Air quality index

An **air quality index** (AQI) is an indicator developed by government agencies[1] to communicate to the public how polluted the air currently is or how polluted it is forecast to become.[2][3] As air pollution levels rise, so does the AQI, along with the associated public health risk. Children, the elderly and individuals with respiratory or cardiovascular problems are typically the first groups affected by poor air quality. When the AQI is high, governmental bodies generally encourage people to reduce physical activity outdoors, or even avoid going out altogether. When wildfires result in a high AQI, the use of a mask (such as an N95 respirator) outdoors and an air purifier (incorporating both HEPA and activated carbon filters) indoors are also encouraged.[4][5]

Different countries have their own air quality indices, corresponding to different national air quality standards. Some of these are Canada's Air Quality Health Index, Malaysia's Air Pollution Index, and Singapore's Pollutant Standards Index.

An annotated satellite photo showing smoke from wildfires in Greece, giving rise to an elevated AQI downwind

Overview

Computation of the AQI requires an air pollutant concentration over a specified averaging period, obtained from an air monitor or model. Taken together, concentration and time represent the dose of the air pollutant. Health effects corresponding to a given dose are established by epidemiological research.[6] Air pollutants vary in potency, and the function used to convert from air pollutant concentration to AQI varies by pollutant. Its air quality index values are typically grouped into ranges. Each range is assigned a descriptor, a color code, and a standardized public health advisory.

An air quality measurement station in Edinburgh, Scotland

The AQI can increase due to an increase of air emissions. For example, during rush hour traffic or when there is an upwind forest fire or from a lack of dilution of air pollutants. Stagnant air, often caused by an anticyclone, temperature inversion, or low wind speeds lets air pollution remain in a local area, leading to high concentrations of pollutants, chemical reactions between air contaminants and hazy conditions.[7]

On a day when the AQI is predicted to be elevated due to fine particle pollution, an agency or public health organization might:

- advise sensitive groups, such as the elderly, children and those with respiratory or cardiovascular problems or suffering from diseases, to avoid outdoor exertion.[8]
- declare an "action day" to encourage voluntary measures to curtail air emissions, such as using public transportation.[9]
- recommend the use of masks outdoors and air purifiers indoors to prevent fine particles from entering the lungs.[10]

Signboard in Gulfton, Houston, Texas, indicating an ozone watch

During a period of very poor air quality, such as an air pollution episode, when the AQI indicates that acute exposure may cause significant harm to the public health, agencies may invoke emergency plans that allow them to order major emitters (such as coal burning industries) to curtail emissions until the hazardous conditions abate.[11]

Most air contaminants do not have an associated AQI. Many countries monitor ground-level ozone, particulates, sulfur dioxide, carbon monoxide and nitrogen dioxide, and calculate air quality indices for these pollutants.[12]

The definition of the AQI in a particular nation reflects the discourse surrounding the development of national air quality standards in that nation.[13] A website allowing government agencies anywhere in the world to submit their real-time air monitoring data for display using a common definition of the air quality index has recently become available.[14]

Indices by location

Australia

Each of the states and territories of Australia is responsible for monitoring air quality and publishing data in accordance with the National Environment Protection (Ambient Air Quality) Measure (NEPM) standards.[15]

Each state and territory publishes air quality data for individual monitoring locations, and most states and territories publish air quality indexes for each monitoring location.

Across Australia, a consistent approach is taken with air quality indexes, using a simple linear scale where 100 represents the maximum concentration standard for each pollutant, as set by the NEPM. These maximum concentration standards are:

Pollutant	Averaging period	Maximum concentration standard
Carbon monoxide	8 hours	9 ppm
Nitrogen dioxide	1 hour	0.12 ppm
	1 year	0.03 ppm
Ozone	1 hour	0.10 ppm
	4 hours	0.08 ppm
Sulfur dioxide	1 hour	0.20 ppm
	1 day	0.08 ppm
	1 year	0.02 ppm
Lead	1 year	0.50 μg/m^3
PM 10	1 day	50 μg/m^3
	1 year	25 μg/m^3
PM 2.5	1 day	25 μg/m^3
	1 year	8 μg/m^3

The air quality index (AQI) for an individual location is simply the highest of the air quality index values for each pollutant being monitored at that location.

