Air Quality Index

Analysis for

Indian Cities

2015-2023

URBAN emissions .info

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Executive Summary

Air Quality Index (AQI) is an important tool for communicating the quality of air pollution levels as health-related alerts. India adopted a methodology in 2014 and started to release AQI daily bulletins from 2015. In this working paper, we summarized the data released between 2015 and 2023.

All the accessible data as PDF reports from CPCB portal are formatted by city and is available @ www.urbanemissions.info. Key messages from the analysis are:

- The number of unique cities used to report AQI in the bulletins increased 12-fold between 2015 and 2023 (from 22 to 271).
- The number of stations used to report AQI in the bulletins increased 15-fold between 2015 and 2023 (from 31 to 469).
- The average number of stations per unique city increased from 1.4 in 2015 to 1.7 in 2023 – an overall 20% increase.
- While the number of cities and overall monitoring capacity increased in the cities between 2015 and 2023, most (80% in 2023) only have one monitoring station.
- In 2023, only 15 cities are operating more than 5 stations to calculate a representative AQI value for the city.
- A minimum of 5 stations is a representative sample size for any city, allowing to cover one location each at residential, commercial, industrial, roadside, and background sites. CPCB guidelines suggests 4.

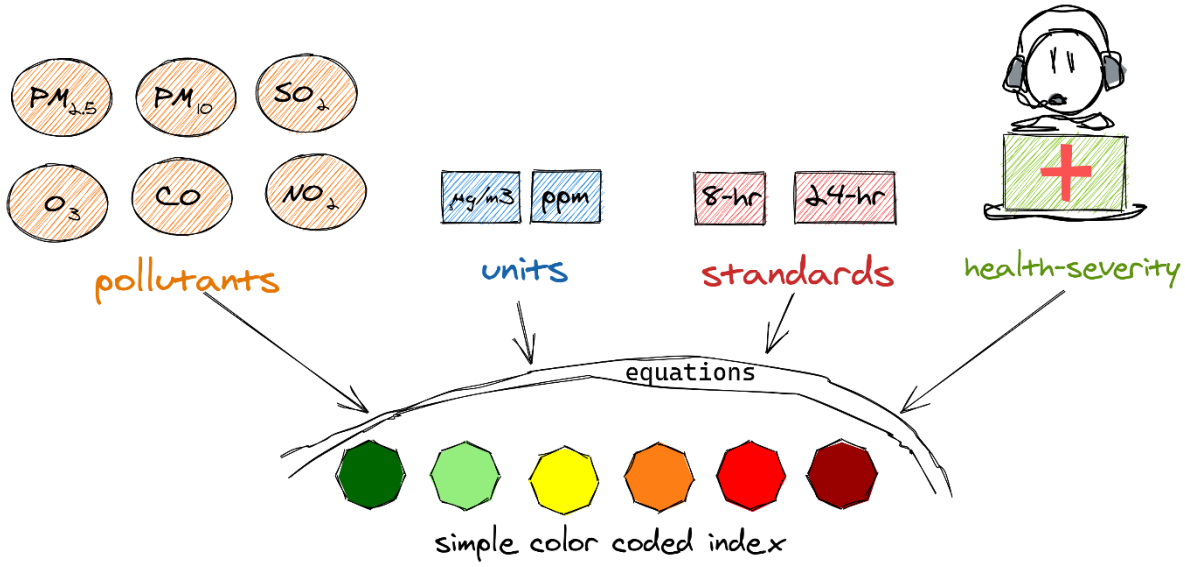
- Overall air quality in India shuttles between moderate and satisfactory categories.
- The winter months (December to February) continue to be worse than the summer/monsoonal months (June to September) for most of the Northern cities.
- Between 2015 and 2023, the number of days reporting $PM_{2.5}$ as the conditional pollutant is decreasing, against an equivalent increase in reporting PM_{10} as the conditional pollutant.
- There is a no clear increasing or decreasing trend in the share of gaseous pollutants being reported as the conditional pollutant across India. Ozone and CO had constant presence over the years (mostly summers) in the cities.
- Across India, the share of these alerts has been consistent for *Satisfactory, Moderate*, and *Poor* categories, a doubling in the share of *Good* days, and fewer *Very-Poor* and *Severe* days reported at the end of 2023.

