2019 WORLD AIR QUALITY REPORT

Region & City PM2.5 Ranking

IQAir

Contents

About this report

The 2019 World Air Quality Report is based on data from the world's largest centralized platform for real-time air quality data, combining efforts from thousands of initiatives run by citizens, communities, companies, non-profit organizations and governments.

Through aggregating, validating and visualizing real-time data from governments and sensors operated by individuals and organizations, IQAir strives to raise awareness of air quality levels, allowing people to take action to improve air quality and protect their health.

The 2019 World Air Quality Report is based on a subset of the information provided through the platform. It includes only PM2.5 (fine particulate matter) data as acquired from ground-based air quality monitoring stations with high data availability.

An extended presentation of the world's most polluted cities during 2019 is available online, allowing further exploration of air quality across different regions and subregions in 2019 in an interactive format. Live and forecast air quality information for all included locations can also be explored through the IQAir Air Quality Map, which presents a real-time overview of the world's air quality data in one place.

Executive summary

Air pollution constitutes the most pressing environmental health risk facing our global population. It is estimated to contribute toward 7 million premature deaths a year, while 92% of the world's population are estimated to breathe toxic air quality (WHO, 2016). In less developed countries, 98% of children under five breathe toxic air. As a result, air pollution is the main cause of death for children under the age of 15, killing 600,000 every year (WHO, 2018). In financial terms, premature deaths due to air pollution cost about $5 trillion in welfare losses worldwide (The World Bank, 2016).

Whilst 95% of the global population breathes air exceeding WHO exposure targets, vast populations around the world lack access to air quality information.

This report presents PM2.5 data made publically available during 2019, in order to highlight the state of particulate pollution around the world and raise awareness about public access to air quality data. The majority of this data has been published in real-time or near real-time, by governmental sources, as well as independently operated and validated non-governmental air quality monitors.

Regionally, South Asia, Southeast Asia, and the Middle East carry the highest burden of fine particulate matter (PM2.5) pollution overall, with only 6 of 355 cities included meeting WHO annual targets in these areas collectively. Cities within these regions also rank highly in the top of the global city ranking. Of the world's top 30 most polluted cities during 2019, 21 are located in India, 27 in South Asia, and all the top 30 cities are within greater Asia.

Using a weighted population average, Bangladesh emerges as the most polluted country, based on available data. Pakistan, Mongolia, Afghanistan and India follow behind respectively, deviating from one another by less than 10%. Bosnia and Herzegovina is the highest ranking country in Europe for PM2.5 pollution, featuring as the 14th most polluted country globally, with only a 4μg/m3 deviation from China's national PM2.5 weighted average.

A global network of real-time, public air quality monitoring data is essential to tackle the urgent issue of air pollution. What is not measured cannot be managed, and publishing live data enables populations to respond quickly and safeguard their health.

2019 saw a significant increase in air quality monitoring coverage, with the number of monitoring stations increasing by more than 200% since the year prior. These gains are due both to expanded or new governmental monitoring networks, as well as sensor contributions from non-governmental organizations, private industry and individuals.

Still, vast populations around the world lack access to air quality information. Often these areas have some of the world's most severe air pollution, putting the health of huge populations at risk. More monitoring data is needed to bridge the information gap, and better tackle air pollution globally.

Awareness of air pollution remains low in areas where real-time monitoring is limited but pollution levels may be high.

Where does the data come from?

This report includes data aggregated from a range of ground-based PM2.5 monitoring stations. Data sources include real-time, hourly data from governmental monitoring stations, as well as validated PM2.5 monitors operated by private individuals and organizations. Some locations are additionally supplemented by governmental historical datasets of hourly PM2.5 measurements, where available.

All measurements have been collected at a monitoring station level, and were later grouped into settlements. Whilst the sizes and densities of these settlements vary, the majority are urban, and so for the purpose of this report, all settlements are hereafter referred to as cities.

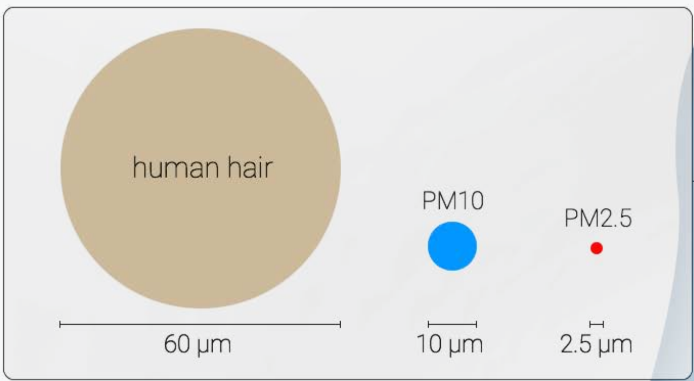
Why PM2.5?

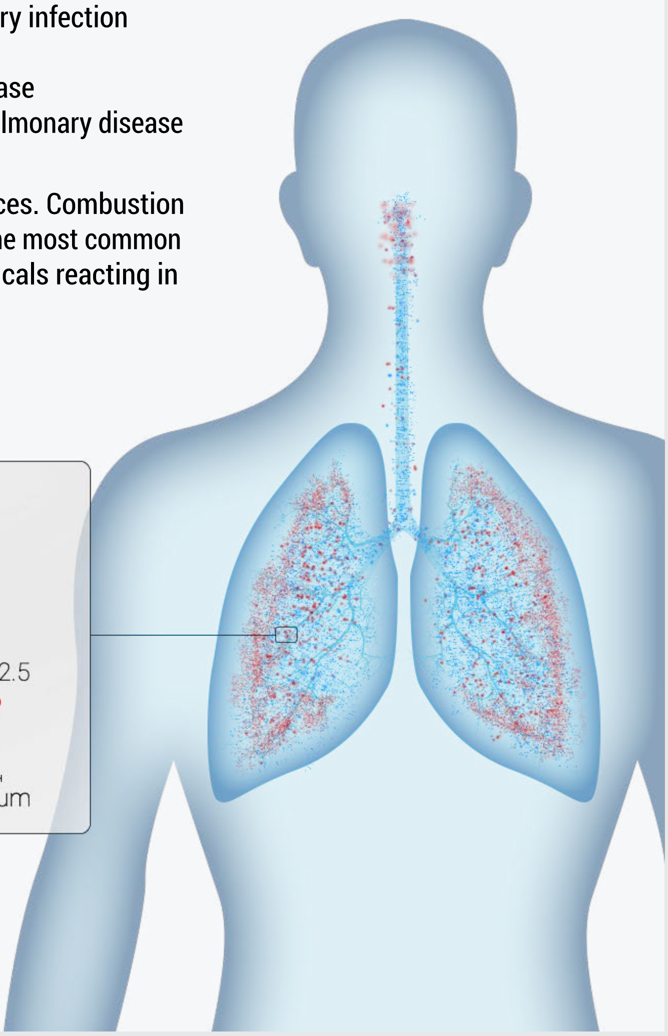
This report focuses on PM2.5 concentrations, as this is the pollutant widely regarded as most harmful to human health. PM2.5 is defined as ambient airborne particles which measure up to 2.5 microns in size. It's microscopic size allows the particles to enter the blood stream via the respiratory system and travel throughout the body, causing far-reaching health effects, including asthma, lung cancer and heart disease. Air pollution has also been associated with low birth weight, increased acute respiratory infections and stroke.

Worldwide ambient air pollution accounts for[1]:

- 29% of all deaths and disease from lung cancer
- 17% of all deaths and disease from acute lower respiratory infection
- 24% of all deaths from stroke
- 25% of all deaths and disease from ischaemic heart disease
- 43% of all deaths and disease from chronic obstructive pulmonary disease

Airborne particulate matter can originate from a range of sources. Combustion from vehicle engines, industry, fires and coal burning represent the most common man-made sources, whilst sandstorms, agriculture, and chemicals reacting in the atmosphere represent the most common natural sources.





1 https://www.who.int/airpollution/ambient/health-impacts/en/

Data presentation

In order to correlate concentration values to a more relatable reference for health risk, this report refers to two guidelines for PM2.5 pollution: the World Health Organization (WHO) Air Quality Guideline value for PM2.5 exposure and the United States Air Quality Index (US AQI). The color index uses the US EPA standard, supplemented by the WHO guideline for values under 10µg/m³.

WHO Air Quality Guideline

Whilst the WHO cautions that no level of PM2.5 exposure has been proven to be free of health impacts, it has outlined an annual mean exposure threshold of 10µg/m³ to minimize the risk of health impacts from PM2.5.

WHO PM2.5 Target: 10 µg/m³

United States Air Quality Index (US AQI)

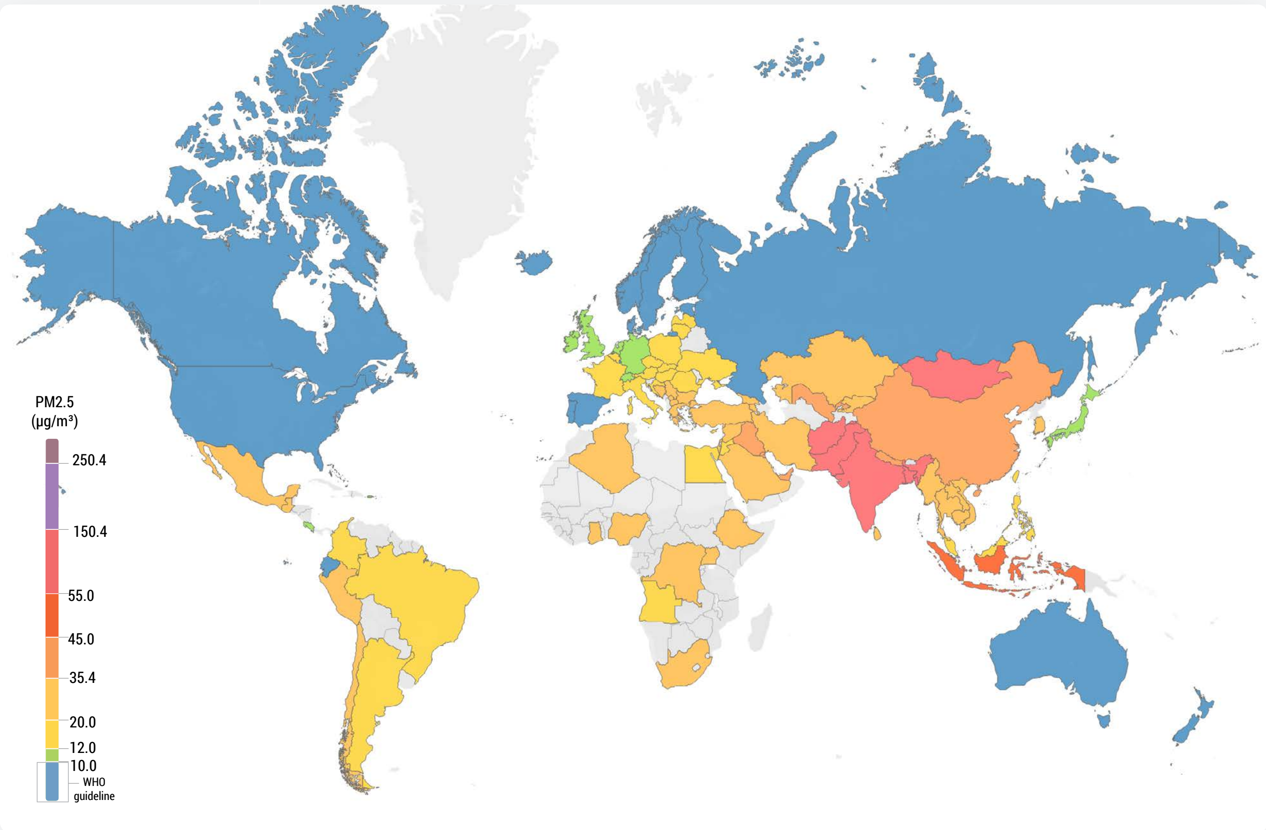
The US AQI is among the most widely recognized index for communicating air quality. The index converts pollutant concentrations into a color-coded scale of 0-500, where higher values indicate increased health risk. The US AQI "Good" range (<12µg/m³) is marginally higher than the WHO Air Quality Guideline (<10µg/m³).

US AQI Level		PM2.5 (µg/m³)	Health Recommendation (for 24hr exposure)
Good	0-50	0-12.0	Air quality is satisfactory and poses little or no risk.
Moderate	51-100	12.1-35.4	Sensitive individuals should avoid outdoor activity as they may experience respiratory symptoms.
Unhealthy for Sensitive Groups	101-150	35.5-55.4	General public and sensitive individuals in particular are at risk to experience irritation and respiratory problems.
Unhealthy	151-200	55.5-150.4	Increased likelihood of adverse effects and aggravation to the heart and lungs among general public.
Very Unhealthy	201-300	150.5-250.4	General public will be noticeably affected. Sensitive groups should restrict outdoor activities.
Hazardous	301+	250.5+	General public is at high risk to experience strong irritations and adverse health effects. Everyone should avoid outdoor activities.

Global overview

Global Country/Region PM2.5 Exposure

This map presents average PM2.5 exposure by country, as calculated from available city data and weighted by population. Grey countries and regions indicate that these locations had insufficient PM2.5 data available for 2019.



Global map of estimated PM2.5 exposure by country/region in 2019

Countries and regions in East Asia, Southeast Asia and South Asia suffer from the highest annual average PM2.5 concentration weighted by population.

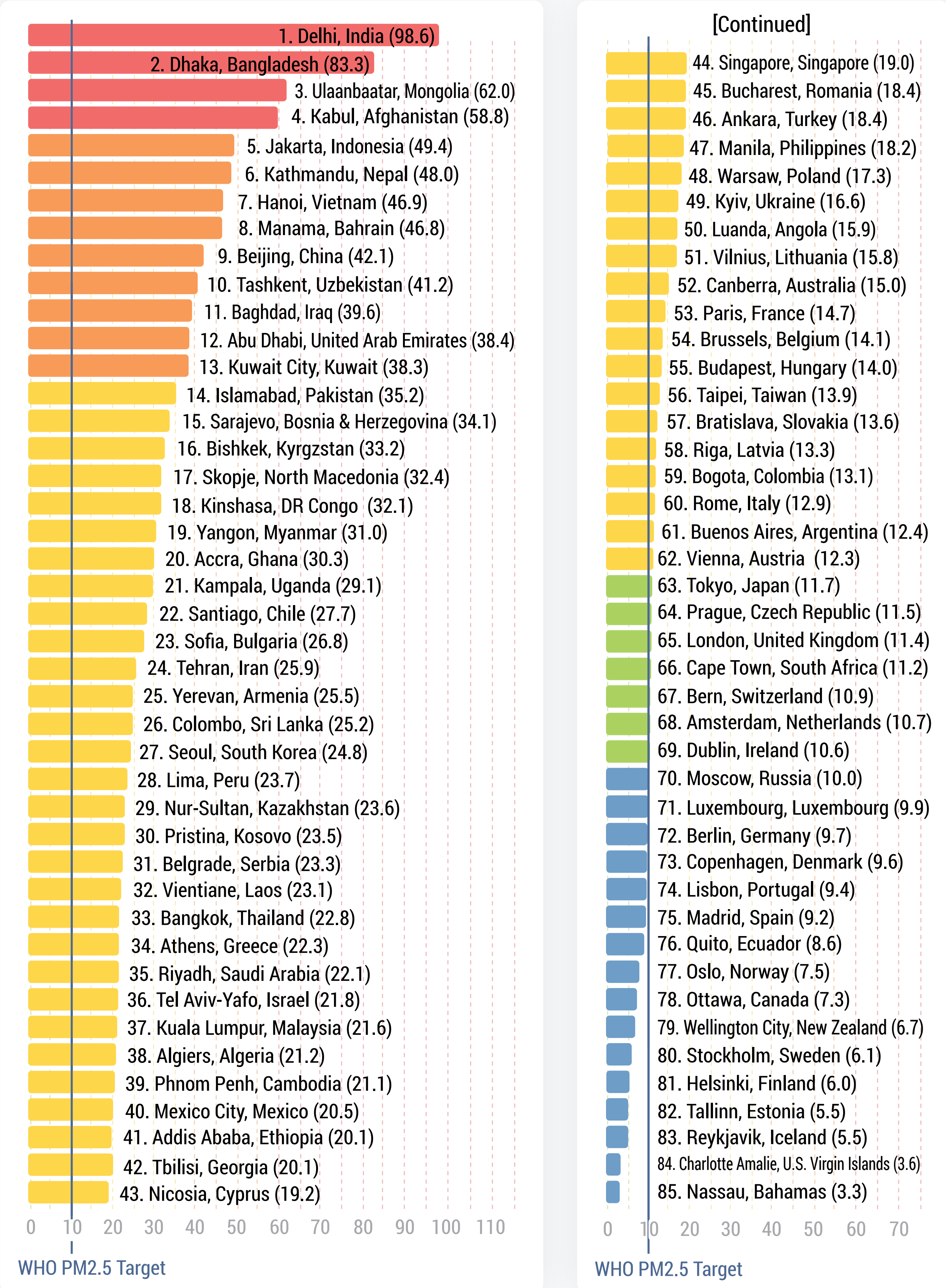
World country/region ranking

Arranged by average PM2.5 concentration (µg/m³), based on the available data

1	Bangladesh	83.3
2	Pakistan	65.8
3	Mongolia	62.0
4	Afghanistan	58.8
5	India	58.1
6	Indonesia	51.7
7	Bahrain	46.8
8	Nepal	44.5
9	Uzbekistan	41.2
10	Iraq	39.6
11	China Mainland	39.1
12	United Arab Emirates	38.9
13	Kuwait	38.3
14	Bosnia & Herzegovina	34.6
15	Vietnam	34.1
16	Kyrgyzstan	33.2
17	North Macedonia	32.4
18	Syria	32.2
19	DR Congo	32.1
20	Myanmar	31.0
21	Ghana	30.3
22	Uganda	29.1
23	Armenia	25.5
24	Bulgaria	25.5
25	Sri Lanka	25.2
26	South Korea	24.8
27	Iran	24.3
28	Thailand	24.3
29	Kazakhstan	23.6
30	Kosovo	23.5
31	Macao SAR	23.5
32	Serbia	23.3
33	Peru	23.3
34	Laos	23.1
35	Chile	22.6
36	Greece	22.5
37	Saudi Arabia	22.1
38	South Africa	21.6
39	Nigeria	21.4
40	Algeria	21.2
41	Cambodia	21.1
42	Israel	20.8
43	Turkey	20.6
44	Hong Kong SAR	20.3
45	Guatemala	20.2
46	Ethiopia	20.1
47	Georgia	20.1
48	Mexico	20.0
49	Cyprus	19.7
50	Malaysia	19.4
51	Croatia	19.1
52	Singapore	19.0
53	Poland	18.7
54	Romania	18.3
55	Jordan	18.3
56	Egypt	18.0
57	Philippines	17.6
58	Taiwan	17.2
59	Italy	17.1
60	Ukraine	16.6
61	Slovakia	16.1
62	Angola	15.9
63	Brazil	15.8
64	Colombia	14.6
65	Argentina	14.6
66	Hungary	14.6
67	Lithuania	14.5
68	Czech Republic	14.5
69	Latvia	13.3
70	Belgium	12.5
71	France	12.3
72	Austria	12.2
73	Japan	11.4
74	Germany	11.0
75	Netherlands	10.9
76	Switzerland	10.9
77	Ireland	10.6
78	United Kingdom	10.5
79	Costa Rica	10.4
80	Puerto Rico	10.2
81	Russia	9.9
82	Spain	9.7
83	Luxembourg	9.6
84	Denmark	9.6
85	Malta	9.4
86	Portugal	9.3
87	USA	9.0
88	Ecuador	8.6
89	Australia	8.0
90	Canada	7.7
91	New Zealand	7.5
92	Norway	6.9
93	Sweden	6.6
94	Estonia	6.2
95	Finland	5.6
96	Iceland	5.6
97	U.S. Virgin Islands	3.5
98	Bahamas	3.3

