New Breathe London data: Covid-19 confinement measures reduce London air pollution

The Breathe London team hopes everyone is staying safe and healthy.

Covid-19 is a respiratory illness. Due to the potential impact of air pollution on respiratory and other illnesses, measurement data from the UK's air quality networks is important to the ongoing evaluation of risk to citizens during the pandemic.

The Breathe London consortium is committed to providing transparent air quality information for Londoners, and has evaluated data from the Breathe London monitoring network in the days before and after the government implemented restrictions* to reduce the spread of Covid-19. The government has stated it will keep these measures under constant review.

Preliminary results include:

Our preliminary results reveal substantial NO_2 pollution reductions after the measures went into place, particularly after social distancing was strongly encouraged on 16 March. Although further work is needed to determine the precise magnitude of reductions, we are sharing these results in provisional form and may periodically update them with additional data and analysis.

- The Breathe London network exhibits lower NO_2 pollution levels across Greater London starting around 18 March (see Figure 1, Figure 3a and 3b).
- From 17 March to 13 April, the following was measured in comparison to pre-confinement levels**:
  - Across the network, monitors register a 9-17% drop in NO_2 pollution.
  - In Central London, monitors show an average 20-24% reduction.
  - The greatest reductions occur during waking hours*** — between 6:00 and 22:00, average NO_2 reductions are 17-24% for the entire network and 28-30% in Central London (see Figure 2a).
- There is an apparent association between the reduced pollution levels and lower traffic congestion on London roads based on anonymous incident and slow-down information data from the Waze For Cities Program (See Figure 2 and 3).
  - Specifically, we assessed that traffic congestion reduced to such an extent that traffic was approaching free-flow in the vast majority of Greater London roads after the stay-at-home order (from 24 March to 13 April). We are further evaluating this and other methods to track changes in road transport emissions and the relationship to measured pollution.
  - Examining the daily pattern of traffic congestion also suggests a tie between Greater London's biggest drops in pollution and the biggest drops in congestion – which both occur in the late afternoon from around 3 to 7 pm (Figure 2a and 2b).

- The Breathe London network exhibits variability of $PM_{2.5}$ levels, but at this stage there is no clear reduction or evident association with the reduction in traffic.
  - London experienced pollution episodes from 25 to 27 March and from 8 to 12 April with elevated $PM_{2.5}$ levels, which have been captured by the Breathe London network. These increases were likely due to wind blowing in industrial and agricultural pollution from mainland Europe, as well as wood burning for the March episode.

The measures and corresponding dates include: 12 March – people with symptoms advised to stay home; 16 March – social distancing strongly encouraged; 20 March – cafes, pubs and restaurants ordered to close; nightclubs, theatres, cinemas, gyms and leisure centres told to close as soon as possible; 23 March – schools closed to most students, but open for vulnerable children and children of essential workers; ULEZ and other traffic charges suspended; 23 March (evening) – all citizens except essential workers advised to stay home.

**Pre-confinement levels are based on Breathe London network data from December 2019, January 2020 and February 2020, with the exception of Christmas Day, Boxing Day, New Year's Eve and New Year's Day.

***Local weather conditions favourable to pollution build-up may have occurred during a number of nights in the study period, which could explain some increases in pollution between 10:00pm to 6:00am.

