COVID-19 AIR QUALITY REPORT

2019 coronavirus pandemic lockdowns result in unprecedented reductions in deadly particle pollution

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✛ **IQAir**

About this report

As lockdowns were implemented in response to the deadly coronavirus pandemic, the dramatic changes brought about by these restrictions have been described as the '**largest scale experiment ever'** into air quality.[1]

Coinciding with the 50th anniversary of Earth Day, this report investigates the impact COVID-19 lockdowns have had on global particulate pollution levels

In many places, the halt of movement and industry has shown a **glimpse of a cleaner world**, with many reports of exceptional blue skies. However, visual perception alone can be deceiving when observing air pollution. This report compares measurements of the world's deadliest air pollutant, fine particulate matter (PM2.5), prior to and during the pandemic in 10 major global cities under lockdown: Delhi, London, Los Angeles, Milan, Mumbai, New York City, Rome, São Paulo, Seoul and Wuhan. Findings reveal a drastic drop in PM2.5 pollution for most global locations under lockdown conditions.

These findings coincide with the **50th anniversary of Earth Day**, whose theme this year is climate action. While ground-level air pollution poses our greatest environmental health hazard today, many sources of PM2.5 pollution - such as fossil fuel combustion - also contribute to climate change.

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1   https://le.ac.uk/news/2020/march/24-largest-experiment

Methodology

This report analyzes levels of PM2.5 reported by ground-level monitoring stations in 10 major global cities.

The data is based on a 3-week period for each city during lockdown conditions, and compares this to the same time period in 2019, 2018, 2017 and 2016.

The same time period across different years was chosen, because air pollution levels often vary greatly with seasonal changes in weather and other conditions.

The 3-week timeframe has been selected for each city to reflect either the period when the most stringent lockdown measures were in place or, during longer lockdown periods such as in Wuhan, to coincide with the 'peak' of daily reported COVID-19 cases.

Cities were selected based on the extent of lockdown measures and the number of coronavirus cases relative to other cities in the same country. The methodology and data representation strives to highlight the effects of the COVID-19 lockdowns on a wide variety of cities with different air quality challenges.
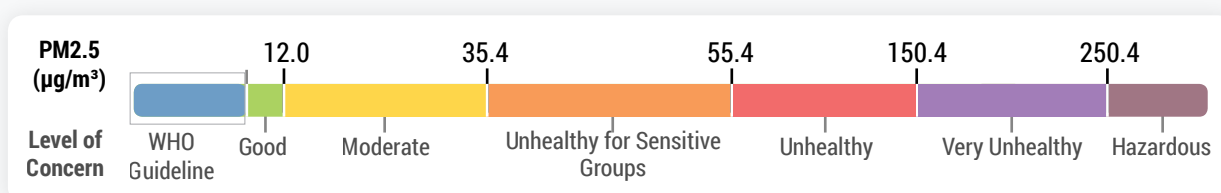
How the data is collected

This report uses hourly PM2.5 readings recorded by 7 governmental agencies: the U.S. State Department, China National Environment Monitoring Center, European Environment Agency, Seoul Metropolitan Government, Companhia Ambiental do Estado de São Paulo, and Ayuntamiento de Madrid. Supplemental data has been obtained from validated non-governmental air quality monitoring stations.

All locations and their data sources are visible on the IQAir AirVisual app and website: https://www.iqair.com/air-quality-map.

How the data is presented

In order to correlate concentration values to a more relatable reference for health risk, this report uses the US EPA standard color index, supplemented by the WHO annual mean exposure threshold of 10 μg/m³.[1,2]

PM2.5 (μg/m³)		12.0		35.4		55.4		150.4		250.4	
Level of Concern	WHO Guideline	Good	Moderate		Unhealthy for Sensitive Groups		Unhealthy		Very Unhealthy		Hazardous

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1   https://www.airnow.gov/aqi/aqi-basics/
2   https://www.who.int/airpollution/publications/aqg2005/en/

Summary

- 9 of 10 key global cities experienced PM2.5 reductions from the same period in 2019

- Cities with historically higher levels of PM2.5 pollution witnessed the most substantial drops, including Delhi (-60%), Seoul (-54%) and Wuhan (-44%)

- During Wuhan's 10-week lockdown, the city experienced its cleanest February and March air quality on record

- Delhi's 'unhealthy' and worse rated hours plummeted from 68% in 2019 to 17% during the lockdown period[1]

- Los Angeles experienced its longest stretch of clean air on record meeting the WHO air quality guidelines

City	Average PM2.5 during lockdown 2020 (µg/m³)	Reduction compared to 2019	Reduction compared with prior 4 year average	3-week lockdown dates, 2020
Delhi, India	32.8	-60%	-55%	Mar 23 - Apr 13
London, UK	16.2	-9%	+6%	Mar 23 - Apr 13
Los Angeles, US	5.5	-31%	-51%	Mar 23 - Apr 13
Madrid, Spain	6.4	-11%	+2%	Mar 23 - Apr 13
Mumbai, India	28.8	-34%	-43%	Mar 23 - Apr 13
New York City, US	4.4	-25%	-29%	Mar 23 - Apr 13
Rome, Italy	16.7	+30%	No data available	Mar 9 - Mar 30
São Paulo, Brazil	10.1	-32%	-26%**	Mar 23 - Apr 13
Seoul, South Korea	24.1	-54%	-32%	Feb 26 - Mar 18
Wuhan, China	35.1	-44%	-50%	3 Feb - Feb 24

** Data for São Paulo is based on a 3-year average, rather than a 4-year average

PM2.5 (µg/m³)	10.0	12.0	35.4	55.4	150.4	250.4
Level of Concern	WHO Guideline	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous

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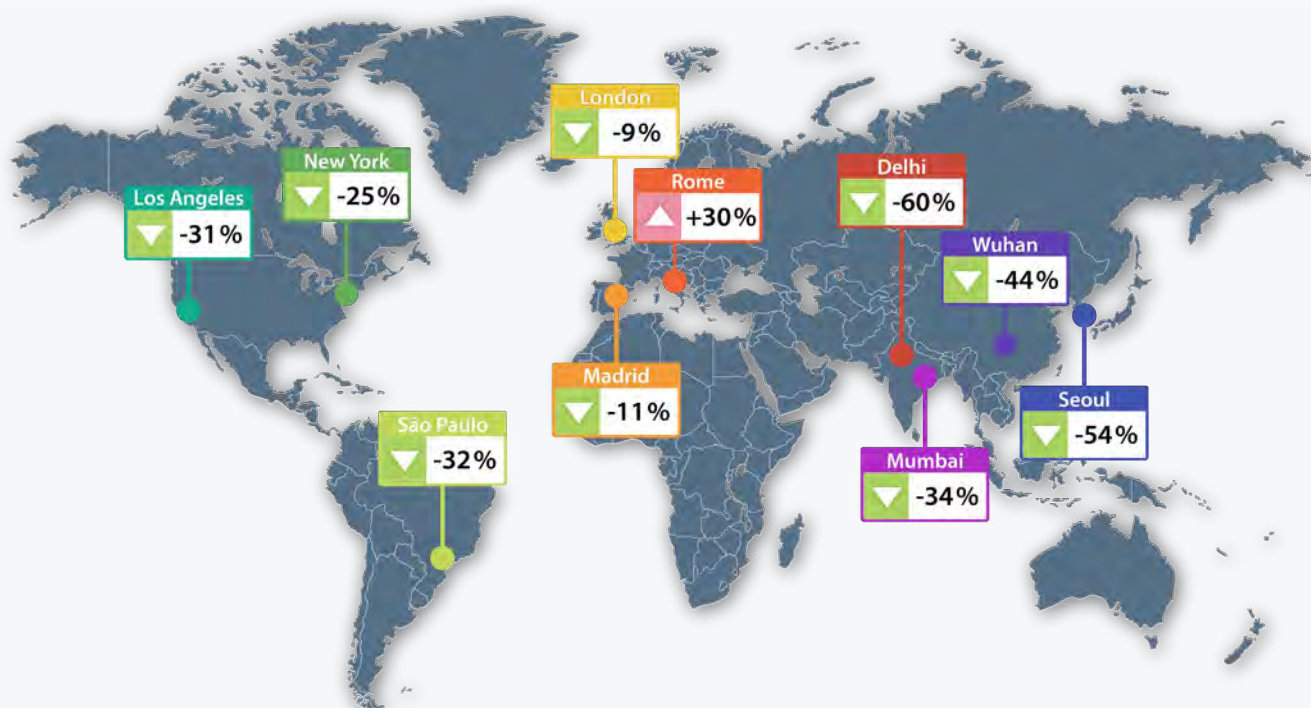1   According to the US Air Quality Index

Global Findings

9 of 10 key global cities experienced PM2.5 reductions from the same period in 2019

Ten major global cities have been studied in this report for their relatively high number of coronavirus cases and government-mandated COVID-19 lockdown measures.

In 7 of these identified cities, drastic restrictions on people's movement and economic activity imposed during lockdowns resulted in PM2.5 reductions of 25-60%, as compared to the same time period last year.[1]

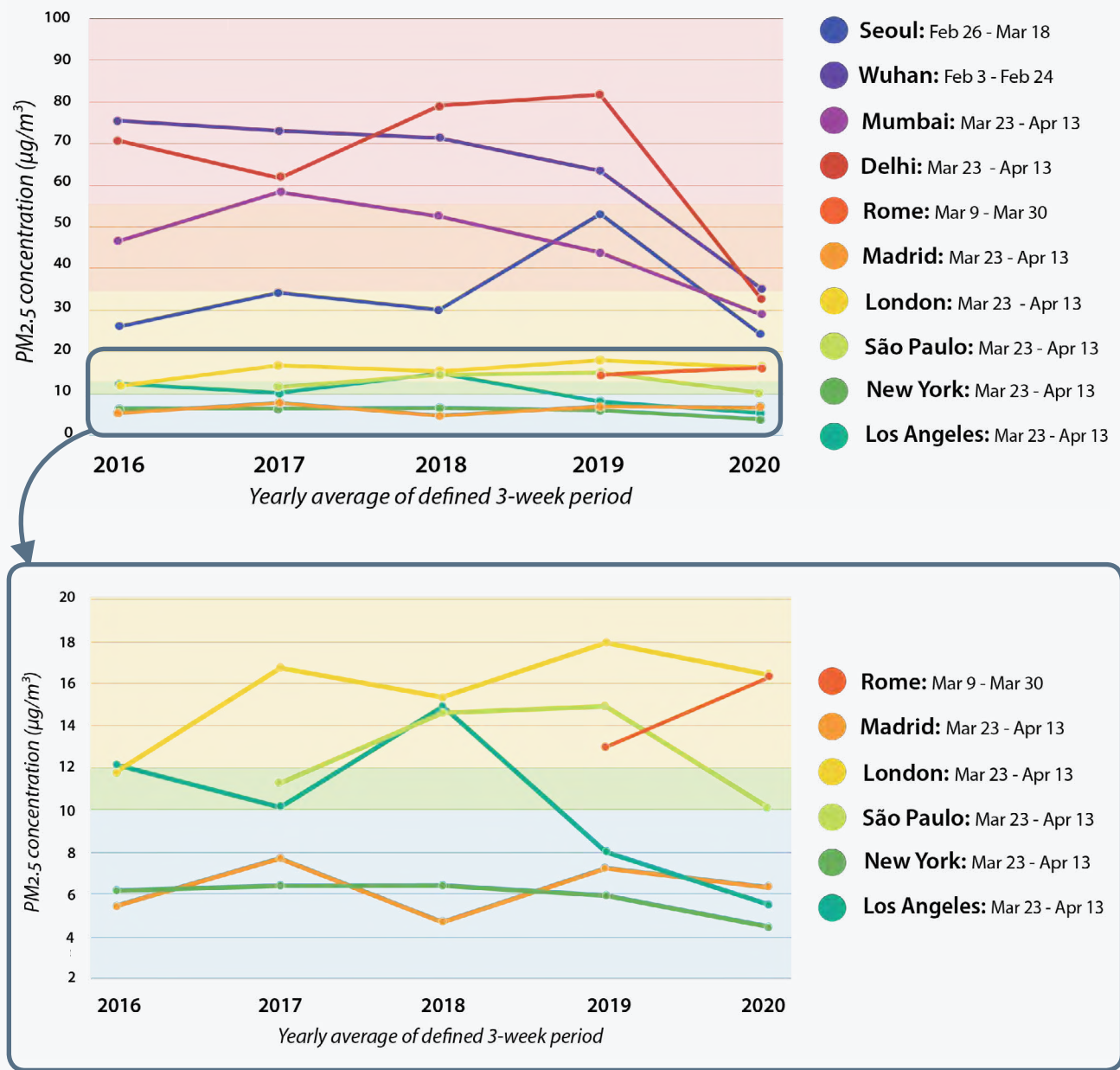**Map 1: Percent reduction in PM2.5 levels when comparing 2020 lockdown period to the same period in 2019**

Los Angeles ▼ -31%
New York ▼ -25%
London ▼ -9%
Rome ▲ +30%
Delhi ▼ -60%
Wuhan ▼ -44%
Madrid ▼ -11%
Seoul ▼ -54%
São Paulo ▼ -32%
Mumbai ▼ -34%

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1   PM2.5 (Particulate matter with a diameter of 2.5 micrometers or less) is widely regarded as the pollutant that poses the greatest threat to health of all commonly measured air pollutants. Due to its small size, PM2.5 is able to penetrate deep into the human respiratory system and into the blood stream, potentially causing a wide range of short- and long-term health effects. For more information, go to https://www.iqair.com/blog/air-quality/pm2-5

Cities with historically higher levels of PM2.5 pollution witnessed the most substantial drops, including Delhi (-60%), Seoul (-54%) and Wuhan (-44%)

While all cities demonstrated a drop in PM2.5 levels during lockdown conditions when compared to 2019, cities with historically higher PM2.5 concentration levels, such as Delhi, Mumbai, and Wuhan, showed the most dramatic reductions in PM2.5.