World regional capital city ranking

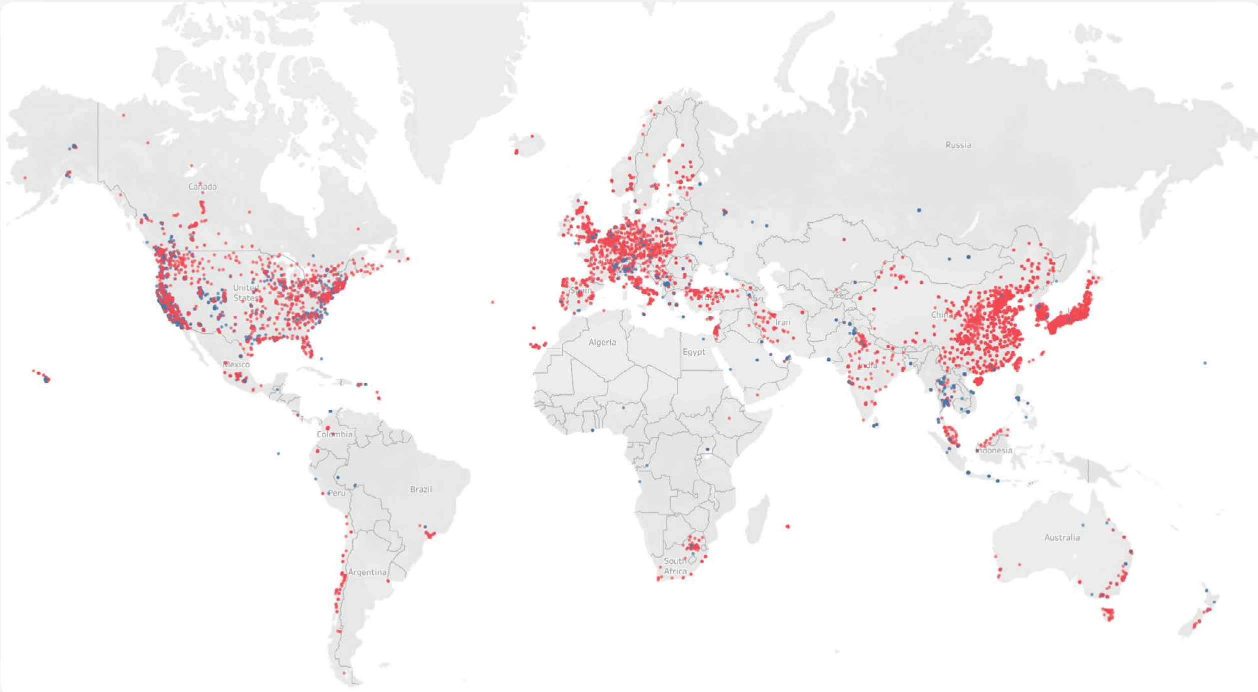
Arranged by average annual PM2.5 concentration (µg/m³)



The capital city ranking compares annual PM2.5 averages in 2019 among capital cities available in the report's dataset. Countries within Asia and the Middle East populate the top of the regional capital city ranking. Delhi tops this ranking for the second year, with annual PM2.5 levels nearly 10 times the WHO target.

Overview of public monitoring status

Public air quality monitoring varies considerably between countries and regions. Mainland China, Japan and the United States have the world's largest governmental monitoring networks that publish air quality data continuously in real-time. The below map illustrates the unequal global distribution of PM2.5 air quality monitors, which met the availability criteria for the year 2019.



Global distribution of PM2.5 air quality monitoring stations included in this report.
Red dots indicate government stations. Blue dots indicate data from independently operated air monitors.

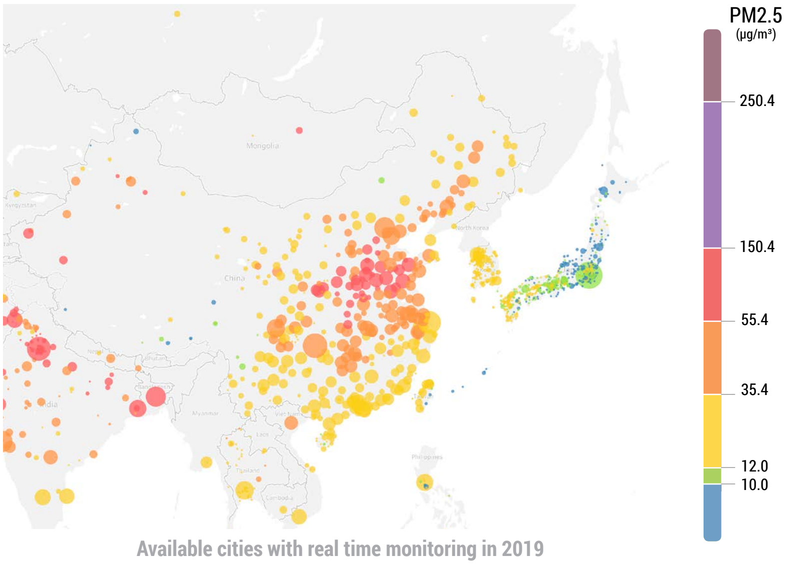
The map indicates a lack of monitoring data in numerous populated areas, particularly within the African and South American continents.

Developed countries tend to have more data availability and public access, than developing countries.

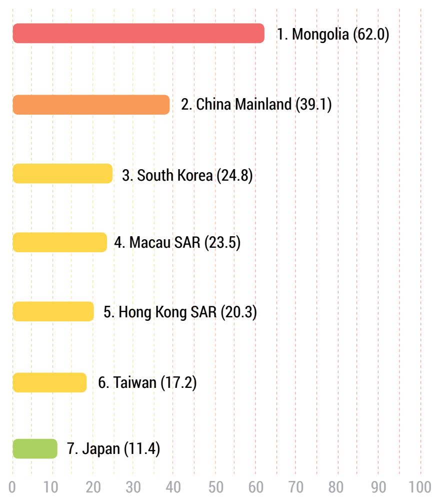
Locations which lack governmental, real-time monitoring networks can benefit from low-cost air quality sensors, which can be installed and managed with fewer resources, and provide an opportunity to accelerate access to air quality information. Data collected from low-cost monitoring stations and validated by the AirVisual platform AI, is also included in this report. These monitors provide the only real-time publicly available air quality data for Algeria, Andorra, Angola, Armenia, the Bahamas, Cambodia, Costa Rica, DR Congo, Egypt, Ghana, Iraq, Jordan, Kyrgyzstan, Laos, Latvia, Myanmar, Nigeria, Saudi Arabia, Syria, Serbia.

EAST ASIA

China Mainland | Hong Kong SAR | Japan | Macau SAR | Mongolia | South Korea | Taiwan



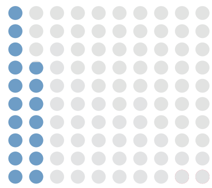
Available cities with real time monitoring in 2019

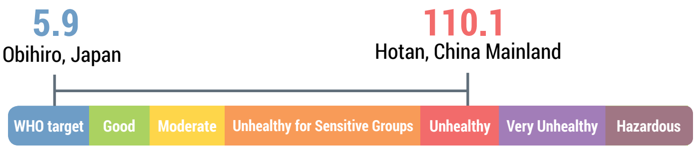


PM2.5 annual mean (µg/m³)

16.9%

Regional cities which met the WHO PM2.5 target in 2019





Range of annual mean PM2.5 (µg/m³) across regional cities

SUMMARY

Data collected in 2015 revealed that 35% of global premature deaths from air pollution occurred in East Asia, followed closely by South Asia (33%) (Clean Air Coalition, 2019). Overall the region has taken significant steps to mitigate the problem, from establishing national monitoring networks and regulating emission sources.

Whilst pollution sources vary across the region, common contributors of airborne particulates include a dependence on coal for energy production, a lack of regulations and enforcement of industrial emissions, oil-based road transportations and domestic heating. Transbountary pollution is a concern for Hong Kong, Taiwan and South Korea, as seasonal dust storms and industry emissions can travel great distances, and affect much of the region (TAQMN, 2019).

MONITORING STATUS

All the countries and regions within East Asia included in this report have public, real-time governmental monitoring networks. Overall, the region has some of the best data availability and coverage globally.

Among the countries included in this report, mainland China's national air monitoring network is the most numerous with nearly 2,200 stations, while Japan's is the densest in terms of monitors per area, with a station for every 210 km2, roughly 400 stations shy of mainland China.

During 2019, Mongolia's national monitoring coverage expanded beyond Ulaanbaatar for the first time, thanks to the additional deployment of sensors by a NGO. Still, while monitoring stations grew from eight in 2018 to 37 in 2019, monitoring data is still sparse throughout the country.

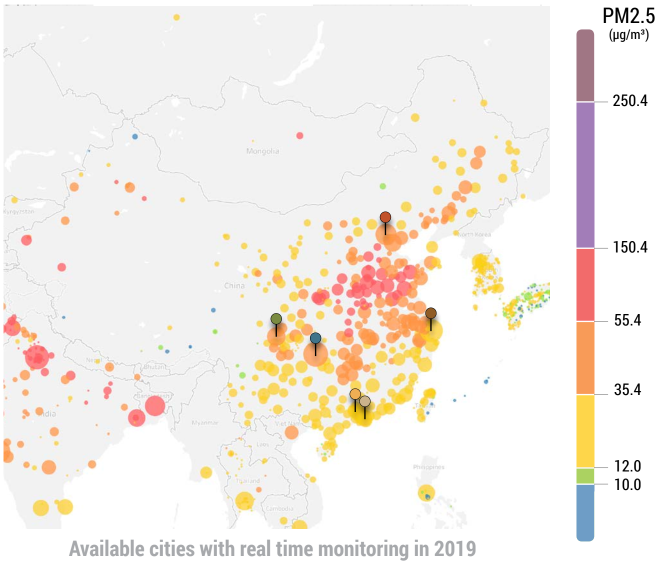
Most Polluted Regional Cities

Rank	City	2019 AVG
1	Hotan, China Mainland	110.1
2	Kashgar, China Mainland	87.1
3	Shangqiu, China Mainland	72.6
4	Anyang, China Mainland	70.3
5	Handan, China Mainland	64.3
6	Shijiazhuang, China Mainland	64.0
7	Xianyang, China Mainland	63.7
8	Xingtai, China Mainland	63.5
9	Puyang, China Mainland	63.4
10	Shihezi, China Mainland	63.3
11	Laiwu, China Mainland	63.1
12	Luoyang, China Mainland	62.4
13	Hebi, China Mainland	62.1
14	Ulaanbaatar, Mongolia	62.0
15	Linfen, China Mainland	61.7

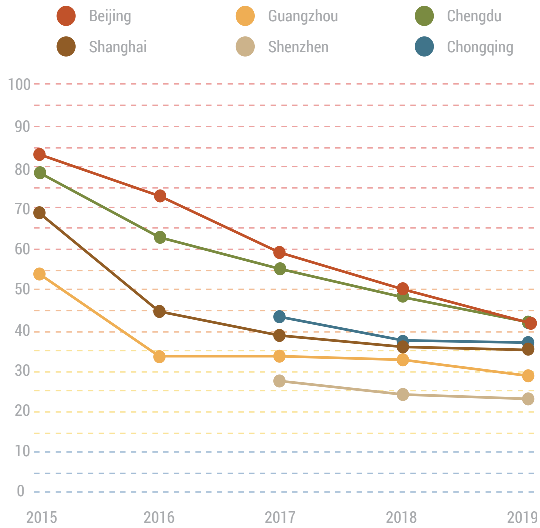
Cleanest Regional Cities

Rank	City	2019 AVG
1	Obihiro, Japan	5.9
2	Okinawa, Japan	6.2
3	Hakuba, Japan	6.3
4	Linzhi, China Mainland	6.5
5	Kitami, Japan	6.5
6	Ebina, Japan	6.7
7	Ngari, China Mainland	6.9
8	Minamiashigara, Japan	7.5
9	Gero, Japan	7.5
10	Gojo, Japan	7.6
11	Suzu, Japan	7.7
12	Hadano, Japan	7.7
13	Minami, Japan	7.8
14	Otofuke, Japan	7.9
15	Naha, Japan	8.0

CHINA MAINLAND



Available cities with real time monitoring in 2019



PM2.5 annual mean (μg/m³) over 5 years*

PM2.5: μg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Beijing	42.1	54.1	53.1	51.4	47.6	36.8	38.4	35.8	22.1	35.2	39.8	45.4	46.0
Shanghai	35.4	49.3	41.6	50.9	40.0	33.0	29.3	26.1	24.5	21.7	31.1	27.4	49.2
Guangzhou	28.9	45.5	24.8	27.9	23.2	20.3	15.6	18.0	22.4	28.4	37.6	41.5	41.2
Shenzhen	23.4	35.6	18.7	21.2	18.7	15.8	9.6	13.7	16.4	23.8	32.6	36.1	37.4
Chengdu	42.4	76.6	55.7	44.0	39.6	32.7	24.0	22.5	28.2	29.5	31.0	47.9	77.1
Chongqing	37.1	74.6	47.5	46.5	29.7	30.4	22.6	19.7	23.0	29.0	23.3	36.3	62.3

PROGRESS

Whilst 47 Chinese cities feature among the top 100 most polluted cities, the quantity of cities covered also indicates the country's strong commitment to air quality monitoring, with what now constitutes one of the world's leading national monitoring networks. Since implementing its Air Pollution Prevention and Control Action Plan in 2013 (Huang, Pan, Guo, & Li, 2018), China has achieved remarkable reductions in PM2.5 levels in numerous major cities, notably Beijing [see below].

CHALLENGES

Whilst air quality in many key Chinese cities is improving, significant challenges remain. These include substantial reliance on coal as part of China's energy mix[1] (BP, 2019), which is a principal contributor to ambient PM2.5 emissions, and pollutants that form PM2.5 in the atmosphere (SO2 and NOx). Although China is achieving the largest growth of any country in renewable energies, it still accounts for approximately half the world's coal consumption, and plans to continue expansion of new coal power plants (Chung, 2019). Diesel emissions from transport also remain an important contributor (International Council on Clean Transportation, 2019). In 2019, only 2% of the 402 cities in this report achieved the WHO's annual PM2.5 target of <10μg/m3, while 47% of cities met China's own less stringent annual target of <35μg/m3.

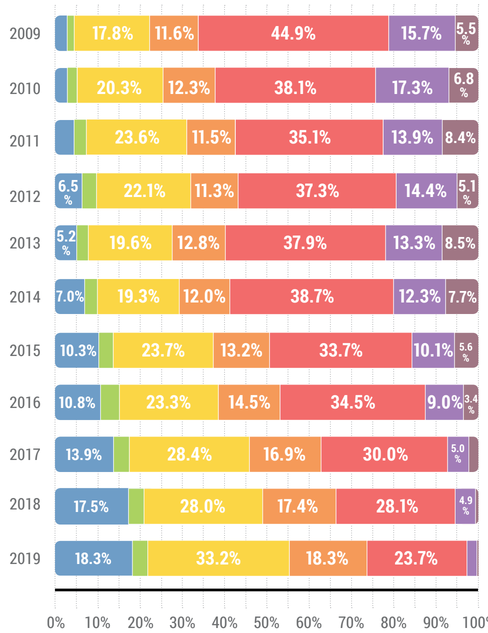
Additionally, areas of Northern China commonly exposed to dust storm pollution may experience increasingly intense events in the future, in response to increased global temperatures, desertification, and intensifying wind patterns as part of climate change (UNESCAP, 2018).