There are six AQI bands, with health advice for each:

AQI	Category	Health advice
0-33	Very Good	Enjoy activities
34-66	Good	Enjoy activities
67-99	Fair	People unusually sensitive to air pollution: Plan strenuous outdoor activities when air quality is better
100-149	Poor	Sensitive groups: Cut back or reschedule strenuous outdoor activities
150-200	Very Poor	Sensitive groups: Avoid strenuous outdoor activities Everyone: Cut back or reschedule strenuous outdoor activities
200+	Hazardous	Sensitive groups: Avoid all outdoor physical activities Everyone: Significantly cut back on outdoor physical activities

Canada

Air quality in Canada has been reported for many years with provincial air quality indices (AQIs). Significantly, AQI values reflect air quality management objectives, which are based on the lowest achievable emissions rate, rather than exclusive concern for human health. The Air Quality Health Index (AQHI) is a scale designed to help understand the impact of air quality on health. It is a health protection tool used to make decisions to reduce short-term exposure to air pollution by adjusting activity levels during increased levels of air pollution. The Air Quality Health Index also provides advice on how to improve air quality by proposing a behavioral change to reduce the environmental footprint. This index pays particular attention to people who are sensitive to air pollution. It provides them with advice on how to protect their health during air quality levels associated with *low*, *moderate*, *high* and *very high* health risks.

The AQHI provides a number from 1 to 10+ to indicate the level of health risk associated with local air quality. On occasion, when the amount of air pollution is abnormally high, the number may exceed 10. The AQHI provides a local air quality current value as well as a local air quality maximums forecast for today, tonight, and tomorrow, and provides associated health advice.[16]

Health risk	Air quality health index	Health messages	
		At risk population	General population
Low Risk	1-3	**Enjoy** your usual outdoor activities.	**Ideal** air quality for outdoor activities.
Moderate Risk	4-6	**Consider** reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	**No need to modify** your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High Risk	7-10	**Reduce or reschedule** strenuous activities outdoors. Children and the elderly should also take it easy.	**Consider** reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High Risk	Above 10	**Avoid** strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	**Reduce or reschedule** strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

China

Hong Kong

On December 30, 2013, Hong Kong replaced the Air Pollution Index with a new index called the *Air Quality Health Index*.[17] This index, reported by the Environmental Protection Department, is measured on a scale of 1 to 10+ and considers four air pollutants: ozone; nitrogen dioxide; sulfur dioxide and particulate matter (including PM10 and PM2.5). For any given hour the AQHI is calculated from the sum of the percentage excess risk of daily hospital admissions attributable to the 3-hour moving average concentrations of these four pollutants. The AQHIs are grouped into five AQHI health risk categories with health advice provided:[18]

Health Risk	AQHI
Low	1
	2
	3
Moderate	4
	5
	6
High	7
Very High	8
	9
	10
Serious	10+

Mainland China

China's Ministry of Environmental Protection (MEP) is responsible for measuring the level of air pollution in China. As of January 1, 2013, MEP monitors daily pollution level in 163 of its major cities. The AQI level is based on the level of six atmospheric pollutants, namely sulfur dioxide (SO_2), nitrogen dioxide (NO_2), suspended particulates smaller than 10 μm in aerodynamic diameter (PM_{10}),[19] suspended particulates smaller than 2.5 μm in aerodynamic diameter ($PM_{2.5}$),[19] carbon monoxide (CO), and ozone (O_3) measured at the monitoring stations throughout each city.[20]

AQI mechanics

An individual score (Individual Air Quality Index, IAQI) is calculated using breakpoint concentrations below, and using same piecewise linear function to calculate intermediate values as the US AQI scale. and The final AQI value can be calculated either per hour or per 24 hours and is *the max* of these six scores.[20]

Chinese AQI category and pollutant breakpoints [20]

