2018 WORLD AIR QUALITY REPORT

Region & City PM2.5 Ranking

IQAir

AirVisual

Contents

About this report

Since 2015, the IQAir AirVisual app and website have provided a centralized platform for global and hyper-local air quality information in real-time.

Through aggregating and validating real-time data from governments and monitors operated by individuals and organizations, IQAir AirVisual strives to promote access to real-time air quality information, to allow people to take actions to improve air quality and protect their health.

The 2018 World Air Quality Report presents PM2.5 air quality data as aggregated through the IQAir AirVisual platform in 2018. The data included is a subset of information provided through the platform, including only PM2.5 measured from ground-based stations with high data availability.

This report accompanies an extended online interactive display of the world's most polluted cities, which allows further exploration of air quality across different regions and subregions in 2018. The real-time status of all included locations, together with many more, can also be explored through the IQAir AirVisual Air Quality Map, which brings together live air quality readings in one accessible place.

Executive summary

Air pollution is the greatest environmental risk to health today, estimated to contribute to 7 million premature deaths[1] every year. Polluted air presents the world's 4th leading contributing cause of early deaths, and burdens the global economy with an estimated annual cost of $225 billion (USD)[2].

Whilst the WHO estimates that 9 out of 10 people worldwide are now breathing unsafe polluted air, huge parts of the world still lack access to real-time data.

This report is based on 2018 air quality data from public monitoring sources, with a focus on data which has been published in real-time or near real-time. These sources include government monitoring networks, as well as validated data from air quality monitors operated by private individuals and organizations.

Out of the over 3000 cities included, 64% exceeded the WHO's annual exposure guideline for fine particulate matter, also known as PM2.5. 100% of measured cities within the Middle East and Africa exceeded this guideline, while 99% of cities in South Asia, 95% of cities in Southeast Asia, and 89% of cities in East Asia also exceed this target. As many areas lack up-to-date public air quality information and are for this reason not represented in this report, the total number of cities exceeding the WHO PM2.5 threshold is expected to be higher.

The city ranking shows Asian locations dominating the highest 100 average PM2.5 levels during 2018, with cities in India, China, Pakistan and Bangladesh occupying the top 50 cities. Numerous cities within the Middle East region also rank highly, with Kuwait City, Dubai and Manama all exceeding the WHO guideline by over 500%.

At a country level, weighted by population, Bangladesh emerges as the most polluted country on average, closely followed by Pakistan and India, with Middle Eastern countries, Afghanistan and Mongolia also within the top 10.

Southeast Asia's most polluted cities during 2018 were the capitals Jakarta and Hanoi, with a number of Thai cities also ranking highly in this region. Public awareness of local pollution levels in these countries has grown considerably during 2018, as well as in South Korea and Pakistan. Public engagement with air pollution also increased in the United States and Canada, particularly during the severe wildfires which punctuated part of the region's generally low PM2.5 levels during August and November.

Real-time, public air quality information is essential not only to empower populations to respond to current conditions and protect human health, but also is a cornerstone in generating public awareness and driving action to combat air pollution in the long-term. More monitoring is needed in large parts of the world without access to this information.

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

1 https://www.who.int/news-room/detail/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action
2 http://www.worldbank.org/en/news/press-release/2016/09/08/air-pollution-deaths-cost-global-economy-225-billion

Where does the data come from?

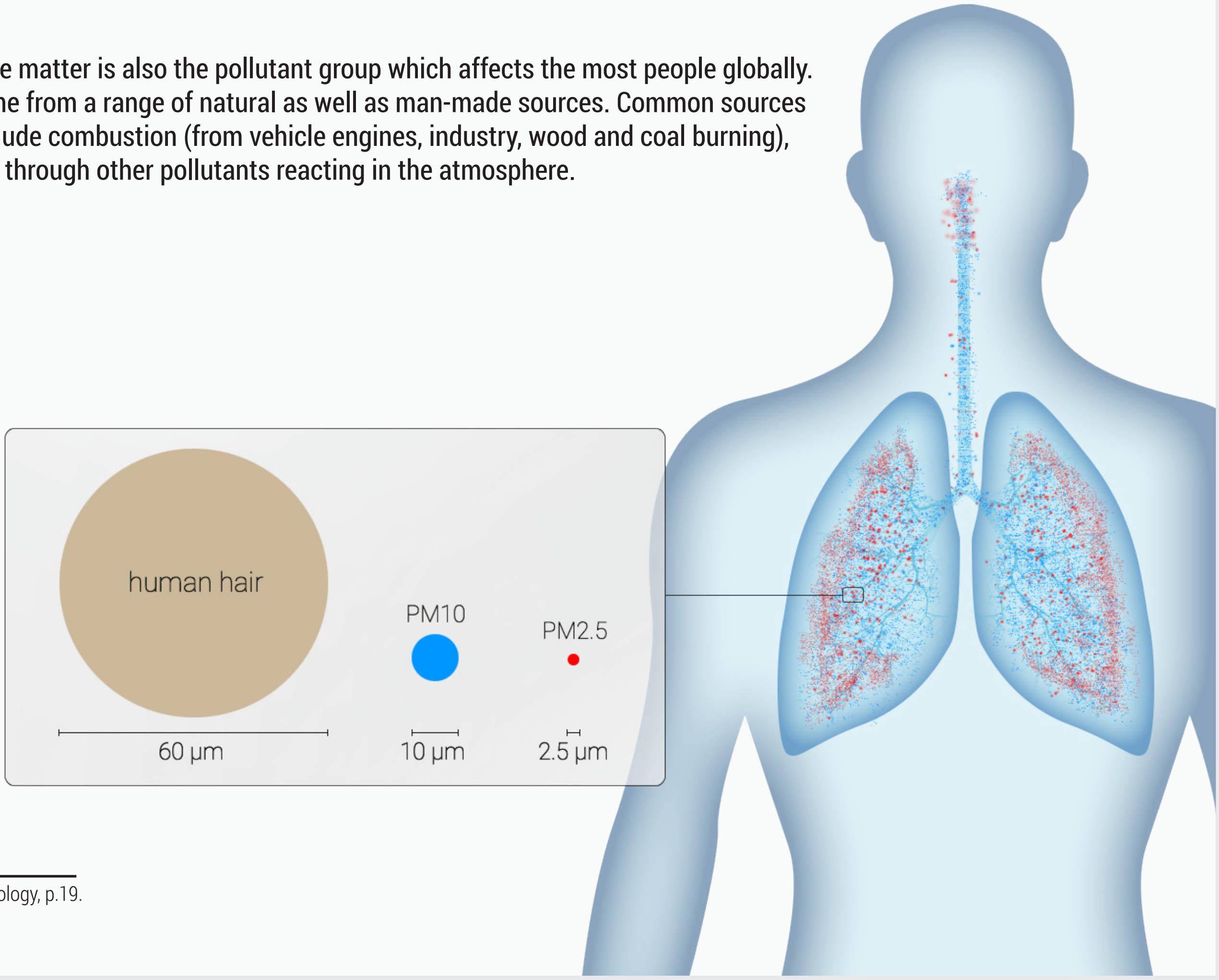
Data included in this report has been aggregated from a range of continuous governmental monitoring sources, as these measurements have been made public in real-time (generally on an hourly basis). In addition, data from a selection of validated outdoor IQAir AirVisual air quality monitors operated by private individuals and organizations have been included. Some locations in Europe are supported by additional PM2.5 data provided by the European Environment Agency, and in some cases other governmental historical data where available.[1]

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

Why PM2.5?

The report focuses on PM2.5 as a representative measure of air pollution. PM2.5 refers to particulate matter (ambient airborne particles) which measure up to 2.5 microns in size, and has a range of chemical makeups and sources. PM2.5 is widely regarded as the pollutant with the most health impact of all commonly measured air pollutants. Due to its small size PM2.5 is able to penetrate deep into the human respiratory system and from there to the entire body, causing a wide range of short- and long-term health effects.

Particulate matter is also the pollutant group which affects the most people globally. It can come from a range of natural as well as man-made sources. Common sources of PM include combustion (from vehicle engines, industry, wood and coal burning), as well as through other pollutants reacting in the atmosphere.



1 Methodology, p.19.

Data presentation

To relate exposure to potential health impacts, 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 US AQI color scale is used, supplemented by the WHO guideline.

WHO Air Quality Guideline

The WHO recommends an annual mean exposure threshold of 10 µg/m³ to minimize the risk of health impacts from PM2.5, whilst advising that no level of exposure has been shown to be free of health impacts[1].