Overall, monitoring and reporting capacity increased between 2015 & 2023.
Now, the focus should be on increasing the number of stations per city to at least 4, by 2025.

1. What is Air Quality Index?

Air pollution includes,

- aerosols and gaseous components, each with proven effects on our health at various degrees of exposure rates.
- some pollutants that can lead to an immediate response like carbon monoxide (CO) and Ozone (O3) compared to other pollutants that can lead to chronic impacts.
- different temporal standards based on their respective importance for short-term and chronic exposure impacts. For example: 8-hourly for CO and O3 and 24-hourly for other pollutants.
- aerosol concentrations as mass fractions (µg/m3) and gaseous concentrations as volumetric fractions (ppm) in a unit volume of air.



AQI unifies all this complicated science of pollution composition, exposure rates-based health severity, ambient standards, measurements, and standard protocols, into simple colour coded bins for everyone to see how good or bad or severe the pollution levels are.

This is part of a pollution-health alert system for managing personal air pollution exposure levels. If this information is provided to the public in a forecast mode (say 2-3 days in advance), it can lead to reducing some exposure rates by planning outdoor activities.

2. Data Source & Scope

All the data and analysis presented in this working paper is extracted from the official daily air quality index (AQI) bulletins issued by the Central Pollution Control Board (CPCB), New Delhi, India, between 2015 and 2023.

The daily bulletins include the following information:

1. City name.
2. AQI value and category of the day.
3. Conditional pollutant of the day. AQI is calculated for all the criteria pollutants in the methodology and the value of only 1 or 2 of the pollutants is used to designate as AQI of the day.
4. Number of stations used to calculate the AQI of the day.

Since, the database doesn't include data on the absolute concentrations of the pollutant(s) defining the AQI of the day or of the other pollutant(s), all the analysis in this working paper is based only on the reported AQI values.

Scope of this working paper is the following: To understand,

1. the evolution of the monitoring network in India
2. the change in the AQI values across India, states, and the cities and
3. the importance of various pollutants defining the AQI.

A library of python scripts used to tabulate the data from PDF bulletins is available here www.github.com/urbanemissions

3. India's Air Quality Index Methodology

India's AQI methodology was approved in 2014 and the online AQI bulletin started disseminating the data from 2015.

Equation to calculate AQI is the following:

$$AQI = \frac{AQI_{hi} - AQI_{lo}}{BP_{hi} - BP_{lo}} * (CONC - BP_{lo}) + AQI_{lo}$$

$CONC$ = concentration of the pollutant
AQI = air quality index corresponding to $CONC$
BP_{hi} = break-point concentration of the pollutant greater than $CONC$
BP_{lo} = break-point concentration of the pollutant less than $CONC$
AQI_{hi} = AQI value corresponding to BP_{hi}
AQI_{lo} = AQI value corresponding to BP_{lo}

This equation is applied by all the countries with an approved methodology, with breakpoints based on their respective national ambient standards. An MS Excel-based calculator is available @ www.urbanemissions.info/tools/ which allows the user to calculate AQI using approved methodologies for seven countries and provides an inter-comparison for one-time data or for a long-series of data.