Graph 1: Yearly PM2.5 levels over defined 3-week period for selected major cities

Seoul: Feb 26 - Mar 18
Wuhan: Feb 3 - Feb 24
Mumbai: Mar 23 - Apr 13
Delhi: Mar 23 - Apr 13
Rome: Mar 9 - Mar 30
Madrid: Mar 23 - Apr 13
London: Mar 23 - Apr 13
São Paulo: Mar 23 - Apr 13
New York: Mar 23 - Apr 13
Los Angeles: Mar 23 - Apr 13

Rome: Mar 9 - Mar 30
Madrid: Mar 23 - Apr 13
London: Mar 23 - Apr 13
São Paulo: Mar 23 - Apr 13
New York: Mar 23 - Apr 13
Los Angeles: Mar 23 - Apr 13

Wuhan, China

Wuhan saw a 50% reduction in PM2.5 during the 2020 COVID-19 lockdown, as compared to the previous 4-year period average

LOCKDOWN MEASURES

Wuhan, the epicenter of the original novel coronavirus outbreak, had some of the highest numbers of reported COVID-19 cases globally. In response to a surge of cases and deaths, the Chinese government ordered its highest Class 1 Response for public health emergencies on January 24.[1]

Wuhan's lockdown directives on its 11 million residents were the most stringent and long-lasting of anywhere globally. After 10 weeks of far-reaching mitigation efforts, the city's lockdown was finally lifted on April 8.[2]

Wuhan's lockdown measures included barring private vehicle movement, a suspension of most public transport, school closures, and the shutdown of all non-essential businesses.[3,4] Some areas restricted outings to one family member every other day to buy necessities. Areas under containment barred residents from leaving, requiring them to order in food and other supplies from delivery services.

IMPACT ON PM2.5

Over the course of Wuhan's full 10-week lockdown, the city experienced its cleanest air quality on record for the months of February and March, with average PM2.5 concentrations (μg/m³) of 36.8 and 32.9 respectively. For context, February and March 2019 averaged PM2.5 concentrations of 63.2 and 43.9 respectively.

Graph 2: Daily PM2.5 levels in Wuhan from 2016-2020, indicated by US AQI color

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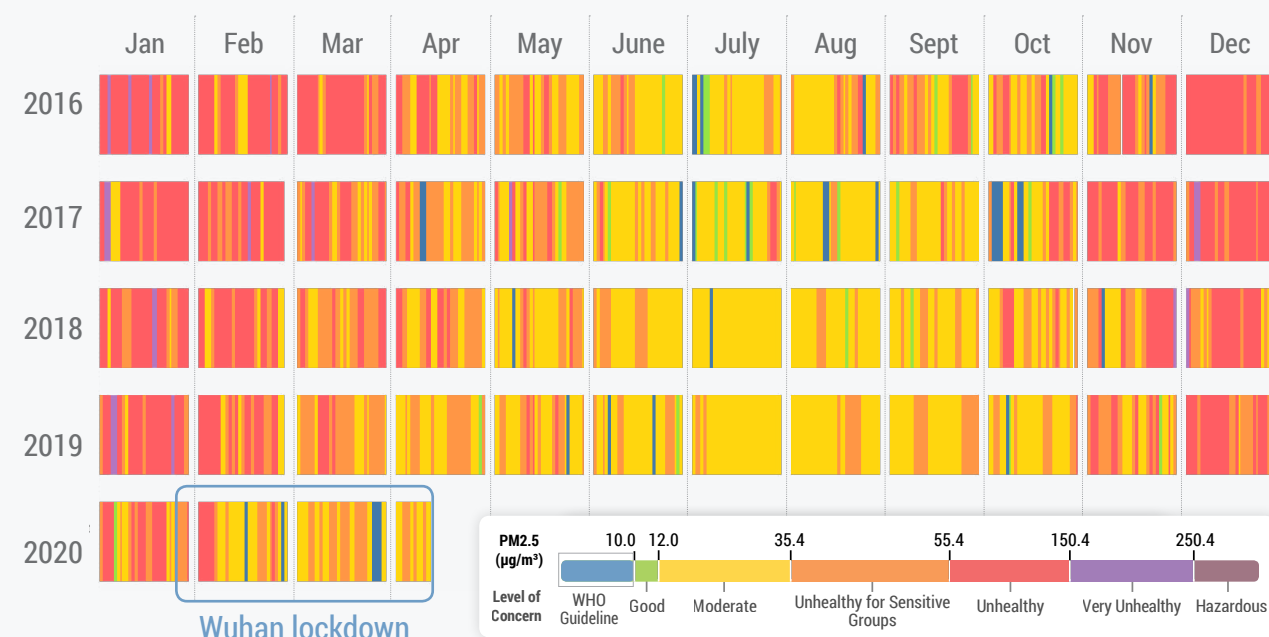
1   Details of Class 1 Response for public health emergencies: http://china.caixin.com/2020-01-29/101509411.html
2   The 3-week time frame used in this report (February 3 - February 24) highlights the 'peak' of the curve when Wuhan was reporting the most new daily cases.
3   https://www.theguardian.com/world/2020/mar/19/chinas-coronavirus-lockdown-strategy-brutal-but-effective#maincontent
4   Essential businesses only included those relating to food, medicine and healthcare.

https://www.iqair.com

During the defined 3-week peak lockdown period, PM2.5 levels in Wuhan were slashed to half the average of the prior 4 years, and were down 44% from 2019. The smaller decrease since 2019 indicates the Chinese government's ongoing efforts to reduce air pollution across major Chinese cities year-on-year.