HIGHLIGHT: BEIJING

For seven consecutive years PM2.5 levels in Beijing have gradually dropped, demonstrating the success and evolution of Beijing's air quality management programme. Compared to 2009, average annual PM2.5 concentrations are reduced by more than half, whilst hours spent in the "Good" US AQI air quality level are four times as frequent. During August 2019, Beijing experienced its cleanest month on record.

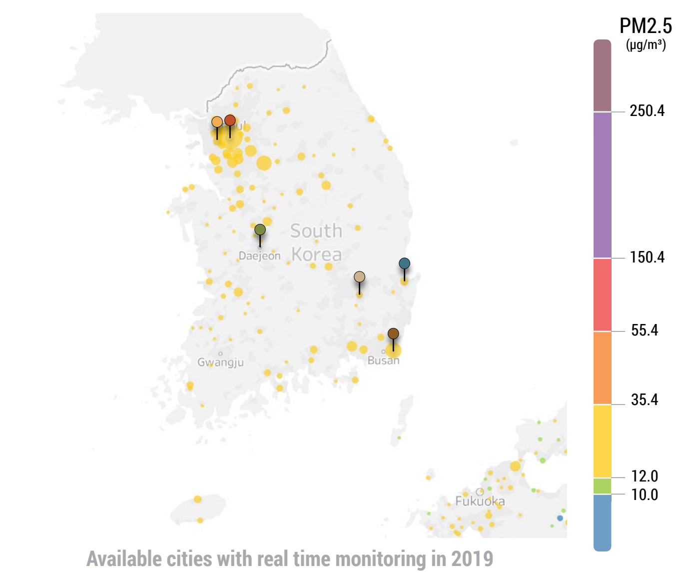
1 In 2018 coal accounted for 59% of China's direct energy consumption. This also represented over half of the world's total coal use (50.5%). (BP, 2019)

BEIJING, CHINA

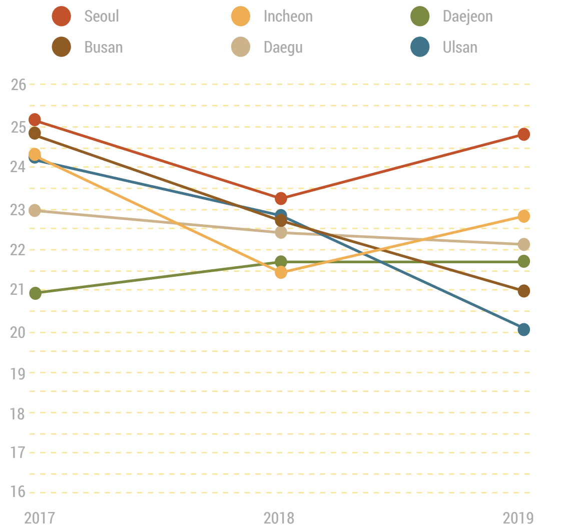


Annual PM2.5 average of hourly pollution

SOUTH KOREA



Available cities with real time monitoring in 2019



PM2.5 annual mean (µg/m³) over 3 years*

PM2.5: µg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Seoul	24.8	37.6	35.5	45.5	20.3	28.8	19.4	18.8	16.2	11.9	15.4	20.3	28.9
Busan	21.0	28.0	27.8	29.6	19.3	24.8	21.0	18.1	19.0	13.0	12.6	16.4	22.5
Incheon	22.8	32.3	30.7	40.9	19.1	25.4	17.0	18.2	17.8	13.4	15.3	18.4	24.9
Daegu	22.1	33.3	31.9	32.2	17.8	22.8	19.7	16.1	15.9	12.0	13.8	21.8	29.0
Daejeon	21.8	33.7	34.4	38.4	16.3	21.9	18.4	13.7	15.0	11.4	14.3	20.5	24.5
Ulsan	20.1	25.7	26.2	28.8	18.1	25.4	21.8	18.0	17.9	12.3	10.4	15.4	21.0

PROGRESS

South Korea has a dense air quality monitoring network, highlighting a strong commitment to tracking and improving air quality. From 2018 to 2019, the national monitoring network grew its urban pollution monitoring, including more PM2.5 monitoring. Much of Korea's particulate pollution is seasonal, with many cities experiencing nearly double the amount of PM2.5 during winter months than in summer months, as indicated by 2019's data.

Following a pollution peak in March 2019, the government legislated to categorise the nation's air pollution a "social disaster". This enabled access to emergency funds, and a range of measures to tackle seasonal emissions were introduced, effective from December to March (Chung, 2019). These include closing up to a quarter of its coal-fired power plants, capping operations at other coal-fired power plants at 80%, and restrictions on emission grade 5 vehicles in metropolitan areas (Regan, 2019). Since these new rules were introduced towards the end of the 2019 winter pollution peak, their impacts on pollution levels remain to be seen in 2020.

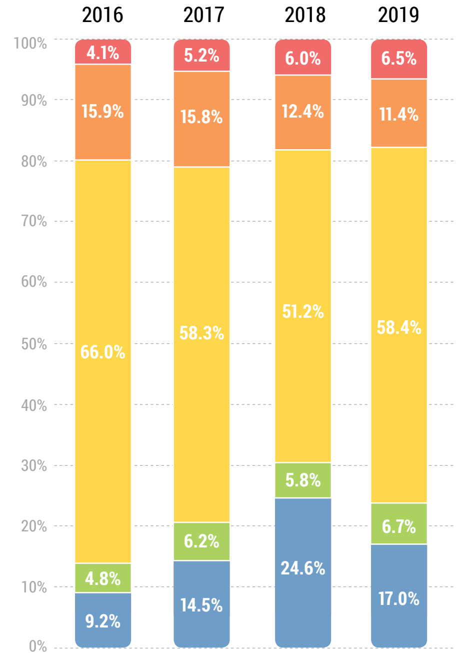
CHALLENGES

Not a single city in South Korea met the WHO's annual PM2.5 guideline of 10µg/m3 in 2019. South Korea had the highest average PM2.5 level during 2019 of any OECD country. Air pollution remains a problem shared by both urban and rural areas, with South Korea's most polluted and cleanest locations only varying by 15 µg/m3 in annual PM2.5 concentration. While transboundary air pollution can contribute additional PM2.5 from neighbouring countries, it is estimated that approximately half the country's PM2.5 is generated domestically [1]. The South Korean government's policies for air pollution are mostly focussed on temporary measures and emission reduction policies. This may be the reason that air quality improvements in South Korea have stagnated for the past several years.

HIGHLIGHT: 2019 LEGISLATURE

South Korea ranks highest among OECD countries for average annual PM2.5 exposure. On a city level, 61 of the top 100 most polluted cities in OECD countries are located in South Korea. This is a considerable increase from 44 ranked cities in 2018. Coal plants contribute to more than 40% of Korea's energy mix (Regan, 2019), whilst these emissions are now being limited during the winter months of December to March under new governmental measures, a shift away from fossil fuel usage in industry, power generation and transportation is needed to more effectively tackle particulate pollution in the long-term.

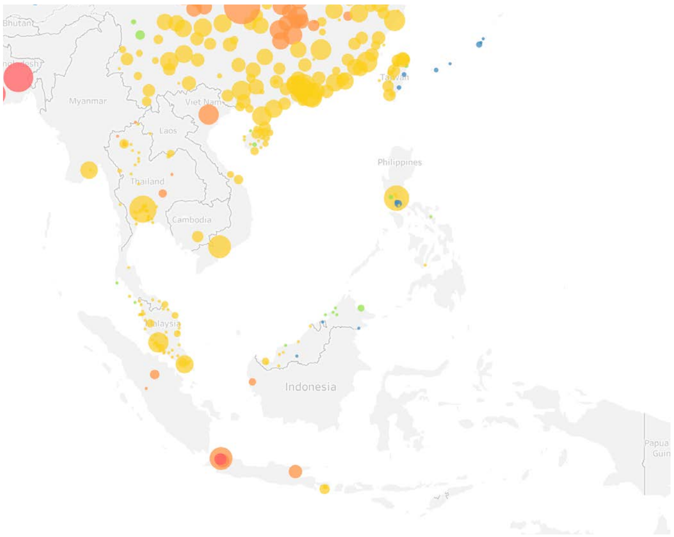
SEOUL, SOUTH KOREA



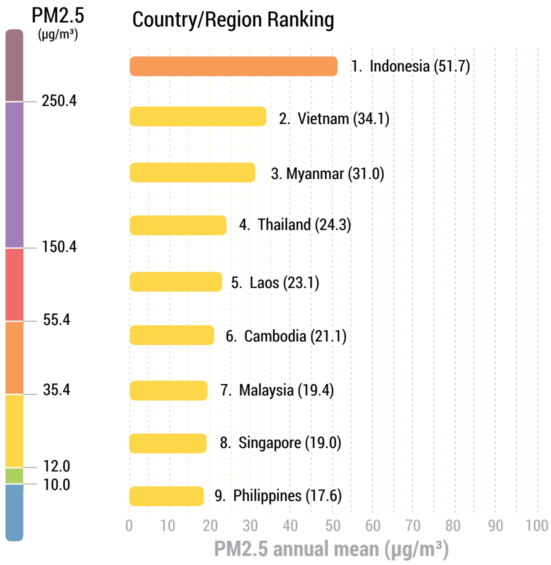
Annual PM2.5 average of hourly pollution

SOUTHEAST ASIA

Cambodia | Indonesia | Laos | Malaysia | Myanmar | Philippines | Singapore | Thailand | Vietnam



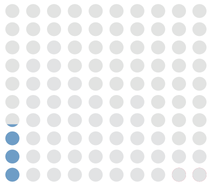
Available cities with real time monitoring in 2019

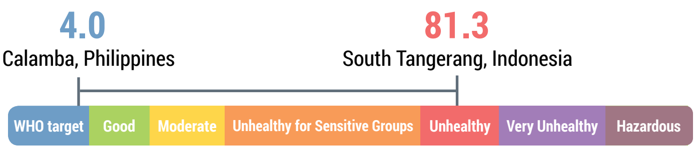


PM2.5 annual mean (μg/m³)

3.2%

Regional cities which met the WHO PM2.5 target in 2019





Range of annual mean PM2.5 (μg/m³) across regional cities

Most Polluted Regional Cities

Rank	City	2019 AVG
1	South Tangerang, Indonesia	81.3
2	Bekasi, Indonesia	62.6
3	Pekanbaru, Indonesia	52.8
4	Pontianak, Indonesia	49.7
5	Jakarta, Indonesia	49.4
6	Hanoi, Vietnam	46.9
7	Talawi, Indonesia	42.7
8	Nakhon Ratchasima, Thailand	42.2
9	Saraphi, Thailand	41.3
10	Surabaya, Indonesia	40.6
11	Pai, Thailand	38.9
12	Hang Dong, Thailand	38.0
13	Chiang Rai, Thailand	37.0
14	Mae Rim, Thailand	36.9
15	Mueang Lamphun, Thailand	36.9

Cleanest Regional Cities

Rank	City	2019 AVG
1	Calamba, Philippines	4.0
2	Tawau, Malaysia	8.6
3	Carmona, Philippines	9.1
4	Kapit, Malaysia	9.5
5	Limbang, Malaysia	9.7
6	Bongawan, Malaysia	10.1
7	Sandakan, Malaysia	10.4
8	Tanjong Malim, Malaysia	11.3
9	Mukah, Malaysia	11.3
10	Legazpi, Philippines	11.3
11	Balanga, Philippines	11.4
12	Phuket, Thailand	11.4
13	Labuan, Malaysia	11.5
14	Keningau, Malaysia	11.5
15	Putatan, Malaysia	11.6

SUMMARY

Southeast Asia's emission sources include vehicle exhaust, biomass burning, industry and coal-based energy production. Rapid growth and development often exacerbates air quality conditions in metropolitan areas, as construction and increased energy consumption result in increased ambient PM2.5. Jakarta is the most polluted capital city for PM2.5 pollution in this region, closely followed by Hanoi. These capital cities have annual PM2.5 levels which are about 20% higher than those of Beijing.

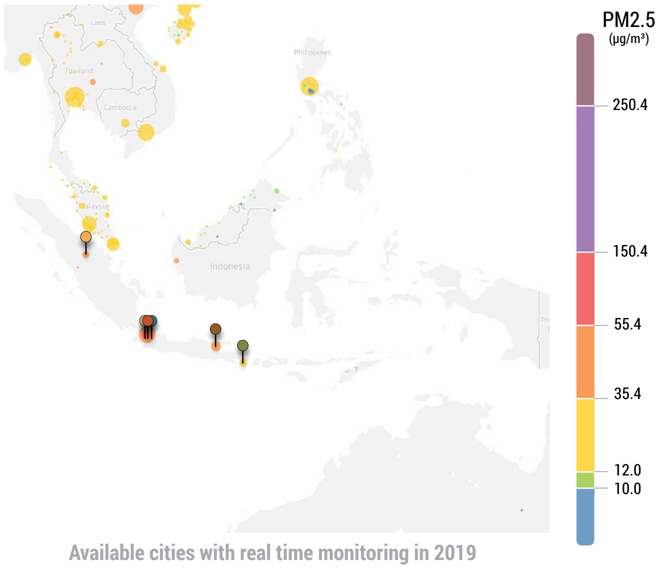
The region is also susceptible to strong seasonal variations. Open burning, the agricultural practice of quickly clearing land for cultivation of future crops, commonly influences air quality across borders from July to November, whilst the region's wet season brings lower PM2.5 levels as monsoon rains wash out airborne particulates and contribute to cleaner skies (Walton, 2019).

MONITORING STATUS

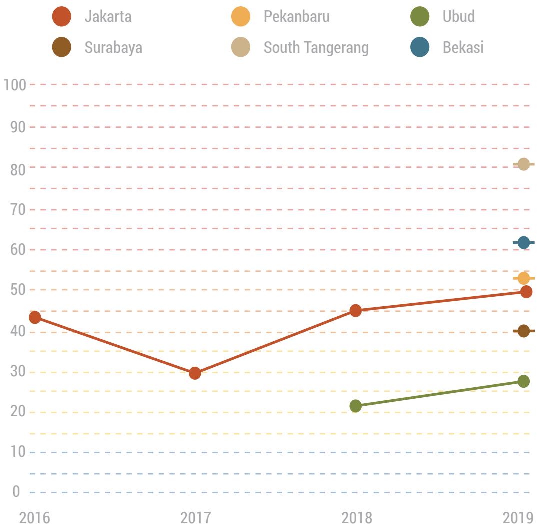
Apart from Thailand and Malaysia which have substantial monitoring networks, public governmental PM2.5 monitoring in Southeast Asia is relatively sparse, with stations primarily located in major cities. Within the region, 158 cities have PM2.5 data, 13 of which were added in 2019. Efforts from non-governmental data contributors have provided about three quarters of the region's data coverage. Non-governmental monitors provide the only real-time data available in Cambodia and Laos.

Bangkok, Thailand has the highest density of PM2.5 stations out of any city included in this report, with 159 stations in the city alone.

INDONESIA



Available cities with real time monitoring in 2019



PM2.5 annual mean (µg/m³) over 4 years*

PM2.5: µg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Jakarta	49.4	24.2	34.5	31.2	46.2	58.3	67.2	63.4	53.4	57.1	60.4	53.3	43.2
Surabaya	40.6	--	--	--	--	33.3	46.9	49.3	34.5	33.8	36.2	37.5	47.8
Pekanbaru	52.8	--	29.2	35.5	20.7	21.8	23.5	46.6	71.6	214.9	47.5	34.9	21.5
South Tangerang	81.3	44.1	61.4	48.9	60.9	87.2	107.6	102.9	90.5	100.7	104.4	88.6	76.1
Ubud	27.9	20.6	13.0	19.3	25.0	21.3	32.4	33.5	30.0	32.0	32.5	27.9	28.3
Bekasi	62.6	52.1	65.7	56.4	66.1	74.6	81.2	--	63.3	62.9	65.2	60.9	55.9

PROGRESS

During 2019, Indonesia experienced both a substantial increase in its live air monitoring coverage, as well as numerous high-profile air pollution events. The government's live PM2.5 monitoring network grew from 6 to 42 stations, while individuals and non-governmental organizations also contributed significantly, by more than doubling the number of low-cost community sensors deployed nationwide.

Grassroots efforts have further escalated the pollution conversation. In July 2019, residents united under the Clean Air Coalition Initiative Movement sought legal action against the government for breaching citizens' rights to a clean and healthy environment (Smith, 2019). The final verdict of the lawsuit is still pending.

CHALLENGES

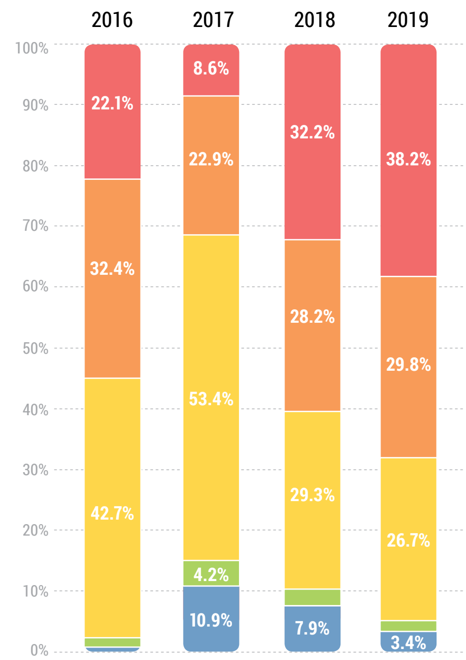
Seasonal agricultural burning practices, especially seasonal forest fires, rapid urban development, open burning of household waste, and a reliance on coal-based energy present primary sources of particulate pollution in Indonesia. Key cities such as Jakarta, Badung and Denpasar all experienced worse air quality in 2019 than the year prior, largely as a result of escalated open burning in July through October (BBC, 2019).