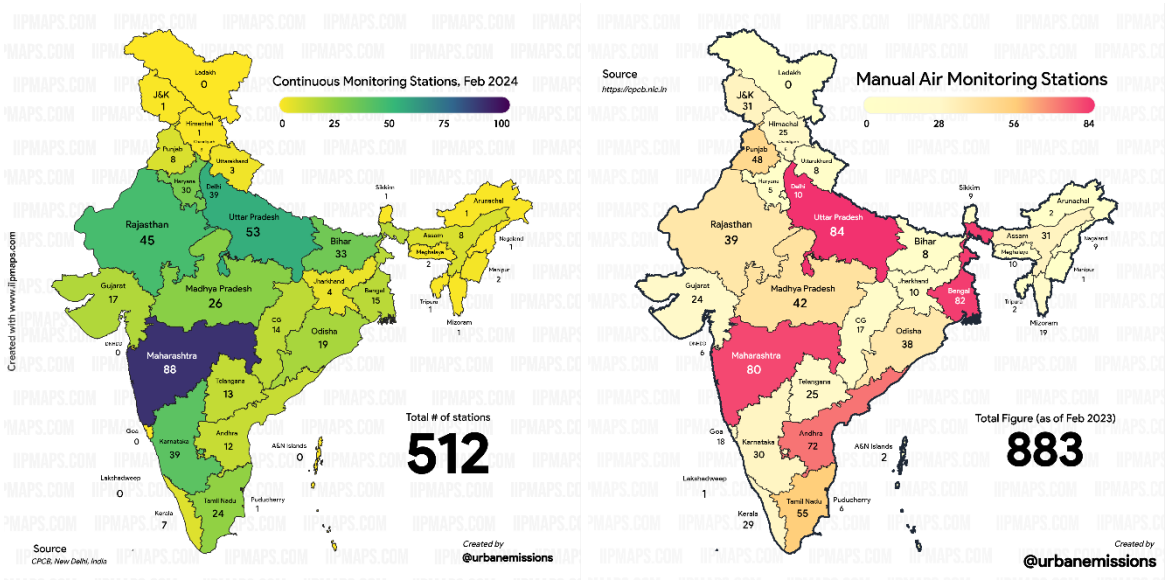
The breakpoints designated for India's AQI methodology are the following:

AQI Category (AQI value)	$PM_{2.5}$ 24-hours $\mu g/m^3$	PM_{10} 24-hours $\mu g/m^3$	SO_2 24-hours $\mu g/m^3$	NO_2 24-hours $\mu g/m^3$	CO 8-hours mg/m^3	O_3 8-hours $\mu g/m^3$
Good (0-50)	0-30	0-50	0-40	0-40	0-1	0-50
Satisfactory (51-100)	30-60	50-100	40-80	40-80	1-2	50-100
Moderate (101-200)	60-90	100-250	80-380	80-180	2-10	100-168
Poor (201-300)	90-120	250-350	380-800	180-280	10-17	168-208
Very Poor (301-400)	120-250	350-430	800-1600	280-400	17-34	208-748
Severe (401-500)	250+	430+	1600+	400+	34+	748+

4. India's Ambient Monitoring Capacity

AQI daily bulletin is based on ambient data collected from 500+ continuous and 900+ manual stations network across the country. The network capacity increased 3-4 times since 2019 (announcement of the National Clean Air Programme - NCAP).

- Continuous monitoring stations report data at 15-minute intervals and the data is posted on the CPCB portal in real time.
- Manual monitoring stations are required to report daily averages of select pollutants for at least 103 days in a year.



The number of unique cities used to report AQI in the bulletins increased **10-fold** between 2015 and 2023.

Number of unique cities listed..	
in the 2015 bulletins	22
in the 2016 bulletins	33
in the 2017 bulletins	54
in the 2018 bulletins	75
in the 2019 bulletins	115
in the 2020 bulletins	135
in the 2021 bulletins	170
in the 2022 bulletins	209
in the 2023 bulletins	271

The number of stations used to report AQI in the bulletins increased **15-fold** between 2015 and 2023.

Number of stations reported..	Avg. (Max)
in the 2015 bulletins	31 (37)
in the 2016 bulletins	53 (54)
in the 2017 bulletins	80 (90)
in the 2018 bulletins	129 (137)
in the 2019 bulletins	188 (206)
in the 2020 bulletins	238 (258)
in the 2021 bulletins	300 (326)
in the 2022 bulletins	338 (396)
in the 2023 bulletins	469 (514)

The average number of stations per unique city increased from 1.4 in 2015 to 1.7 in 2023 – an overall **20% increase**.

