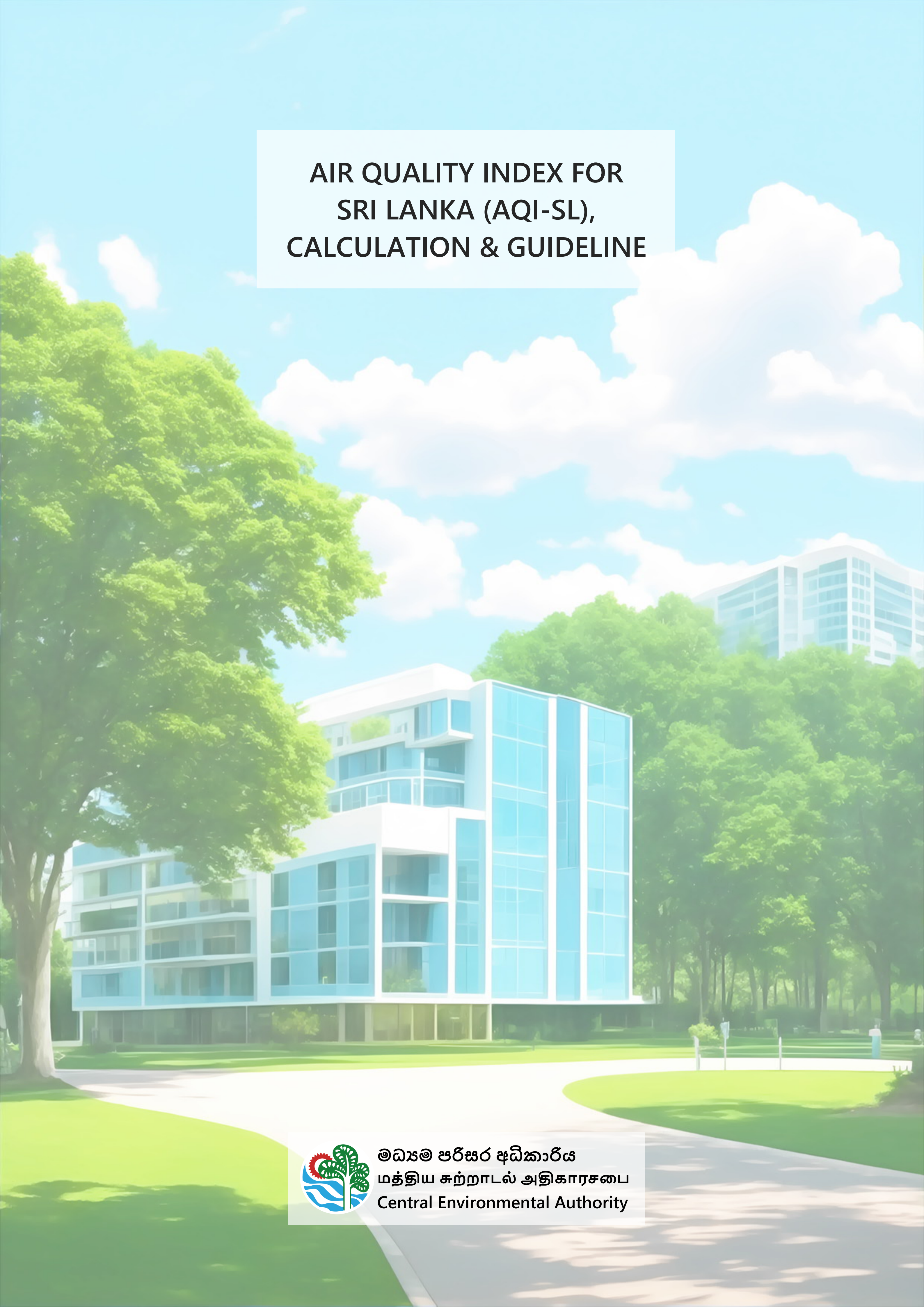

AIR QUALITY INDEX FOR SRI LANKA (AQI-SL), CALCULATION & GUIDELINE

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மத்திய சுற்றாடல் அதிகாரசபை
Central Environmental Authority

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Introduction

The document is divided into two main sections. The first section, titled "GENERAL", provides essential information for a general audience. The second section, "TECHNICAL DETAILS", offers specific guidelines, methodologies, and examples for calculating AQI and publishing air quality information.

Contents

GENERAL

Requirement of an Air Quality Index

Air Quality is determined by the pollution level in the air. When determining air quality, consideration is given to the most commonly found pollutants that have a significant impact. At different levels, each pollutant can cause different impacts. In here we consider six air pollutants and they are called criteria pollutants.

Knowing the air quality level is key to taking necessary actions and precautions against health issues caused by poor air quality, as well as mitigating harm to wildlife and ecosystems. It also helps making informed decisions on regulations and policies to improve air quality.

In measuring the air pollutant level, the concentration of the pollutant in the air is considered, and units such as $\mu g/m^3$ (micrograms per cubic meter) and ppb (parts per billion) are used. It shows the amount of the pollutant in the air. As the general public is often unfamiliar with measurement units, a single scale has been introduced to simplify the understanding of air pollutant levels and their effects. This scale is known as the Air Quality Index (AQI) and ranges from 0 to 500. Additionally, the AQI is categorized and each category is assigned a specific color to aid in comprehension.

Leveraging the health and environmental impacts of exposure to pollutants, distinct breakpoint concentration values and averaging periods are introduced for each criteria pollutant to enable the determination of category levels and the index values. The index for each criteria pollutant is referred to as the sub-AQI value, which enables the assessment of each pollutant individually. The highest sub-AQI value is regarded as The AQI value.

A number of different air quality indices are introduced for different countries and regions, frequently influenced by their respective regulations and standards. When enforcing an air quality index, the pollutant composition, social and economic conditions should also be taken into account. This **Air Quality Index for Sri Lanka**, referred to as **AQI-SL**, takes inspiration from the AQI published by United States Environmental Protection Agency (US EPA). Breakpoints are largely derived from the National Ambient Air Quality Standards of Sri Lanka, which was based on the Guidelines and Interim Targets set by World Health Organization (WHO). The aim is to establish a comprehensive air quality index that takes into account international standards as well as local regulations.

AQI Color	Level of Concern	Index
Green	Good	0 - 50
Yellow	Moderate	51 -100
Orange	Slightly Unhealthy	101 - 150
Red	Unhealthy	151 - 200
Purple	Very Unhealthy	201 - 300
Maroon	Hazardous	301 - 500

Table 1 – Categories

AQI Category Descriptions

0 to 50. Good.

Ambient air quality is considered to be healthy or the potential risk for health is negligible.

51 to 100. Moderate.

Air quality is acceptable; however, the minor pollution level may pose a moderate health concern for vulnerable sensitive individuals.

101 to 150. Slightly Unhealthy.

At-risk population such as hypersensitive people, people with respiratory disease, may experience health effects, but the general public is unlikely to be affected.

151 to 200. Unhealthy.

Everyone may begin to experience negative health effects where as members of sensitive groups may experience more serious health effects.

201 to 300. Very Unhealthy.

Trigger a health alert, meaning everyone exposure to the concern air may experience more serious health effects.

301 to 500. Hazardous.

Trigger health warnings in emergency condition. The entire population is even more likely to be affected by serious health impacts. In order to eliminate adverse health impacts, instantaneous countermeasures to be deployed and keep the public aware on the situation with management practices.

Exceeds 500. Beyond AQI.

Pollutant level is too high and out of range, & hazardous even more.