WHO PM2.5 Target: 10 µg/m³

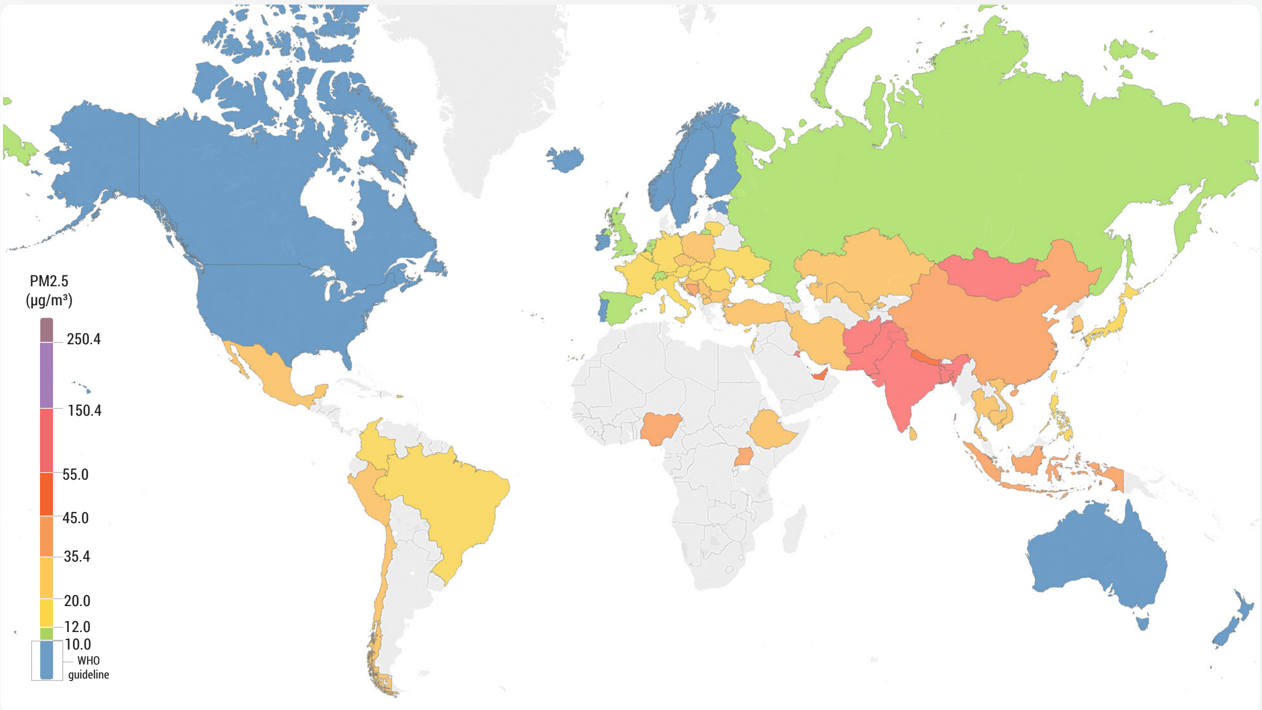
United States Air Quality Index (US AQI)

The US AQI is one of the most widely recognized AQI systems available. The US AQI converts pollutant concentrations into a color-coded scale of 0-500, to easily represent the level of associated health risk. The US AQI's "Good" range (<12µg/m3) is slightly 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.

1 https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

Global overview



Global map of estimated PM2.5 exposure by country/region in 2018

This global map provides an overview of the average, estimated PM2.5 exposure by country/region in 2018. The estimation is calculated from available city data as a regional sample and then weighted by population. Countries and regions that remain grey had no or limited PM2.5 data available for 2018.

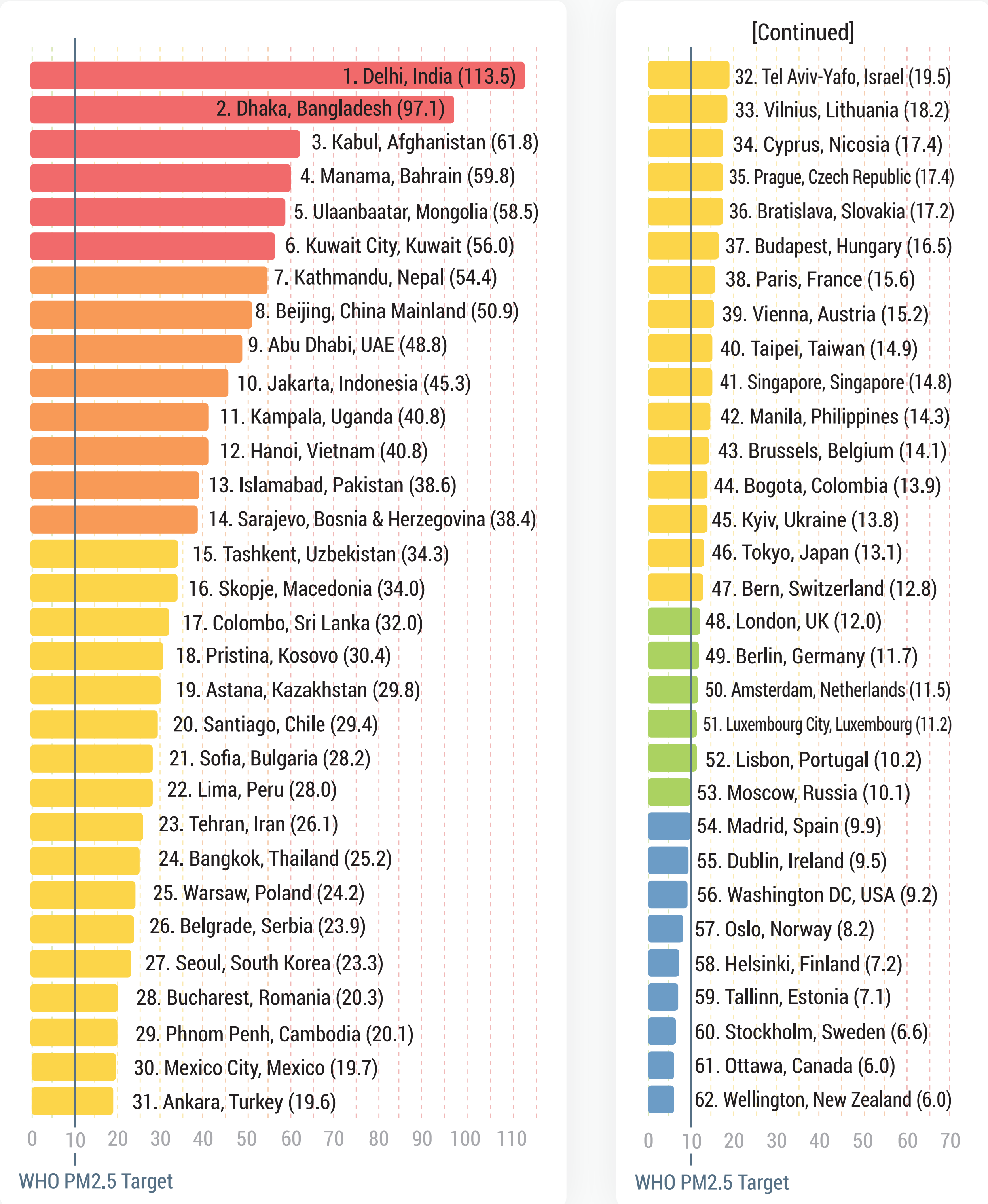
World country/region ranking

Sorted by estimated average PM2.5 concentration (µg/m³)

1	Bangladesh	97.1
2	Pakistan	74.3
3	India	72.5
4	Afghanistan	61.8
5	Bahrain	59.8
6	Mongolia	58.5
7	Kuwait	56.0
8	Nepal	54.2
9	United Arab Emirates	49.9
10	Nigeria	44.8
11	Indonesia	42.0
12	China Mainland	41.2
13	Uganda	40.8
14	Bosnia & Herzegovina	40.0
15	Macedonia	35.5
16	Uzbekistan	34.3
17	Vietnam	32.9
18	Sri Lanka	32.0
19	Kosovo	30.4
20	Kazakhstan	29.8
21	Peru	28.0
22	Ethiopia	27.1
23	Thailand	26.4
24	Bulgaria	25.8
25	Iran	25.0
26	Chile	24.9
27	South Korea	24.0
28	Serbia	23.9
29	Poland	22.4
30	Croatia	22.2
31	Turkey	21.9
32	Macau	21.2
33	Mexico	20.3
34	Czech Republic	20.2
35	Hong Kong	20.2
36	Cambodia	20.1
37	Romania	18.6
38	Israel	18.6
39	Taiwan	18.5
40	Slovakia	18.5
41	Cyprus	17.6
42	Lithuania	17.5
43	Hungary	16.8
44	Brazil	16.3
45	Austria	15.0
46	Italy	14.9
47	Singapore	14.8
48	Philippines	14.6
49	Ukraine	14.0
50	Colombia	13.9
51	Puerto Rico	13.7
52	Belgium	13.5
53	France	13.2
54	Germany	13.0
55	Japan	12.0
56	Netherlands	11.7
57	Switzerland	11.6
58	Russia	11.4
59	Luxembourg	11.2
60	Malta	11.0
61	United Kingdom	10.8
62	Spain	10.3
63	Ireland	9.5
64	Portugal	9.4
65	USA	9.0
66	Canada	7.9
67	New Zealand	7.7
68	Norway	7.6
69	Sweden	7.4
70	Estonia	7.2
71	Australia	6.8
72	Finland	6.6
73	Iceland	5.0