FIGURE 1: Breathe London network NO_2 measurements during 1 March to 13 April 2020.
Each trace is an individual monitor in the network ("AQMesh site"; 71 producing valid data in this period) and the thick black line represents the network average. The grey line represents upwind background from a rural site outside of London; elevated background readings indicate pollution from abroad.
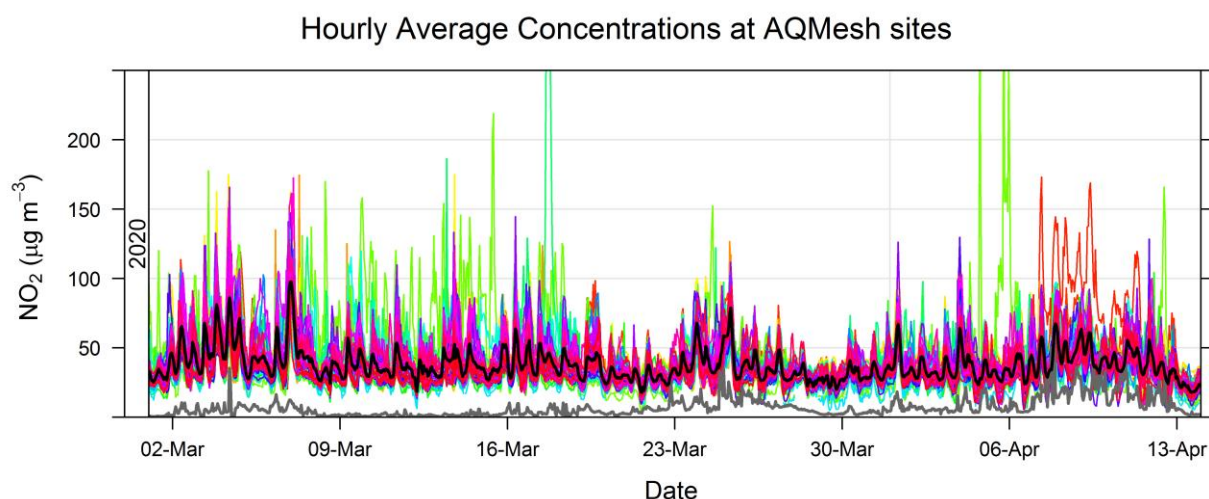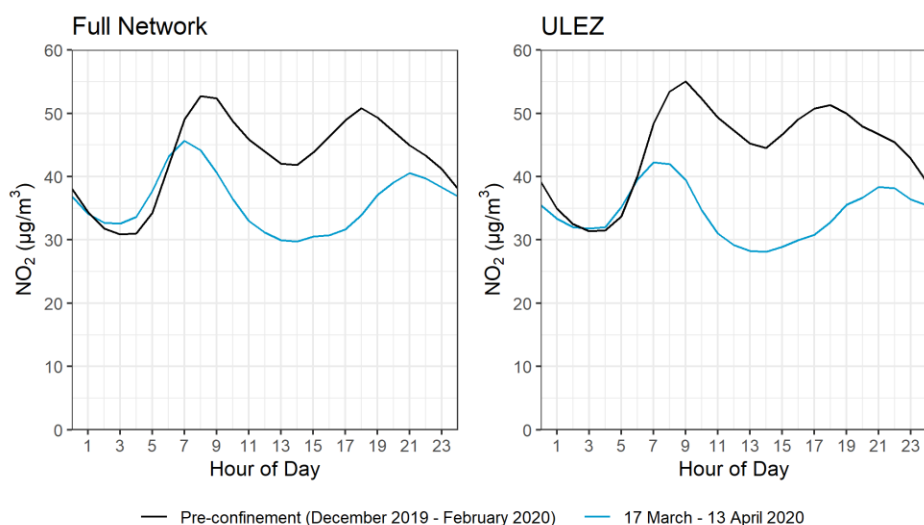

Source: Breathe London data

FIGURE 2a: Breathe London network hourly mean NO₂ measurements during 17 March to 13 April 2020 compared to pre-confinement levels.
*Levels shown for the full Breathe London network and a subset of monitors in Central London's Ultra Low Emission Zone (ULEZ). Both in Greater London and within the ULEZ, the greatest average decrease in NO₂ occurs during daytime hours.*

Source: [Breathe London data](#)