Health Messages

	Health Message	
Category	At-risk population	General population
Good	Enjoy outdoor activities.	Ideal air quality for outdoor activities.
Moderate	Continue day-to-day activities, with a caution.	Continue usual outdoor activities.
Slightly Unhealthy	Reduce outdoor activities, avoid strenuous outdoor activities.	Continue day-to-day activities, with a caution.
Unhealthy	Avoid outdoor activities. Limit the pollutant exposure.	Reduce outdoor activities. Limit the pollutant exposure.
Very Unhealthy	Avoid outdoor activities. Limit the pollutant exposure. Get medical advice.	Avoid outdoor activities. Limit the pollutant exposure.
Hazardous	Avoid outdoor activities. Limit the pollutant exposure. Get medical advice. Be alert.	Avoid outdoor activities. Limit the pollutant exposure. Get medical advice.
Beyond AQI	Health risk is too high and follow the instructions for "Hazardous".	

Table 2 - Health Messages

"At-risk population" refers to individuals who are weaker and more vulnerable, due to existing conditions, such as heart or respiratory diseases.

Outdoor vs Indoor: The ambient air is measured outdoors, which is why it is advised not to remain outside when the AQI is high. If a pollution source such as a road or an industry is present nearby, the situation may be even worse. However, a presence of dense tree cover in outdoor areas may result in lower levels of air pollution, especially regarding particulates. Additionally, indoor air quality may not be significantly better if the indoor area is directly exposed to outdoor air through open windows, doors, and vents. However, the use of air conditioning or any active/ passive air filtering system can result in better indoor air quality than outdoor air quality during high AQI scenarios. For specific pollutant filtering, a respirator can be beneficial, such as a K(N)95 mask that filters particulates, and it is recommended to seek medical advice for the best solution based on the atmospheric conditions and the individual's needs. Furthermore, during episodes of high air pollution, it is advised to minimize household activities that contribute to air pollutant emissions, as well as lifestyle activities that can lead to increased exposure to pollutants, such as smoking.

Although the AQI is regularly published, it can be helpful to have special media coverage when the category exceeds the Red/ Unhealthy level. In such cases, it is necessary for the public to take appropriate actions to ensure safety and reduce emissions as much as possible. Additionally, a Contingency Response Action Plan at the national or regional level may be implemented in such situations.

Using AQI in day-to-day life

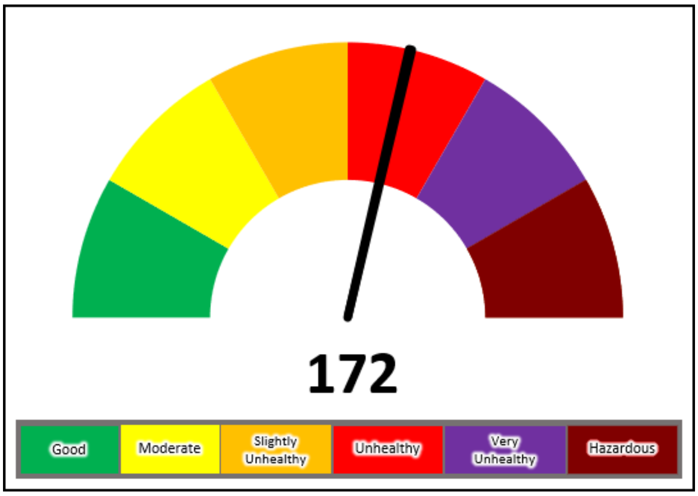
The AQI information could be displayed in various platforms such as website, app, mobile phone screen, computer screen, display board, TV, newspaper, and social media. Depending on the viewer's knowledge, the AQI provides information in different layers.

Firstly, it displays a color that indicates a certain meaning and a category name that conveys a message. Additionally, a numerical value is shown, which indicates where it falls on the AQI scale. All these layers of information allow individuals to adjust and plan their activities accordingly.

However, the colors and categories of the AQI are determined based on a specific exposure time and health effects. Therefore, the message conveyed by the colors and categories is accurate only if the exposure time matches. For instance, the AQI category and color may indicate a different level of health risk for short-term exposure than for long-term exposure.

Example:

AQI-SL (1H), 2022-02-22, 02:00 PM



$PM_{2.5}$	PM_{10}	O_3	CO	NO_2	SO_2
172	151	120	65	21	18

AQI from 1 hour data

Here, AQI 172 was given for the 1-hour data and the dominant pollutant is PM2.5.

The color "Red" and the category "Unhealthy" are indicated by the AQI. As it was calculated using 1-hour data, but the categories were set based on 24-hour exposure, it actually means that if someone was or will be exposed to the current/last hour's air pollution level for 24 hours, it would be unhealthy. It is recommended to take precautions to avoid being exposed for longer periods.

If we look at the Sub-Index values for each pollutant, it indicates that if the current PM2.5 and PM10 levels continue for 24 hours, it would be unhealthy.

Similarly, if we look at Sub-Index values for each pollutant, it indicates that if current PM2.5 and PM10 level continues for 24 hours, it would be unhealthy.

For Ozone, the color "Orange" and category "Slightly Unhealthy" are indicated. Since the hourly exposure is used to set the categories for O_3, it implies that if someone has already been at the location for an hour, that person has already been exposed to "Slightly Unhealthy" air. If someone will be exposed to similar conditions for an hour, it will also be "Slightly Unhealthy". Regardless, it is recommended to avoid being exposed anyway.

For CO, the "Yellow" color and "Moderate" category are shown, which implies that there is no need to worry, but the air quality is not at its best.

For NO_2 and SO_2, the "Green" color and "Good" category are displayed, indicating that the air quality is at its best.

Here, the overall air quality is determined based on the level of the most dominant pollutant. However, it is important to consider the additional health effects caused by the presence of other pollutants. It is possible to create an AQI scheme that takes into account all pollutants, but this would be complex and require extensive research. The combined effects of pollutants may behave in non-linear ways, making it difficult to create a simple formula. Additionally, limitations of the measurements must also be taken into consideration. For instance, most measurement locations only have a PM2.5 sensor, despite there being six criteria pollutants. In terms of air quality awareness, having a general understanding of the situation is often sufficient to be cautious and stay safe.

Different AQI Schemes

Various countries and regions have developed their own AQI schemes to suit their local standards, and these are called by different names, such as AQI, API, AQHI, CAI, PSI, etc. The term AQI is commonly associated with the US EPA scheme, but it may also be used in conjunction with the name of the country or region by some other nations. Therefore, it is important to clearly specify the AQI scheme being used to avoid any confusion. Additionally, it is recommended to include the corresponding concentration levels, or provide a means to access them. The term "AQI" in this document refers to "AQI-SL", unless a different scheme is specified along with it.