World regional capital city ranking

Sorted by average yearly PM2.5 concentration (µg/m³)

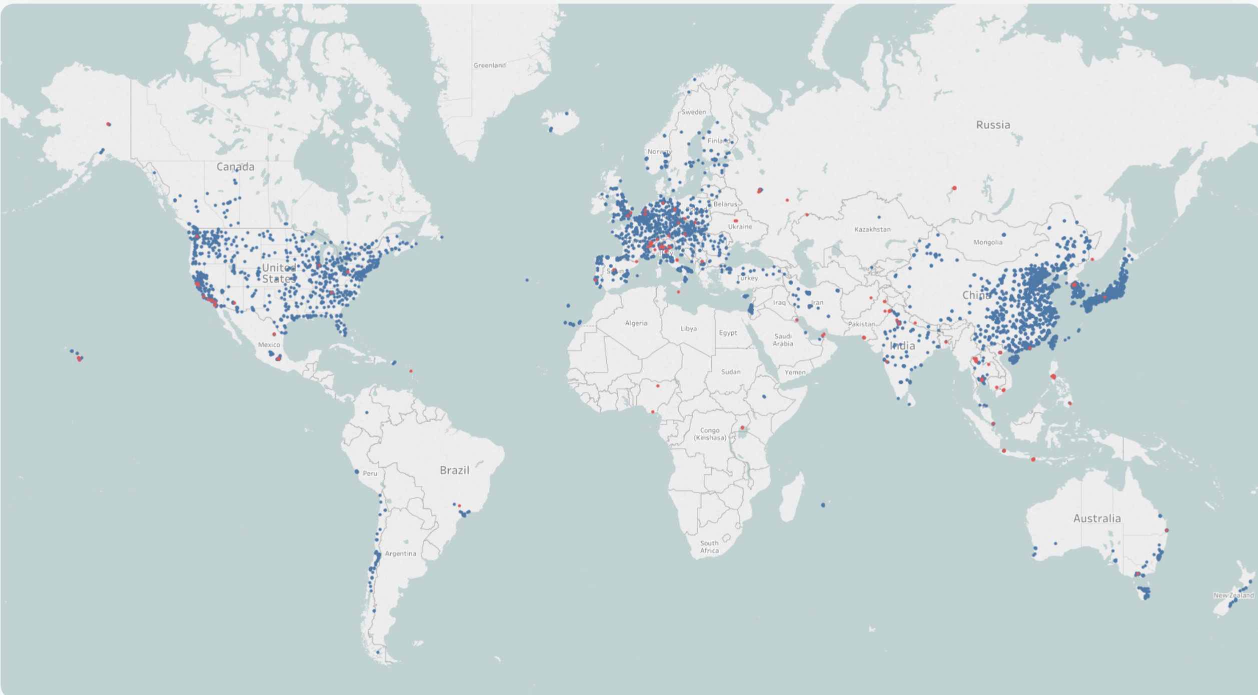


This capital city ranking compares annual mean PM2.5 values from the available regional capitals in this report's dataset. Countries from Asia and the Middle East occupy most of the top of this regional capital city ranking, with Delhi and Dhaka's values both 50% higher than the 3rd ranking capital, Kabul.

Only 9 out of 62 regional capitals included here have an annual mean PM2.5 level within the WHO air quality guideline of 10µg/m³.

Overview of public monitoring status

Air quality monitoring varies greatly among countries and regions. With regard to continuous monitoring stations published in real-time, China Mainland, Japan and the United States have the world's most extensive networks. The map below shows the global distribution of PM2.5 air quality monitors which met the availability criteria for this report.



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

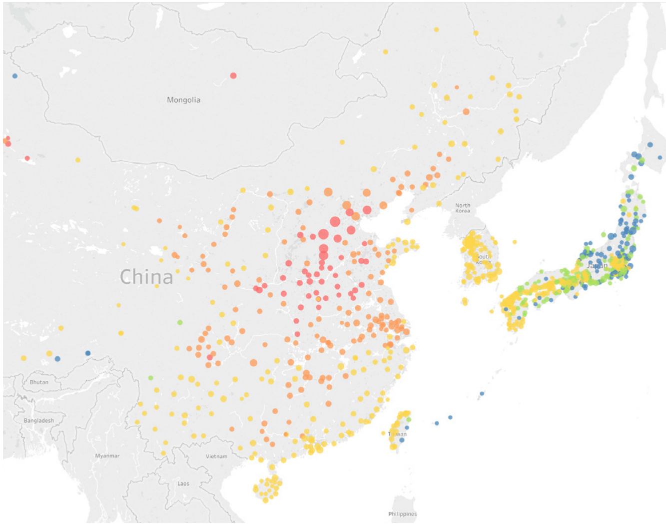
As this map indicates, many populated areas still lack publicly available real-time or near real-time air quality information.

Densely populated areas within developed countries tend to have access to a larger network of governmental air monitors, whilst in many developing countries, access to air quality information is limited.

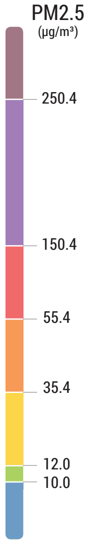
In countries and regions which lack governmental, real-time monitoring networks, lower cost monitoring sensors which can be set up quickly and with fewer resources provide an opportunity to accelerate access to air quality information. Data collected and published from validated IQAir AirVisual monitoring stations operated by private individuals and organizations is also included in this report. It provides the only real-time public readings for Pakistan, Afghanistan, Nigeria and Cambodia.

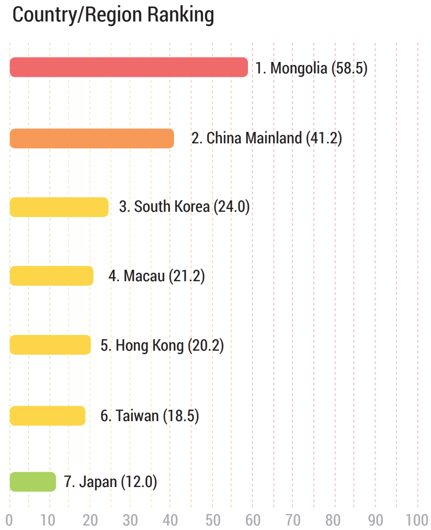
EAST ASIA

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

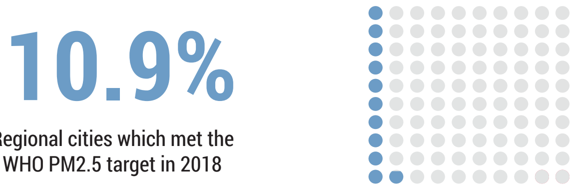


Available cities with real time monitoring in 2018





PM2.5 annual mean (µg/m³)



Regional cities which met the WHO PM2.5 target in 2018

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

Most Polluted Regional Cities

Rank	City	2018 AVG
1	Hotan, China Mainland	116.0
2	Kashgar, China Mainland	95.7
3	Xingtai, China Mainland	76.7
4	Shijiazhuang, China Mainland	76.7
5	Aksu, China Mainland	74.1
6	Handan, China Mainland	74.0
7	Anyang, China Mainland	72.9
8	Baoding, China Mainland	70.7
9	Linfen, China Mainland	68.2
10	Wujiaqu, China Mainland	67.8
11	Xianyang, China Mainland	67.8
12	Jiaozuo, China Mainland	66.9
13	Hengshui, China Mainland	65.7
14	Xuzhou, China Mainland	65.5
15	Cangzhou, China Mainland	65.2

Cleanest Regional Cities

Rank	City	2018 AVG
1	Otofuke, Japan	7.0
2	Sapporo, Japan	7.3
3	Ebina, Japan	7.5
4	Hakuba, Japan	7.6
5	Uchinada, Japan	7.7
6	Nyingchi, China Mainland	7.8
7	Wajima, Japan	7.8
8	Suzu, Japan	7.9
9	Minamiashigara, Japan	8.0
10	Miyakojima, Japan	8.1
11	Toyama, Japan	8.1
12	Minami, Yamanashi Japan	8.3
13	Sakata, Japan	8.3
14	Gojo, Japan	8.3
15	Kanazawa, Japan	8.4

SUMMARY

In recent times, East Asia has demonstrated a strong correlation between rapid economic development and increased air pollution. However, as the urgency of reducing air pollution has become apparent in countries such as China Mainland, extensive monitoring networks and air pollution reduction policies have been put into place. In mainland China, in particular, this has led to significant improvements in year-on-year reductions in PM2.5 levels[1]. Whilst good progress is being made to improve regional air quality, significant challenges remain, as indicated by the 89% of cities here which exceeded the WHO guideline during 2018.

