has passed between the previous and next such death. The User has the option initially of displaying the above information for one local area, one region and/or England as a whole.

In addition, CAL has created a new colour-coded index to report its view of the potential health impact of long-term exposure to different annual mean concentrations of total $PM_{2.5}$. This index is called the 'Clean Air in Cities Air Pollution Index' or the 'Birkett Index'. The Index starts at zero and increases in 10 bands of 2.0 $\mu g/m^3$ to 20 $\mu g/m^3$ in population-weighted exposure to total $PM_{2.5}$ in a local area or region. The WHO guideline is 10 $\mu g/m^3$ for total $PM_{2.5}$ but the WHO has found no safe level of human exposure to it down to 8 $\mu g/m^3$ or below. CAL has therefore chosen bands of LOW (zero to 6.0 $\mu g/m^3$), MODERATE (6.01 $\mu g/m^3$ to 12.0 $\mu g/m^3$), HIGH (12.01 $\mu g/m^3$ to 18.0 $\mu g/m^3$) and VERY HIGH (18.1 $\mu g/m^3$ to 20.0 $\mu g/m^3$). On this basis, the WHO guideline is at the top of the middle of the three sub-bands within the MODERATE band.



The 'Clean Air in Cities Air Pollution Index' (or the 'Birkett Index') uses similar colours to the Daily Air Quality Indexes used in the UK, the United States and elsewhere. This is deliberate in order to reflect CAL's view on the dangers of long-term exposure to $PM_{2.5}$ relative to WHO guidelines for

such exposure (whether short-term or long-term). Please note however that, as described earlier, the health impacts of short-term and long-term exposure to air pollution are quite different. CAL is the first, as far as it is aware, to propose such an index for long-term exposure to air pollution.

The App allows Users to see three levels of information in the grouping shown also in the 'Public Health Indicators' i.e. local areas, regions and England as a whole. Users may choose to display two local areas or regions or one of each in addition to England as a whole which is included to give context to any local area(s) or region(s) chosen. These local areas or regions can be selected by typing in letters in the appropriate menu. The four nearest local area(s) will also be offered if the GPS function is operating for the mobile/iPad. Thereafter, Users have the option of making one or more donations to CAL and adding other local areas or regions in England using a similar process. The Edit function allows Users to delete or change the order of locations displayed in the App and the Share function allows the latest information for an area to be disseminated to others.

A more detailed explanation of the health impacts of air pollution is available on the CAL website.

This App is intended to build public understanding of the health impact of air pollution. Please contact us if you have comments or suggestions for improving it at: contact (at) cleanairinlondon (dot) org.