Some popular Air Quality Index Schemes

- AQI (US EPA): Air Quality Index
- API (Malaysia): Air Pollution Index
- NAQI (India): National Air Quality Index
- DAQI (UK): Daily Air Quality Index
- CAQI/EAQI: Common AQI / European AQI
- AQHI (Canada): Air Quality Health Index
- AQI (Australia): AQI Australia (WA)
- AQI-SL: Air Quality Index for Sri Lanka

Breakpoints

Category	Color	Index	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	O_3 (ppb)	CO (ppb)	NO_2 (ppb)	SO_2 (ppb)
		0	0	0	0	0	0	0
Good	Green							
		50	25	50	50	2,250	65	15
Moderate	Yellow							
		100	50	100	100	4,500	130	30
Slightly Unhealthy	Orange							
		150	75	150	200	9,000	350	80
Unhealthy	Red							
		200	150	275	300	15,000	650	250
Very Unhealthy	Purple							
		300	250	450	400	30,000	1,250	600
Hazardous	Maroon							
		500	400	650	600	50,000	2,000	1,000

A category & breakpoint table can be provided as follows: **Breakpoint Table 1 - Ranges**

AQI Color	Level of Concern	Index	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	O_3 (ppb)	CO (ppb)	NO_2 (ppb)	SO_2 (ppb)
Green	Good	0 - 50	0 - 25	0 - 50	0 - 50	0 - 2,250	0 - 65	0 - 15
Yellow	Moderate	50 -100	25 - 50	50 - 100	50 - 100	2,250 - 4,500	65 - 130	15 - 30
Orange	Slightly Unhealthy	100 - 150	50 - 75	100 - 150	100 - 200	4,500 - 9,000	130 - 350	30 - 80
Red	Unhealthy	150 - 200	75 - 150	150 - 275	200 - 300	9,000 - 15,000	350 - 650	80 - 250
Purple	Very Unhealthy	200 - 300	150 - 250	275 - 450	300 - 400	15,000 - 30,000	650 - 1,250	250 - 600
Maroon	Hazardous	300 - 500	250 - 400	450 - 650	400 - 600	30,000 - 50,000	1,250 - 2,000	600 - 1,000
Beyond AQI		>500	>400	>650	>600	>50,000	>2,000	>1,000

Table 3 – Breakpoint Table 1 - Ranges

(Please see the "Table 9 - Breakpoint Table 2" & "- Breakpoint Table 3" as well.)

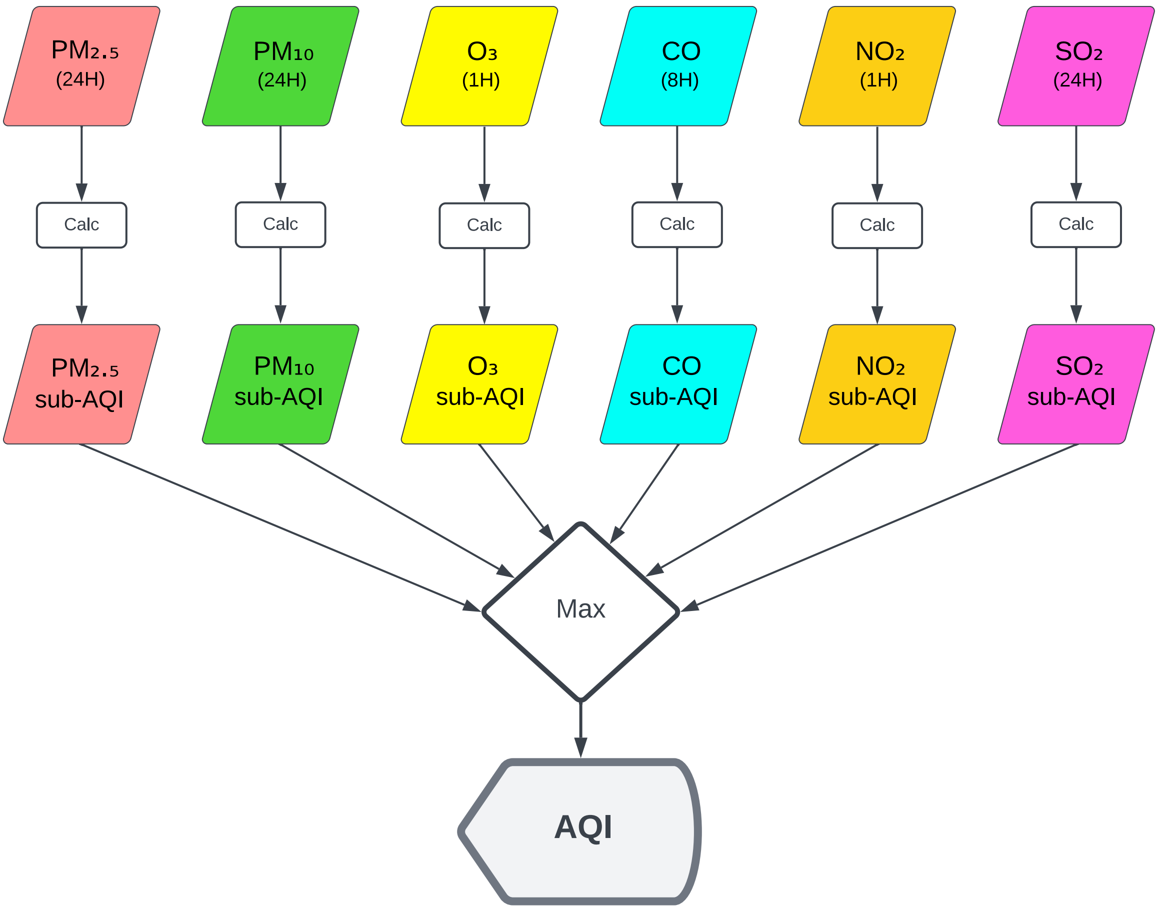
As the pollutant concentrations increase, their impact also increases accordingly. At lower levels, adverse effects are negligible. However, as the pollutant concentration increases, the adverse effects become progressively more significant.

The impact is indicated by the numerical index value, which ranges from 0 to 500. For ease of use, reference and management, the index scale is divided into six categories. To establish the categories, the boundary line between two categories shall be given. The concentration values at these boundaries are given as breakpoints.

There is a certain threshold of air pollution that is considered "Good" for both living beings and the environment. Once the pollutant levels exceed this threshold, the air quality becomes "Moderate". That threshold concentration value varies for each pollutant. However, the use of the Air Quality Index (AQI) makes it simple as in the index, that threshold value is 50 for all pollutants. Accordingly, other category threshold values in the index are 100, 150, 200, 300, and 500. The concentration values that represent those index values for each pollutant are the breakpoints.

Different concentrations of pollutants that cause the same level of overall health effects are converted into a common index value that represents the health concern level. This is achieved by applying calculations that enforce a weighing process using appropriate weight factors.

AQI Determination Process



TECHNICAL DETAILS

AQI Calculation Formula

A common formula for the calculation of the AQI value is given below.

$$I_P = (C_P - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I = max\{I_P\}$$

P = Pollutant

C = Concentration

I = Air Quality Index

BP = Breakpoint

Hi = High

Lo = Low

C_p = Concentration of the Pollutant P

I_p = Sub-Index of the Pollutant P

BP_{Hi} = Breakpoint concentration that is greater than C_p

BP_{Lo} = Breakpoint concentration that is less than or equal to C_p

I_{Hi} = Index value corresponding to BP_{Hi}

I_{Lo} = Index value corresponding to BP_{Lo}

Note

Quality control shall be performed prior to the calculation.

Each pollutant has its own sub-AQI and the AQI value would be the Maximum sub-AQI value.

The pollutant having the maximum index value is the Dominant Pollutant.

At least one particulate matter concentration shall be present to get the AQI.

AQI values shall be rounded into the nearest integer, when publishing.

Unit conversion is needed if the measurement unit is not the unit specified in breakpoints.

Variations of AQI

The AQI categories are established based on the levels of exposure and environmental impact when exposed. Thus, the AQI value, category level/name, color, and description are considered accurate when the exposure time or averaging time of the measurement is comparable to the time period stated in the AQI scheme. In the case of most pollutants, this period is 24 hours. A 24-hour measurement is required for such pollutants, and by the time the AQI value is obtained, the environment and individuals have already been exposed to the pollutants, despite the precision of the AQI. Therefore, obtaining an indication of the current or future air quality would be preferable. Forecasting and generating AQI for shorter time periods would assist in achieving this objective.