Coal burning remains a significant contributor to regional air pollution, with high levels of coal production and consumption in China Mainland and Mongolia in particular[2]. Transboundary pollution is also a concern for neighbouring areas such as Hong Kong, Taiwan and South Korea, including both emissions from human activity as well as seasonal dust storms which can affect much of the region[3].

MONITORING STATUS

All countries within the East Asia region, excluding North Korea, support public real-time air quality monitoring. As a collective, the prevalence and quality of public PM2.5 data is among the best in the world.

China Mainland has the world's most numerous and far reaching monitoring network, with around 1,500 monitors managed by the central government and a total of over 5,000 monitors managed at a central, provincial, municipal and county level[4].

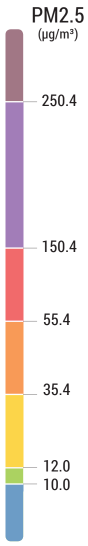
Mongolia currently has the most limited monitoring network of the region by land area, with only a handful of public stations in Ulaanbaatar, where almost half of the country's population resides.

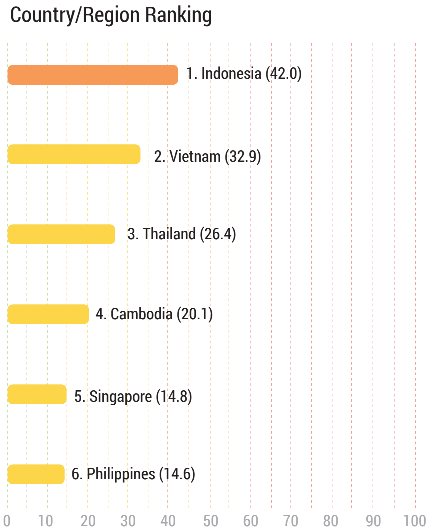
1 http://www.greenpeace.org/eastasia/press/releases/climate-energy/2018/PM25-in-Beijing-down-54-nationwide-air-quality-improvements-slow-as-coal-use-increases/
2 https://www.worldenergy.org/data/resources/region/east-asia/coal/
3 https://taqm.epa.gov.tw/taqm/en/b0301.aspx
4 http://www.gov.cn/xinwen/2018-01/31/content_5262775.htm

SOUTHEAST ASIA

Cambodia | Indonesia | Philippines | Singapore | Thailand | Vietnam

Available cities with real time monitoring in 2018

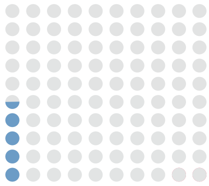




PM2.5 annual mean (μg/m³)

4.5%

Regional cities which met the WHO PM2.5 target in 2018



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

Most Polluted Regional Cities

Rank	City	2018 AVG
1	Jakarta, Indonesia	45.3
2	Hanoi, Vietnam	40.8
3	Samut Sakhon, Thailand	39.8
4	Nakhon Ratchasima, Thailand	37.6
5	Tha bo, Thailand	37.2
6	Saraburi, Thailand	32.6
7	Meycauyan City, Philippines	32.4
8	Samut Prakan, Thailand	32.2
9	Ratchaburi, Thailand	32.2
10	Mae Sot, Thailand	32.2
11	Caloocan, Philippines	31.4
12	Si Maha Phot, Thailand	30.9
13	Pai, Thailand	29.4
14	Chon Buri, Thailand	27.3
15	Ho Chi Minh City, Vietnam	26.9

Cleanest Regional Cities

Rank	City	2018 AVG
1	Calamba, Philippines	9.3
2	Valenzuela, Philippines	9.9
3	Carmona, Philippines	10.9
4	Satun, Thailand	11.3
5	Paranaque, Philippines	12.2
6	Davao City, Philippines	12.6
7	Makati, Philippines	13.7
8	Manila, Philippines	14.3
9	Mandaluyong, Philippines	14.5
10	Singapore, Singapore	14.8
11	Narathiwat, Thailand	15.2
12	Balanga, Philippines	16.1
13	Quezon City, Philippines	17.5
14	Nan, Thailand	17.6
15	Las Pinas, Philippines	17.9

SUMMARY

Sources of air pollution in Southeast Asia vary between rural and urban areas in its various countries, with the burning of biomass, vehicular emissions and transportation as common leading sources. High regional pollution spikes are often related to the seasonal agricultural practice of open burning, where land is burned in order to provide a more nutrient rich environment for future crops, particularly within Indonesia[1]. These emissions often contribute to the spread of transboundary air pollution across the neighboring countries[2].

In urban areas, transportation and industry are among the leading contributors, with high numbers of small vehicles such as motorbikes. There is strong correlation between urbanization and air pollution in this region: Jakarta and Hanoi have the highest recorded air pollution in the region, and are also among the most populated cities.

MONITORING STATUS

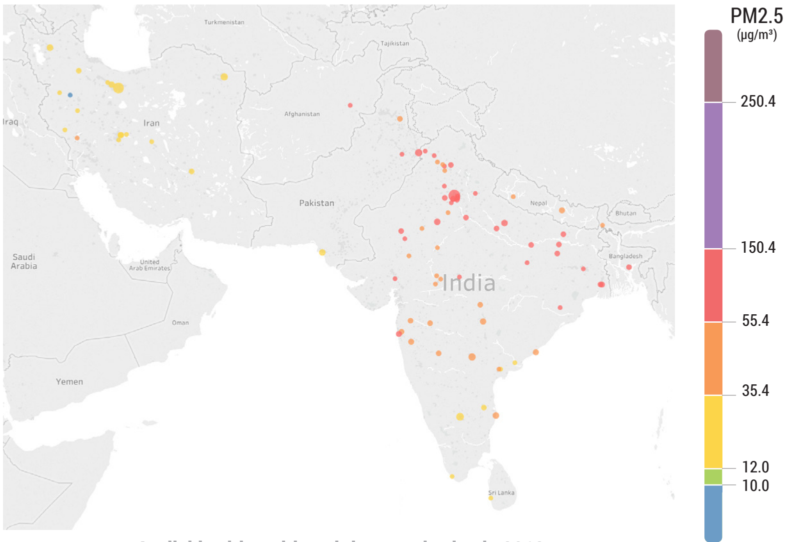
Government supported public PM2.5 monitoring is relatively sparse in Southeast Asia. Collectively, only 145 monitors reporting real-time data across the region are included in this report. In response to limited real-time information, many local organizations and concerned citizens have deployed their own lower cost air quality monitoring devices. As a result of these contributions, non-governmental measurements make up approximately half of the region's coverage here, notably within the Philippines, Thailand, and Indonesia. Non-governmental monitors also provide the only real-time data available in Cambodia.

Whilst Malaysia has run public monitoring networks measuring other pollutants previously, the local government has also introduced public PM2.5 monitoring during 2018.

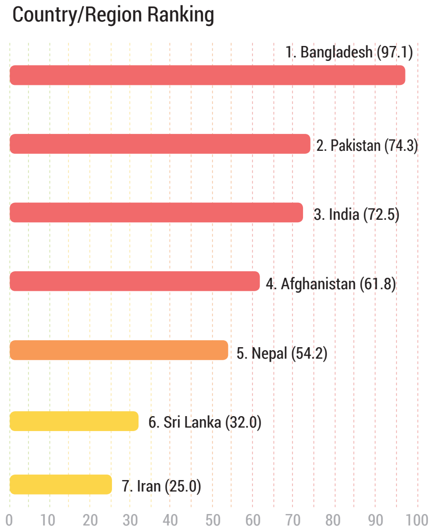
1 https://www.unenvironment.org/resources/report/south-east-asia-air-quality-regional-report
2 http://www.ccacoalition.org/en/resources/air-pollution-asia-and-pacific-science-based-solutions

SOUTH ASIA

Afghanistan | Bangladesh | India | Iran | Nepal | Pakistan | Sri Lanka



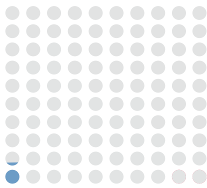
Available cities with real time monitoring in 2018



PM2.5 annual mean (µg/m³)

1.2%

Regional cities which met the WHO PM2.5 target in 2018



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

Most Polluted Regional Cities

Rank	City	2018 AVG
1	Gurugram, India	135.8
2	Ghaziabad, India	135.2
3	Faisalabad, Pakistan	130.4
4	Faridabad, India	129.1
5	Bhiwadi, India	125.4
6	Noida, India	123.6
7	Patna, India	119.7
8	Lucknow, India	115.7
9	Lahore, Pakistan	114.9
10	Delhi, India	113.5
11	Jodhpur, India	113.4
12	Muzaffarpur, India	110.3
13	Varanasi, India	105.3
14	Moradabad, India	104.9
15	Agra, India	104.8

Cleanest Regional Cities

Rank	City	2018 AVG
1	Qorveh, Iran	7.8
2	Tabriz, Iran	12.2
3	Sanandaj, Iran	12.5
4	Nahavand, Iran	16.1
5	Zanjan, Iran	18.6
6	Meybod, Iran	21.1
7	Abdanan, Iran	21.2
8	Hashtgerd, Iran	22.1
9	Karaj, Iran	22.2
10	Sejzi, Iran	22.3
11	Isfahan, Iran	23.8
12	Mobarakeh, Iran	24.1
13	Kerman, Iran	24.4
14	Tehran, Iran	26.1
15	Esfahan, Iran	27.6

SUMMARY

Of the countries and regions with available data for this report during 2018, four of the five most polluted in the world were located in South Asia. Of the 84 cities monitored in this area, 99% failed to meet the WHO annual guideline for PM2.5. As a whole, cities here average a PM2.5 concentration of 60 µg/m³, 6 times the recommended limit of 10 µg/m³.