Individual index	Units are in μg/m^3 except CO, which is in mg/m^3									
IAQI	SO_2, 24 hour	SO_2, 1 hour (1)	NO_2, 24 hour	NO_2, 1 hour (1)	PM_{10}, 24 hour	CO, 24 hour	CO, 1 hour (1)	O_3, 1 hour	O_3, 8 hour	$PM_{2.5}$, 24 hour
0	0	0	0	0	0	0	0	0	0	0
50	50	150	40	100	50	2	5	160	100	35
100	150	500	80	200	150	4	10	200	160	75
150	475	650	180	700	250	14	35	300	215	115
200	800	800	280	1200	350	24	60	400	265	150
300	1600	(2)	565	2340	420	36	90	800	800	250
400	2100	(2)	750	3090	500	48	120	1000	(3)	350
500	2620	(2)	940	3840	600	60	150	1200	(3)	500

The score for each pollutant is non-linear, as is the final AQI score. Thus an AQI of 300 does not mean twice the pollution of AQI at 150, nor does it mean the air is twice as harmful. The concentration of a pollutant when its IAQI is 100 does not equal twice its concentration when its IAQI is 50, nor does it mean the pollutant is twice as harmful. While an AQI of 50 from day 1 to 182 and AQI of 100 from day 183 to 365 does provide an annual average of 75, it does not mean the pollution is acceptable even if the benchmark of 100 is deemed safe. Because the benchmark is a 24-hour target, and the annual average must match the annual target, it is entirely possible to have safe air every day of the year but still fail the annual pollution benchmark.

AQI and health implications (HJ 633–2012)[20]

AQI	Air Pollution Level	Air Pollution Category	Health Implications	Recommended Precautions
0-50	Level 1	Excellent	No health implications.	Everyone can continue their outdoor activities normally because the air is not polluted.
51-100	Level 2	Good	Some pollutants may slightly affect very few hypersensitive individuals.	Only very few hypersensitive people should reduce outdoor activities.
101-150	Level 3	Lightly Polluted	Healthy people may experience slight irritations and sensitive individuals will be slightly affected to a larger extent because the air is slightly polluted.	Children, seniors and individuals suffering respiratory or heart diseases should reduce sustained and high-intensity outdoor exercises.
151-200	Level 4	Moderately Polluted	Sensitive individuals will experience more serious conditions because the air is moderately polluted. The hearts and respiratory systems of healthy people may be affected.	Children, seniors and individuals with respiratory or heart diseases should avoid sustained and high-intensity outdoor exercises. General population should moderately reduce outdoor activities.
201-300	Level 5	Heavily Polluted	Healthy people will commonly show symptoms. People suffering from respiratory or heart diseases will be seriously affected and will experience reduced endurance in activities.	Children, seniors and individuals with heart or lung diseases should stay indoors and avoid outdoor activities. General population should reduce outdoor activities.
301-500	Level 6	Severely Polluted	Healthy people will experience reduced endurance in activities and may also show noticeably strong symptoms. Other illnesses may be triggered in healthy people. Seniors and those suffering from diseases should remain indoors and avoid exercise. Healthy individuals should avoid outdoor activities because the air is severely polluted.	Children, seniors and the sick should stay indoors and avoid physical exertion. General population should avoid outdoor activities.

Europe

The *Common Air Quality Index* (CAQI)[21] is an air quality index used in Europe since 2006.[22] In November 2017, the European Environment Agency announced the *European Air Quality Index* (EAQI) and started encouraging its use on websites and for other ways of informing the public about air quality.[23]

CAQI

As of 2012, the EU-supported project *CiteairII* argued that the CAQI had been evaluated on a "large set" of data, and described the CAQI's motivation and definition. *CiteairII* stated that having an air quality index that would be easy to present to the general public was a major motivation, leaving aside the more complex question of a health-based index, which would require, for example, effects of combined levels of different pollutants. The main aim of the CAQI was to have an index that would encourage wide comparison across the EU, without replacing local indices. *CiteairII* stated that the "main goal of the CAQI is not to warn people for possible adverse health effects of poor air quality but to attract their attention to urban air pollution and its main source (traffic) and help them decrease their exposure."[22]

The CAQI is a number on a scale from 0 to 100, where a low value means good air quality and a high value means extremely poor air quality. The index is defined in both hourly and daily versions, and separately near roads (a "roadside" or "traffic" index) or away from roads (a "background" index). As of 2012, the CAQI had two mandatory components for the roadside index, NO_2 and PM_{10}, and three mandatory components for the background index, NO_2, PM_{10} and O_3. It also included optional pollutants $PM_{2.5}$, CO and SO_2. A "sub-index" is calculated for each of the mandatory (and optional if available) components. The CAQI is defined as the sub-index that represents the worst quality among those components.[22]