Graph 3: Daily PM2.5 levels in Wuhan from 2016-2020 (Feb 3 - Feb 24)
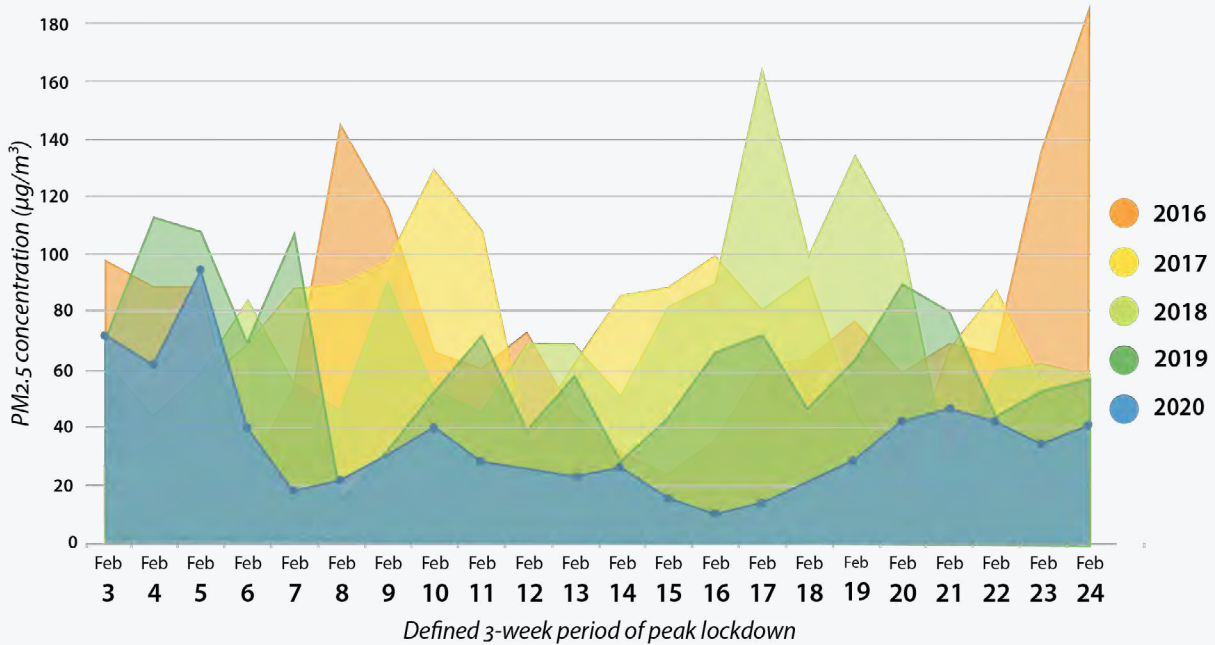
During the past 4 years, between February 3 and February 24, 50-60% of hours qualified as "unhealthy" or "very unhealthy" according to the US Air Quality Index (AQI).[1,2] For the same period in 2020, only 22% of hours were classified as US AQI "unhealthy". Moreover, 2020's period had 7.5% of hours meet the stringent WHO target for PM2.5 levels (<10 μg/m³), up from only 1.2% in 2019, and 0% in 2018.[3]

Graph 4: Wuhan's distribution of hourly PM2.5 concentrations from Feb 3 - Feb 24, shown as US Air Quality Index categories

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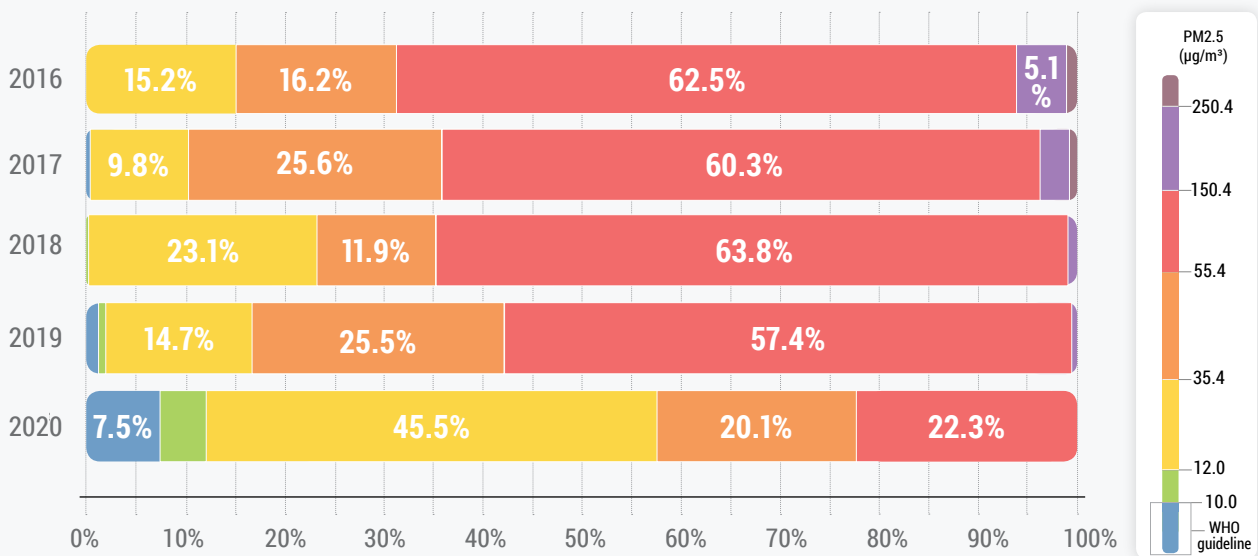
1   The US AQI designation for PM2.5 concentration levels between 55.0 μg/m³ and 150.4 μg/m³
2   The US AQI designation for PM2.5 concentration levels between 150.4 μg/m³ and 250.4 μg/m³.
3   https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