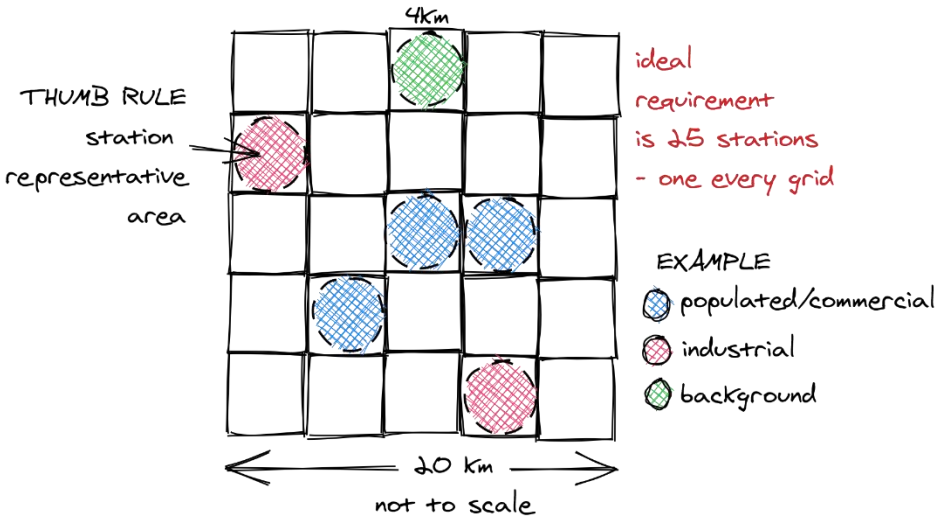
Number of stations per unique city..	
in the 2015 bulletins	1.4
in the 2016 bulletins	1.6
in the 2017 bulletins	1.5
in the 2018 bulletins	1.7
in the 2019 bulletins	1.6
in the 2020 bulletins	1.8
in the 2021 bulletins	1.8
in the 2022 bulletins	1.6
in the 2023 bulletins	1.7

While the number of cities and overall monitoring capacity increased in the cities between 2015 and 2023, **most (80% in 2023)** only have one monitoring station.

Number of cities with... # stations ➔	1	2	3	4	5-10	10-20	20+
in 2015	17	2	1	0	2	0	0
in 2016	28	1	2	1	1	0	0
in 2017	47	1	2	2	1	1	0
in 2018	66	3	2	1	2	0	1
in 2019	99	2	5	4	4	0	1
in 2020	111	9	7	2	4	1	1
in 2021	139	9	8	4	8	1	1
in 2022	170	14	9	6	7	2	1
in 2023	215	18	16	7	11	2	2

In 2023, only metropolitan and some Tier-1 cities, reported more than 5 stations – which is a representative sample size for any city, allowing to cover one location each at residential, commercial, industrial, roadside, and background sites. These 15 cities are – Agra (6), Ahmedabad (9), Bengaluru (13), Chennai (8), Delhi (39), Hyderabad (14), Jaipur (6), Jodhpur (5), Kolkata (7), Lucknow (6), Moradabad (6), Mumbai (28), Navi Mumbai (7), Patna (6), and Pune (8).

A thumb rule suggests that a regulatory grade monitoring station represents the sources within a radius of 2-km. Which translates into at least 25 stations for a city covering of 400 km^2 size. This is financially and technically prohibitive.