FIGURE 2b: Waze data – mean total length of congested roads by hour during 17 March to 13 April 2020 compared to pre-confinement levels.
*Levels shown for Greater London and within the ULEZ (scales are different).*
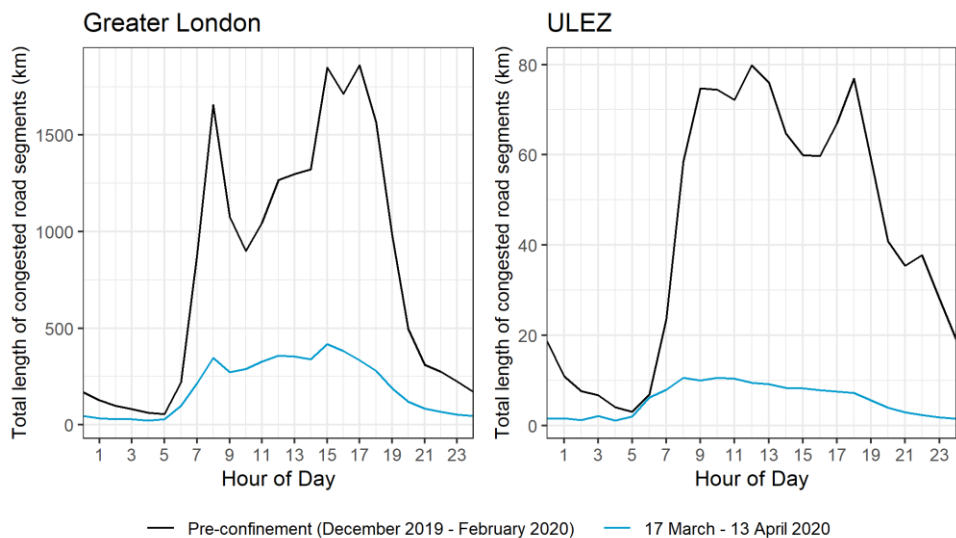
Source: Waze data (by permission)

FIGURE 3a: Breathe London network NO₂ measurements during 13 March to 13 April 2020 in comparison to the typical hourly pre-confinement levels.

The blue line in the top half represents March/April measurements and the black line with grey shading represents the pre-confinement weekly average. The red line represents road congestion due to traffic in March 2020 and the green line represents the pre-confinement weekly congestion average. The bottom half shows magnitude of difference between the pre and post confinement measurements for both pollution (blue line) and traffic congestion (red line). Methods used to generate the figures are described below.
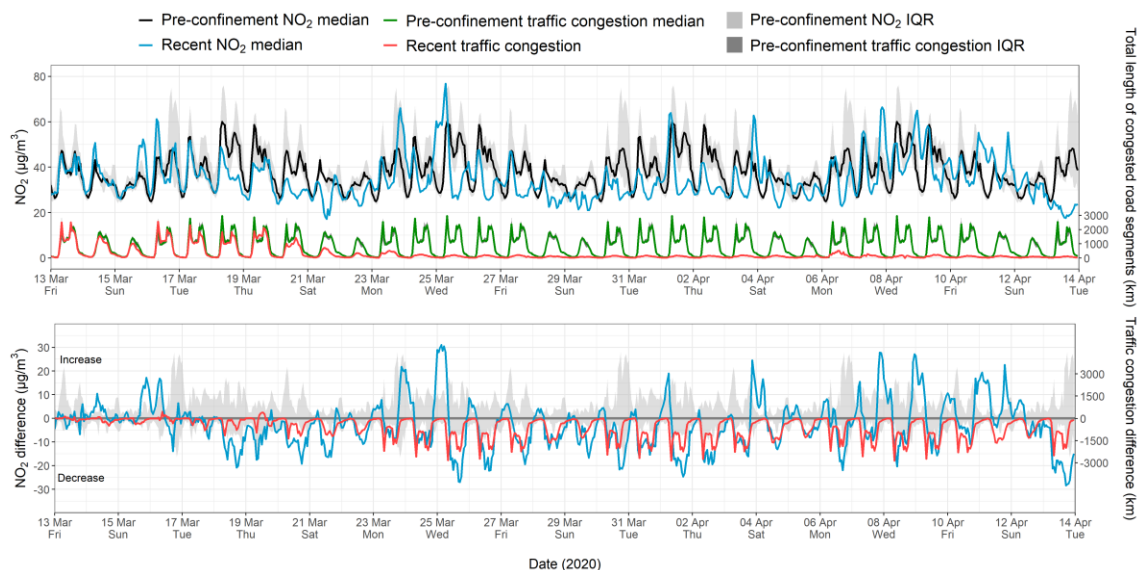
Source: **Breathe London data** **and Waze data (by permission)**

FIGURE 3b: Breathe London ULEZ monitors NO₂ measurements during 13 March to 13 April 2020 in comparison to the typical hourly pre-confinement levels.