Some of the key pollutant concentrations in $\mu g/m^3$ for the hourly background index, the corresponding sub-indices, and five CAQI ranges and verbal descriptions are as follows.[22]

Qualitative name	Index or sub-index	Pollutant (hourly) concentration in $\mu g/m^3$			
		NO_2 $\mu g/m^3$	PM_{10}	O_3 $\mu g/m^3$	$PM_{2.5}$ (optional) $\mu g/m^3$
Very low	0-25	0-50	0-25	0-60	0-15
Low	25-50	50-100	25-50	60-120	15-30
Medium	50-75	100-200	50-90	120-180	30-55
High	75-100	200-400	90-180	180-240	55-110
Very high	>100	>400	>180	>240	>110

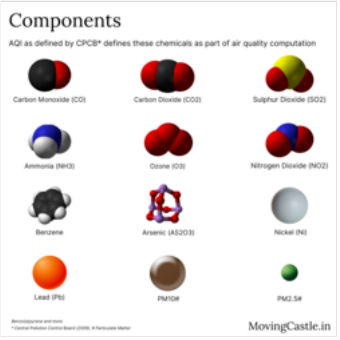
Frequently updated CAQI values and maps are shown on www.airqualitynow.eu[24] and other websites.[21] A separate *Year Average Common Air Quality Index* (YACAQI) is also defined, in which different pollutant sub-indices are separately normalised to a value typically near unity. For example, the yearly averages of NO_2, PM_{10} and $PM_{2.5}$ are divided by 40 $\mu g/m^3$, 40 $\mu g/m^3$ and 20 $\mu g/m^3$, respectively. The overall background or traffic YACAQI for a city is the arithmetic mean of a defined subset of these sub-indices.[22]

India

The National Air Quality Index (NAQI) was launched in New Delhi on September 17, 2014, under the Swachh Bharat Abhiyan.[25][26][27][28]

The highest AQI in India was recorded in New Delhi on 18th November 2024 with it being 1,081 and the concentration of PM2.5 - particulate matter measuring 2.5 microns or less in diameter that can be carried into lungs, causing deadly diseases and cardiac issues. Expected to soar even higher later or next year.

The Central Pollution Control Board along with State Pollution Control Boards has been operating National Air Monitoring Program (NAMP) covering 240 cities of the country having more than 342 monitoring stations.[29] An Expert Group comprising medical professionals, air quality experts, academia, advocacy groups, and SPCBs was constituted and a technical study was awarded to IIT Kanpur. IIT Kanpur and the Expert Group recommended an AQI scheme in 2014.[30] While the earlier measuring index was limited to three indicators, the new index measures eight parameters.[31] The continuous monitoring systems that provide data on near real-time basis are installed in New Delhi, Mumbai, Pune, Kolkata and Ahmedabad.[32]



Components of India's National Air Quality Index (NAQI)

There are six NAQI categories, namely *Good*, *Satisfactory*, *Moderate*, *Poor*, *Very Poor* and *Severe*. The proposed NAQI will consider eight pollutants PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3, NH_3, and Pb) for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed.[33] Based on the measured ambient concentrations, corresponding standards and likely health impact, a sub-index is calculated for each of these pollutants. The worst sub-index reflects overall NAQI. Likely health impacts for different NAQI categories and pollutants have also been suggested, with primary inputs from the medical experts in the group. The NAQI values and corresponding ambient concentrations (health breakpoints) as well as associated likely health impacts for the identified eight pollutants are as follows:

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0–1.0	0-40	0-200	0-0.5
Satisfactory (51–100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.6-1.0
Moderate (101–200)	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0
Poor (201–300)	251-350	91-120	181-280	169-208	10.1-17	801-1600	801-1200	2.1-3.0
Very Poor (301–400)	351-430	121-250	281-400	209–748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401–500)	430+	250+	400+	748+*	34+	1600+	1800+	3.5+

AQI	Remark	Color Code	Possible Health Impacts
0-50	Good		Minimal impact
51-100	Satisfactory		Minor breathing discomfort to sensitive people
101-200	Moderate		Breathing discomfort to the people with lungs, asthma and heart diseases
201-300	Poor		Breathing discomfort to most people on prolonged exposure
301-400	Very Poor		Respiratory illness on prolonged exposure
401-500	Severe		Affects healthy people and seriously impacts those with existing diseases

Japan

According to Japan Weather Association, Japan uses a different scale to measure the air quality index.