Sources of PM2.5 pollution in this region vary by region and city, but common contributors include vehicle exhaust, open crop and biomass burning, industrial emissions and coal combustion[1].

Of the cities included in South Asia, it is interesting to note that, although Delhi typically receives most media coverage as one of the world's "pollution capitals", the Indian capital "only" ranks 10th for annual PM2.5 concentration. Other cities across Northern India and Pakistan have a higher recorded annual PM2.5 level, with nearby Gurugram narrowly resulting in the highest annual concentration of any global city recorded here during 2018.

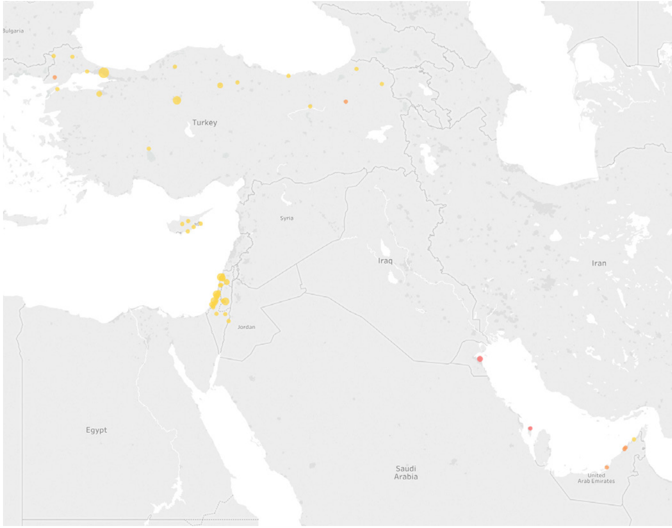
MONITORING STATUS

Real-time air quality data coverage is most numerous within India and Iran, and the highest number of public monitors in any city here is in Delhi. The majority of South Asia, meanwhile, including Afghanistan, Bangladesh, Pakistan and Sri Lanka, lack government supported real-time public stations. All measurements representing these countries and regions are from U.S. State department monitors and citizen-led monitoring networks, the most extensive of which is in Pakistan[2], covering 17 locations in 2018.

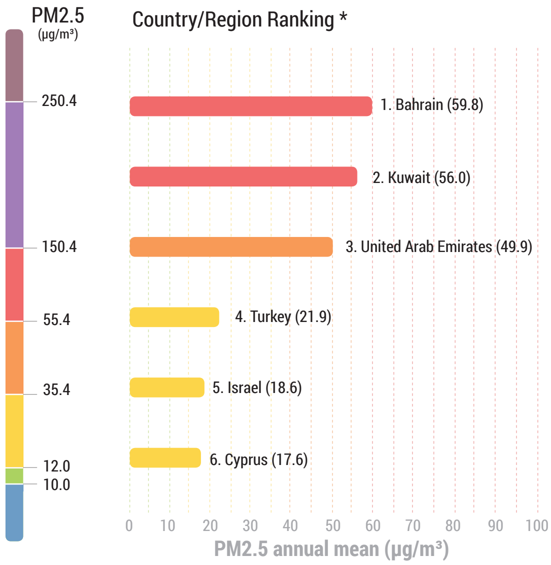
1 https://www.researchgate.net/publication/311901640_Fine_particulates_over_South_Asia_Review_and_meta-analysis_of_PM25_source_apportionment_through_receptor_model
2 https://www.airvisual.com/blog/revealing-the-invisible-airvisual-community-activism-ignites-action-to-fight-smog-in-pakistan

MIDDLE EAST

Bahrain | Cyprus | Israel | Kuwait | Turkey | United Arab Emirates

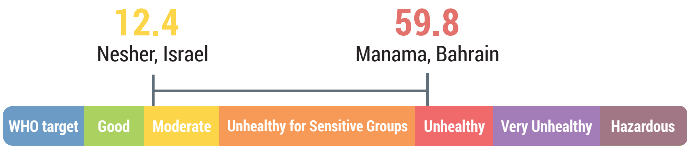


Available cities with real time monitoring in 2018



0%

Regional cities which met the WHO PM2.5 target in 2018 *



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

SUMMARY

The primary contributor to air pollution in the Middle East is natural, from windblown dust storms. However, human activity also significantly contributes to local air pollution, including industrial emissions from oil refineries, fossil fueled power plants, combustion-based transportation and high usage of private vehicles, and open waste burning[1].

The Middle East region includes some of the cities and countries with the highest PM2.5 levels from this 2018 dataset, with Manama, Kuwait City and Dubai all exceeding the WHO annual guideline by more than 5 times.

Most Polluted Regional Cities *

Rank	City	2018 AVG
1	Manama, Bahrain	59.8
2	Kuwait City, Kuwait	56.0
3	Dubai, UAE	55.3
4	Abu Dhabi, UAE	48.8
5	Kazimkarabekir, Turkey	42.7
6	Kesan, Turkey	38.3
7	Sharjah, UAE	37.6
8	Amasya, Turkey	34.0
9	Barkai, Israel	30.7
10	Pinarhisar, Turkey	30.0
11	Erzincan, Turkey	28.9
12	Ein Tamar, Israel	28.4
13	Bursa, Turkey	28.4
14	Pardes Hanna-Karkur, Israel	26.8
15	Corum, Turkey	24.8

Cleanest Regional Cities *

Rank	City	2018 AVG
1	Nesher, Israel	12.4
2	Ayia Marina, Cyprus	12.9
3	Arnavutköy, Turkey	13.8
4	Giresun, Turkey	14.0
5	Zygi, Cyprus	14.3
6	Edirne, Turkey	15.0
7	Be'er Sheva, Israel	16.1
8	Artvin, Turkey	16.4
9	Sde Yoav, Israel	16.6
10	Haifa, Israel	16.7
11	Acre, Israel	17.2
12	Nicosia, Cyprus	17.4
13	Şarkikaraağaç, Turkey	17.4
14	Nir Yisrael, Israel	17.5
15	Gvar'am, Israel	17.6

* Based on available data.

MONITORING STATUS

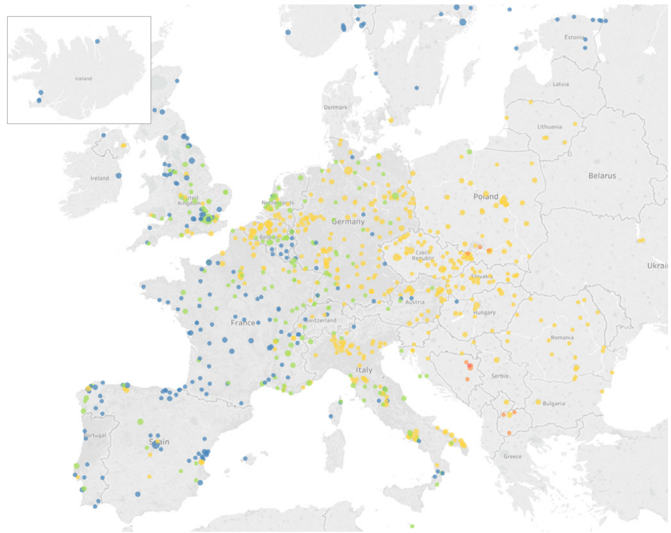
Current levels of governmental air monitoring in this region are low. Cyprus, Israel and Turkey are the only countries with domestic governmental monitors contributing real-time air quality readings. Israel and Turkey have the highest number of monitoring stations included in this region.

The remaining countries (Bahrain, Kuwait, United Arab Emirates) have their real-time air quality data reported here through contributions from the US State Department's overseas air monitoring program, along with IQAir AirVisual monitoring stations operated by individuals and NGOs.