When releasing AQI information, it is expected to provide all the relevant details, such as the averaging time or exposure time, and whether the information is based on a measurement or forecast.

Daily AQI: AQI of the given date from midnight to next midnight. From 00:00 to 24:00.

AQI for 2023-04-28 means the AQI for the measurements from 2023-04-28, 00:00 to 2023-04-29, 00:00.

AQI at the given time / for the given 24H: AQI for past 24 hours, or AQI from 2023-04-28, 08:00 to 2023-04-29, 08:00, etc.

AQI – Averaging Time: AQI – 1 Hour, at 2023-04-19, 16:00.

Which means the AQI for the measurement from 2023-04-19, 15:00 to 16:00.

Averaging time could be anything which is convenient. It may depend on the platform, measurement device etc.

Ex: AQI (1H), AQI (8H), AQI (15min), AQI (5min), AQI (Instant), etc.

AQI (Forecast):

AQI generated using a Forecasting model. Details shall be given.

AQI – Pollutant: AQI – PM2.5 / PM2.5 AQI etc.

Where only one criteria pollutant is measured, or to display the sub-AQI of a single pollutant.

Etc.

Category Colors

Technical details of the category colors for purposes of Web and Graphics.

Category Name	Category Color	HTML Color Name	Hex	RGB
Good	**Green**	LimeGreen	#32CD32	rgb(50,205,50)
Moderate	**Yellow**	Yellow	#FFFF00	rgb(255,255,0)
Slightly Unhealthy	**Orange**	DarkOrange	#FF8C00	rgb(255,140,0)
Unhealthy	**Red**	Red	#FF0000	rgb(255,0,0)
Very Unhealthy	**Purple**	DarkViolet	#9400D3	rgb(148,0,211)
Hazardous	**Maroon**	Maroon	#800000	rgb(128,0,0)

Table 4 - Color Codes

AQI Comparison - US, IN, CN vs SL

Cat. Level	US = SL			IN			CN		
	Color	Range	Name	Color	Range	Name	Color	Range	Name
1	Green	0 - 50	Good	Green	0 - 50	Good	Green	0 - 50	Excellent
2	Yellow	50 - 100	Moderate	Yellowish Green	50 - 100	Satisfactory	Moderate	Yellowish Green	Good
3	Orange	100-150	Slightly Unhealthy / Unhealthy for S.G	Yellow	100-200	Moderate	Greenish Yellow	100-150	Lightly Polluted
4	Red	150-200	Unhealthy	Orange	200-300	Poor	Orange	150-200	Moderately Polluted
5	Purple	200-300	Very Unhealthy	Red	300-400	Very Poor	Orange-Red	200-300	Heavily Polluted
6	Maroon	300-500	Hazardous	Maroon	400-500	Severe	Red	300-500	Severely Polluted

Table 5 - AQI Category Comparison

The comparisons below provide a rough idea using line graphs. However, due to differences in the category systems in different AQI schemes, a comprehensive analysis is necessary to do an accurate comparison.

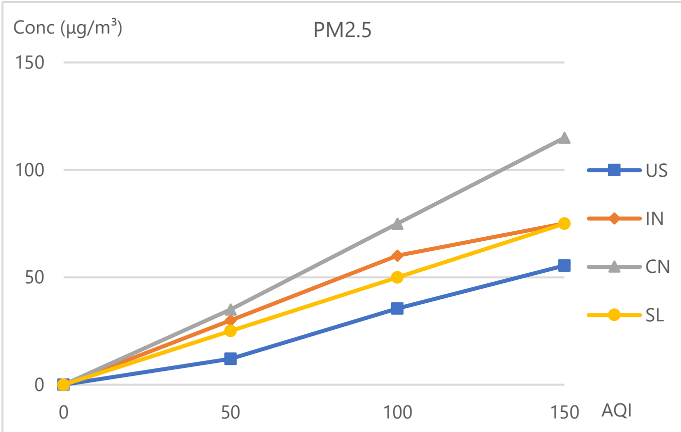
A rough comparison between US-EPA AQI, NAQI India, AQI China and AQI-SL for Particulates.

$PM_{2.5}$ ($\mu g/m^3$)

Index	US	IN	CN	SL
0	0	0	0	0
50	12	30	35	25
100	35.4	60	75	50
150	55.4		115	75
200	150.4	90	150	150
300	250.4	120	250	250
400		250		
500	500.4	380	450	400

Table 6 - Comparison, PM2.5

Graph 2 - Comparison, PM2.5, Full Range

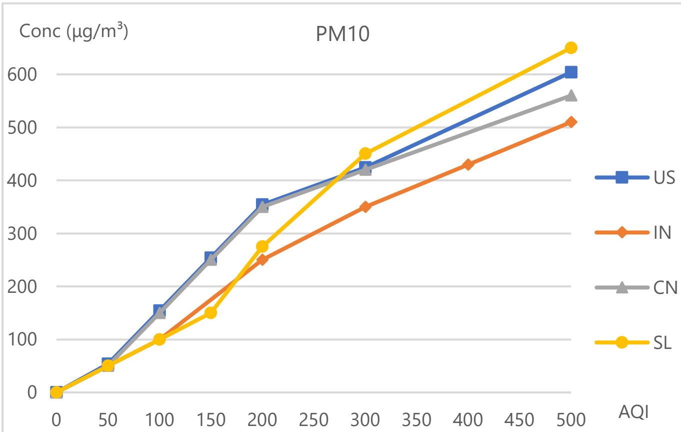


Graph 2 - Comparison, PM2.5, Frequent Range

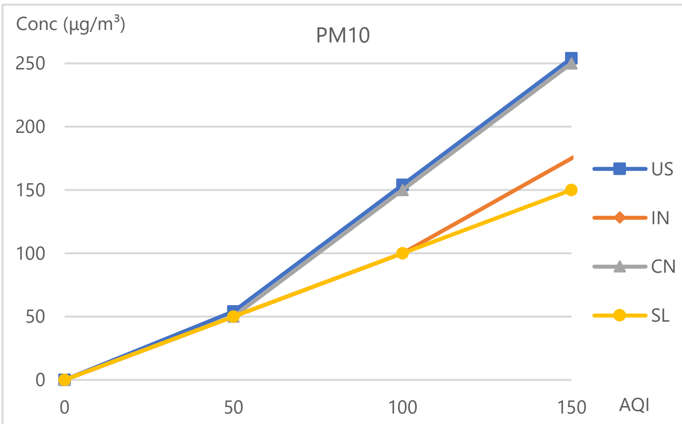
PM_{10} ($\mu g/m^3$)

Index	US	IN	CN	SL
0	0	0	0	0
50	54	50	50	50
100	154	100	150	100
150	254		250	150
200	354	250	350	275
300	424	350	420	450
400		430		
500	604	510	560	650

Table 7 - Comparison, PM10



Graph 4 - Comparison, PM10, Full Range



Graph 4 - Comparison, PM10, Frequent Range

Based on past experience, the AQI values typically remain below 150 most of the time, despite having a range of 0 to 500. Therefore, comparison graphs specifically for this crucial range of common occurrence are provided.

