A simple model of urban air pollution

Traffic fumes can cause serious health problems, but their distribution and spread in complex urban environments can be hard to predict. Now, researchers have created the ‘STEMS-Air dispersion model’, which can be used by planners and health authorities to give accurate daily and annual estimates of exposure to traffic fumes and other forms of air pollution in cities.

Air pollution from traffic and other sources in urban areas has been linked with respiratory and cardiac illness, yet it can be difficult to measure accurately how much air pollution people are exposed to. Mathematical modelling provides an alternative way to estimate exposure in urban areas. Existing modelling techniques, such as land use regression, can model air pollution over long timescales but, as they do not account for local weather conditions, they are not suitable for modelling daily exposure to air pollution. Instead, dispersion models are often used for shorter timescales, such as daily predictions. However, dispersion models can be expensive and require large amounts of data. They can also struggle to model the effects of many different sources of pollution over a large urban area.

The STEMS-Air (Space Time Exposure Modelling System – Air pollution) model aimed to overcome these limitations as it was designed to model many emissions sources over a large urban area. To test the model the researchers looked at the distribution of a single air pollutant, PM$_{10}$, which has well-established links with health problems, across London, UK. Daily levels of PM$_{10}$ were measured at six kerbside air pollution monitoring sites and the researchers also obtained annual average PM$_{10}$ levels for 53 sites from the London Air Quality Network website.

They found that, for daily exposure, the STEMS-Air model performed reasonably well. The results were improved when the researchers included in the model a measure of background PM$_{10}$ taken from nearby rural areas. This helped because the model initially only considered PM$_{10}$ emissions from traffic, whereas the kerbside monitors recorded total environmental PM$_{10}$ levels.

When modelling long-term exposure, STEMS-Air under-estimated PM$_{10}$ levels because the annual meteorological data used in the model came from an exposed site, where higher wind speeds reduced the amount of PM$_{10}$ present. The short-term predictions did not suffer the same problem because the meteorological data here more closely resembled typical city wind speeds. Despite this, the model still provided a reasonably accurate guide to air pollution concentrations, which could be improved further by using wind speed data from a less exposed site.

The researchers caution, however, that STEMS-Air should be used only as a screening model as it cannot replace formal dispersion models, which use more data to map relatively small areas in great detail. However, as STEMS-Air can be used by non-specialists, it is a useful a mapping or screening tool for anyone, such as planners and health authorities, interested in air pollution effects on health.


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