India

Delhi's 'unhealthy' and worse rated days plummeted from 68% in 2019 to 17% during lockdown
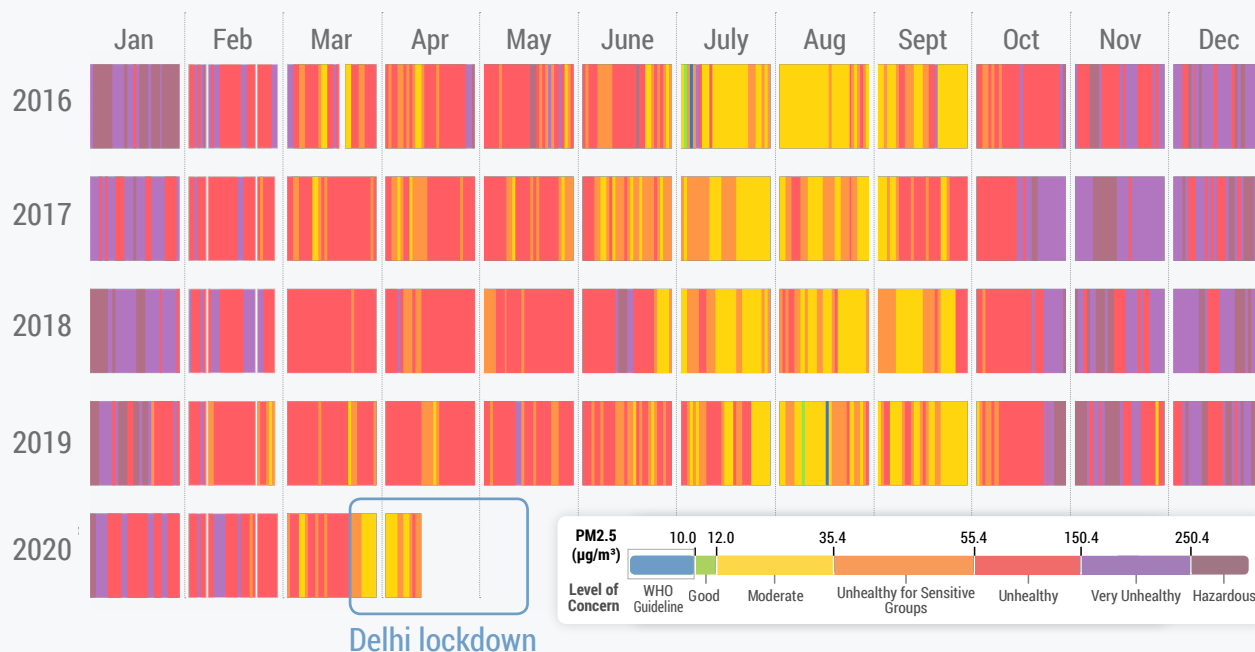
LOCKDOWN MEASURES

India Prime Minister Narendra Modi ordered the world's largest lockdown on March 25, affecting everyone of its 1.3 billion residents.[1] The lockdown, initially framed to last 21 days, was extended on April 11 for an additional 2 weeks.[2] Mandates of the previous lockdown, effective until April 15, and then relaxed, included: sealed borders, curfews and restrictions on movement to only essential outings such as for food and health care. Containment areas in major cities (381 in Mumbai; 30 in Delhi) added additional restrictions - mandating no movement outdoors, thus forbidding grocery purchases and restaurant delivery.[3]

IMPACT ON PM2.5

India is among the most polluted countries globally. An average resident is exposed to air pollution that exceeds the WHO target for annual PM2.5 exposure by more than 500%.[4] Recent government-mandated lockdowns in response to climbing COVID-19 cases have shuttered businesses, eliminated traffic congestion, and paused construction projects and non-essential industry. The dramatic impact seen on air quality reflects the sheer scale of India's average air pollution emissions.

Both Delhi and Mumbai experienced their best March air quality on record in 2020 (49.8 µg/m³ and 34.5 µg/m³ PM2.5 respectively), while April 2020 is also on track to be the best April on record, should the current trends continue.

Graph 5: Daily PM2.5 levels in Delhi from 2016-2020, indicated by US AQI color

PM2.5 (µg/m³)	10.0	12.0	35.4	55.4	150.4	250.4
Level of Concern	WHO Guideline	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous

Delhi lockdown

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1   https://economictimes.indiatimes.com/news/politics-and-nation/india-will-be-under-complete-lockdown-starting-midnight-narendra-modi/articleshow/74796908.cms?from=mdr
2   https://www.news18.com/news/india/coronavirus-pandemic-live-updates-covid-19-india-updates-narendra-modi-lockdown-jharkhand-coronavirus-info-2573255.html
3   http://timesofindia.indiatimes.com/articleshow/75075290.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
4   According to IQAir's 2019 World Air Quality Report

In Delhi, PM2.5 concentration levels are down by 60% from the same time last year, and down 55% from the average of the prior 4 years. In Mumbai, PM2.5 levels are down 34% from 2019, and 43% from the average of the last 4 years.

Graph 6:   Daily PM2.5 levels in Delhi and Mumbai from 2016-2020, during the 2020 lockdown period (Mar 23 - Apr 13)

Delhi | Mar 23 - Apr 13

Mumbai | Mar 23 - Apr 13

Defined 3-week period of peak lockdown
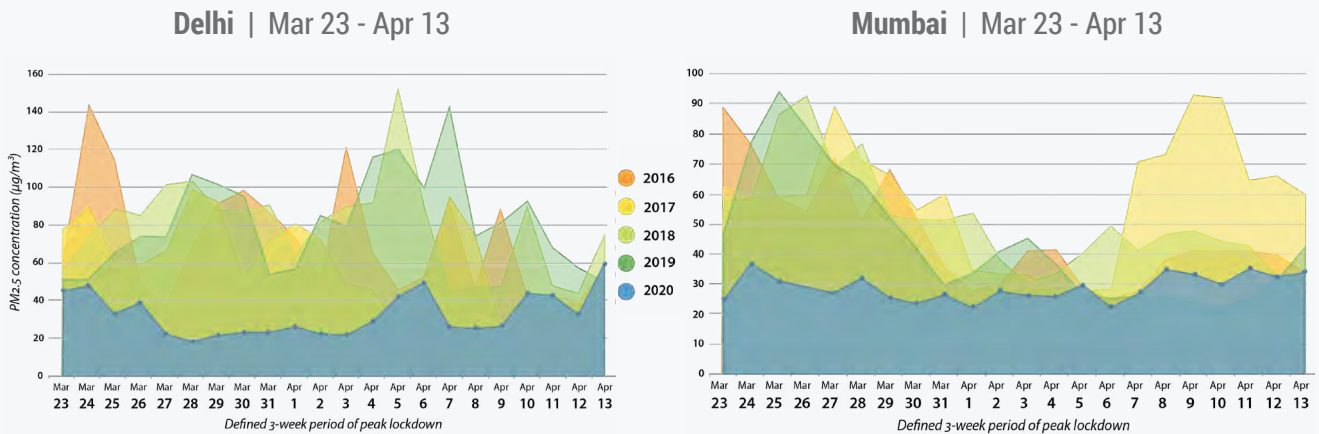
During the 3-week lockdown period, Delhi's air quality rated as 'unhealthy' and worse dropped from 68% in 2019 to 17% in 2020 - while 3% of hours experienced "good" US AQI air quality, up from 0% in 2019. Mumbai observed a drop in 'unhealthy' air quality hours from 22.5% to 0.4%.