HIGHLIGHT: JAKARTA

Jakarta ranks as the most polluted capital city in Southeast Asia in 2019, and the 5th most polluted capital city in this global report (up from its 10th position in 2018).

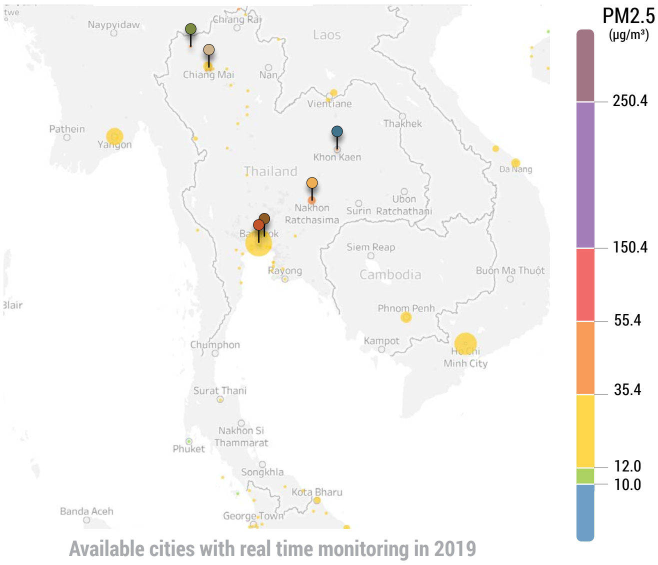
The Jakarta metropolitan area is home to more than 30 million residents and growing. In the next decade, it is estimated that Jakarta will become the world's biggest megacity (Kutty, 2018), with a population of 35.6 million. The city's rapid growth has coincided with heightened PM2.5 levels, as the growing population adds to its notorious traffic congestion, and coal-based energy demand. Since 2017, PM2.5 levels in the city have increased by 66%. In 2019, residents were exposed to more than 3 times the amount of hours in the "Unhealthy" range (US AQI 150+) than two years prior. Currently plans are underway to build 4 more coal-fired power plants encircling the capital region, which may add significant extra exposure risk for the capital's residents (Coca, 2019).

JAKARTA, INDONESIA

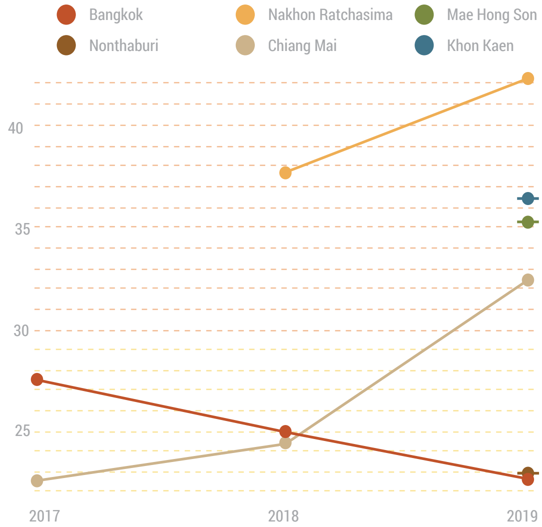


Annual PM2.5 average of hourly pollution

THAILAND



Available cities with real time monitoring in 2019



PM2.5 annual mean (µg/m³) over 3 years*

PM2.5: µg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Bangkok	22.8	47.4	24.1	27.7	19.0	19.6	9.4	10.2	7.6	20.4	23.2	30.2	34.2
Nonthaburi	23.2	70.6	29.4	29.4	19.1	19.2	9.5	10.1	7.6	21.2	25.1	32.9	38.9
Nakhon Ratchasima	42.2	42.1	67.9	68.0	41.4	28.3	17.1	15.7	--	--	--	--	32.6
Chiang Mai	32.3	24.4	47.2	98.7	74.1	33.6	7.8	6.8	7.9	15.8	16.8	23.0	33.1
Mae Hong Son	35.3	29.4	46.8	116.1	99.7	21.3	11.5	5.9	4.7	10.1	9.5	13.1	24.6
Khon Kaen	36.4	51.6	67.2	68.6	41.5	29.2	17.4	16.9	15.8	29.6	26.3	31.4	42.6

PROGRESS

The Thai government has established a substantial network of air quality monitoring stations, adding 15 new stations in 2019. Non-governmental data contributors however, supply the majority (75.7%) of monitoring stations nationally. Outside of the US this is the largest network of community contributed, lower-cost monitors. The publication and engagement around this data has helped raise a national dialogue around air quality and increase public awareness on the issue.

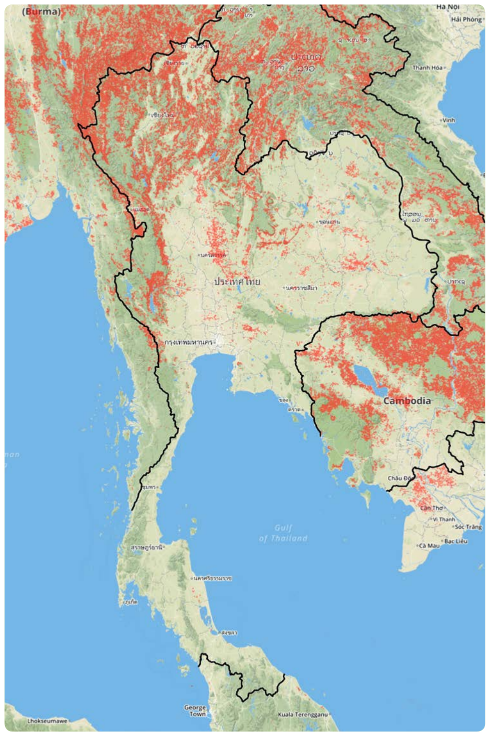
Bangkok is the city with the most public PM2.5 stations, globally. At the same time, the city's annual PM2.5 average has gradually improved over the last 3 years. Despite improvements, Bangkok's annual PM2.5 average remains more than four times the WHO target.

CHALLENGES

Much of Thailand's air pollution is seasonal, with pollution peaking during the dry season from December to April. Major sources of emissions in metropolitan areas such as Bangkok include inefficient, diesel-fuelled transportation, factories and construction (UNEP, 2019) and seasonal transboundary impacts from neighboring provinces and countries, while agricultural regions are more exposed to pollution from open agricultural and waste burning. Thailand experienced several high-profile air pollution episodes during 2019. In January, hundreds of schools were closed in Bangkok to limit exposure to polluted air. March and April saw intense air pollution across the northern region, including Chiang Mai (Kuhakan, 2019).

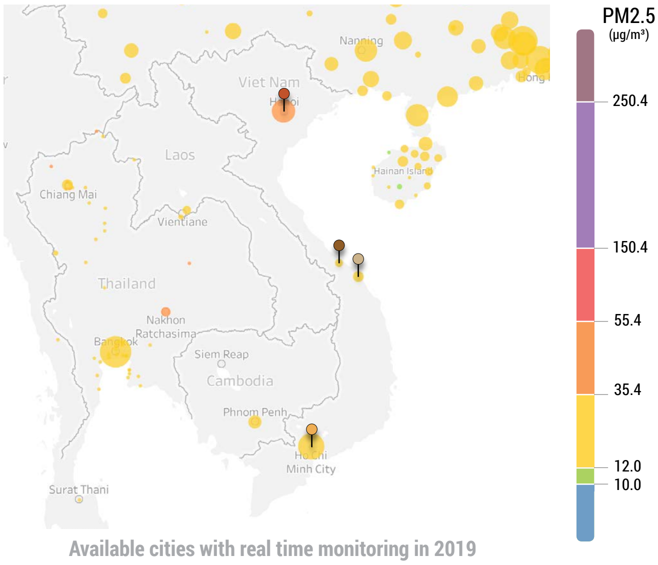
HIGHLIGHT: OPEN BURNING PRACTICES

The annual practice of open burning is commonly used in agricultural areas to clear land for the following season's cultivation. Whilst the practice is beneficial to farmers as it requires few resources and quickly eliminates agricultural waste, open burning can cause far-reaching air pollution, sometimes lasting for weeks or months at a time. The top five most polluted cities here are all located in Thailand's Northern agricultural areas, commonly affected by open burning from February to April (Pasukphun, 2018).

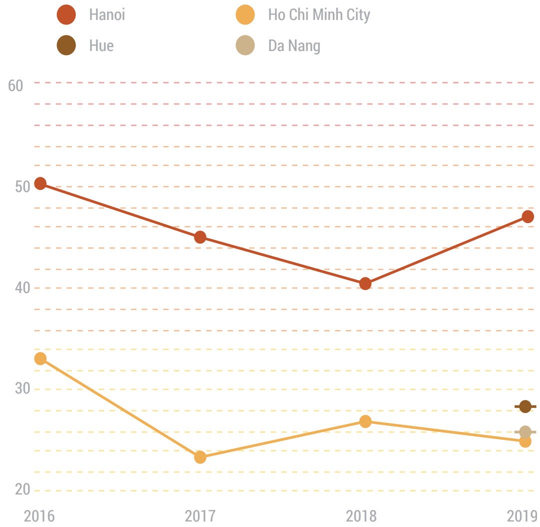


Map of acreage burned in 2019

VIETNAM



Available cities with real time monitoring in 2019



PM2.5 annual mean (μg/m³) over 4 years*

PM2.5: μg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Hanoi	46.9	59.3	36.0	50.2	40.3	45.8	36.5	30.4	33.1	48.3	43.2	66.3	72.7
Ho Chi Minh City	25.3	34.1	17.5	22.5	18.1	23.9	18.6	18.9	17.3	26.7	29.8	39.0	37.0
Hue	28.6	--	41.8	53.5	45.2	25.9	12.2	11.1	12.6	25.0	27.0	36.9	37.3
Da Nang	25.9	40.5	28.3	36.0	--	--	22.6	30.0	29.9	18.2	12.0	28.1	26.4

PROGRESS

Whilst Vietnam has a relatively small governmental air quality monitoring network, covering only Hanoi and Ho Chi Minh City, numerous independently operated PM2.5 sensors have been brought online by individuals and local organizations in 2019. These contributions currently outnumber governmental monitoring stations, tripling the number of live PM2.5 monitoring stations within the country. With the publication of real-time data, air quality has become a national talking point. The government has responded with positive efforts, including the first Vietnamese public advisory on air pollution, which outlined a 14-step guideline for reducing exposure (Anh, 2019), expanding their monitoring network (Truong, 2020) and an update to the Vietnam Environment Administration Technical guidance on calculation and publication of Vietnam's air quality index (Bai, 2019).

CHALLENGES

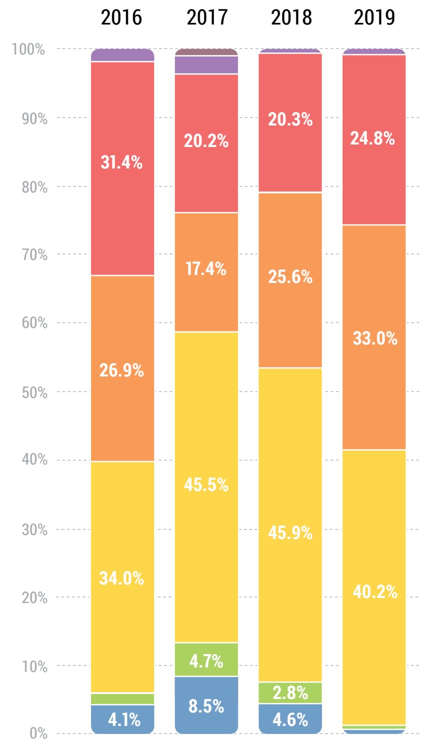
Vietnam's rapid development and urbanisation poses severe challenges to managing its PM2.5 pollution. In 2019, Hanoi overtook Beijing in the ranking of global capital cities. Hanoi was also 2019's most polluted city in Southeast Asia for PM2.5 pollution, outside of Indonesia. Research done by Vietnamese experts showed that Vietnam suffers between 10.8 – 13.2 billion USD worth of economic losses associated with ambient air pollution each year, equivalent to about 5% of the country's GDP (VNA, 2020).

Rapid development coupled with weak emission standards for power plants, vehicles and industries and a high and rising share of coal in power generation contribute to high air pollution levels in bigger cities. Vietnam's coal consumption doubled and oil consumption increased by 30% over the past five years (BP, 2019).

HIGHLIGHT: HEAVY SMOG SPARKS ENVIRONMENAL LAW

Following several high-pollution episodes in Hanoi during 2019, during which the government issued public advisories to stay indoors and limit outdoor exercise (Samuel, 2019), Vietnam's Ministry of Natural Resources and the Environment (MONRE) have pledged to revise the country's Environmental Protection Law, established in 2014. The updated legislation is due for submission in 2020 (Ecologic Institute, 2019), and should require stronger action on air quality management and more stringent emission control from heavy industrial sources and energy production, such as coal-fired power plants. Only 0.7% of hours in 2019 met the WHO target for annual average PM2.5 exposure.

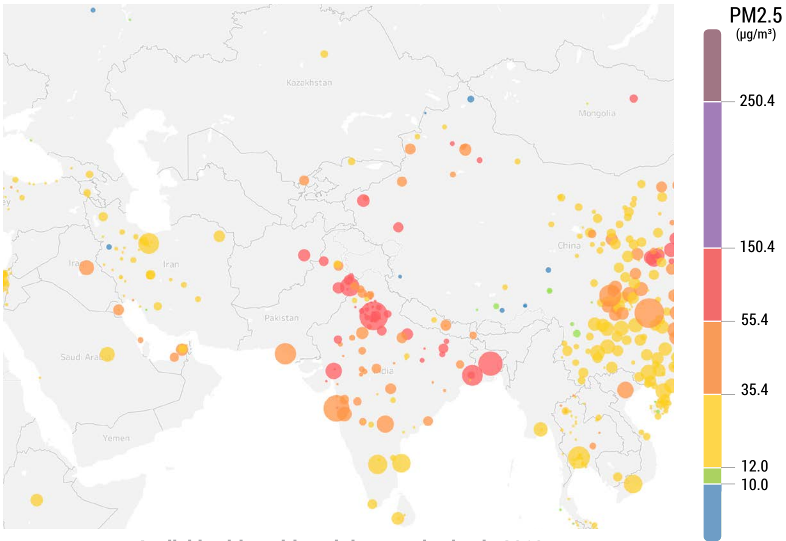
HANOI, VIETNAM



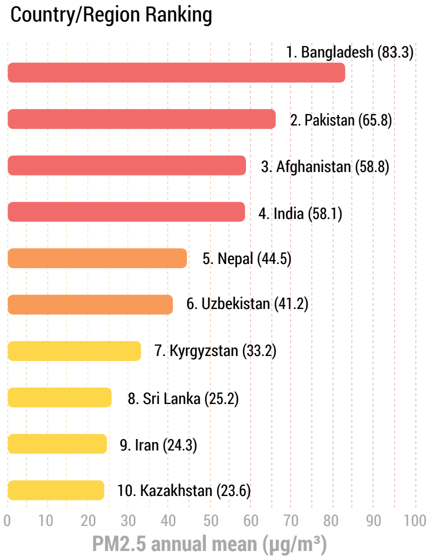
Annual PM2.5 average of hourly pollution

CENTRAL & SOUTH ASIA

Afghanistan | Bangladesh | India | Iran | Kazakhstan | Kyrgyzstan | Nepal | Pakistan | Sri Lanka | Uzbekistan



Available cities with real time monitoring in 2019



0.7%

Regional cities which met the WHO PM2.5 target in 2019

Range of annual mean PM2.5 (µg/m³) across regional cities

Most Polluted Regional Cities

Rank	City	2019 AVG
1	Ghaziabad, India	110.2
2	Gujranwala, Pakistan	105.3
3	Faisalabad, Pakistan	104.6
4	Delhi, India	98.6
5	Noida, India	97.7
6	Gurugram, India	93.1
7	Raiwind, Pakistan	92.2
8	Greater Noida, India	91.3
9	Bandhwari, India	90.5
10	Lucknow, India	90.3
11	Lahore, Pakistan	89.5
12	Bulandshahr, India	89.4
13	Muzaffarnagar, India	89.1
14	Bagpat, India	88.6
15	Jind, India	85.4

Cleanest Regional Cities

Rank	City	2019 AVG
1	Sanandaj, Iran	6.5
2	Borazjan, Iran	11.6
3	Kabudrahang, Iran	12.7
4	Tabriz, Iran	13.2
5	Qorveh, Iran	13.7
6	Yazd, Iran	13.7
7	Zanjan, Iran	15.1
8	Nahavand, Iran	15.4
9	Satna, India	15.5
10	Saqqez, Iran	15.7
11	Darreh Shahr, Iran	16.6
12	Pardis, Iran	16.9
13	Pokhara, Nepal	17.1
14	Eslamshahr, Iran	19.7
15	Saveh, Iran	19.8

SUMMARY

The majority of the most polluted cities and countries included in this report are located in the South Asia region. The region includes 30 of the top 40 most polluted cities and four of the five most polluted countries. Only one city in this region (Sanandaj, Iran), out of 147 cities with monitoring data in 2019, met WHO targets for PM2.5 levels.