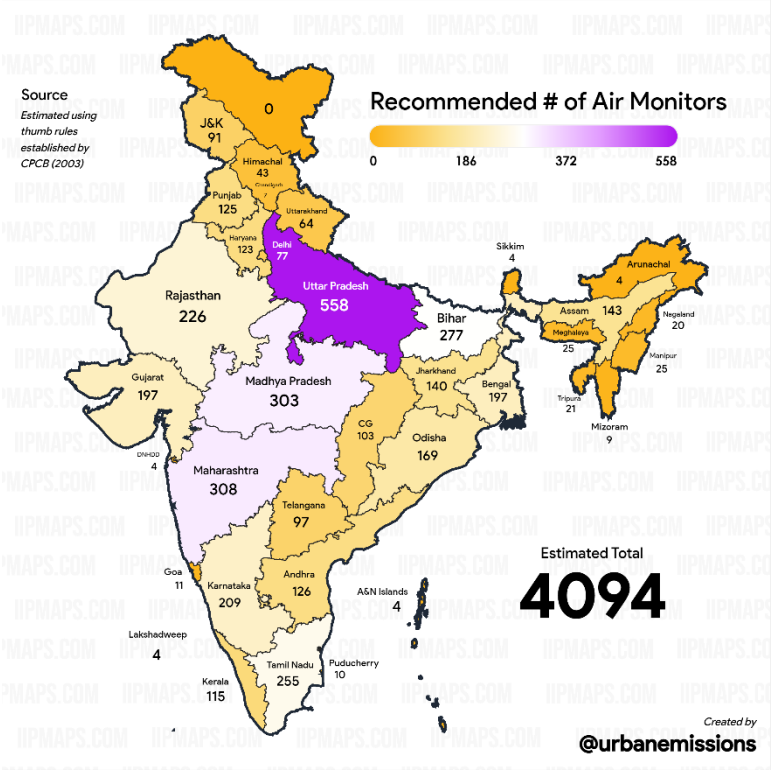
CPCB approved the following guidelines to calculate the minimum number of monitoring stations required to operate in an airshed, based on airshed's population and commercial density. Even the guidelines start with a minimum of 4 stations for any airshed. Similar guidelines exist for gaseous pollutants – SO_2, NO_2, CO and Ozone.

Based on total population (TP) for PM monitoring.

For TP under 100,000 -- 4 units
For TP under 1 million - 4 + 0.6 per 100,000
For TP under 5 million – 7.5 + 0.25 per 100,000
For TP above 5 million - 12 + 0.16 per 100,000

While monitoring efforts in most of the cities start with only one station, the representativeness of its location is always in question and could lead to biases in interpreting the data, till the overall sample size is at least 4, and covers a mix of residential, commercial, industrial, transportation, and background characteristics of the airshed.

Using this thumb, we estimated that India requires at least 4094 ambient monitoring stations to represent the ambient PM pollution patterns spatially and temporally. For state/district-wise information visit www.urbanemissions.info



Combining both the manual and the continuous stations, the operational capacity as of March 2024, stands at 30-40% of the recommended minimum number of stations.

5. Seasonality in AQI Values

While AQI is not a measure of absolute pollution nor represents one pollutant, the changes in its value can represent the efforts (or lack-off) in addressing the air pollution problems in the city.

Table: All India monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					147	114	87	85	110	178	239	242
in 2016	252	190	149	162	139	118	84	72	82	152	225	234
in 2017	208	188	148	147	144	111	85	82	99	164	215	204
in 2018	209	177	159	141	143	126	77	79	87	157	202	211
in 2019	203	155	134	143	149	122	86	68	70	139	186	183
in 2020	157	145	98	85	93	77	61	53	78	147	179	180
in 2021	173	157	142	126	91	86	69	67	57	109	185	179
in 2022	155	138	144	141	122	106	61	65	70	111	164	174
in 2023	172	145	115	114	103	88	65	77	71	114	167	153

Keeping in mind that all the population exposed to air pollution is not represented by the current monitoring network, the above table provides a glimpse of current all-India average AQI. General observations include:

- Overall air quality in India shuttles between moderate and satisfactory categories.
- The winter months (December to February) continue to be worse than the summer/monsoonal months (June to September).
- Overall drop in the AQI from 2015 to 2023, while some of it is due to reductions in emission intensities in the big cities, most of it is due to an increase in the representativeness of the network.

For the metropolitan and select Tier-1 cities, separate tables are presented in the following pages. General observations include:

- Northern cities have strong seasonality in their AQI values – Winter months are worse than the summer/monsoonal months.
- Southern cities experienced uniform ranges.