AQI Calculation - Examples

Dataset

Measurement Time	PM2.5 Conc (µg/m³)	PM10 Conc (µg/m³)	O3 Conc (ppb)	CO Conc (ppb)	NO2 Conc (ppb)	SO2 Conc (ppb)
2023-04-28 01:00	23	37	6.79	422	2.57	2.09
2023-04-28 02:00	25	41	6.27	410	2.17	2.40
2023-04-28 03:00	24	40	5.99	437	1.75	2.19
2023-04-28 04:00	23	40	5.40	503	4.02	2.30
2023-04-28 05:00	24	39	5.21	542	5.52	2.16
2023-04-28 06:00	26	46	5.54	648	8.69	2.43
2023-04-28 07:00	27	45	5.34	981	12.97	2.87
2023-04-28 08:00	26	44	5.44	1224	14.68	3.06
2023-04-28 09:00	21	36	6.43	1015	14.26	3.18
2023-04-28 10:00	22	38	8.99	610	10.12	2.69
2023-04-28 11:00	22	35	10.33	559	9.85	2.69
2023-04-28 12:00	21	39	14.14	495	8.75	2.25
2023-04-28 13:00	22	42	18.71	485	9.29	1.93
2023-04-28 14:00	23	37	15.12	473	7.37	2.04
2023-04-28 15:00	22	38	12.31	772	14.95	2.09
2023-04-28 16:00	23	38	8.07	863	19.68	2.28
2023-04-28 17:00	25	45	6.86	933	23.78	2.41
2023-04-28 18:00	34	63	6.73	916	23.07	2.54
2023-04-28 19:00	42	74	7.15	891	20.05	2.26
2023-04-28 20:00	40	71	6.85	848	15.74	1.87
2023-04-28 21:00	38	70	6.32	753	12.52	1.99
2023-04-28 22:00	34	60	7.68	623	5.49	1.71
2023-04-28 23:00	28	48	6.38	555	10.04	2.23
2023-04-29 00:00	25	41	6.49	507	6.02	2.37
2023-04-29 01:00	23	43	7.10	436	3.56	1.56
2023-04-29 02:00	20	37	6.39	395	2.88	2.40
2023-04-29 03:00	20	35	6.12	471	2.29	1.47
2023-04-29 04:00	21	40	6.53	610	2.19	1.49
2023-04-29 05:00	22	38	5.9	657	3.64	1.48
2023-04-29 06:00	22	44	5.55	872	4.78	1.63
2023-04-29 07:00	24	44	5.47	1019	7.88	1.77
2023-04-29 08:00	28	45	5.55	1470	13.76	1.81
2023-04-29 09:00	29	51	6.35	1003	9.13	1.57
2023-04-29 10:00	32	52	7.24	613	11.30	1.38
2023-04-29 11:00	36	63	10.54	562	7.06	1.47
2023-04-29 12:00	28	52	13.84	470	8.24	1.50
2023-04-29 13:00	24	44	16.38	486	9.80	1.40
2023-04-29 14:00	20	32	14.59	469	15.20	1.66
2023-04-29 15:00	20	33	8.90	806	10.59	1.50
2023-04-29 16:00	22	41	8.05	898	13.02	1.39
2023-04-29 17:00	28	53	7.41	899	17.09	1.53
2023-04-29 18:00	32	59	5.70	896	22.65	2.01
2023-04-29 19:00	35	63	6.22	875	16.26	1.71
2023-04-29 20:00	33	58	6.59	787	13.79	1.55
2023-04-29 21:00	28	49	6.85	937	10.01	1.61
2023-04-29 22:00	24	45	6.10	618	5.25	1.68
2023-04-29 23:00	22	37	6.05	665	9.05	1.51
2023-04-30 00:00	25	44	5.46	561	8.02	1.53

Table 8 - Dataset

AQI values can be calculated for the above dataset as follows.

First, the Daily AQI of 2023-04-28.

Relevant data: Concentration values for AQI Calculation

Date	PM2.5 Conc 24H Avg (µg/m³)	PM10 Conc 24H Avg (µg/m³)	O3 Conc 1H Max (ppb)	CO Conc 8H Max (ppb)	NO2 Conc 1H Max (ppb)	SO2 Conc 24H Avg (ppb)
2023-04-28	26.67	46.13	18.71	753	23.78	2.33

For PM2.5, PM10 and SO2, the average of the measurements of the day was taken.

For O3 and NO2, the maximum of hourly measurements was taken.

For CO, the day was divided into three 8-hour sections, and the 3 averages for each section was calculated using the hourly measurements, and the maximum out of those three values (646, 659, 753) was taken. (Maximum of 8-hour moving/ rolling average values also could be taken, but it may raise some confusion).

Sub-AQI Values

If we apply the common formula for PM2.5

$$I_{PM2.5} = (C_{PM2.5} - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I_{PM2.5} = (26.67 - 25) \times \frac{(100 - 50)}{(50 - 25)} + 50$$

$$I_{PM2.5} = 1.67 \times \frac{50}{25} + 50$$

$$I_{PM2.5} = 1.67 \times 2 + 50$$

$$I_{PM2.5} = 1.67 \times 2 + 50$$

$$I_{PM2.5} = 53.34$$

However, since PM2.5 concentration is less than 75, we can easily calculate the AQI using the algorithm lines for each pollutant.

Concentration	Index	Formula
$C_{PM2.5} \leq 75$	$I_{PM2.5} \leq 150$	$I_{PM2.5} = C_{PM2.5} \times 2$

$I_{PM2.5} = 26.67 \times 2$

$I_{PM2.5} = 53.34$

sub-AQI PM2.5 = 53

After rounding to the nearest integer, 53.34 becomes 53. However, the rounding is done after the AQI is chosen, as it helps to decide the dominant pollutant, in case two or more pollutants may give same integer value as the AQI.

Similarly, we get **sub-AQI** values for all parameters as follows.

Date	Number Format	PM2.5 (24H) AQI	PM10 (24H) AQI	O3 (1H max) AQI	CO (8H max) AQI	NO2 (1H max) AQI	SO2 (24H) AQI
2023-04-28	Available Actual Value	53.34	46.13	18.71	16.73	18.29	7.77
	Rounded to Integer	**53**	**46**	**19**	**17**	**18**	**8**

As the AQI, the maximum of the sub-AQI values was chosen, and the pollutant that gives the maximum value was chosen as the Dominant/Prominent Pollutant.

$$I = max\{ I_{PM2.5}, I_{PM10}, I_{O3}, I_{CO}, I_{NO2}, I_{SO2} \}$$

$$I = max\{ 53.34, 46.13, 18.71, 16.73, 18.29, 7.77 \}$$

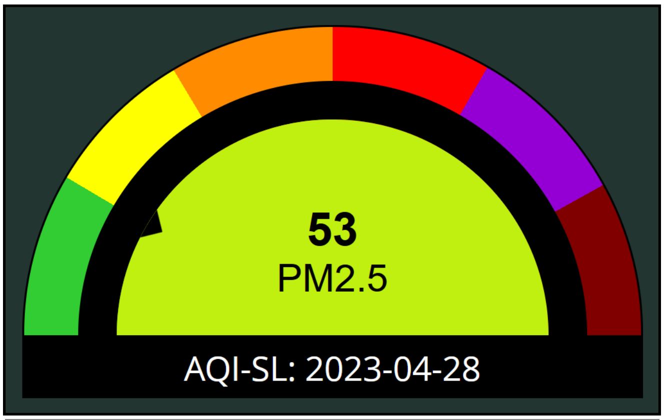
$$I = 53.34$$

AQI = 53

Dominant Pollutant = PM2.5

After the determination of the AQI and the Dominant Pollutant, all the AQI values shall be rounded to the nearest integer and those integer values shall be used for the publication.

Daily AQI



$PM_{2.5}$	PM_{10}	O_3	CO	NO_2	SO_2
53	46	19	17	16	8

At a specific time, the AQI could be generated using the data from Past 24 hours.