CAI	Description	Health Implications
0–50	Good (良い)	There is no impact on humans. Outdoor activities are always allowed.
51–100	Moderate (適度)	Outdoor activities are often allowed because air is seldom considered unhealthy.
101–200	Unhealthy (不健康)	Outdoor activities are sometimes allowed because air is sometimes considered unhealthy.
201–350	Very unhealthy (非常不健康)	There are serious health hazards. Outdoor activities are seldom allowed.
351–500	Hazardous (危険な)	Pollutants trigger extremely serious health hazards to humans. Outdoor activities are never allowed.

Mexico

The air quality in Mexico City is reported in IMECAs. The IMECA is calculated using the measurements of average times of the chemicals ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particles smaller than 2.5 micrometers ($PM_{2.5}$), and particles smaller than 10 micrometers (PM_{10}).

Singapore

Singapore uses the Pollutant Standards Index to report on its air quality,[34] with details of the calculation similar but not identical to those used in Malaysia and Hong Kong.[35] The PSI chart below is grouped by index values and descriptors, according to the National Environment Agency.[36]

PSI	Category	Healthy Persons	Elderly, Pregnant Women, Children	Persons with Chronic Lung Disease or Heart Disease
0-50	Good	Normal activities	Normal activities	Normal activities
51-100	Moderate	Normal activities	Normal activities	Normal activities
101-200	Unhealthy	Reduce prolonged or strenuous outdoor physical exertion	Minimise prolonged or strenuous outdoor physical exertion	Avoid prolonged or strenuous outdoor physical exertion
201-300	Very Unhealthy	Avoid prolonged or strenuous outdoor physical exertion	Minimise outdoor activity	Avoid outdoor activity
301-500	Hazardous	Minimise outdoor activity	Avoid outdoor activity	Avoid outdoor activity

South Korea

The Ministry of Environment of South Korea uses the Comprehensive Air-quality Index (CAI) to describe the ambient air quality based on the health risks of air pollution. The index aims to help the public easily understand the air quality and protect people's health. The CAI is on a scale from 0 to 500, which is divided into six categories. The higher the CAI value, the greater the level of air pollution. Of values of the five air pollutants, the highest is the CAI value. The index also has associated health effects and a colour representation of the categories as shown below.[37]

CAI	Description	Health Effects
0-50	Good	A level that will not impact patients suffering from diseases related to air pollution
51-100	Moderate	A level which may have a meager impact on patients in case of chronic exposure
101-250	Unhealthy	A level that may have harmful impacts on patients and members of sensitive groups (children, aged or weak people), and also cause the general public unpleasant feelings
251-500	Very unhealthy	A level which may have a serious impact on patients and members of sensitive groups in case of acute exposure

The N Seoul Tower on Namsan Mountain in central Seoul, South Korea, is illuminated in blue, from sunset to 23:00 and 22:00 in winter, on days where the air quality in Seoul is 45 or less. During the spring of 2012, the Tower was lit up for 52 days, which is four days more than in 2011.[38]

United Kingdom

The most commonly used air quality index in the UK is the *Daily Air Quality Index* recommended by the Committee on the Medical Effects of Air Pollutants (COMEAP).[39] This index has ten points, which are further grouped into four bands: low, moderate, high and very high. Each of the bands comes with advice for at-risk groups and the general population.[40]

Air Pollution Banding	Value	Accompanying health messages for at-risk individuals	Accompanying health messages for the general population
Low	1-3	**Enjoy** your usual outdoor activities.	**Enjoy** your usual outdoor activities.
Moderate	4-6	Adults and children with lung problems, and adults with heart problems, **who experience symptoms**, should **consider reducing** strenuous physical activity, particularly outdoors.	**Enjoy** your usual outdoor activities.
High	7-9	Adults and children with lung problems, and adults with heart problems, should **reduce** strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhalator more often. Older people should also **reduce** physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat, should **consider reducing** activity, particularly outdoors.
Very High	10	Adults and children with lung problems, adults with heart problems, and older people, should **avoid** strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.	**Reduce** physical exertion, particularly outdoors, especially if you experience symptoms such as cough or sore throat.