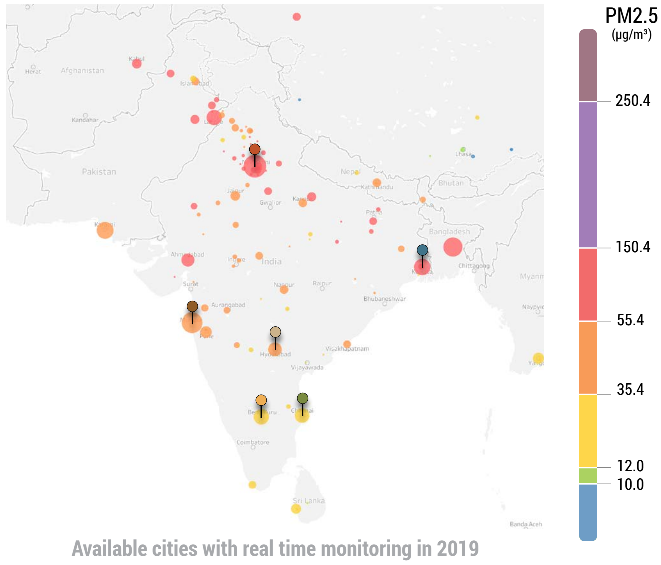
Whilst pollution sources across the region vary, common contributors include transportation emissions, biomass burning for household cooking, open agricultural burning, industry and coal combustion.

Numerous cities within the region, particularly in Pakistan and India, saw improvements in PM2.5 levels from 2018 to 2019. This resulted in an overall decrease in PM2.5 levels by 14.8% across the region, among cities with comparable PM2.5 data in 2018 and 2019. Much of this can be attributed to increased monitoring data, economic slowdown, favorable meteorological conditions and government action. 2019 marked the start of India's National Clean Air Program, which set ambitious PM2.5 targets and outlined new strategies for meeting these goals.

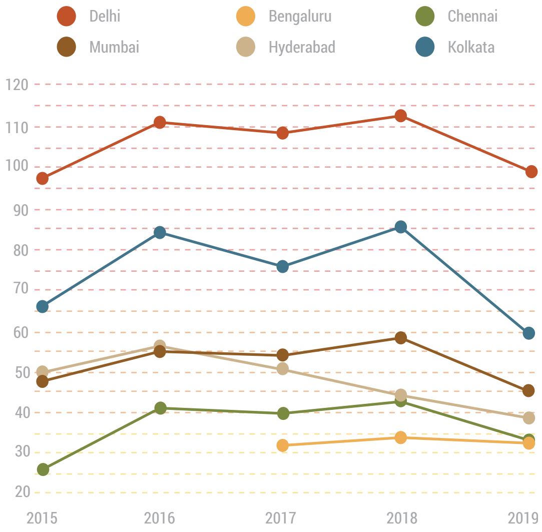
MONITORING STATUS

India, Iran and Nepal are the only countries within the South Asia region which have live public, national PM2.5 monitoring networks. In 2019, India nearly doubled its governmental monitoring network, growing the number of stations to 283, whilst individual contributors provided an additional 31 stations. Pakistan also doubled its monitoring stations, with more than 90% owing to individual data contributors. While major cities within the region tend to have several stations, much of the region still lacks air quality data, leaving large populations without information regarding the air they are breathing.

INDIA



Available cities with real time monitoring in 2019



PM2.5 annual mean (µg/m³) over 5 years*

PM2.5: µg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Delhi	98.6	191.7	84.8	75.3	71.4	76.6	56.7	43.2	31.9	37.2	116.7	200.7	194.8
Mumbai	45.3	104.5	71.0	59.0	41.0	31.8	25.3	18.1	15.8	12.6	31.5	57.7	81.1
Bengaluru	32.6	57.8	44.6	43.4	39.6	35.2	20.1	17.3	15.6	17.5	24.7	40.3	35.5
Chennai	34.6	74.9	35.8	30.4	23.0	39.1	34.0	28.5	21.1	22.3	20.5	48.0	40.2
Hyderabad	39.0	70.5	32.7	45.0	35.6	42.6	23.2	15.5	16.5	19.9	34.6	67.0	63.6
Kolkata	59.8	176.1	50.3	66.1	36.8	37.3	29.5	25.6	22.6	19.7	63.3	92.6	102.1

PROGRESS

2019 marked the launch of India's first National Clean Air Programme (NCAP), marking a shift in India's commitment to tackling air pollution. The NCAP aims to reduce PM2.5 and PM10 air pollution in 102 cities by 20-30% by 2024 compared to 2017 levels, by working directly with local governments to create more customized regulations and targets (Government of India, 2019). In July 2019, India additionally joined the UN's Climate & Clean Air Coalition (CCAC) as the 65th member to collaborate with global leaders on air pollution solutions. While the long-term impacts of these activities are yet to be seen, India saw widespread improvements in PM2.5 levels in 2019, compared to the year prior as a result of economic slowdown, favorable meteorological conditions, as well as more dedicated efforts towards cleaning the air.

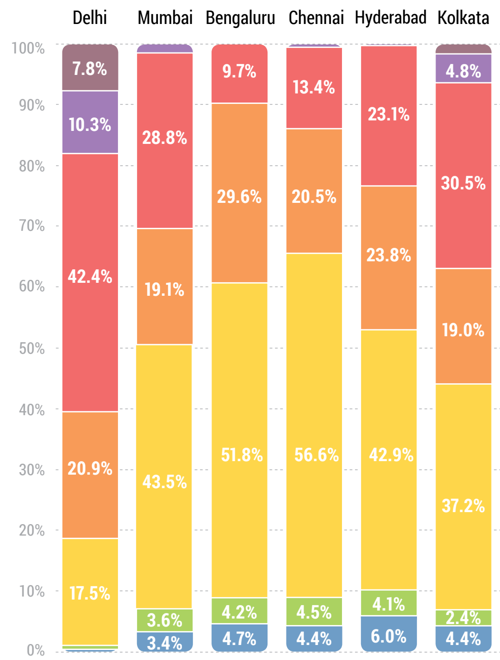
CHALLENGES

Despite improvements, India still faces serious air pollution challenges. India again heads this report's ranking of annual PM2.5 levels by city with half of the 50 most polluted cities being in India. No Indian cities included in this report met the WHO target for annual pollution exposure (10ug/m3) during 2019. Additionally, the country still has a relatively limited air quality monitoring network given its population size, with many communities and even highly populated cities without access to real-time information.

HIGHLIGHT: NATIONAL AIR QUALITY IMPROVEMENTS

Every city in India with PM2.5 data in 2018 and 2019, except for Nagpur[1], saw a decrease in PM2.5 levels in 2019. As a weighted average based on the available data, national air pollution decreased by a remarkable 20% from 2018 to 2019. Unfortunately these improvements are not representative of the very recent but promising National Clean Air Programme and promising cleaner fuel Bharat VI introduction, but are rather more indicative of a slowing of the marketplace.

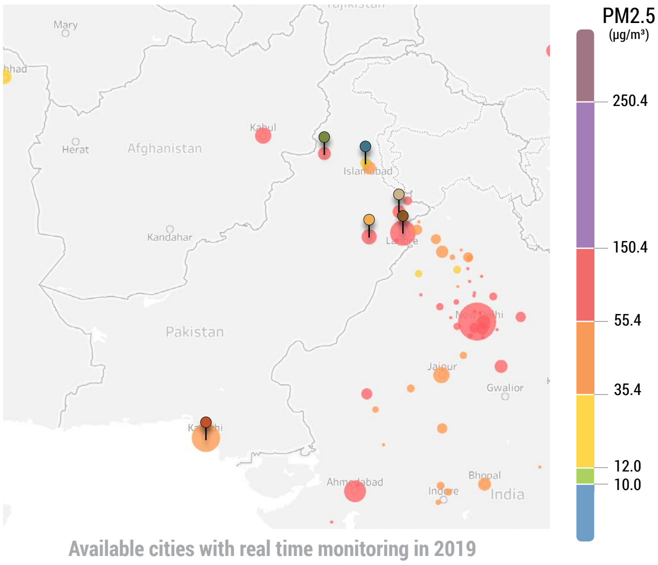
Key Cities in India



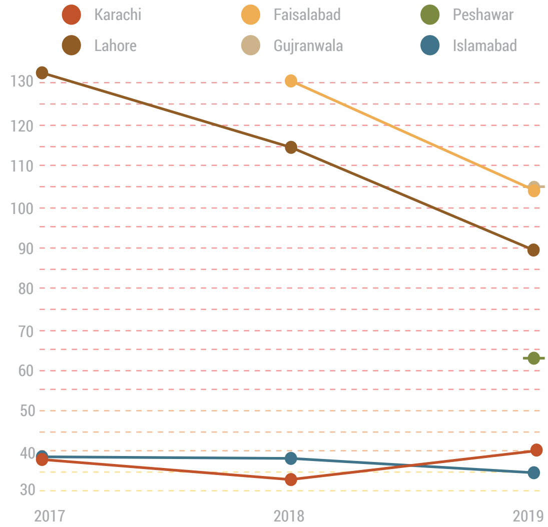
Annual PM2.5 average of hourly pollution in 2019

1 Nagpur saw a slight increase in average PM2.5 level, of +1.3%.

PAKISTAN



Available cities with real time monitoring in 2019



PM2.5 annual mean (μg/m³) over 3 years*

PM2.5: μg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Karachi	40.2	86.7	42.1	32.4	18.2	16.1	18.1	23.3	22.2	28.5	44.9	67.1	75.9
Lahore	89.5	199.1	110.3	73.6	62.5	53.7	44.5	39.9	40.9	54.7	104.6	134.9	182.7
Faisalabad	104.6	223.0	128.3	82.0	59.1	56.5	46.3	54.2	58.4	66.5	92.0	148.5	226.2
Gujranwala	105.3	220.4	127.4	86.4	70.9	65.8	53.3	59.2	48.8	67.4	107.6	144.9	217.3
Peshawar	63.9	81.2	44.3	28.6	53.7	44.4	56.4	52.8	41.4	60.9	75.2	77.9	113.5
Islamabad	35.2	37.0	24.9	18.6	17.2	14.6	20.5	31.7	29.8	42.9	40.0	48.8	96.3

PROGRESS

Globally, Pakistan ranks second overall for highest annual PM2.5 exposure, weighted by city population. Until recently, there was no government monitoring in Pakistan. The data provided in this report comes from low-cost sensors operated by engaged individuals and non-governmental organizations. New Prime Minister Imran Khan has cited air pollution as a key priority for his administration, and recently reinstated the monitoring infrastructure in Lahore, a program previously abandoned by the last government (Khan, 2019). Current anti-smog measures include stricter emission standards on factories, as well as fining heavily polluting vehicles and farmers burning crop stubble. Much more must be done however, to tackle emissions at the source, and shift to cleaner energy sources.

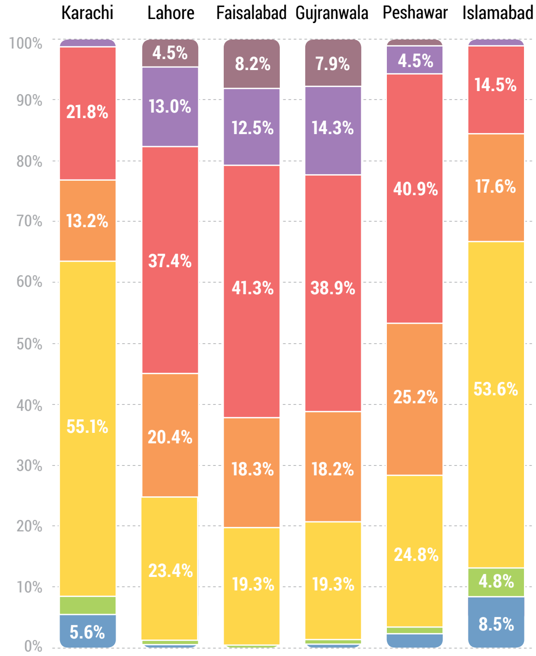
CHALLENGES

Air pollution is responsible for nearly 22% of premature deaths in Pakistan (Shaikh, 2018). Several cities in Pakistan rank prominently among the most polluted cities globally. Gujranwala and Faisalabad, which rank third and fourth respectively, both experience annual average PM2.5 levels that are more than 10 times the WHO target for annual PM2.5 exposure. These cities observe ten times more yearly hours in the highest US AQI bracket (250.4μg/m3) than in the US AQI bracket which meets the WHO annual target (<10μg/m3). Relative to the heavy pollution burden, Pakistan has very few public air quality monitors. A national monitoring network offering data granularity and coverage in more cities is critically important to better understand emission sources and drive action.

HIGHLIGHT: COMMUNITIES TAKE URGENT ACTION

Young Pakistanis and engaged communities have taken a leadership role in raising social awareness, growing available outdoor air quality data and demanding government action in Pakistan. Since 2017, the air quality monitoring infrastructure has grown to 46 stations as a result of contributions through the non-governmental organization Pakistan Air Quality Initiative (PAQI) and individual data contributors. In November, three teenage girls sought legal action against the government of Punjab, claiming a "violation of their fundamental right to a clean and healthy environment," demanding urgent action (Amnesty International, 2019).

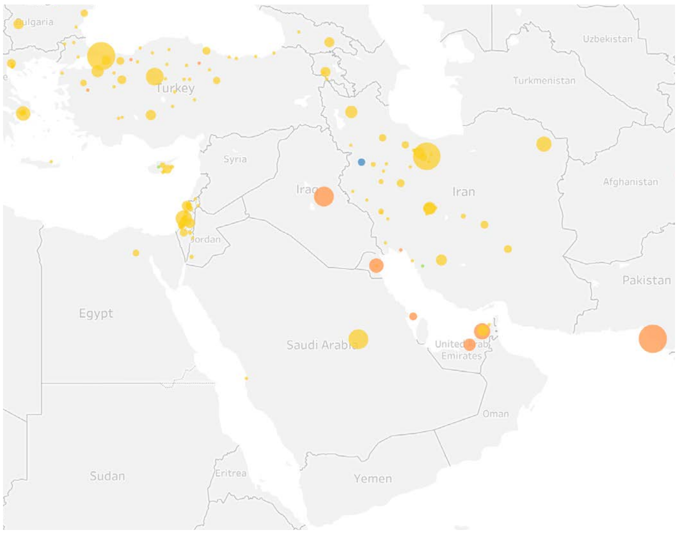
Key Cities in Pakistan



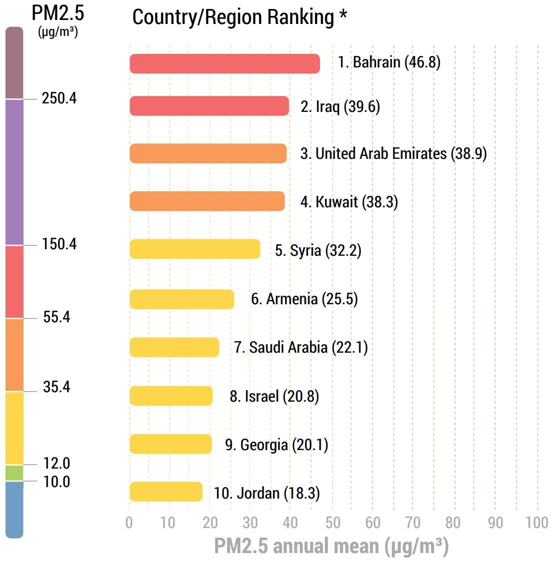
Annual PM2.5 average of hourly pollution in 2019

WESTERN ASIA

Armenia | Bahrain | Georgia | Iraq | Israel | Jordan | Kuwait | Saudi Arabia | Syria | United Arab Emirates



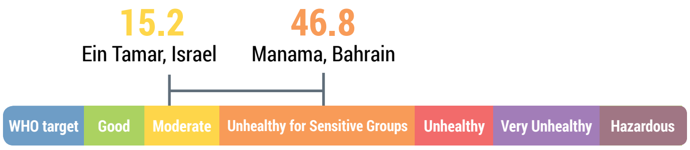
Available cities with real time monitoring in 2019



PM2.5 annual mean (μg/m³)

0%

Regional cities which met the WHO PM2.5 target in 2019 *



Range of annual mean PM2.5 (μg/m³) across regional cities

SUMMARY

Sources for PM2.5 air pollution in the Middle East include a mix of both natural sources, such as dust storms, and man-made sources, including energy production, transport exhaust and construction (UNEP, 2016).

Whilst sandstorms contribute to elevated PM2.5 levels year-round, their effect is noticeably seasonal, impacting air quality more severely in May through August. During these months, strong winds, thunderstorm activity and convective low-pressure systems, as a result of the intense heat, kick up significant amounts of dust. Dust particles have been found to be comprised of hydrocarbons, trace elements, heavy metals, sulphates and nitrates (UNEP, 2016).

The top five most polluted cities in this region, Manama, Dubai, Baghdad, Abu Dhabi, and Kuwait City are all heavily affected by sandstorms in the summer months. These months can experience nearly twice the PM2.5 levels as winter months.

MONITORING STATUS

Among the countries in this region, only Israel and UAE have national PM2.5 air quality monitoring networks. The US State Department has established PM2.5 monitoring stations at consulates and embassies in the capital cities of Bahrain, Kuwait, Iraq, Jordan, Saudi Arabia and the United Arab Emirates. The US-owned stations in Jordan, Iraq, and Saudi Arabia are all new within 2019. Additional data has been provided by individual data contributors. These contributions have added 26 stations within the region, and are the first to cover the nation of Syria and Salwa, Kuwait.