Similar to Figure 3a above, but for the monitors in the ULEZ only.
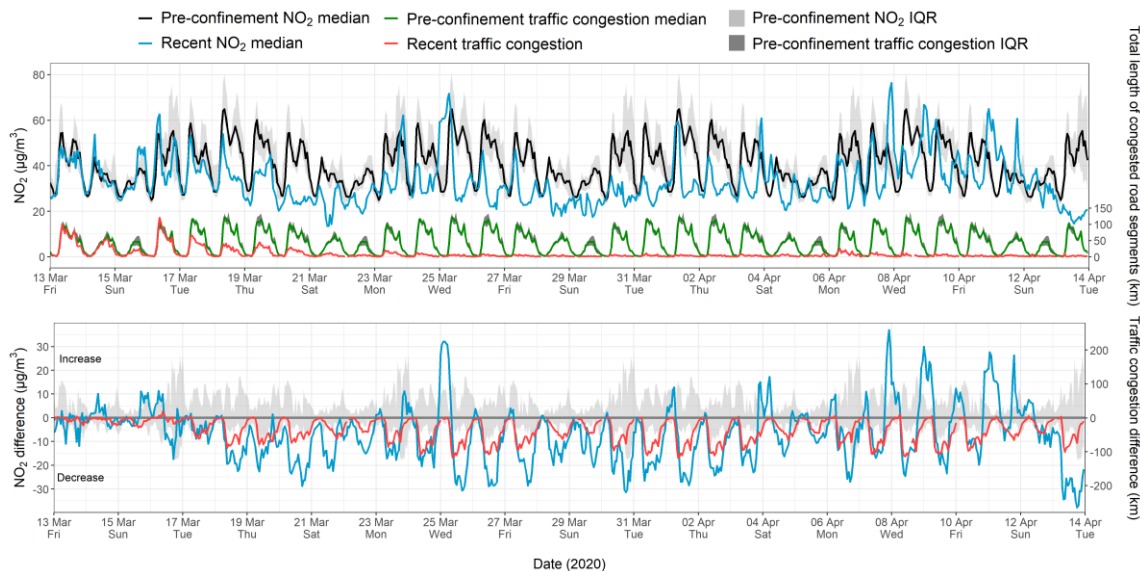
Source: **Breathe London data** **and Waze data (by permission)**

Methodologies used to analyse data

Pre-confinement levels: To estimate the typical NO_2 concentrations during the pre-confinement period by weekday and hour (black lines and grey strips in Figure 3a and 3b), we assumed the behaviour across the network for the three months between December 2019 and February 2020 would be representative of March behaviour. This is not a perfect assumption because there is seasonal variation in monthly mean NO_2 concentrations across the year, with the magnitude varying from year to year. In future updates to this analysis, we may evaluate the uncertainty introduced with this assumption.

The pre-confinement concentrations in Figure 3a and 3b (black line) were obtained by first determining the median from all network sites for each date and hour and then pooling these network medians for each day-hour combination (i.e., pools of 13 values, collected across the 13-week December-February period). The median of each pool, or distribution, of network medians by day and hour is shown in Figure 3a and 3b. The interquartile range of these distributions is shown as the gray shaded area. Note that the day-hour time series repeats every seven days. We also conducted this analysis using the *mean* of the pool of network *means* (instead of the *median* of *medians* as described above), to constrain the upper bound in the method.

Traffic data (source: Waze For Cities Program by permission): The traffic data represented in the time series is a sum of road lengths with unique traffic congestion during a given hour based on Waze-generated anonymous incident and slow-down information, which we use as a proxy for transportation-related sources of pollution. We define a congested road segment as one exhibiting 60% or less of each road's free flow speed. We summed the length of congestion within two different areal extents:

1. the area within the ULEZ for comparison to the pods within the ULEZ and
2. the area of Greater London for the comparison with all pods.

Both the recent time series and historical pattern from the pre-confinement period (December 2019 through February 2020) are presented. Note that this data represents unique traffic congestion as identified by the Waze system, and not an estimate of actual emissions from on-road transport. This is a preliminary analysis and needs to be validated for robustness especially given the likely reduction in number of Waze users on London roads during the confinement period.

To derive the pre-confinement traffic data by weekday and hour, we calculated the interquartile range and median of all the Waze data by day of week and hour of day within the given time period (December 2019 to February 2020). The recent time series of congestion was similarly calculated for the same spatial domains as the pre-containment period.