The index is based on the concentrations of five pollutants. The index is calculated from the concentrations of the following pollutants: ozone, nitrogen dioxide, sulfur ioxide, PM2.5 and PM10. The breakpoints between index values are defined for each pollutant separately and the overall index is defined as the maximum value of the index. Different averaging periods are used for different pollutants.[40]

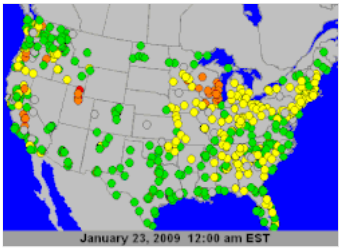
Index	Ozone, running 8 hourly mean (µg/m^3)	Nitrogen dioxide, hourly mean (µg/m^3)	Sulfur dioxide, 15 minute mean (µg/m^3)	$PM_{2.5}$ particles, 24 hour mean (µg/m^3)	PM_{10} particles, 24 hour mean (µg/m^3)
1	0-33	0-67	0-88	0-11	0–16
2	34-66	68-134	89-177	12-23	17–33
3	67-100	135-200	178-266	24-35	34–50
4	101-120	201-267	267-354	36-41	51–58
5	121-140	268-334	355-443	42-47	59–66
6	141-160	335-400	444-532	48-53	67–75
7	161-187	401-467	533-710	54-58	76–83
8	188-213	468-534	711-887	59-64	84–91
9	214-240	535-600	888-1064	65-70	92–100
10	≥ 241	≥ 601	≥ 1065	≥ 71	≥ 101

United States

AQI	Category	Color	Health implications	What should people do
0-50	Good	Green	Air quality is considered satisfactory, and air pollution poses little or no risk.	It's a great day to be active outside.
51-100	Moderate	Yellow	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Unusually sensitive people: Consider reducing prolonged or heavy exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. Everyone else: It's a good day to be active outside.
101-150	Unhealthy for Sensitive Groups	Orange	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Sensitive groups: Reduce prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. People with asthma should follow their asthma action plans and keep quick relief medicine handy. If you have heart disease: Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your health care provider.
151-200	Unhealthy	Red	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Sensitive groups: Avoid prolonged or heavy exertion. Move activities indoors or reschedule to a time when the air quality is better. Everyone else: Reduce prolonged or heavy exertion. Take more breaks during all outdoor activities.
201-300	Very Unhealthy	Purple	Health alert: everyone may experience more serious health effects.	Sensitive groups: Avoid all physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. Everyone else: Avoid prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.
301-500	Hazardous	Maroon	Health warnings of emergency conditions. The entire population is more likely to be affected.	Everyone: Avoid all physical activity outdoors. Sensitive groups: Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.

The United States Environmental Protection Agency (EPA) has developed an Air Quality Index that is used to report air quality. This AQI is divided into six categories indicating increasing levels of health concern.[12]

The AQI is based on the five "criteria" pollutants regulated under the Clean Air Act: ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. The EPA has established National Ambient Air Quality Standards (NAAQS) for each of these pollutants in order to protect public health. An AQI value of 100 generally corresponds to the level of the NAAQS for the pollutant.[12] The Clean Air Act (USA) (1990) requires the EPA to review its National Ambient Air Quality Standards every five years to reflect evolving health effects information. The Air Quality Index is adjusted periodically to reflect these changes.



$PM_{2.5}$ 24-Hour AQI Loop, Courtesy US EPA

Computing the AQI

The air quality index is a piecewise linear function of the pollutant concentration. At the boundary between AQI categories, there is a discontinuous jump of one AQI unit. To convert from concentration to AQI this equation is used:[41]

$$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}}(C - C_{low}) + I_{low}$$

(If multiple pollutants are measured, the calculated AQI is the highest value calculated from the above equation applied for each pollutant.)

where:

I = the (Air Quality) index,
C = the pollutant concentration,
C_{low} = the concentration breakpoint that is ≤ C,
C_{high} = the concentration breakpoint that is ≥ C,
I_{low} = the index breakpoint corresponding to C_{low},
I_{high} = the index breakpoint corresponding to C_{high}.