Graph 7: Delhi and Mumbai's distribution of hourly PM2.5 concentrations from Mar 23 - Apr 13, shown as US Air Quality Index categories

Delhi | Mar 23 - Apr 13

Mumbai Mar 23 - Apr 13

https://www.iqair.com
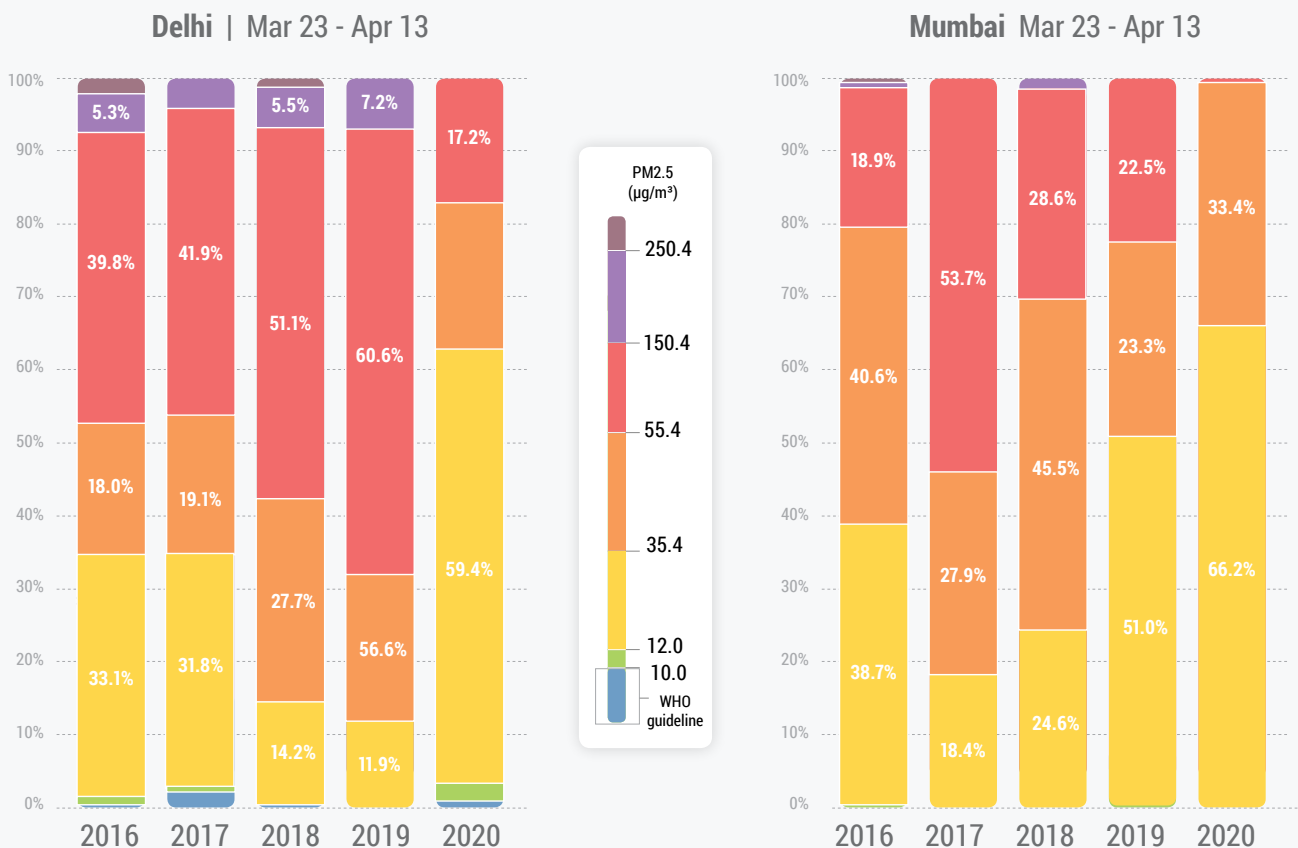
United States

Los Angeles experienced its longest stretch of clean air on record meeting WHO guidelines
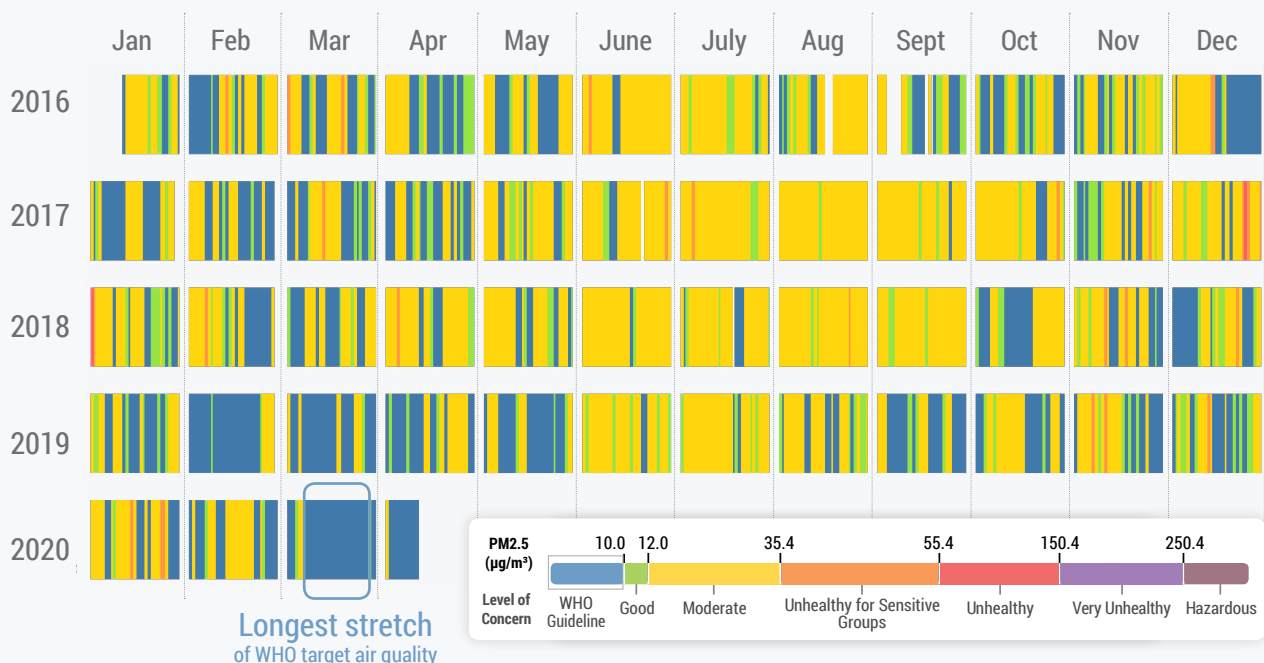
LOCKDOWN MEASURES

In the US, states and municipalities have been responsible for ordering measures to slow the spread of COVID-19. California, the country's most populous state, was the first in the US to issue a mandatory lockdown among its 40 million residents on March 20.[1] The directive ordered the closure of all non-essential services, banned social gatherings public and private, and encouraged residents to stay-at-home unless enjoying solitary outdoor activities. While responses across the 50 states have varied, the majority have followed suit in upholding similar orders as California. New York state, the current epicenter of the US outbreak, went into lockdown on March 23.[2]

IMPACT ON PM2.5

Los Angeles experienced its longest stretch of WHO target air quality (<10 μg/m³), spanning 18 days from March 7-28. This long stretch of exceptionally clean air helped to establish March as Los Angeles's cleanest air quality month on record, averaging 5.6 μg/m³ (US AQI 23).