Most Polluted Regional Cities*

Rank	City	2019 AVG
1	Manama, Bahrain	46.8
2	Dubai, UAE	40.9
3	Baghdad, Iraq	39.6
4	Abu Dhabi, UAE	38.4
5	Kuwait City, Kuwait	38.3
6	Sharjah, UAE	34.6
7	Salwa, Kuwait	32.2
8	Fiq, Syria	32.2
9	Yeghegnavan, Armenia	31.8
10	Musalerr, Armenia	30.2
11	Prroshyan, Armenia	25.5
12	Gan Raveh, Israel	24.5
13	Rishon LeTsiyon, Israel	22.9
14	Bnei Brak, Israel	22.9
15	Ramat Gan, Israel	22.6

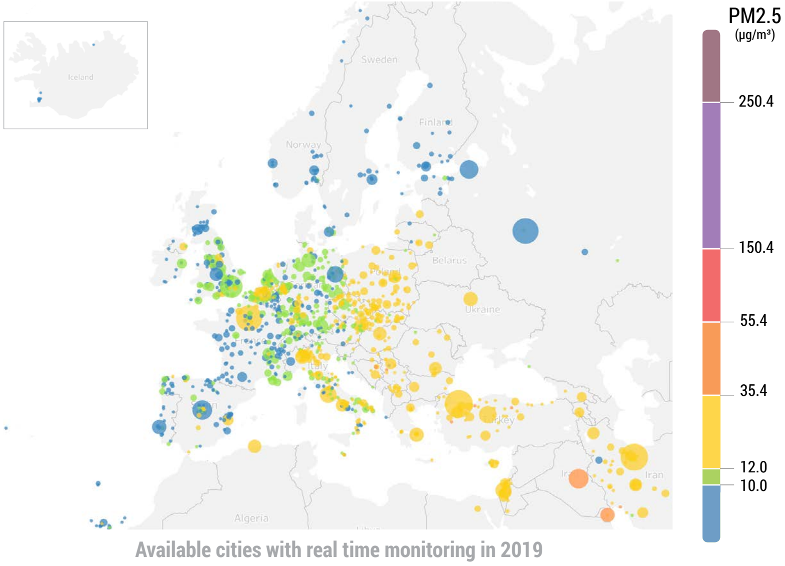
Cleanest Regional Cities *

Rank	City	2019 AVG
1	Ein Tamar, Israel	15.2
2	Kutaisi, Georgia	16.3
3	Nesher, Israel	16.8
4	Haifa, Israel	18.0
5	Kiryat Yam, Israel	18.1
6	Gvar'am, Israel	18.2
7	Al Quwayrah, Jordan	18.3
8	Kiryat Tiv'on, Israel	18.4
9	Afula, Israel	18.5
10	Gan Yavne, Israel	18.8
11	Ashkelon, Israel	18.8
12	Nir Yisrael, Israel	18.8
13	Arad, Israel	19.1
14	Kiryat Gat, Israel	19.1
15	Be'er Sheva, Israel	19.2

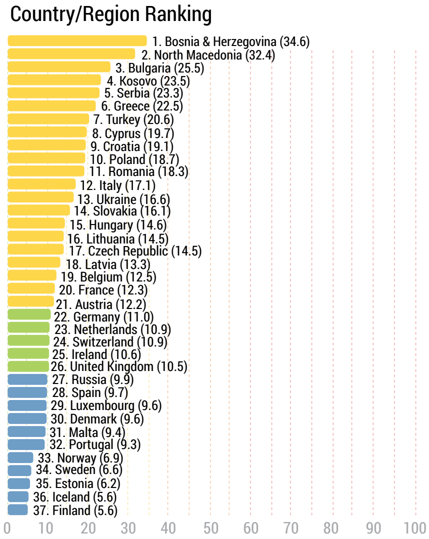
* Based on available data.

EUROPE

Austria | Belgium | Bosnia and Herzegovina | Bulgaria | Croatia | Cyprus | Czech Republic | Denmark | Estonia | Finland | France | Germany
Greece | Hungary | Iceland | Ireland | Italy | Kosovo | Latvia | Lithuania | Luxembourg | Macedonia | Malta | Netherlands | Norway
Poland | Portugal | Romania | Russia | Serbia | Slovakia | Spain | Sweden | Switzerland | Turkey | Ukraine | United Kingdom



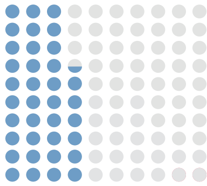
Available cities with real time monitoring in 2019



PM2.5 annual mean (μg/m³)

36.4%

Regional cities which met the WHO PM2.5 target in 2019



3.8 Villalba de Guardo, Spain

53.8 Lalapaşa, Turkey

Range of annual mean PM2.5 (μg/m³) across regional cities

Most Polluted Regional Cities

Rank	City	2019 AVG
1	Lalapaşa, Turkey	53.8
2	Düzce, Turkey	46.0
3	Sindirgi, Turkey	45.8
4	Lukavac, Bosnia & Herzegovina	39.9
5	Valjevo, Serbia	37.9
6	Horozluhan Osb, Turkey	37.2
7	Amasya, Turkey	35.9
8	Tuzla, Bosnia & Herzegovina	35.3
9	Zenica, Bosnia & Herzegovina	34.8
10	Sarajevo, Bosnia & Herzegovina	34.1
11	Konya, Turkey	33.2
12	Skopje, North Macedonia	32.4
13	Nis, Serbia	32.4
14	Ceglie Messapica, Italy	30.7
15	Kastamonu, Turkey	30.5

Cleanest Regional Cities

Rank	City	2019 AVG
1	Bodo, Norway	3.8
2	Salao, Portugal	3.8
3	Villalba de Guardo, Spain	3.8
4	Mosfellsbaer, Iceland	3.9
5	Husavik, Iceland	4.0
6	Vaasa, Finland	4.1
7	Korsholm, Finland	4.1
8	Bredkalen, Sweden	4.1
9	Santana, Portugal	4.2
10	Kuopio, Finland	4.3
11	Hafnarfjoerdur, Iceland	4.3
12	Harmondsworth, United Kingdom	4.3
13	Fundao, Portugal	4.4
14	Melgaço, Portugal	4.5
15	Lahti, Finland	4.6

SUMMARY

Air pollution continues to present varied challenges across different parts of Europe, as only 36% of European cities with PM2.5 monitoring in place met the WHO's annual target for PM2.5. Within Europe, 2019's PM2.5 levels were generally found to be highest in Eastern and Southern Europe, with the cleanest cities and regions mostly found in Northern and Western Europe. While PM2.5 emission sources vary considerably across the continent, common sources include energy production and use, industry, agriculture and livestock, road transport, and households and commercial buildings (EEA, 2019).

As countries across Europe continue to face challenges with unsafe levels of PM2.5, many European cities are also focused on combating high levels of other pollutants, such as NOx, which is frequently found to exceed EU limits and has led to numerous legal actions in 2019, as well as NH3 (European Commission, 2019). Since NO2 and NH3 can react as a precursor to form PM2.5 in the atmosphere, efforts to manage these pollutants should also help reduce PM2.5 levels.

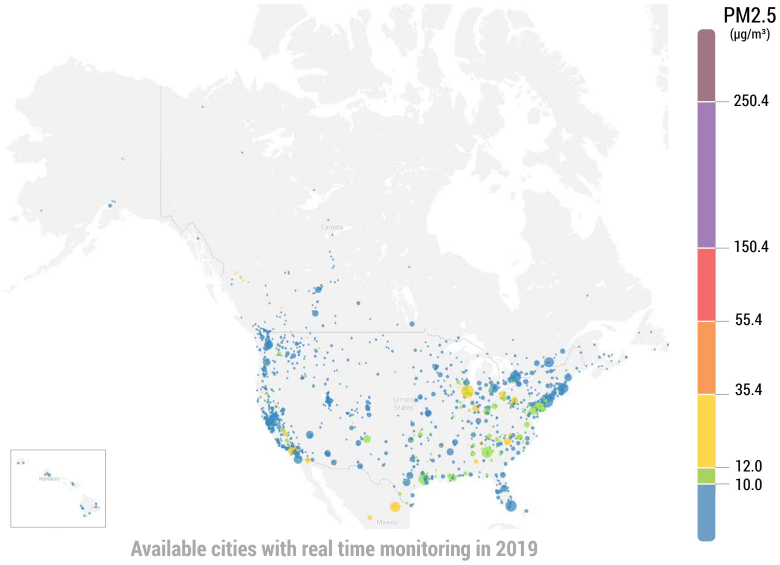
MONITORING STATUS

North and Western European cities had more dense monitoring coverage than Eastern and Southern European cities. Western Europe has the most cities with monitoring coverage during 2019 (428), of which 61% of these cities failed to meet the WHO annual PM2.5 targets (<10ug/m3). In contrast, Eastern Europe had the fewest cities with monitoring coverage (184), of which only 3% of cities met the WHO annual target.

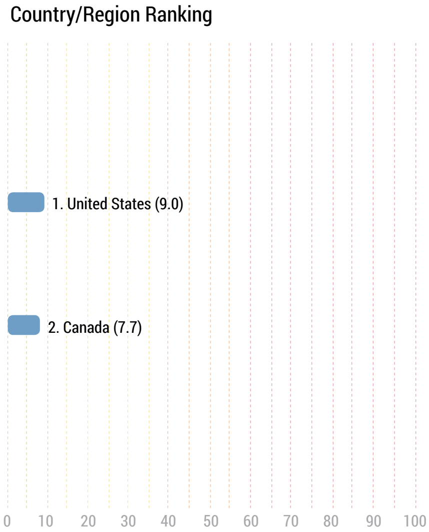
Many countries within Europe have well-established air quality monitoring and real-time reporting systems. However, some countries such as Italy, still do not report PM2.5 information in real-time to citizens, so this information cannot be acted upon to protect health. To complement governmental monitoring infrastructure, individuals and non-governmental organizations have contributed large numbers of sensors to report live PM2.5 data within Europe during 2019. Notably within Italy, Kosovo and Russia, where these now provide 100%, 97% and 51% of live data respectively.

NORTHERN AMERICA

United States | Canada



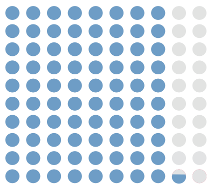
Available cities with real time monitoring in 2019



PM2.5 annual mean (µg/m³)

80.5%

Regional cities which met the WHO PM2.5 target in 2019



Range of annual mean PM2.5 (µg/m³) across regional cities

Most Polluted Regional Cities

Rank	City	2019 AVG
1	Royal Palm Beach, USA	22.6
2	Kitwanga, Canada	19.4
3	Portola, USA	16.9
4	Maywood, USA	16.5
5	Walnut Park, USA	16.3
6	Eastvale, USA	16.2
7	Colton, USA	16.1
8	Florence-Graham, USA	16.1
9	Diamond Bar, USA	16.0
10	McCloud, USA	16.0
11	Ontario, USA	16.0
12	North Bend, USA	16.0
13	Compton, USA	15.7
14	Burbank, USA	15.5
15	Huntington Park, USA	15.4

Cleanest Regional Cities

Rank	City	2019 AVG
1	Kailua-Kona, USA	1.9
2	Captin Cook, USA	1.9
3	Waimea, USA	2.0
4	Oak Harbor, USA	2.6
5	Oro Valley, USA	2.8
6	Yellowstone National Park, USA	2.8
7	Mesa County, USA	2.9
8	Naalehu, USA	2.9
9	Cedaredge, USA	3.0
10	Ocean View, USA	3.0
11	Lander, USA	3.0
12	Labrador City, USA	3.1
13	Kapolei, USA	3.2
14	Thompson, Canada	3.3
15	Palisade, USA	3.3

SUMMARY

Over the past several decades, the United States and Canada have managed to continue growing gross domestic product (GDP) while reducing emissions of all 6 criteria pollutants, including PM2.5. The success has been the result of pollution emission controls across numerous industries and sectors. Whilst the Trump administration has rolled back 16 air pollution regulations, with another 9 in process (Popovich, Albeck-Ripka, & Pierre-Louis, 2019), Northern America remains one of the regions with the lowest overall PM2.5 levels worldwide. Still, nearly 20% of regional cities fail to meet WHO air quality guidelines for annual exposure, contributing to 30,000 premature deaths from air pollution annually (Carnegie Mellon University, 2019), indicating an ongoing severe national health risk.

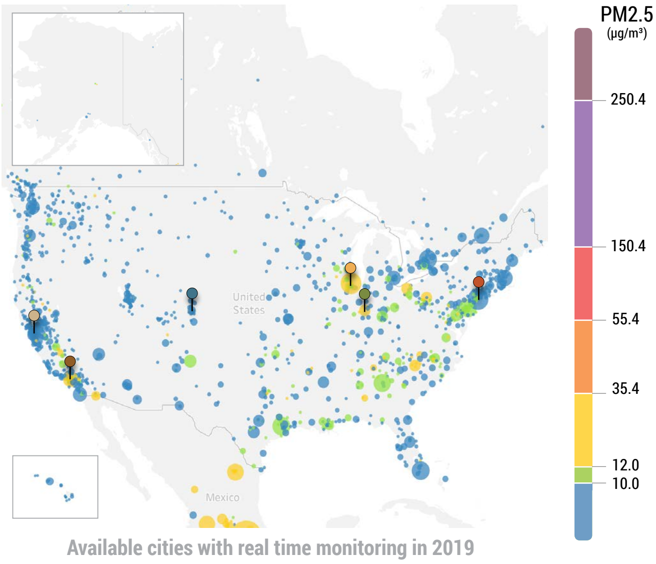
Primary PM2.5 emission sources include transport, a continued dependence on fossil fuel-driven energy production and wildfires as the dominant natural cause.

While 2019 saw fewer wildfires and acreages burned than in the past 5 years (NOAA, 2020), these events still contributed to elevated PM2.5 levels in the regions most polluted cities, which are dominantly located in California (9 out of the top 10, or 25 out of the top 30). As environments become warmer and drier with climate change, the frequency and intensity of wildfires is expected to grow.

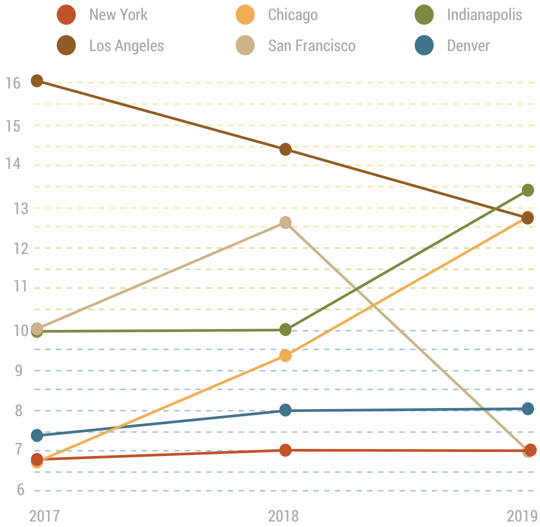
MONITORING STATUS

The United States has one of the world's most established air monitoring networks with more than 1,000 governmental PM2.5 stations and nearly 4,000 PM2.5 stations contributed by local organizations and individuals. Of the non-governmental monitoring stations, over 2,500 stations were added in 2019. Whilst Canada's air quality monitoring network is considerably smaller than its US neighbor, its metropolitan areas, which represent locations more affected by air pollution are also well represented, with 433 stations included in this report.

UNITED STATES



Available cities with real time monitoring in 2019



PM2.5 annual mean (μg/m³) over 3 years*

PM2.5: μg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
New York	7.0	8.7	8.1	7.1	5.7	5.6	7.1	9.1	6.7	5.9	4.8	6.5	8.4
Los Angeles	12.7	11.7	7.8	7.7	10.5	10.1	18.1	18.0	15.0	10.3	12.2	18.3	12.1
Chicago	12.8	9.9	18.5	14.4	11.7	9.7	13.3	15.1	9.0	11.1	8.0	14.9	17.9
San Francisco	7.1	10.7	3.4	4.8	5.3	5.3	6.7	7.1	6.6	4.4	7.4	14.5	8.2
Indianapolis	13.4	10.3	15.3	13.9	10.2	12.9	14.1	17.1	11.7	13.6	9.7	15.4	17.0
Denver	8.2	8.3	14.7	11.8	5.9	5.9	5.0	7.1	7.1	6.3	6.1	11.2	9.8

PROGRESS

The United States has one of the world's most established governmental air quality monitoring networks. Efforts put in place as a result of the Clean Air Act of 1970, in addition to the 1990 amendments, have created gradual improvements in national air quality across all 6 key criteria pollutants, including PM2.5. These air quality improvements were led despite increases in GDP, population, energy consumption, and transport miles traveled (US EPA, 2019).

In addition to government monitoring, in 2019 more than 3,500 additional stations were added nationwide, as a result of contributions from non-governmental organizations and individuals. This represents the largest crowd-sourced monitoring network in this report, by a significant margin.