The EPA's table of breakpoints is:[42][43][44][45][46]

O_3 (ppb) 8-hr	O_3 (ppb) 1-hr	$PM_{2.5}$ (µg/m^3) 24-hr	PM_{10} (µg/m^3) 24-hr	CO (ppm) 8-hr	SO_2 (ppb) 1-hr; 24-hr
0-54	-	0.0-9.0	0-54	0.0-4.4	0-35
55-70	-	9.1-35.4	55-154	4.5-9.4	36-75
71-85	125-164	35.5-55.4	155-254	9.5-12.4	76-185
86-105	165-204	55.5-125.4	255-354	12.5-15.4	186-304
106-200	205-404	125.5-225.4	355-424	15.5-30.4	305-604
-	405-604	225.5-325.4	425-604	30.5-50.4	605-1,004

Suppose a monitor records a 24-hour average fine particle ($PM_{2.5}$) concentration of 26.4 micrograms per cubic meter. The equation above results in an AQI of:

$$\frac{100-51}{35.4-9.1}(26.4-9.1)+51=83.2$$

which rounds to index value of 83, corresponding to air quality in the "Moderate" range.[47] To convert an air pollutant concentration to an AQI, EPA has developed a calculator.[48]

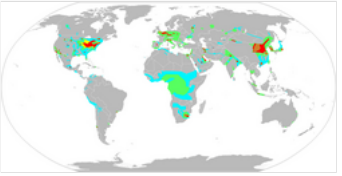
If multiple pollutants are measured at a monitoring site, then the largest or "dominant" AQI value is reported for the location. The ozone AQI between 100 and 300 is computed by selecting the larger of the AQI calculated with a 1-hour ozone value and the AQI computed with the 8-hour ozone value.

Eight-hour ozone averages do not define AQI values greater than 300; AQI values of 301 or greater are calculated with 1-hour ozone concentrations. 1-hour SO_2 values do not define higher AQI values greater than 200. AQI values of 201 or greater are calculated with 24-hour SO_2 concentrations.

Real-time monitoring data from continuous monitors are typically available as 1-hour averages. However, computation of the AQI for some pollutants requires averaging over multiple hours of data. (For example, calculation of the ozone AQI requires computation of an 8-hour average and computation of the $PM_{2.5}$ or PM_{10} AQI requires a 24-hour average.) To accurately reflect the current air quality, the multi-hour average used for the AQI computation should be centered on the current time, but as concentrations of future hours are unknown and are difficult to estimate accurately, EPA uses surrogate concentrations to estimate these multi-hour averages. For reporting the $PM_{2.5}$, PM_{10} and ozone air quality indices, this surrogate concentration is called the NowCast. The Nowcast is a particular type of weighted average that provides more weight to the most recent air quality data when air pollution levels are changing.[49][50]

Public availability of the AQI

Real time monitoring data and forecasts of air quality that are color-coded in terms of the air quality index are available from EPA's AirNow web site.[51] Other organizations provide monitoring for members of sensitive groups such as asthmatics, children and adults over the age of 65.[52] Historical air monitoring data including AQI charts and maps are available at EPA's AirData website.[53] There is a free email subscription service for New York inhabitants – AirNYC.[54] Subscribers get notifications about the changes in the AQI values for the selected location (e.g. home address), based on air quality conditions. A detailed map containing current AQI levels and a two-day AQI forecast is available at the Aerostate web site.[55]



A global air quality map

Regulatory Air Monitors and Low Cost Sensors

Historically, EPA has only allowed data from regulatory monitors operated by regulatory or public health professionals to be included in its real time national maps.[56][57] In the past decade, low cost sensors (LCS's) have become increasingly popular with citizen scientists, and large LCS networks have sprung up in the US and across the globe. Recently, EPA has developed a data correction algorithm[58][59] for a particular brand of $PM_{2.5}$ LCS (the Purple Air (https://www2.purpleair.com/products/list) monitor) that makes the LCS data comparable to regulatory data for the purpose of computing the AQI. This corrected LCS data currently appears alongside regulatory data on EPA's national fire map.[60]

History of the AQI

The AQI made its debut in 1968, when the National Air Pollution Control Administration undertook an initiative to develop an air quality index and to apply the methodology to Metropolitan Statistical Areas. The impetus was to draw public attention to the issue of air pollution and indirectly push responsible local public officials to take action to control sources of pollution and enhance air quality within their jurisdictions.