As the category breakpoints are decided targeting the 24-hour time period, it is more accurate to consider the whole past 24-hour period in this case.

However, in order to get an idea about the current situation at the moment, the current reading which shows the latest situation could be also used. In order to give a clear message, it is expected to mention the averaging time and the period.

For an example, to generate the AQI at 2023-04-29, 08:00 AM, the relevant concentration values are taken considering the past 24-hour time period. (From hourly measurements taken from 2023-04-28, 09:00 to 2023-04-29, 08:00).

PM2.5, PM10 and SO2

a) 24-hour moving/rolling average at each hour is being used, which is the average for the past 24 hours. (24H)
b) 1-hour measurement of the given time, which shows the air quality for the past hour could be used to show the latest situation. (1H). This covers only the last hour.

O3 and NO2,

a) Maximum of the 1-hour measurements of past 24 hours could be used. (1H max). This covers a 24-hour period.
b) The measurement reading at the given time, which is the value for the last hour could be taken as well. (1H). This covers a 1-hour period.

CO

a) The past 24-hour period could be divided into three 8-hour parts, and calculate the average concentration for each part using the hourly measurements. The maximum out of the three 8-hour averages could be used. (8H max). This covers a 24-hour period. (Also, the maximum 8-hour moving average for past time period could be used as well, but it may make it more complex).
b) The average of past 8-hour period could be used. (8H). It covers the last 8 hours.
c) 1-hour measurement of the given time, which shows the air quality for the past hour could be used to show the latest situation. (1H). This covers only the last hour.

$PM_{2.5}$ at 2023-04-29, 08:00 AM.

	$PM_{2.5}$ Conc ($\mu g/m^3$)	$PM_{2.5}$ AQI
24H	25.92	51.84
1H	28.00	56.00

Therefore, at 2023-04-29, 08:00 AM.

- AQI $PM_{2.5}$ (24H) : 52
- AQI $PM_{2.5}$ (1H) : 56

O_3 at 2023-04-29, 08:00 AM.

Therefore, at 2023-04-29, 08:00 AM.

- AQI O_3 (1H max) : 19
- AQI O_3 (1H) : 6

	O_3 Conc (ppb)	O_3 AQI
1H max (in past 24 hours)	18.71	18.71
1H	5.55	5.55

CO at 2023-04-29, 08:00 AM.

Therefore, at 2023-04-29, 08:00 AM.

- AQI CO (8H max) : 17
- AQI CO (8H mov max) : 18
- AQI CO (8H) : 16
- AQI CO (1H) : 33

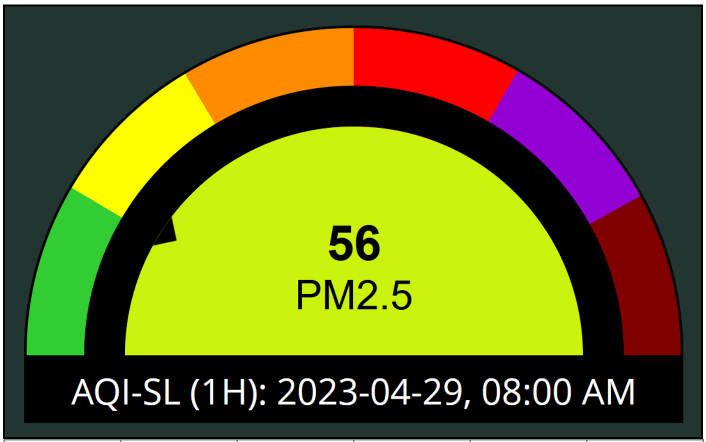
	CO Conc (ppb)	CO AQI
8H max (in past 24 hours)	753	16.73
8H mov max (for past 24 hours)	825	18.33
8H	741	16.47
1H	1470	32.67

2023-04-28, 08:00 AQI for past 24H	PM2.5 (24H)	PM10 (24H)	O3 (1H max)	CO (8H max)	NO2 (1H max)	SO2 (24H)
Conc	25.92	45.88	18.71	753	23.78	2.09
AQI	51.84	45.88	18.71	16.73	18.29	6.97
	52	46	19	17	18	7

2023-04-28, 08:00 Current AQI which covers respective standard averaging periods	PM2.5 (24H)	PM10 (24H)	O3 (1H)	CO (8H)	NO2 (1H)	SO2 (24H)
Conc	25.92	45.88	5.55	741	13.76	2.09
AQI	51.84	45.88	5.55	16.47	10.58	6.97
	52	46	6	16	11	7

2023-04-28, 08:00 Current AQI which covers the mentioned averaging period (1H)	PM2.5 (1H)	PM10 (1H)	O3 (1H)	CO (1H)	NO2 (1H)	SO2 (1H)
Conc	28	45	5.55	1470	13.76	1.81
AQI	56	45	5.55	32.67	10.58	6.03
	56	45	6	33	11	6

AQI (1H)



$PM_{2.5}$	PM_{10}	O_3	CO	NO_2	SO_2
56	45	6	33	11	6

Data Availability & Completeness

At least 75% availability is expected, for averaging and AQI calculation.

At least one PM data shall be present to generate the AQI. (Either $PM_{2.5}$ or PM_{10})

As per the past experience, the most abundant pollutants in the region are Particulate Matter. Therefore, in order to get the Daily AQI, it is a must either having PM2.5 or PM10 sub-AQI. In case none of them are available, it is expected to not to publish the Daily AQI. However, other sub-AQI values can be and expected to be published as Sub-Index values, possibly with the message of “No data for PM” or similar.

The aim of this approach is to avoid conveying a false misleading message about air quality. In many areas, PM (particulate matter) is the most prevalent pollutant and often other sub-AQI values remain in the "good" range. In such cases, there is a risk of displaying a "Good" Green AQI when there is no PM data available, even though the actual level of PM in the air may be significantly high.

Exceptions/ Special cases: If it is determined that the AQI for a gaseous pollutant would be higher than that of PM, then it may be considered as the representative AQI and published. This determination should be based on analysis of recent & historical data of each location, considering seasonal patterns, as well as weekly and diurnal variations.

If forecasting is available, the information based on actual measured data and the information based on forecasted data should be presented in a clearly distinguishable manner.

Formula/ Algorithm for Each Pollutant

Optionally, the common "AQI Calculation Formula" given above is presented here in a different way for each pollutant, by dividing into multiple sections according to the decisive breakpoint values that matters. Using either the above common "AQI Calculation Formula", or the below formula/algorithm for each pollutant, the AQI calculation could be done manually, using a spreadsheet, or with the use of a computer program etc.

Particulate Matter 2.5 ($PM_{2.5}$)

Unit: µg/m^3

Averaging time: 24 Hours

Concentration	Index	Formula
C ≤ 75	I ≤ 150	I = C × 2
C ≤ 150	I ≤ 200	I = (C-75) × (2/3) + 150
C ≤ 250	I ≤ 300	I = (C-150) + 200
C ≤ 400	I ≤ 500	I = (C-250) × (4/3) + 300
C > 400	Beyond AQI	

Note: At first three breakpoints, which are 25, 50 and 75, the same weight factor shall be applied. Therefore, I = C × 2 is applied up to C = 75. A separate line is needed only if the weight factor changes.