Graph 8: Daily PM2.5 levels in Los Angeles from 2016-2020, indicated by US AQI color

Longest stretch
of WHO target air quality

| PM2.5 (μg/m³)	10.0	12.0	35.4	55.4	150.4	250.4
Level of Concern	WHO Guideline	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous

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1   https://www.wsj.com/articles/china-reports-no-new-domestic-coronavirus-infections-for-the-first-time-since-outbreak-started-11584611233
2   https://www.wsj.com/articles/new-york-gov-cuomo-orders-all-nonessential-workers-in-state-to-stay-home-11584718223

During Los Angeles's defined 3-week lockdown period, PM2.5 concentration levels are down by 31% from the same time last year, and down 51% from the average of the prior 4 years.

Graph 9: Daily PM2.5 levels in Los Angeles from 2016-2020, during the 2020 lockdown period (Mar 23 - Apr 13)
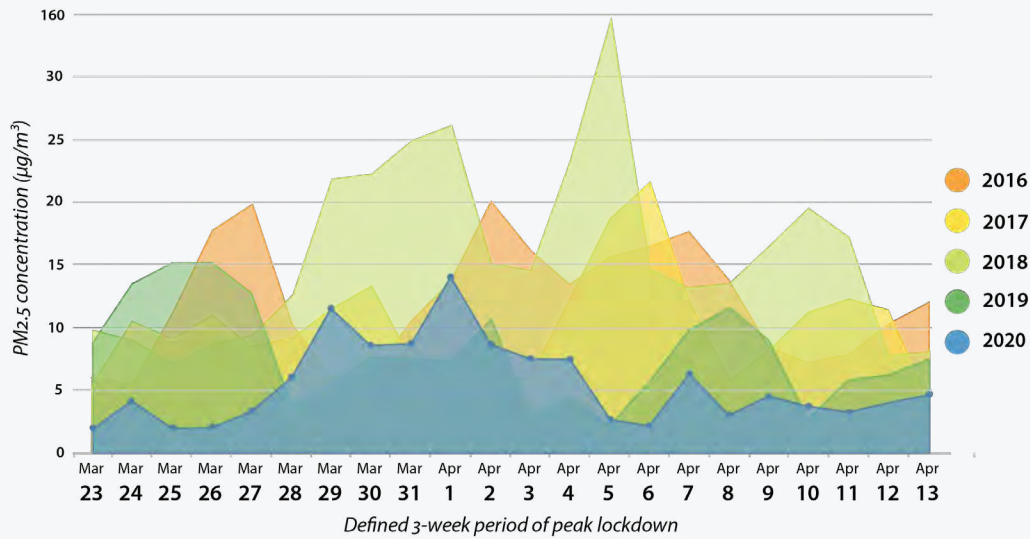
In Los Angeles during this lockdown period, 90% of hours met the WHO target for PM2.5, while 95% of hours met the US 'good' category (up from 70% and 81% in 2019).

In New York, 98% of hours met WHO targets for PM2.5 in 2020, while 100% of hours were in the best US AQI "Good" category (up from 94% in 2019). A handful of hours have observed PM2.5 levels below 1.3 μg/m³ (or AQI 5), an extremely rare event.

Graph 10: Los Angeles and New York City's distribution of hourly PM2.5 concentrations from Mar 23 - Apr 13, shown as US Air Quality Index categories
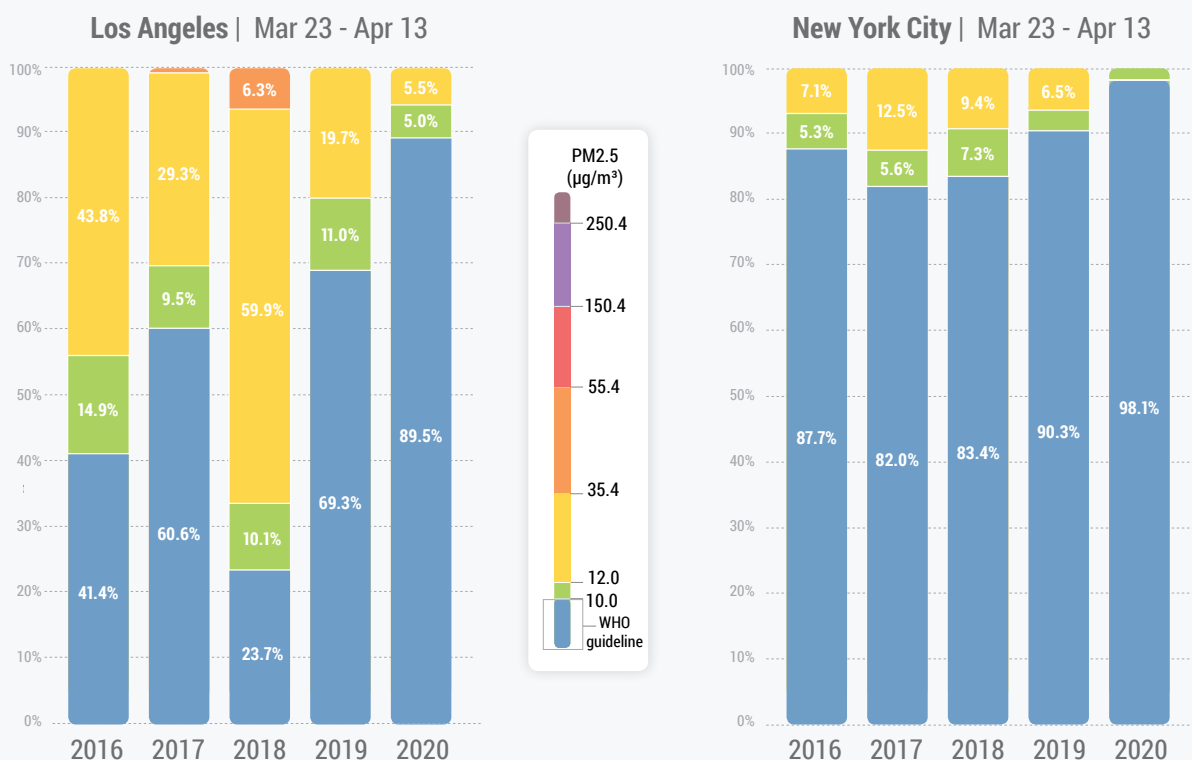
Europe