Jack Fensterstock, the head of the National Inventory of Air Pollution Emissions and Control Branch, was tasked to lead the development of the methodology and to compile the air quality and emissions data necessary to test and calibrate resultant indices.[61]

The initial iteration of the air quality index used standardized ambient pollutant concentrations to yield individual pollutant indices. These indices were then weighted and summed to form a single total air quality index. The overall methodology could use concentrations that are taken from ambient monitoring data or are predicted by means of a diffusion model. The concentrations were then converted into a standard statistical distribution with a preset mean and standard deviation. The resultant individual pollutant indices are assumed to be equally weighted, although values other than unity can be used. Likewise, the index can incorporate any number of pollutants although it was only used to combine SO_x, CO, and TSP[62] because of a lack of available data for other pollutants.

While the methodology was designed to be robust, the practical application for all metropolitan areas proved to be inconsistent due to the paucity of ambient air quality monitoring data, lack of agreement on weighting factors, and non-uniformity of air quality standards across geographical and political boundaries. Despite these issues, the publication of lists ranking metropolitan areas achieved the public policy objectives and led to the future development of improved

indices and their routine application.

See also

Environment portal

- Air pollution
- Air pollution forecasting
- Air pollution measurement
- Clean air zone
- Indoor air quality
- Low emission zone
- Ultra Low Emission Zone

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External links

Some of the following websites display actively updated air quality index maps; others are archived versions of inactive websites:

- Global:
  - Worldwide Air Pollution: Real-time Air Quality Index Visual Map (http://aqicn.org/map/world/#@g/2.0574/7.9102/2z)
- Europe:
  - CAQI (http://www.airqualitynow.eu/index.php)- AirqualityNow
  - EAQI (http://www.eea.europa.eu/themes/air/air-quality-index) - European Environment Agency
  - The UK Air Quality Archive (http://www.airquality.co.uk/archive/index.php)
- North America:
  - AQI at airnow.gov (https://www.airnow.gov/) - cross-agency U.S. Government site
  - New Mexico Air Quality and API data (https://web.archive.org/web/20070623011137/http://air.state.nm.us/) - Example of how New Mexico Environment Department publishes their Air Quality and API data.
  -
  - EPA Air Quality Index (https://www.cays.com/wp-content/uploads/2024/04/air-quality-index.pdf) - A Guide to Air Quality and Your Health
  - AQI at Meteorological Service of Canada (https://web.archive.org/web/20060706053637/http://www.msc-smc.ec.gc.ca/aq_smog/index_e.cfm)
  - San Francisco Bay Area Spare-the-Air (https://web.archive.org/web/20070613193732/http://www.sparetheair.org/data/air_quality.htm) - AQI explanation
- Asia:
  - CAI at Airkorea.or.kr (https://web.archive.org/web/20070719042151/http://eng.airkorea.or.kr/cai/main.jsp) - website of South Korea Environmental Management Corp.
  - Malaysia Air Pollution Index (https://apims.doe.gov.my/home.html)
  - API at Hong Kong (https://web.archive.org/web/20070410055414/http://www.epd-asg.gov.hk/) - Environmental Protection Department of the Government of the Hong Kong Special Administrative Region *(inactive as of 19 February 2018)*
  - AQI in Thailand (http://aqmthai.com/index.php?lang=en) Archived (https://web.archive.org/web/20170606174552/http://aqmthai.com/index.php?lang=en) 2017-06-06 at the Wayback Machine
  - AQI in Vietnam (http://enviinfo.cem.gov.vn/)
    - AQI in Hanoi (https://moitruongthudo.vn/)
    - Unofficial PM25 AQI in Hanoi, Vietnam (http://www.aqivn.org/en/) Archived (https://web.archive.org/web/20170617074153/http://www.aqivn.org/en/) 2017-06-17 at the Wayback Machine