Table: Agra (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					109	86	63	73	91	208	330	342
in 2016	377	233	143	168	134	129	124	79	89	229	378	377
in 2017	331	248	176	149	136	96	56	58	111	274	345	340
in 2018	354	236	183	146	162	109	66	56	61	216	317	363
in 2019	309	216	161	141	129	115	63	71	47	104	173	135
in 2020	222	186	100	94	97	99	81	76	139	258	296	303
in 2021	285	212	190	190	87	92	70	68	50	153	298	217
in 2022	178	122	133	143	126	102	37	40	45	105	120	104
in 2023	88	55	57	72	73	76	58	78	74	108	143	106

Table: Ahmedabad (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					140	87	87	71	89	237		
in 2016						61	87	91	69	188	287	251
in 2017	182	253	188								227	151
in 2018	187	221	201	175	105	109	108	89	108	218	204	181
in 2019	179	129	142	190	129	183	137	128	134	184	164	129
in 2020	119	152	103	99	170	76	73	69	89	133	167	154
in 2021	164	165	178	150	132	95	73	71	65	111	141	134
in 2022	124	152	154	129	154	90	73	72	71	137	132	123
in 2023	130	158	129	115	112	82	81	74	77	123	135	109

Table: Bengaluru (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					81	51	50	62	70	98	62	89
in 2016	132	145	145	130	74	38	38	53	53	88	89	83
in 2017	82	85	76	84	57	49	61	54	51	73	72	83
in 2018	97	78	97	90	78	60	54	54	68	83	91	112
in 2019	111	103	121	115	94	59	55	48	58	64	83	72
in 2020	87	88	85	56	60	47	39	48	49	64	70	83
in 2021	81	85	82	87	51	55	53	58	57	71	67	89
in 2022	82	95	102	87	72	60	64	57	60	82	93	84
in 2023	93	98	79	80	62	52	49	66	48	84	75	87

Table: Chennai (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					156	131	129	100	80	92	99	128
in 2016	135	147	145	126	121	88	65	69	66	122	154	147
in 2017	105	108	89	118	116	94	96	63	68	87	87	108
in 2018	142	110	98	67	80	98	98	86	80	94	109	126
in 2019	115	86	89	70	96	99	72	65	82	83	116	80
in 2020	82	76	62	47	59	82	77	61	64	63	74	76
in 2021	80	78	67	58	62	66	57	60	59	63	58	87
in 2022	64	80	78	43	69	65	60	59	68	88	86	99
in 2023	107	102	72	66	74	71	74	73	61	81	72	85

Table: Delhi (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					242	192	138	147	194	264	358	301
in 2016	370	293	238	271	246	208	146	105	163	271	374	365
in 2017	304	267	211	227	249	174	98	103	139	285	361	316
in 2018	328	243	203	222	217	202	104	111	112	269	335	360
in 2019	328	242	184	211	221	189	134	86	98	234	312	337
in 2020	286	241	128	110	144	123	84	64	118	265	328	332
in 2021	324	288	223	202	144	147	110	107	78	173	377	336
in 2022	279	225	217	255	212	190	87	93	104	210	321	319
in 2023	311	237	170	180	171	130	84	116	108	219	373	348

Table: Hyderabad (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					91	64	45	64	146	173	118	103
in 2016	138	116	103	93	71	69	57	35	40	91	129	138
in 2017	163	173	146	160	127	59	54	56	67	107	110	138
in 2018	148	111	110	89	90	63	53	57	78	107	111	134
in 2019	134	114	104	90	111	59	41	48	43	76	138	132
in 2020	105	94	78	62	76	45	37	34	49	96	114	145
in 2021	129	125	121	102	61	49	40	49	43	99	97	140
in 2022	113	118	121	102	100	75	51	54	55	68	103	98
in 2023	100	105	91	88	83	72	56	74	65	91	92	96