London and Madrid's average PM2.5 levels reduced by 9% and 11% respectively, since 2019
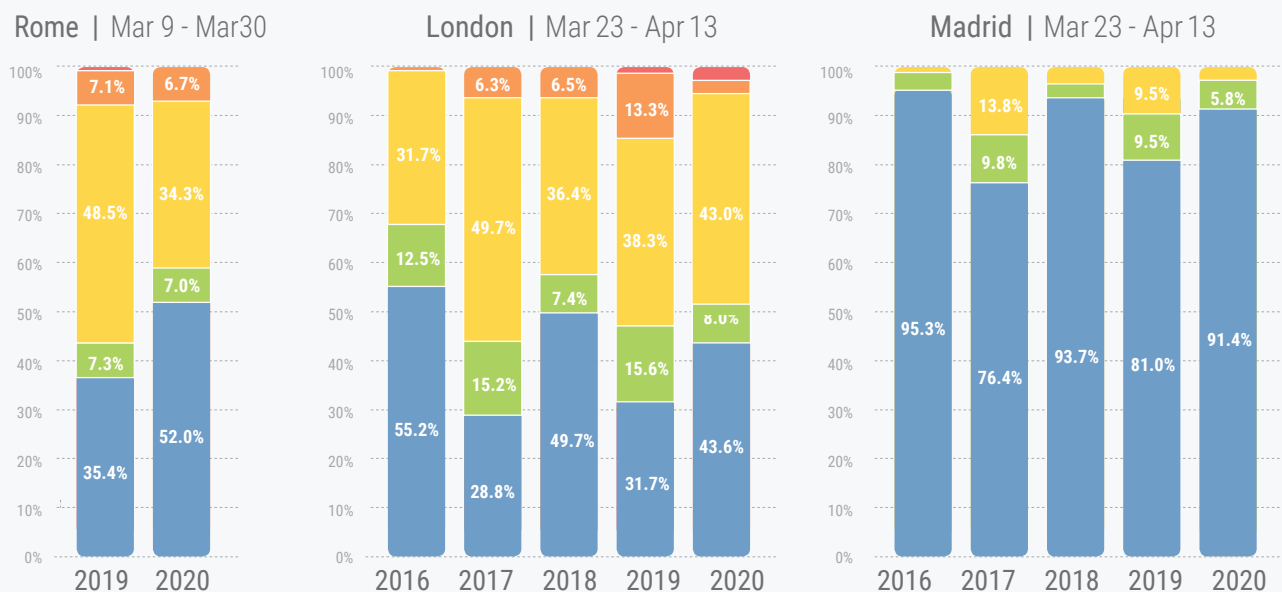
LOCKDOWN MEASURES

As the pandemic spread within Europe, Italy was the first country to announce a lockdown on non-essential movement, first in the North of Italy on March 10, then nationwide on March 12 in response to growing cases around the country.[1] Spain followed soon after, with the government introducing confinement rules on March 14 allowing citizens to leave the home only for essential trips.[2] The lockdown rules were extended March 30 to order the closure of all businesses not providing key services during the pandemic.[3] The UK followed on March 23 when Prime Minister Boris Johnson announced a lockdown prohibiting non-essential trips, aside from shopping, dealing with health issues, commuting where necessary and exercise.[4] People were instructed to work from home wherever possible. In most European countries, social distancing has been mandated, and large numbers of businesses closed.

IMPACT ON PM2.5

London and Madrid experienced reductions in PM2.5 of 9% and 11% respectively, during their lockdown periods compared to 2019. Contributing factors are likely to include a significant reduction in traffic and power generation.[5,6] Rome conversely observed a 30% increase in particle pollution as compared to 2019 levels, despite an increase of hours which met the WHO guideline (<10 µg/m³). Domestic heating is a significant source of air pollution in Rome from November 1 to April 15.[7] Increased reliance on residential heating systems, coupled with cool air inversions that trap particulate pollution in the atmosphere, may explain PM2.5 gains in the city as compared to 2019.

Comparing London and Madrid's PM2.5 levels during the 2020 lockdowns to the average of the prior 4 years doesn't show such a clear downward trend as in comparison to last year alone. Weather conditions and geographical location can greatly influence measured air quality, even after emissions fall. More data quantifying the changing levels of PM2.5 as these cities' lockdown periods continue will be beneficial to gain a more thorough comparison with previous years and clearer understanding of longer term trends.

Graph 11: Rome, London and Madrid's distribution of hourly PM2.5 concentrations

Rome | Mar 9 - Mar 30
London | Mar 23 - Apr 13
Madrid | Mar 23 - Apr 13

1   https://www.nytimes.com/interactive/2020/04/05/world/europe/italy-coronavirus-lockdown-reopen.html
2   https://www.theguardian.com/world/2020/apr/06/europe-looks-past-lockdowns-as-us-and-japan-brace-for-coronavirus-trauma
3   https://www.thelocal.es/20200403/when-and-how-will-spains-lockdown-measures-end
4   https://www.telegraph.co.uk/news/2020/04/11/uk-coronavirus-lockdown-government-rules-extended/
5   https://www.theguardian.com/uk-news/2020/apr/03/uk-road-travel-falls-to-1955-levels-as-covid-19-lockdown-takes-hold-coronavirus-traffic
6   https://www.icis.com/explore/resources/news/2020/03/27/10487371/european-power-and-carbon-markets-affected-by-covid-19-an-early-impact-assessment
7   https://www.sciencedirect.com/science/article/pii/S1876610217337773

About IQAir AirVisual

IQAir is a Swiss-based air quality technology company that empowers the world to breathe cleaner air through information, collaboration and technology solutions. With the vision of a world where everyone breathes clean air, IQAir provides individuals, organizations and communities with tools to improve air quality. Since 1963, IQAir has pioneered air quality solutions that include air quality data, sensors, monitoring systems, air purification and expert services.

AirVisual is IQAir's air quality data platform, which offers the world's largest set of real-time and historical global air quality data. The platform processes billions of data points each day, reporting from a range of sources including government monitoring stations, satellite data and privately-operated low-cost monitors.

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