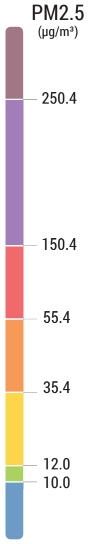
1 https://wedocs.unep.org/bitstream/handle/20.500.11822/20255/NorthAfricaMiddleEast_report.pdf

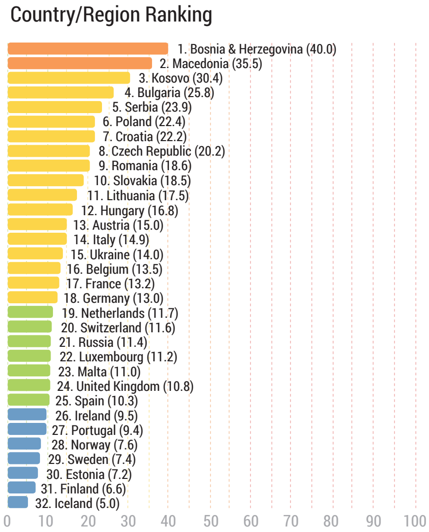
EUROPE

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



Available cities with real time monitoring in 2018

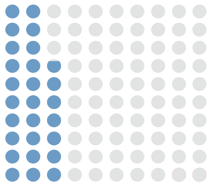




PM2.5 annual mean (μg/m³)

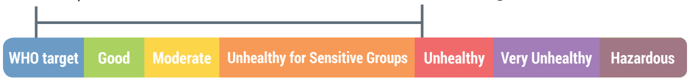
26.8%

Regional cities which met the WHO PM2.5 target in 2018



3.0
Bredkalen, Sweden

55.6
Lukavac, Bosnia & Herzegovina



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

Most Polluted Regional Cities

Rank	City	2018 AVG
1	Lukavac, Bosnia & Herzegovina	55.6
2	Zivinice, Bosnia & Herzegovina	54.0
3	Gracanica, Bosnia & Herzegovina	48.4
4	Tetovo, Macedonia	44.6
5	Jaworzno, Poland	38.9
6	Sarajevo, Bosnia & Herzegovina	38.8
7	Kumanovo, Macedonia	37.2
8	Bitola, Macedonia	36.3
9	Al Krasinskiego, Poland	36.2
10	Tuzla, Bosnia & Herzegovina	35.9
11	Dolni Lutyne, Czech Republic	35.8
12	Skopje, Macedonia	34.0
13	Sassuolo, Italy	31.2
14	Pristina, Kosovo	30.4
15	Katowice, Poland	30.4

Cleanest Regional Cities

Rank	City	2018 AVG
1	Bredkalen, Sweden	3.0
2	Husavik, Iceland	3.1
3	Santana, Portugal	3.4
4	Sao Roque, Portugal	3.6
5	Grundartangi, Iceland	3.7
6	Kuopio, Finland	3.9
7	Salao, Portugal	4.3
8	Vaasa, Finland	4.3
9	Hafnarfjoerdur, Iceland	4.3
10	Alacant, Spain	4.4
11	Saint-Pierre, France	4.6
12	Narvik, Norway	4.6
13	Albalat dels Tarongers, Spain	4.7
14	Umeå, Sweden	4.9
15	La Granja de San Ildefonso, Spain	5.0

SUMMARY

Within Europe, Eastern and Southern European locations reported the highest air pollution levels during 2018. Bosnia and Herzegovina as well as Macedonia have the highest reported annual levels of PM2.5, whilst Poland, the Czech Republic, Romania and Bulgaria, joined by Italy and Kosovo are home of the rest of the 30 most polluted cities.

There is considerable variation between European countries' and cities' main sources of particulate matter. Transportation, agricultural emissions which travel distances to impact cities, and industrial emissions are all common contributors across different areas. Residential heating is an important factor in Eastern European countries as well as parts of Italy[1] and the UK[2]. Poland's relatively high pollution level in particular, may be partly attributed to its high consumption of coal and wood, commonly burned for household energy and in industry.

Transboundary air pollution is a concern for this closely grouped set of countries. Transnational policy such as the United Nations Economic Commission for Europe's (UNECE) Gothenburg protocol is one example of policy measures to manage transboundary emissions

MONITORING STATUS

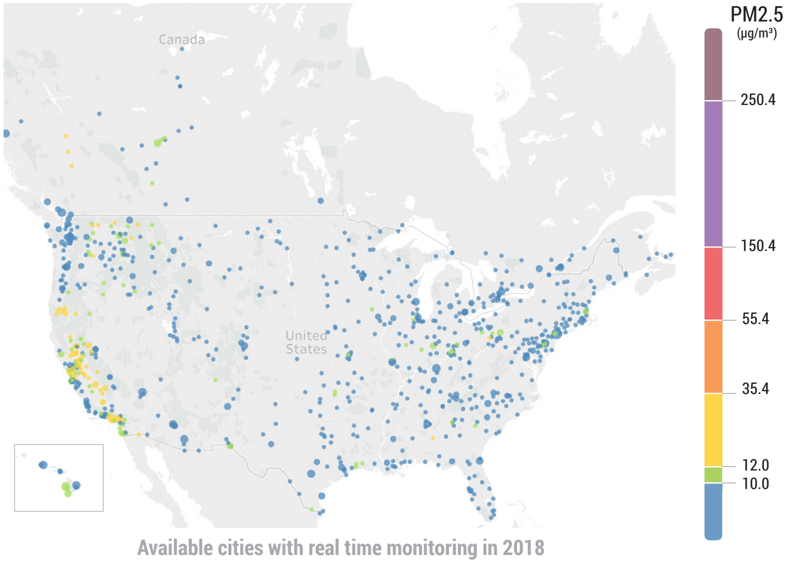
Whilst most countries within the EU have a fairly robust system of public air monitoring and reporting in place, not all monitoring stations measure PM2.5 pollution and some areas do not report their data in real-time. Italy is one example where data is published a day later, thus calling into question its usefulness when it comes to guiding people's decisions to implement personal protection measures or prevent activities that contribute to air pollution.

Some other European countries outside the EU have modest public governmental monitoring networks. Russia only had public PM2.5 monitoring available within Moscow for this report, while citizens have contributed additional IQAir AirVisual monitor networks in other parts of Russia, notably in Krasnoyarsk region, as well as in Ukraine. Kosovo's readings are supplied by the US State Department and these privately operated monitors.

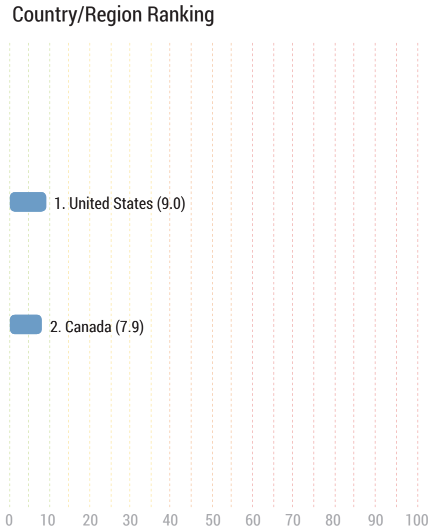
1 https://ec.europa.eu/jrc/en/news/air-quality-atlas-europe-mapping-sources-fine-particulate-matter
2 https://www.gov.uk/government/publications/clean-air-strategy-2019/clean-air-strategy-2019-executive-summary#chapter-6-action-to-reduce-emissions-at-homeShow

NORTHERN AMERICA

United States | Canada



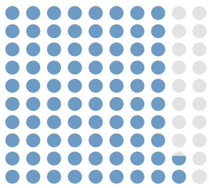
Available cities with real time monitoring in 2018



PM2.5 annual mean (µg/m³)

81.7%

Regional cities which met the WHO PM2.5 target in 2018



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

Most Polluted Regional Cities

Rank	City	2018 AVG
1	Anderson, USA	27.8
2	Medford, USA	22.0
3	Three Rivers, USA	20.8
4	Yosemite Valley, USA	20.4
5	Portola, USA	20.4
6	Klamath Falls, USA	18.9
7	Yuba City, USA	18.2
8	Paradise, USA	17.9
9	Stockton, USA	17.7
10	Chico, USA	17.6
11	Visalia, USA	17.6
12	Turlock, USA	17.3
13	Gridley, USA	16.9
14	Porterville, USA	16.8
15	Twisp, USA	16.6

Cleanest Regional Cities

Rank	City	2018 AVG
1	Oak Harbor, USA	3.0
2	Wellington, Canada	3.4
3	Kapolei, USA	3.5
4	Perry, USA	3.6
5	Wilmington, NY, USA	3.7
6	Santa Fe, USA	3.7
7	Kahului, USA	3.7
8	Reubens, USA	3.8
9	Moncton, Canada	3.8
10	Mount Vernon, USA	3.8
11	Southampton, Canada	3.8
12	Honolulu, USA	3.9
13	Peterborough, USA	4.1
14	Hot Springs, USA	4.1
15	Bar Harbor, USA	4.1

SUMMARY

Northern America is one of the regions with lowest PM2.5 levels represented in this report, although 18% of cities still exceeded the WHO annual target in 2018. The region includes one of the world's pioneering air quality monitoring systems within the USA.

Notable sources of air pollution in Northern America include transport emissions, demand for energy production through fossil fuels, household energy consumption, and wildfires as a prominent natural cause. 2018 saw a series of severe wildfires particularly in the California and Oregon areas during August and November, as well as in Canada's British Columbia with the fumes spreading heavily over nearby Alberta during August[1]. These events constituted some of the most severe wildfires in recent years in both areas, temporarily raising pollution levels far above typical local ranges.