Particulate Matter 10 (PM_{10})

Unit: µg/m^3

Averaging time: 24 Hours

Concentration	Index	Formula
C ≤ 150	I ≤ 150	I = C
C ≤ 275	I ≤ 200	I = (C-150) × (2/5) + 150
C ≤ 450	I ≤ 300	I = (C-275) × (4/7) + 200
C ≤ 650	I ≤ 500	I = (C-450) + 300
C > 650	Beyond AQI	

Ozone (O_3)

Unit: ppb

Averaging time: 1 Hour

(For the Daily AQI, maximum concentration of 1-hour readings shall be considered)

Concentration	Index	Formula
C ≤ 100	I ≤ 100	I = C
C ≤ 300	I ≤ 200	I = (C-100) × 0.5 + 100
C ≤ 600	I ≤ 500	I = (C-300) + 200
C > 600	Beyond AQI	

Carbon Monoxide (CO)

Unit: ppb

Averaging time: 8 Hours

(For the Daily AQI, maximum concentration of 8-hour readings shall be considered)

Concentration	Index	Formula
C ≤ 4500	I ≤ 100	I = C × (1/45)
C ≤ 9000	I ≤ 150	I = (C-4500) × (1/90) + 100
C ≤ 15000	I ≤ 200	I = (C-9000) × (1/120) + 150
C ≤ 30000	I ≤ 300	I = (C-15000) × (1/150) + 200
C ≤ 50000	I ≤ 500	I = (C-30000) × 0.01 + 300
C > 50000	Beyond AQI	

Nitrogen Dioxide (NO_2)

Unit: ppb

Averaging time: 1 Hour

(For the Daily AQI, maximum concentration of 1-hour readings shall be considered)

Concentration	Index	Formula
C ≤ 130	I ≤ 100	I = C × (10/13)
C ≤ 350	I ≤ 150	I = (C-130) × (5/22) + 100
C ≤ 1250	I ≤ 300	I = (C-1250) × (1/6) + 150
C ≤ 2000	I ≤ 500	I = (C-1250) × 0.01 + 300
C > 2000	Beyond AQI	

Sulfur Dioxide (SO_2)

Unit: ppb

Averaging time: 24 Hours

Concentration	Index	Formula
C ≤ 30	I ≤ 100	I = C × (10/3)
C ≤ 80	I ≤ 150	I = (C-30) + 100
C ≤ 250	I ≤ 200	I = (C-80) × (5/17) + 150
C ≤ 600	I ≤ 300	I = (C-250) × (2/7) + 200
C ≤ 1000	I ≤ 500	I = (C-600) × 0.5 + 300
C > 1000	Beyond AQI	

Rounding and Truncating

No strict instructions have been given regarding the rounding and truncating of concentration values. An appropriate method may be used as long as it is not too extreme. Although the use of the actual value provides accurate results, rounding or truncating may save storage space and processing power. Usually, the final the result would be almost the same, and the maximum difference would be like ±1, which is a much smaller value considering the uncertainties of actual measurement values.

With concentrations, the use of truncating may be preferred if it saves processing power or helps with instrument limitations. Otherwise, rounding is the preferred method.

With AQI values, the rounding is always preferred. Result values from AQI calculation could be kept without rounding until the dominant pollutant with the final AQI is determined. Once that is done, the values shall be rounded to the nearest integer for publication.

Since there is rounding of results, and the ranges given are in integer format, just exceeding the breakpoint value given may not give a value in the next category.

Regarding PM2.5, Concentration 25 means AQI 50. And, AQI value 50.49 would still be rounded into 50 in the end. Therefore, in order to fall into the second category, the AQI value has to be 50.50 or higher. In other words, even though conc 25.2 is out of the first range of 0-25, it still falls into the first category as its rounded AQI is 50.

Index (Range)	Index (Integer Array)	Conc. Range as Integers $PM_{2.5}$ (µg/m³)	Conc. Range with 2 Decimal Points $PM_{2.5}$ (µg/m³)
0 - 50	0 - 50	0 - 25	0 – 25.24
50 -100	51 -100	25 - 50	25.25 – 50.24

Which means: 2 decimal points

Conc	AQI	
25.00	50.00	50
25.24	50.48	50
25.25	50.50	51

1 decimal point

Conc	AQI	
25.0	50.0	50
25.2	50.4	50
25.3	50.6	51

Therefore, effectively, the first breakpoint of PM2.5 would be something like 25.24, and it depends on the number of digits being used.

If the use of integer breakpoints given in the beginning is confusing, or cause technical difficulties, then a rounding/ truncating rule can be applied, and the breakpoints with decimal values could be given.

The previously provided common "AQI Calculation Formula" and "Formula/ Algorithm for Each Pollutant" always remains valid. However, alternative breakpoints and index values with specific decimal points may also be used if it offers any advantages.

Breakpoint Table 2

Index/ Category	Index (with decimal points) I		$PM_{2.5}$ (µg/m³) BP		PM_{10} (µg/m³) BP		O_3 (ppb) BP		CO (ppb) BP		NO_2 (ppb) BP		SO_2 (ppb) BP	
Range	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi
0 - 50	0.00	50.49	0.00	25.24	0.00	50.49	0.00	50.49	0	2,272	0.00	65.64	0.00	15.14
51 -100	50.50	100.49	25.25	50.24	50.50	100.49	50.50	100.99	2273	4544	65.65	132.19	15.15	30.49
101 - 150	100.50	150.49	50.25	75.74	100.50	151.24	101.00	200.99	4545	9059	132.20	352.99	30.50	81.69
151 - 200	150.50	200.49	75.75	150.49	151.25	275.87	201.00	300.49	9060	15074	353.00	652.99	81.70	251.74
201 - 300	200.50	300.49	150.50	250.37	275.88	450.49	300.50	400.49	15075	30049	653.00	1251.87	251.75	600.99
301 - 500	300.50	500.49	250.38	400.37	450.50	650.49	400.50	600.49	30050	50049	1251.88	2001.87	601.00	1000.99
≥501	≥500.50		≥400.38		≥650.50		≥600.50		≥50050		≥2001.88		≥1001.00	

Table 9 - Breakpoint Table 2

Note: All concentration values except CO, shall be rounded/ truncated to two decimal points, while CO shall be rounded/ truncated to the nearest integer.

Breakpoint Table 3

Index/ Category	Index (with decimal points) I		$PM_{2.5}$ (µg/m³) BP		PM_{10} (µg/m³) BP		O_3 (ppb) BP		CO (ppb) BP		NO_2 (ppb) BP		SO_2 (ppb) BP	
Range	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi
0 - 50	0.0	50.4	0.0	25.2	0.0	50.4	0.0	50.4	0	2,272	0.0	65.6	0.0	15.1
51 -100	50.5	100.4	25.3	50.2	50.5	100.4	50.5	100.9	2273	4544	65.7	132.1	15.2	30.4
101 - 150	100.5	150.4	50.3	75.7	100.5	151.2	101.0	200.9	4545	9059	132.2	352.9	30.5	81.6
151 - 200	150.5	200.4	75.8	150.4	151.3	275.8	201.0	300.4	9060	15074	353.0	652.9	81.7	251.7
201 - 300	200.5	300.4	150.5	250.3	275.9	450.4	300.5	400.4	15075	30049	653.0	1251.8	251.8	600.9
301 - 500	300.5	500.4	250.4	400.3	450.5	650.4	400.5	600.4	30050	50049	1251.9	2001.8	601.0	1000.9
≥501	≥500.5		≥400.4		≥650.5		≥600.5		≥50050		≥2001.9		≥1001.0	

Table 10 - Breakpoint Table 3

Note: All concentration values except CO, shall be rounded/ truncated to one decimal point, while CO shall be rounded/ truncated to the nearest integer.

Also, alternative formulas for each pollutant, that involve these breakpoints may be determined and used if it offers any further advantages such as storage, processing or simplicity, etc.