CHALLENGES

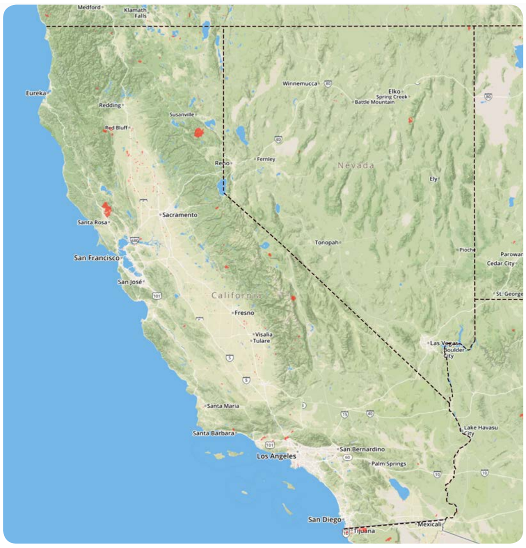
Despite improvements over time, 20.9% of US cities still exceeded the WHO annual PM2.5 exposure target in 2019. It is estimated that air pollution contributes to 30,000 premature US deaths a year (Carnegie Mellon University, 2019) with more than 40% of the US population at risk of disease and premature death as a result of current air quality levels (American Lung Association, 2018).

The Trump administration has led 25 EPA regulatory rollbacks on air pollution and emissions, 16 of which have been completed as of 2019 (Popovich, Albeck-Ripka, & Pierre-Louis, 2019). Rollbacks include weakening of governmental standards, oversight, monitoring, and enforcement of polluting industries, particularly within the oil and gas industry. It is expected these moves will have a negative effect on air quality over time.

HIGHLIGHT: WILDFIRES

19 of the 20 most polluted cities for PM2.5 pollution in the United States were in California, where wildfires contributed to heightened monthly averages. Whilst wildfires in 2019 were less severe and fewer than in the previous 5 years (NOAA, 2020), they still constituted a major source of national air pollution, particularly in the Pacific West. Human-driven climate change is expected to further aggravate the intensity of wildfires in the future as warmer and drier climates transform brush into fuel for wildfires.

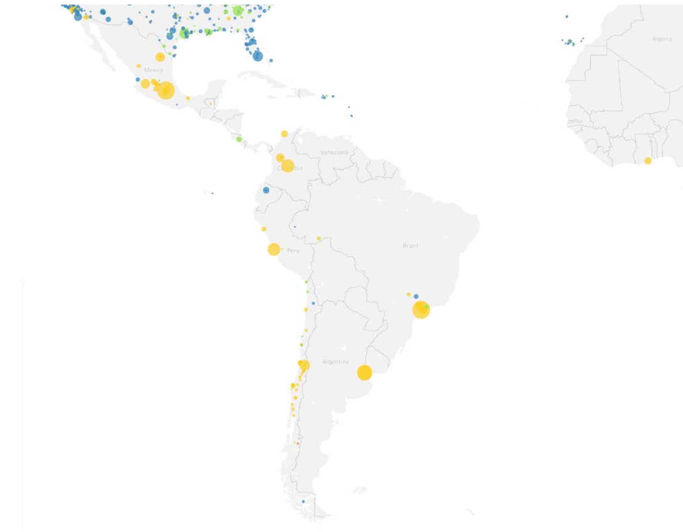
	Number of fires	Acres burned	Avg. acres/fire
2015	6,027	312,668	51.9
2016	5,339	163,153	30.6
2017	9,945	595,161	59.8
2018	3,400	98,542	29.0
2019	2,569	13,353	5.2



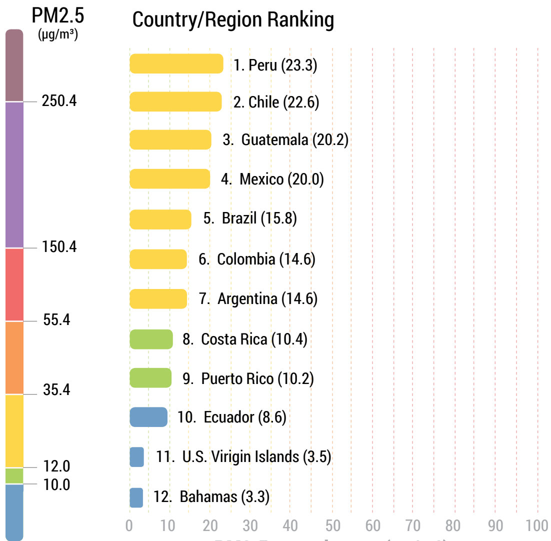
Map of acreage burned in the California in 2019

LATIN AMERICA & CARIBBEAN

Argentina | Bahamas | Brazil | Chile | Colombia | Costa Rica | Ecuador | Guatemala
Mexico | Peru | Puerto Rico | US Virgin Islands



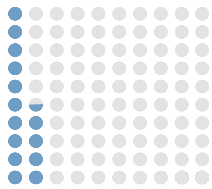
Available cities with real time monitoring in 2019



PM2.5 annual mean (µg/m³)

14.5%

Regional cities which met the WHO PM2.5 target in 2019



Range of annual mean PM2.5 (µg/m³) across regional cities

Map of acreage burned in Latin America in 2019

Most Polluted Regional Cities

Rank	City	2019 AVG
1	Coyhaique, Chile	41.5
2	Osorno, Chile	32.8
3	Padre las Casas, Chile	32.5
4	Providencia, Chile	29.5
5	Toluca, Mexico	29.4
6	Santiago, Chile	27.7
7	Linares, Chile	27.6
8	Pudahuel, Chile	27.6
9	Nezahualcóyotl, Mexico	27.1
10	Rancagua, Chile	26.9
11	Puerto Montt, Chile	26.4
12	Los Cerrillos, Chile	26.2
13	Curico, Chile	25.8
14	Ecatepec de Morelos, Mexico	25.4
15	Quilicura, Chile	25.3

Cleanest Regional Cities

Rank	City	2019 AVG
1	Nassau, Bahamas	3.3
2	Cruz Bay, U.S. Virgin Islands	3.3
3	Charlotte Amalie, U.S. Virgin Islands	3.6
4	San German, Puerto Rico	3.7
5	Camuy, Puerto Rico	4.1
6	Punta Arenas, Chile	4.7
7	Puerto Baquerizo Moreno, Ecuador	5.8
8	Calama, Chile	6.4
9	Iztacalco, Mexico	6.4
10	Tutamandahostel, Ecuador	6.7
11	Sangolqui, Ecuador	7.4
12	Ribeirao Preto, Brazil	8.2
13	Guarne, Colombia	8.5
14	Quito, Ecuador	8.6
15	Santiago de Queretaro, Mexico	9.2

SUMMARY

Latin America and the Caribbean face air quality challenges as a consequence of significant urban growth, resulting in heightened energy consumption and transport emissions in cities. These contributing factors, coupled with inefficient vehicles, weak fuel standards and biomass burning for household and commercial heating and cooking further contribute to heightened PM2.5 levels.

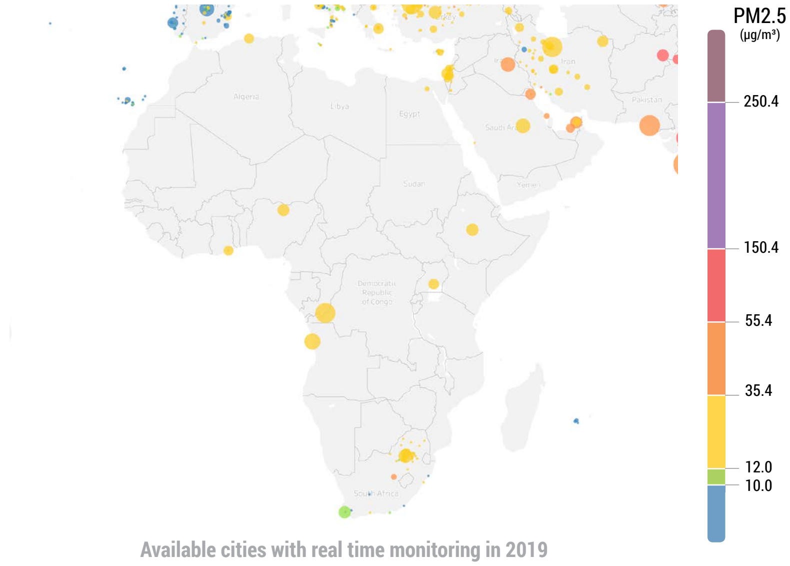
Whilst Peru has the highest average annual pollution exposure in the region, Chile follows closely behind, and is additionally home to 8 out of the 10 most polluted cities in the region.

MONITORING STATUS

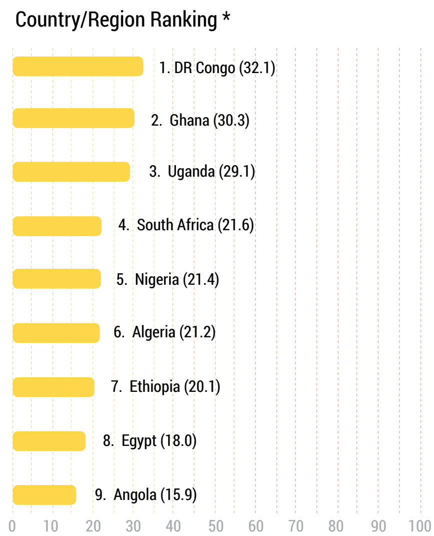
Public real-time air quality monitoring remains relatively sparse in Latin America and the Caribbean. Chile and Mexico's governmental monitoring networks supply the majority of the data points here, representing 66% of the data coverage in the region. Brazil's network of live, public governmental PM2.5 stations are limited to the Sao Paulo state, whilst independently contributed lower cost monitors provide the only data to the state of Acre, within the Amazon rainforest. Independent contributions via lower cost air quality monitors comprise 24% of the regional coverage, and provide the only data for Ecuador, Guatemala, and the Bahamas.

AFRICA

Algeria | Angola | DR Congo | Egypt | Ethiopia | Ghana | Nigeria | South Africa | Uganda



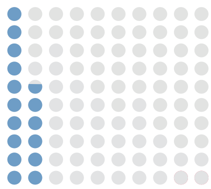
Available cities with real time monitoring in 2019

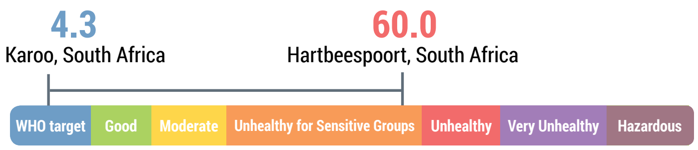


PM2.5 annual mean (µg/m³)

13.7%

Regional cities which met the WHO PM2.5 target in 2019





Range of annual mean PM2.5 (µg/m³) across regional cities

Most Polluted Regional Cities*

Rank	City	2019 AVG
1	Hartbeespoort, South Africa	60.0
2	Bloemfontein, South Africa	42.3
3	Springs, South Africa	39.1
4	Vanderbijlpark, South Africa	34.7
5	Sebokeng, South Africa	32.7
6	Kinshasa, DR Congo	32.1
7	Sasolburg, South Africa	31.4
8	Marikana, South Africa	30.9
9	Accra, Ghana	30.3
10	Vereeniging, South Africa	30.0
11	Embalenhle, South Africa	30.0
12	Kampala, Uganda	29.1
13	Ermelo, South Africa	28.4
14	Midstream, South Africa	27.5
15	Kriel, South Africa	27.4

Cleanest Regional Cities *

Rank	City	2019 AVG
1	Karoo, South Africa	4.3
2	Mokgorwane, South Africa	5.4
3	Richards Bay, South Africa	7.5
4	Komati, South Africa	8.0
5	Sunset Beach, South Africa	8.1
6	Worcester, South Africa	8.7
7	East London, South Africa	8.8
8	Port Elizabeth, South Africa	10.6
9	Cape Town, South Africa	11.2
10	Potchefstroom, South Africa	11.9
11	George, South Africa	12.4
12	Bethlehem, South Africa	12.4
13	Burgersfort, South Africa	12.8
14	Nkangala, South Africa	13.2
15	Lephalale, South Africa	14.1

SUMMARY

Whilst only 15.4% of monitored cities in Africa met WHO guidelines for annual PM2.5 exposure, the majority of the region's population (60%) lives in rural areas, that tend to have cleaner ambient air, yet notably lack air quality data (Schwela, 2012). These populations are generally more affected by indoor air pollution from poorly ventilated housing and a dependence on biomass or coal burning for cooking.

In Africa's high-density urban areas, ambient air pollution has worsened with growing urbanization and industrialization and limited regulation. With the region's population expected to nearly double in the next 30 years, reaching an estimated 2.2 billion (AfDB, 2011), mitigating air pollution in metropolitan areas will present an important opportunity to create clean air if abundant renewable energy resources are fully utilized.

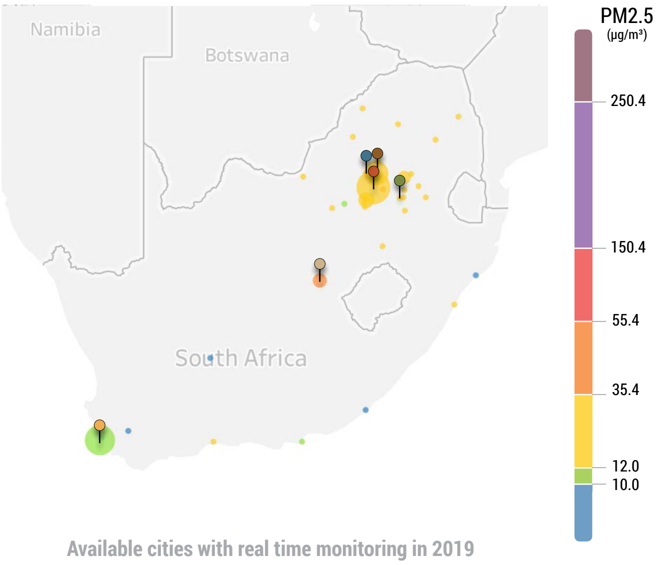
Environmental factors, including dust blown from the Sahara Desert and wildfires, contribute significantly to regional airborne particulates. The Sahara is the main source of global dust, yet 60% flows southwards to the Gulf of Guinea, primarily afflicting the African region. Meanwhile, an estimated 70% of active fires burning across the planet are in Africa (Meko, 2019).

MONITORING STATUS

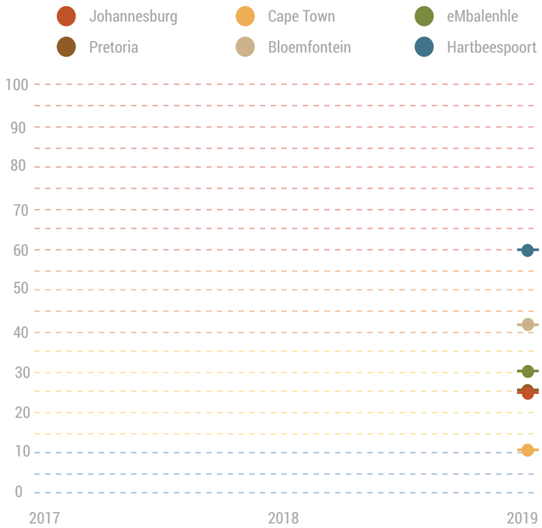
Much of the African continent lacks sufficient measured air quality data, leaving nearly a billion people without information about their pollution exposure. For perspective, there are more public monitoring stations in greater London, UK than the entire African continent. Available real-time data included in this report is supplied by US State department monitors, South African government monitors, and lower cost air quality monitors.

Whilst low cost air quality monitors present an opportunity for growing measured data within the region, today Africa's low internet penetration rate of roughly 40% remains a challenge in using and applying new technologies for data and information sharing (Internet World Stats, 2019).

SOUTH AFRICA



Available cities with real time monitoring in 2019



PM2.5 annual mean (µg/m³) over 3 years*

PM2.5: µg/m³	2019 Annual AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Johannesburg	25.3	17.8	22.1	19.0	17.3	34.3	37.8	34.2	30.1	25.0	22.1	13.6	29.2
Pretoria	25.5	13.5	18.2	18.3	19.3	34.6	45.1	41.5	32.5	25.1	20.6	12.7	14.3
Cape Town	11.2	14.6	4.1	3.6	8.5	12.8	17.0	10.9	8.8	9.9	7.0	12.3	21.1
Bloemfontein	42.3	12.6	11.2	--	42.8	62.0	102.1	72.8	49.7	33.8	28.9	20.1	16.4
eMbalenhle	30.0	6.4	9.6	11.2	46.4	132.9	27.4	16.4	49.8	21.0	19.7	13.4	12.9
Hartbeespoort	60.0	42.0	65.6	68.5	57.5	112.1	41.1	31.4	59.9	61.0	76.3	21.4	--

PROGRESS

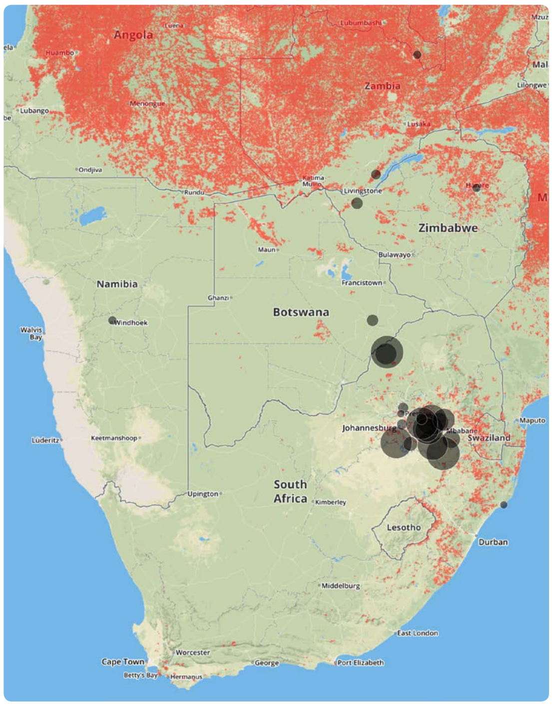
South Africa still has a relatively weak air quality monitoring network, but the network is rapidly expanding due in part to efforts from the government as well as independent contributors. Whilst monitoring is a critical first step in the direction of mitigating PM2.5 emissions, decisive action is necessary to improve the country's relatively weak minimum emission standards, and to start rapidly improving national air quality levels. In June 2019, environmental justice organisation groundWork and community organisation Vukani Environmental Justice Movement in Action brought a case against the South African government over a failure to address coal and industrial air pollution, on the grounds that it is violating residents' right to a healthy environment (Heiberg & Mashishi, 2019). The result of the case is pending, but offers hope to South Africa's most vulnerable Highveld Priority Area.