16 out of the 20 most polluted cities in Northern America were in California. All of the top 40 most polluted cities in the region are in the Pacific West, where wildfires severely impacted typical monthly averages. Los Angeles, known for its historic struggles with air pollution and traffic congestion, ranks 31st in the region. PM2.5 adds to the well documented ozone haze[2].

MONITORING STATUS

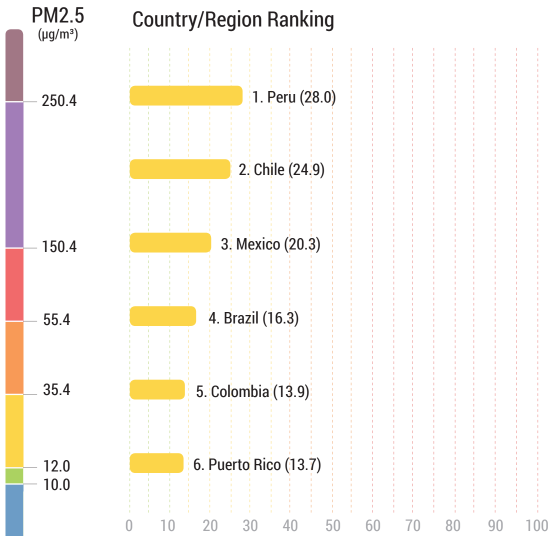
The United States has one of the world's most numerous air monitoring networks with 914 PM2.5 stations nationwide included in this report. In addition, the US State Department's overseas air monitoring program brings valuable air quality readings to numerous cities and countries otherwise lacking this information.

1 https://www.bbc.com/news/world-us-canada-45250919
2 https://doi.org/10.1002/jgrd.50472

LATIN AMERICA & CARIBBEAN

Brazil | Chile | Colombia | Mexico | Peru | Puerto Rico

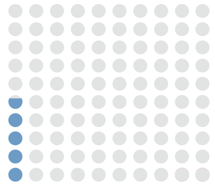
Available cities with real time monitoring in 2018



PM2.5 annual mean (μg/m³)

4.8%

Regional cities which met the WHO PM2.5 target in 2018



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

Most Polluted Regional Cities

Rank	City	2018 AVG
1	Padre las Casas, Chile	43.3
2	Osorno, Chile	38.2
3	Coyhaique, Chile	34.2
4	Valdivia, Chile	33.3
5	Temuco, Chile	30.4
6	Mexicali, Mexico	30.2
7	Santiago, Chile	29.4
8	Lima, Peru	28.0
9	Toluca, Mexico	26.4
10	Linares, Chile	25.5
11	Ecatepec de Morelos, Mexico	24.9
12	Tlalnepantla de Baz, Mexico	23.7
13	Rancagua, Chile	22.9
14	Nezahualcóyotl, Mexico	22.8
15	Puerto Montt, Chile	22.6

Cleanest Regional Cities

Rank	City	2018 AVG
1	Punta Arenas, Chile	4.5
2	Guanajuato, Mexico	9.0
3	Antofagasta, Chile	9.1
4	Alto Hospicio, Chile	10.5
5	Ribeirao Preto, Brazil	11.3
6	Taubate, Brazil	11.4
7	Huasco, Chile	11.5
8	Vina del Mar, Chile	11.9
9	Arica, Chile	12.5
10	Catano, Puerto Rico	12.8
11	Coquimbo, Chile	12.8
12	Abasolo, Mexico	13.0
13	Pachuca de Soto, Mexico	13.3
14	Valparaiso, Chile	13.4
15	Piracicaba, Brazil	13.6

SUMMARY

Chile has the highest recorded PM2.5 pollution levels in this region, providing the top 5 most polluted cities here. Major regional emission sources contributing to air pollution in all countries include agriculture, transportation with inefficient vehicle and fuel standards, as well as biomass fuel burning for household and commercial heating and cooking.

Chile in particular suffers from high levels of particulate pollution as a result of wood burning for heating[1], which government policies are aiming to tackle by promoting access to cleaner heating technologies.

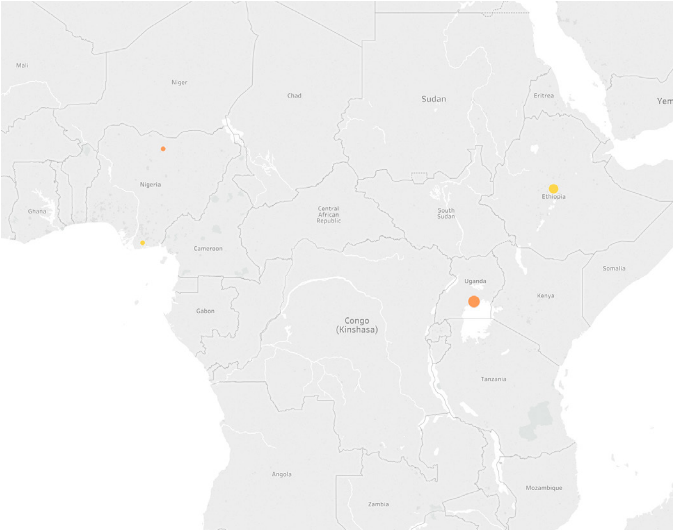
MONITORING STATUS

Real-time air monitoring coverage in this region remains moderately low, with Chile and Mexico supplying the largest number of measurement points. Brazil's real-time PM2.5 data is limited to a network of stations located within Sao Paulo state, whilst the US State Department program provides air quality readings for Colombia and Puerto Rico.

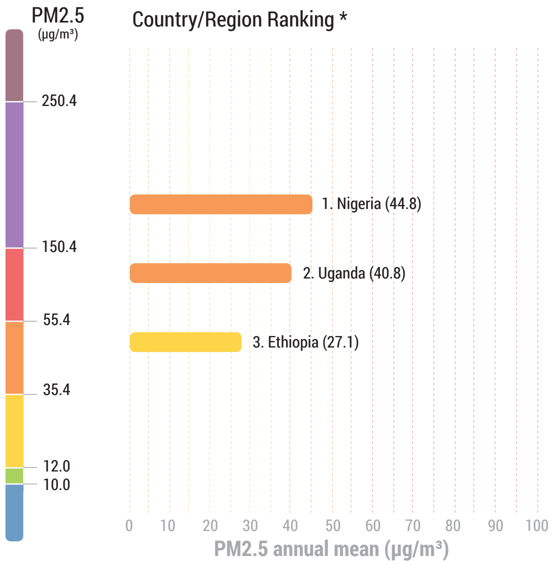
1 https://www.unenvironment.org/news-and-stories/story/chile-takes-action-air-pollution

AFRICA

Ethiopia | Nigeria | Uganda

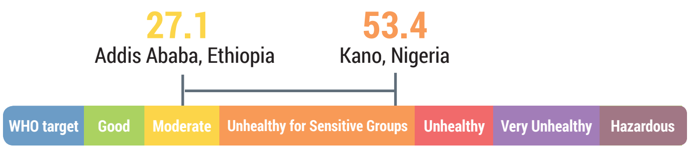


Available cities with real time monitoring in 2018



0%

Regional cities which met the WHO PM2.5 target in 2018 *



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

Most Polluted Regional Cities *

Rank	City	2018 AVG
1	Kano, Nigeria	53.4
2	Kampala, Uganda	40.8
3	Port Harcourt, Nigeria	32.7
4	Addis Ababa, Ethiopia	27.1

Cleanest Regional Cities *

Rank	City	2018 AVG
1	Addis Ababa, Ethiopia	27.1
2	Port Harcourt, Nigeria	32.7
3	Kampala, Uganda	40.8
4	Kano, Nigeria	53.4

* Based on availability of real-time monitoring stations. In Africa (2018), this was limited to 4 cities.

SUMMARY

The African continent has the most notable lack of accessible air quality monitoring data, whilst facing numerous challenges related to regional air quality. Africa has one of the fastest rates of urbanization of any region, with increasing numbers of the population moving to large cities, where air pollution levels tend to be higher. Significant pollution emission sources include fuels such as coal, wood and kerosene for cooking, made more challenging to tackle in rural areas due to limited infrastructure or accessibility of alternative energy sources. Waste and agricultural burning and inefficient transportation also contribute to high PM2.5 levels[1].

MONITORING STATUS

Apart from South Africa where there is a deployment of a substantial network of air quality monitors[2], overall, Africa suffers from a serious lack of air quality monitoring data, leaving more than a billion people without adequate air pollution exposure information. Available real-time data included in this report is supplied by US State department monitors in addition to privately operated IQAir AirVisual monitors. This lack of data results in low regional levels of awareness about air pollution, limiting people's capacity to protect their health.

1 https://www.unenvironment.org/news-and-stories/story/air-pollution-africas-invisible-silent-killer-1
2 The aggregated real-time data from the South African monitoring network is not included here since it did not meet the availability criteria for this report.