For an example, for Breakpoint Table 2:

Particulate Matter 2.5 ($PM_{2.5}$)

Concentration	Index	Formula
C ≤ 50.24	I ≤ 100.49	I = C × 2
C ≤ 75.74	I ≤ 150.49	I = (C-50.25) × 1.961 + 100.50
C ≤ 150.49	I ≤ 200.49	I = (C-75.75) × 0.669 + 150.50
C ≤ 250.37	I ≤ 300.49	I = (C-150.50) × 1.001 + 200.50
C ≤ 400.37	I ≤ 500.49	I = (C-250.38) × 1.333 + 300.50
C ≥ 400.38	Beyond AQI	

Particulate Matter 10 (PM_{10})

Concentration	Index	Formula
C ≤ 100.49	I ≤ 100.49	I = C
C ≤ 151.24	I ≤ 150.49	I = C × 0.985
C ≤ 275.87	I ≤ 200.49	I = (C-151.25) × 0.401 + 150.50
C ≤ 450.49	I ≤ 300.49	I = (C-275.88) × 0.573 + 200.50
C ≤ 650.49	I ≤ 500.49	I = (C-450.50) + 300.50
C ≥ 650.50	Beyond AQI	

Similar formulas can also be developed for other parameters as well.

Calculation Methods - Examples

Let's calculate couple of AQI values using five different methods.

(Please note that the intermediate results of the calculations here are rounded to three decimal points before being used for further calculations. If the resulting index values given are compared with the values generated using a computer program or a spreadsheet, a slight difference may be observed)

Example 1: PM2.5 Concentration = 32.416 µg/m3

Method 1: Common AQI Calculation Formula

25 < 32.416 < 50

$$I_{PM2.5} = (C_{PM2.5} - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I_{PM2.5} = (32.416 - 25) \times \frac{(100 - 50)}{(50 - 25)} + 50$$

$$I_{PM2.5} = 7.416 \times \frac{50}{25} + 50$$

$$I_{PM2.5} = 7.416 \times 2 + 50$$

$$I_{PM2.5} = 64.832$$

PM2.5 AQI = 64.832 = **65**

Method 2: Formula/ Algorithm for Each Pollutant

Concentration	Index	Formula
C ≤ 75	I ≤ 150	I = C × 2
C ≤ 150	I ≤ 200	I = (C-75) × (2/3) + 150
C ≤ 250	I ≤ 300	I = (C-150) + 200
C ≤ 400	I ≤ 500	I = (C-250) × (4/3) + 300
C > 400	Beyond AQI	

32.416 ≤ 75

I = C × 2

I = 32.416 × 2

I = 64.832

PM2.5 AQI = 64.832 = **65**

Method 3: Breakpoint Table 2, and Common AQI Calculation Formula

32.416 µg/m3 → 32.42 µg/m3

25.25 ≤ 32.42 ≤ 50.24

$$I_{PM2.5} = (C_{PM2.5} - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I_{PM2.5} = (32.42 - 25.25) \times \frac{(100.49 - 50.50)}{(50.24 - 25.25)} + 50.50$$

$$I_{PM2.5} = 7.17 \times \frac{49.99}{24.99} + 50.50$$

$$I_{PM2.5} = 7.17 \times 2.000 + 50.50$$

$$I_{PM2.5} = 14.34 + 50.50$$

$$I_{PM2.5} = 64.84$$

PM2.5 AQI = 64.84 = **65**

Method 4: Breakpoint Table 2, and Formula/ Algorithm for Each Pollutant for it.

Concentration	Index	Formula
C ≤ 50.24	I ≤ 100.49	I = C × 2
C ≤ 75.74	I ≤ 150.49	I = (C-50.50) × 1.961 + 100.50
C ≤ 150.49	I ≤ 200.49	I = (C-75.75) × 0.669 + 150.50
C ≤ 250.37	I ≤ 300.49	I = (C-150.50) × 1.001 + 200.50
C ≤ 400.37	I ≤ 500.49	I = (C-250.38) × 1.333 + 300.50
C ≥ 400.38	Beyond AQI	

32.416 µg/m3 → 32.42 µg/m3

25.25 ≤ 32.42 ≤ 50.24

I = C × 2

I = 32.42 × 2

I = 64.84

PM2.5 AQI = 64.84 = **65**

Method 5: Breakpoint Table 3, and Common AQI Calculation Formula

32.416 µg/m3 → 32.4 µg/m3

25.3 ≤ 32.4 ≤ 50.2

$$I_{PM2.5} = (C_{PM2.5} - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I_{PM2.5} = (32.4 - 25.3) \times \frac{(100.4 - 50.5)}{(50.2 - 25.3)} + 50.5$$

$$I_{PM2.5} = 7.1 \times \frac{49.9}{24.9} + 50.5$$

$$I_{PM2.5} = 7.1 \times 2.004 + 50.5$$

$$I_{PM2.5} = 14.23 + 50.50$$

$$I_{PM2.5} = 64.73$$

PM2.5 AQI = 64.73 = **65**

Example 2: PM10 Concentration = 205.724 µg/m3

Method 1: Common AQI Calculation Formula

150 < 205.724 < 275

$$I_{PM10} = (C_{PM10} - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I_{PM10} = (205.724 - 150) \times \frac{(200 - 150)}{(275 - 150)} + 150$$

$$I_{PM10} = 55.724 \times \frac{50}{125} + 150$$

$$I_{PM10} = 55.724 \times 0.4 + 150$$

$$I_{PM10} = 172.2896$$

PM10 AQI = 172.2896 = **172**

Method 2: Formula/ Algorithm for Each Pollutant

.....

PM10 AQI = 172.2896 = **172**

Method 3: Breakpoint Table 2, and Common AQI Calculation Formula

205.724 µg/m3 → 205.72 µg/m3

151.25 ≤ 205.72 ≤ 275.87

$$I_{PM10} = (C_{PM10} - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I_{PM10} = (205.72 - 151.25) \times \frac{(200.49 - 150.50)}{(275.87 - 151.25)} + 150.50$$

$$I_{PM10} = 54.47 \times \frac{49.99}{124.62} + 150.50$$

$$I_{PM10} = 54.47 \times 0.401 + 150.50$$

$$I_{PM10} = 21.842 + 150.50$$

$$I_{PM10} = 172.342$$

PM10 AQI = 171.342 = **172**

Method 4: Breakpoint Table 2, and Formula/ Algorithm for Each Pollutant for it

.....

PM10 AQI = 172.342 = **172**

Method 5: Breakpoint Table 3, and Common AQI Calculation Formula

205.724 µg/m3 → 205.7 µg/m3

151.3 ≤ 205.7 ≤ 275.8

$$I_{PM10} = (C_{PM10} - BP_{Lo}) \times \frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})} + I_{Lo}$$

$$I_{PM10} = (205.7 - 151.3) \times \frac{(200.4 - 150.5)}{(275.8 - 151.3)} + 150.5$$

$$I_{PM10} = 54.4 \times \frac{49.9}{127.5} + 150.5$$

$$I_{PM10} = 54.4 \times 0.391 + 150.5$$

$$I_{PM10} = 21.270 + 150.5$$

$$I_{PM10} = 171.770$$

PM10 AQI = 171.770 = **172**

Contacts

Supportive documents, calculation files, further information, updates, regarding Air Quality and revisions & amendments of AQI-SL would be published in the official website.

For any queries, clarifications, comments, feedback or suggestions, feel free to contact Central Environmental Authority, Sri Lanka.

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Resources

References. And special thanks to:

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AQI-SL