CHALLENGES

Only 20.9% of South African cities met WHO targets for annual PM2.5 exposure in 2019. Much of the country's air pollution comes from its heavy reliance on coal-based energy. Nearly 90% of South Africa's electricity demands are met by old and highly polluting coal-fired power plants (Ratshomo & Nembahe, 2017). With so much of the country's energy mix coming from coal, South Africa still has weaker regulations and fewer emission policies than many other countries. Mpumalanga, a central region of South Africa, is home to more than a dozen coal-based power plants that contribute to the worst nitrogen oxide and sulphur dioxide emissions in the country (Ratshomo & Nembahe, 2017) (Greenpeace, 2019), precursor pollutants to PM2.5, as well as PM2.5 directly.

HIGHLIGHT: COAL-BASED ENERGY RELIANCE

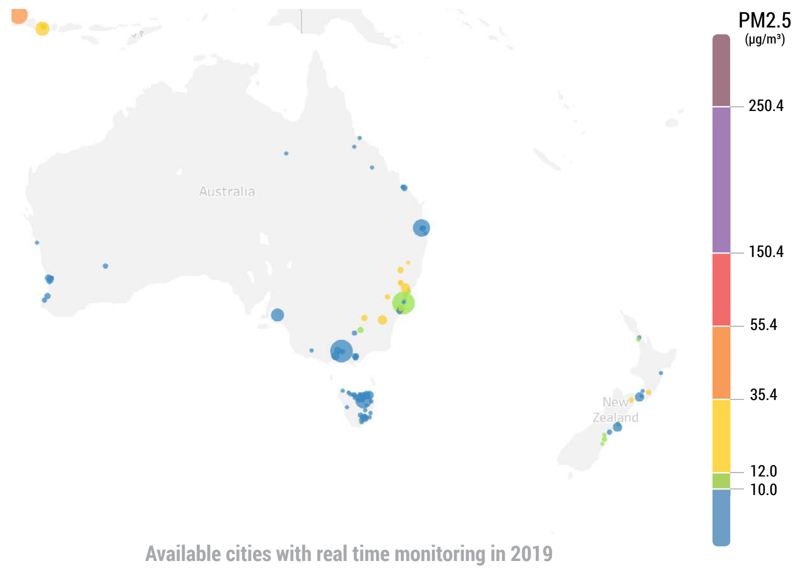
South Africa's most polluted cities are primarily located in the areas near the country's coal-fired power plants. These plants often fail to meet even the weak emission standards set forth by the government (Greenpeace, 2020). South Africa is the seventh largest coal producer, accounting for roughly 3% of the world's coal production (Ambrose, 2019). Shifting away from coal-based energy to cleaner alternatives presents an opportunity for the country to reach WHO annual PM2.5 targets.



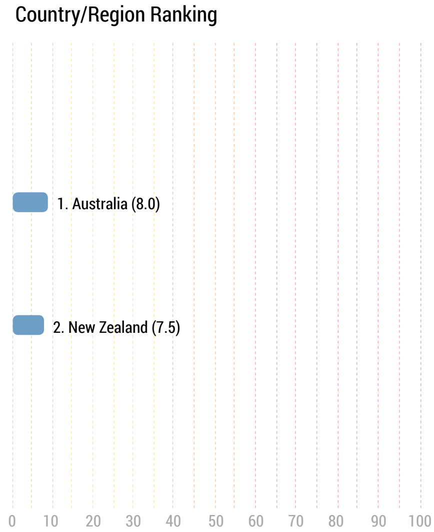
Map of acreage burned in 2019 (in red)
& Coal-fired power plans (in black)

OCEANIA

Australia | New Zealand

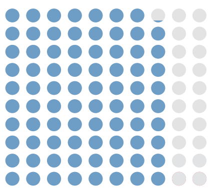


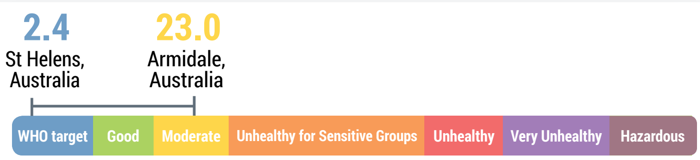
Available cities with real time monitoring in 2019



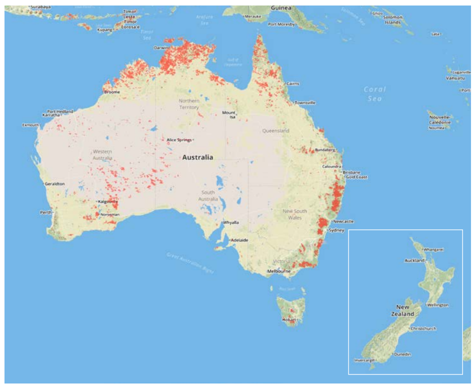
79.1%

Regional cities which met the WHO PM2.5 target in 2019





Range of annual mean PM2.5 (μg/m³) across regional cities



Map of acreage burned in Oceania in 2019

Most Polluted Regional Cities

Rank	City	2019 AVG
1	Armidale, Australia	23.0
2	Tamworth, Australia	15.2
3	Canberra, Australia	15.0
4	Beresfield, Australia	13.6
5	Muswellbrook, Australia	13.5
6	Bathurst, Australia	13.1
7	Newcastle, Australia	12.5
8	Singleton, Australia	12.5
9	Masterton, New Zealand	12.5
10	Wagga Wagga, Australia	12.4
11	Blenheim, New Zealand	12.2
12	Wyong, Australia	12.1
13	Kaiapoi, New Zealand	11.9
14	Geeveston, Australia	11.8
15	Wallsend, Australia	11.7

Cleanest Regional Cities

Rank	City	2019 AVG
1	St Helens, Australia	2.4
2	Emu River, Australia	2.5
3	Fingal, Australia	3.0
4	Derby, Australia	3.4
5	Exeter, Australia	3.6
6	West Ulverstone, Australia	3.7
7	Mornington, Australia	3.8
8	Monranbah, Australia	4.1
9	George Town, Australia	4.1
10	Paraparaumu, New Zealand	4.1
11	Bream Creak, Australia	4.3
12	Smithton, Australia	4.3
13	Hobart, Australia	4.4
14	Gretna, Australia	4.7
15	Glenorchy, Australia	4.8

SUMMARY

Despite representing two of the cleanest countries for PM2.5 pollution, 'only' 79% of cities here met WHO targets for annual air pollution. Were it not for the Australian bushfires in late November and December, and should past years trends have continued, Oceania would have surpassed Northern America for the cleanest region overall, with up to 88% of cities in the region meeting targets. The most polluted cities in the region, including Armidale, Tamworth, Canberra, were all severely affected by the fires (Popovich, Lu, & Migliozzi, 2020).

Wildfires in Australia present a threat to air quality in the region, particularly as climate change is set to exacerbate the frequency and intensity of these fires in the future, with rising temperatures and drier weather.

MONITORING STATUS

With just 110 monitored cities in Oceania, coverage is relatively sparse. Yet while huge portions of Australia lack PM2.5 data, population dense metropolitan areas are better served. In 2019, 73 additional stations in Australia, and 9 additional stations in New Zealand, were installed by non-governmental contributors. Overall, these contributions in the last two years have more than doubled the coverage established by the region's governmental departments.

Next Steps

Growing accessible, public air quality data is one of the most effective means for tackling the air pollution problem, as what is not be measured cannot be managed. Public air quality information drives public awareness, and creates demand for action.

Making air quality data accessible is one of the most effective ways to improve air quality, as what cannot be measured cannot be effectively managed

Whilst some gains have been made in growing air quality monitoring infrastructure in 2019, a majority of cities around the world still remain unrepresented. Often locations bearing the highest particulate pollution levels tend to notably have the least monitoring data, leaving the most vulnerable communities without access to timely and relevant air quality data, necessary to guide actions to safeguard their health.

Growing air quality data by way of increased government reference monitors, as well as lower-cost, non-governmental sensors is urgently needed to accelerate access to localized air quality information.

Accessibly priced non-governmental monitors provide a unique opportunity for communities and individuals around the world to expose local air pollution. The participation of these groups via lower-cost monitors presents a valuable opportunity to amplify efforts to combat air pollution.

What can I do?

There are numerous simple and effective means for reducing personal pollution exposure. These include limiting outdoor activities and wearing a mask during pollution episodes and safeguarding indoor spaces by sealing doors and windows shut, and where possible, using indoor air purification systems.

Checking real-time and forecast air quality information from resources such as IQAir AirVisual's free Air Quality App allows communities and individuals to take proper precautions to protect human health and reduce emissions.

Everyone has the ability to contribute to lowered pollution emissions

Everyone has the ability to contribute to lowering pollution emissions. Personal choices such as choosing cleaner modes of transport (cycling, walking, public transport where available), reducing personal energy usage and waste, contributing to increased local awareness, and supporting local air quality initiatives can all contribute to healthier air in our communities and on our planet.

Installing a low-cost air quality monitor to grow neighbourhood data granularity is another valuable step in improving access to real-time information and raising air quality awareness.

Methodology

Data sources

PM2.5 data included in this report has been aggregated from ground-based monitoring stations. The majority of this data was collected in real-time (on an hourly basis) as it was made available by governmental agencies. Additional PM2.5 data has been brought together from thousands of initiatives run by citizens, communities and companies, through validated low-cost sensors. Many of these stations represent the only available, real-time air quality information for their area.

Where possible, supplemental historical datasets from various governments have been combined with the real-time aggregated data to increase data coverage and completeness. Historical datasets have contributed to this report's PM2.5 data in South Africa, Romania, Turkey and Canberra, Australia. Additionally, data aggregated in real-time from government sources within Europe have been merged with historical data records made available by the European Environment Agency (EEA) for 2019, in order to provide a fuller dataset where possible.

PM2.5 data is also included from select validated non-governmental monitoring stations operated by private individuals and organizations, many of which provide the only available, real-time air quality information for their area.

Data calculation

Data in this report is collected from individual monitoring stations and then organized into cities. City-level data is determined by calculating the hourly median between stations in the same city. These hourly median values for a city are then used to calculate both the city's monthly and annual mean values, respectively.

Supplemental historical data records are combined between the available real-time data from various public sources on a city-by-city basis. Cities which have data from both real-time aggregation and supplemental historical records use whichever offers the highest level of data availability over the year, and secondarily the highest number of stations providing measurements.

The country/region average pollution exposure values (p.7) are based on data sampling. These values are calculated using the country or region's available city data as a sample, weighted by population. As data granularity across country and region may vary, it must be noted that this method, while imperfect, is an attempt to provide a broad global overview and context between countries and regions.

The following calculation is used to estimate a country/region's average PM2.5 exposure based on the available data and weighted city-sample population:

$$\frac{\Sigma \text{ Regional city mean PM2.5 } (\mu g/m^3) \times \text{ City population}}{\text{Total regional population covered by available city data}}$$

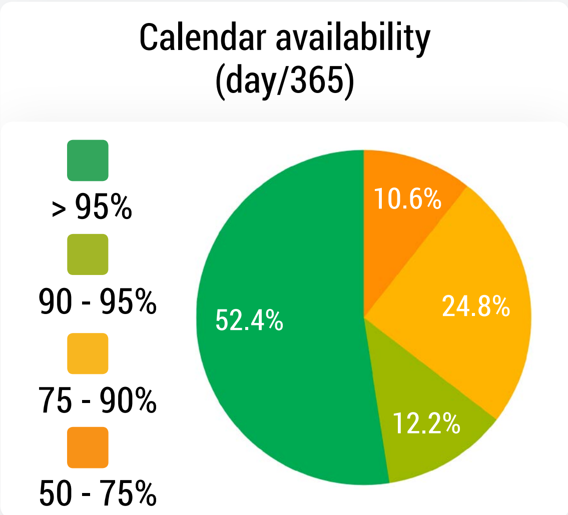
Data availability

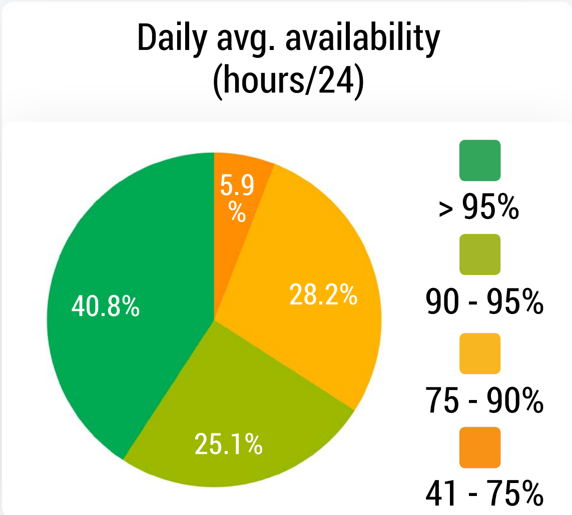
Data availability is a key determinant for cities that have been included in the data set.

Data availability for the report was measured in two ways:

- “Calendar availability”: a percentage of days of the year (/365) when the city had at least one reading from at least one station.
- “Daily average availability”: an average percentage of hours of the day (/24) which have measurements available, from those days which have at least one reading from at least one station.

For data to be included in this report, a data availability criteria of >50% calendar availability had to be met. Additionally, cities with <41% daily average availability (equivalent to a mean availability of <10 hours readings per day), were excluded from the dataset.





Disclaimer

This report presents PM2.5 data collected from global monitoring stations in 2019. The data represented has been primarily aggregated in real-time by the IQAir AirVisual information platform, with additional historical datasets providing supplemental data from governmental sources, where available.

Data sources for real-time aggregated data are displayed on the IQAir AirVisual website.

As data is limited to locations with ground-based monitoring stations, this report lays no claim on completeness.

We invite feedback and active dialogue of the information provided.

IQAir is politically independent. Graphs, maps and content included in this report are intended to expand on the dataset, and do not indicate any political stance. Regional maps have been created using OpenStreetMap.

FAQ

Why are some locations (city / country / region) not included in this ranking?

- The area lacks public, ground-based PM2.5 monitoring stations. The report only includes stations or cities where PM2.5 data is measured.
- The area lacks adequate calendar or daily data availability in 2019 to be representative.

Why does the data provided within this report differ from the data provided by my government?

- There are different ways to calculate city averages over an hour, day, month and year. This report uses an hourly median value across all stations in a city. Outlier data can have an effect on averages calculated in different ways.
- Data aggregated by the IQAir AirVisual platform may include more or less stations than provided by a government. For example, governments may have monitoring stations that are either not public or that IQAir AirVisual did not collect. Alternatively, lower cost monitors provided by independent contributors, may not be reflected by a governmental dataset.
- There are numerous Air Quality Index systems. Often, countries all use their own. In order to make direct data comparisons, PM2.5 concentrations in µg/m³ should be the basis.

Why is the report missing some locations that are available on the IQAir website?

- Monitoring stations may have only recently been added to the IQAir AirVisual platform, and as a result did not meet the data availability criteria for 2019.
- Some locations on the IQAir website do not report PM2.5 data. Only locations with PM2.5 data have been included in this report.
- For some global locations which lack measured PM2.5 data, the IQAir-AirVisual platform includes estimated PM2.5 values (marked with an asterisk *). Estimated data is not included in this report.

Where can I find the complete city ranking of all locations included in the report?

The full air quality data set of the world's most polluted cities has been provided in an interactive format on the IQAir website. This ranking also includes monthly mean values, and historical annual mean values.

How precise is the ranking?

The data included in the report is collected from a variety of monitors and data sources. All monitoring stations and collection methods have a degree of error. Whilst the data is checked and validated, some uncertainty remains. For locations (city/country/region) that have similar PM2.5 concentrations, ranking position should be considered to be indicative rather than absolute.

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This report would not be possible without the efforts of numerous governmental agencies whose work in publishing live air quality information is vital in empowering people to take proactive steps to breathe cleaner air. These contributions have also contributed critical data to global efforts in air pollution research and analysis.

Furthermore, the participation of many groups and citizens who operate their own air quality monitors and have made this data publicly available, has increased data coverage significantly. If it were not for these valuable contributions, there would be no publically available data in Angola, the Bahamas, Cambodia, DR Congo, Egypt, Ghana, Latvia, Nigeria, Syria, and Ukraine.

Maps illustrating burned acreage in 2019 are made possible in part by NASA's Fire Information and Resource Management and their archives of fire data.

A special thanks to Greenpeace Korea, India, Indonesia, Japan, South Africa, US, and Vietnam for their valuable insights and support in promoting access to public air quality data.

About IQAir AirVisual

IQAir AirVisual is a global air quality information platform operated by the IQAir Group. By aggregating and validating air quality data from governments, private individuals and non-governmental organizations, IQAir AirVisual aims to provide global and hyper-local air quality information that allows individuals, organizations and governments to take steps that improve air quality in communities, cities and countries all over the world.

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