Next Steps

As this report illustrates, while some regions have made considerable progress in providing real-time air quality monitoring data, many cities and regions remain underrepresented. The scale of the health hazard now posed by global air pollution stresses the urgent need for more access to timely air quality data that allows citizens and communities to take informed decisions and actions to protect their health.

Making real-time air quality data accessible is one of the most effective ways to catalyze change.

In addition to increasing the number of high-cost governmental reference stations, generating more public data through low-cost sensors is one solution for cities and communities to accelerate access to localized air quality information.

Making air quality data accessible is one of the most effective ways to improve air quality. Public readings generate public awareness, which drives demand for action. The advances made in air pollution control and reduction since China's implementation of national air quality monitoring, is just one example of how access to real-time air quality information can positively impact a country's approach to air quality policy and management. Today, China has one of the most comprehensive air quality monitoring programs and is leading the way in improving air quality in its major cities.

What can I do?

Reducing personal exposure to air pollution can be achieved through simple actions. These can include reducing outdoor activities when pollution levels are high, protecting indoor spaces by closing windows during outdoor air pollution episodes, and where possible, implementing indoor air purification and/or personal outdoor respiratory protection.

The free IQAir AirVisual Air Quality App provides real-time air quality information, air quality forecasts and actionable health recommendations that allow individuals and organizations to reduce their exposure to air pollutants.

Reducing personal exposure to air pollution can be achieved through simple actions

Personal choices can also have a significant impact on reducing pollution emissions. Choosing clean modes of transport (cycling, walking, public transport where available), lowering household energy usage and personal waste output, and supporting local air quality initiatives can all positively impact the air quality in our communities and on our planet.

Deploying an air quality monitor in your neighbourhood is also one way to accelerate access to real-time information, and raise awareness of local conditions within your community[1].

1 https://www.airvisual.com/air-pollution-information/blog/join-the-movement-for-a-cleaner-planet-become-a-public-air-pollution-data-contributor-today

Methodology

Data sources

The air quality data included in this report is generated from ground-based monitoring stations that report PM2.5 concentrations.

The majority of data presented here has been aggregated in real-time (on an hourly basis) from data made publicly available by various governmental agencies.

The real-time aggregated data from government sources within Europe has been combined with historical data records made available by the European Environment Agency (EEA) for 2018, to provide a fuller dataset where there may have been delays in some areas' real-time reporting. Historical data has also been added from some local government sources not available from the EEA at the time of creating this report, including from Turkey, Hungary and Romania.

Further PM2.5 data is also included from a selection of validated outdoor IQAir AirVisual PM2.5 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 is collected from individual monitoring stations and then grouped under a city. For cities with more than one monitoring station, city data is averaged by calculating the hourly median between stations in the same city. These hourly median values are then used to calculate both the city's monthly and annual mean values, respectively[1].

European data records were combined between the available real-time aggregated history from various public sources, and the EEA historical record on a city-by-city basis. For any city with a data record provided both by the real-time aggregated history and the EEA historical data, the record which offers primarily the highest level of data availability over the year, and secondarily the highest number of stations providing measurements, was selected to represent that city.

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

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

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

1 Given this calculation method, the annual average may not always be equal to an average of the year's monthly average values, if some months do not have a complete record of hourly measurements.

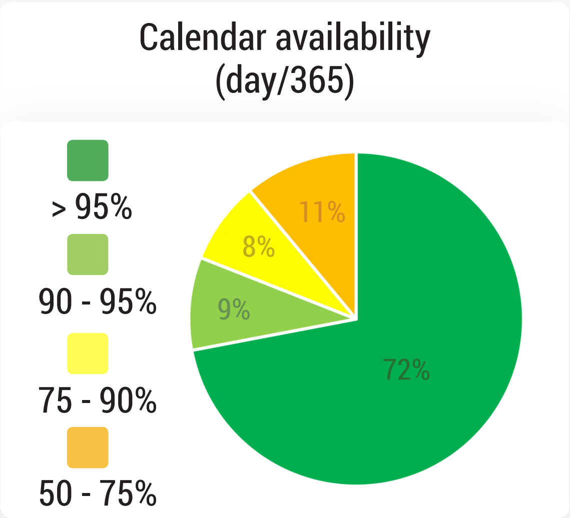
Data availability

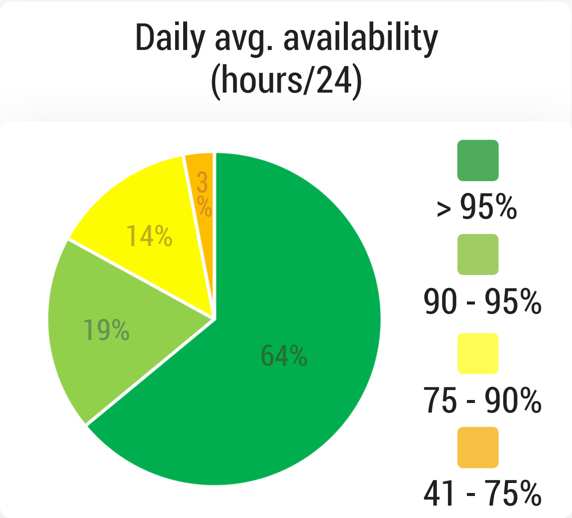
Data availability was measured in 2 ways:

- “Calendar availability”: a percentage of days of the year (/365) when the location had at least one reading from at least one station.
- “Daily average availability”: a mean 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.

The availability criteria for data included in this report is, that a city has >50% calendar availability during 2018. In addition, from the cities with >50% calendar availability, any city with <41% daily average availability (equivalent to a mean availability of <10 hours readings per day), was removed from the dataset.

For reference, a summary of this dataset’s cities’ data availability for 2018:





Disclaimer

This report summarizes available PM2.5 data from global locations during 2018, based primarily on public air quality data aggregated by the IQAir AirVisual information platform and supplemented with additional historical datasets from government sources where available.

The information presented lays no claim on completeness. Data sources for real-time aggregated data are displayed on the IQAir AirVisual website.

We invite suggestions and discussion of the information provided.

IQAir is politically independent and any illustrations or content included in this report are not intended to indicate any political stance. Regional map images have been generated using OpenStreetMap[1].

1 https://www.openstreetmap.org/

FAQ

Why is my area (city / country / region) not listed in this ranking?

- The area lacks available data from governmental or privately operated air quality monitoring stations.
- The area has data from air monitoring stations (such as PM10, Ozone, SO2, etc), but does not include PM2.5 data. This report only includes stations and cities where PM2.5 data is measured.
- The accessible measurements for the city had insufficient availability over the year 2018 to be representative[1].

Why is there a difference between the information in this report and the information provided by my government?

- There are different ways to calculate a yearly, monthly, daily and hourly PM2.5 average. This report aggregates city-level data in cities with multiple stations, by calculating the hourly median value across stations. Some outlier values may affect the average calculated in a different way.
- Governments may have data from more monitoring stations that are either not published or that IQAir AirVisual did not collect. Alternatively, IQAir AirVisual may be referencing more stations within a city or country for its average than a government.
- Different governments may use a different Air Quality Index system to represent air quality readings in a local context. To make direct comparisons, it is important to compare PM2.5 concentration in µg/m³.

Why are some locations available on the AirVisual website, not included in this report?

- It is possible that newer data sources have recently been added to the IQAir AirVisual reporting platform, whilst they may not have been aggregated for long enough to meet this report's availability criteria to be representative of 2018.
- Some locations may report other pollutants via the AirVisual website, but not PM2.5, which is a requirement to be included in this report.
- For some locations which lack real-time PM2.5 information, AirVisual provides an estimated PM2.5 value, which is marked with an asterisk (*)[2]. Only measured PM2.5, not estimations, have been included in this report.

I would like to view the whole city ranking, where can I find it?

You can browse through the full interactive air quality data set of the world's most polluted cities presented on the IQAir AirVisual website, which also provides monthly mean values for each location, so that seasonal trends may also be seen.

If you have further questions, you can contact IQAir AirVisual directly.

How precise is the ranking?

The rankings are based on real world monitoring data from a variety of sources. All monitoring methods have a degree of error. The rankings presented here represent annual average concentrations taken from multiple monitoring sites, and data is checked and validated. However, even after this process the data may have some uncertainty. Where cities and countries in the ranking have similar PM2.5 concentrations, the ranking may be affected by measurement error and the ranking position should be considered to be indicative rather than absolute.

1 See Methodology, "Data availability", p.20.
2 http://support.airvisual.com/knowledgebase/articles/1885072-what-does-the-asterisk-mean-on-some-locations

Acknowledgements

This report is made possible through the efforts of numerous governmental agencies, whose work in publishing real-time air quality data is invaluable to empower people to protect their health and take steps to improve air quality.

This report is also made possible through the efforts of countless individuals and NGO data contributors who operate their own air quality monitors and make this data publicly available.

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.

IQAir
AirVisual