Table: Jaipur (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015											282	290
in 2016	296	221	186	234	224	205	178	196	112	162	240	259
in 2017	181	170	155	154	143	111	76	110	156	223	229	164
in 2018	182	162	116	145	165	164	99	100	94	143	168	151
in 2019	141	113	101	139	137	115	79	60	69	129	155	126
in 2020	105	120	94	82	106	88	67	52	81	137	175	142
in 2021	154	130	134	139	102	111	75	79	52	110	213	168
in 2022	142	132	136	162	190	135	56	66	76	117	153	144
in 2023	152	151	95	119	114	99	88	108	80	138	240	200

Table: Jodhpur (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015												294
in 2016	269	186	171	174	229	255	106	74	138	180	270	225
in 2017	197	165	181	222	208	170	108	87	100	196	278	223
in 2018	270	250	228	268	301	241	129	135	115	226	256	222
in 2019	203	145	141	208	231	183	187	116	112	168	147	169
in 2020	155	176	137	99	133	111	102	86	88	161	222	182
in 2021	185	178	207	188	141	124	106	115	79	142	224	182
in 2022	165	180	175	181	215	158	74	91	93	144	171	146
in 2023	143	173	147	136	117	91	90	101	77	122	186	158

Table: Kolkata (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015												
in 2016							31	37	33	60	153	208
in 2017	193	170	96	78	74	87	91	73	85	110		
in 2018				65	73	83	46	63	78	155	259	327
in 2019	343	251	161	81	84	68	57	46	38	115	196	201
in 2020	204	188	122	66	49	39	41	45	46	76	176	284
in 2021	268	227	160	99	59	51	52	56	49	103	166	202
in 2022	210	153	137	71	72	59	40	47	50	76	189	254
in 2023	225	129	96	95	65	58	37	67	45	102	165	176

Table: Moradabad (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015												
in 2016												
in 2017									152	316	390	266
in 2018	248	259	203	224	196	210	93	97	121	249	265	326
in 2019	301	231	182	214	238	169	95	83	88	245	262	328
in 2020	313	309			64	98	69	64	117	280	315	318
in 2021	287	324	247	209	116	123	89	101	96	186	286	220
in 2022	163	136	140	149	119	138	63	75	65	118	136	130
in 2023	112	100	115	114	106	96	73	95	79	118	166	145

Table: Lucknow (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					106	140	109	96	124	212	371	353
in 2016	347	307	179	250	196	137	111	89	82	236	375	385
in 2017	293	297	245	250	239	158	68	95	98	237	363	357
in 2018	361	279	209	186	208	172	85	76	120	247	337	332
in 2019	295	229	202	204	172	156	81	74	67	195	314	280
in 2020	255	206	128	104	112	95	78	74	129	249	291	343
in 2021	315	252	212	172	105	80	71	61	62	129	252	213
in 2022	173	141	161	202	133	143	67	54	65	128	204	209
in 2023	189	155	114	124	122	105	56	81	74	119	219	172

Table: Mumbai (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015								67	72	134	119	134
in 2016	172	100	106	75	66	52	56	53	55	81	108	168
in 2017	186	168	126	97	66	55	78	51	71	107	136	152
in 2018	160	149	130	90	74	71	67	70	76	115	138	151
in 2019	169	148	120	93	86	69	52	57	45	85	133	179
in 2020	163	156	100	70	55	38	39	36	58	96	154	173
in 2021	215	161	150	99	72	60	59	56	56	96	148	176
in 2022	176	159	165	107	122	62	64	62	60	97	173	202
in 2023	203	194	147	105	80	80	72	63	66	146	141	144

Table: Navi Mumbai (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					98	84	86	62	82	104	106	109
in 2016	103	103	107	100	85	79	112	58	73	103	85	55
in 2017	57	72	76	68	79	74	65	73	60	79	97	109
in 2018	113	117	109	93	99	76	80	60	66	106	115	121
in 2019	142	123	118	133	115	90	69	65	56	87	155	184
in 2020	151	168	118	100	69	56	34	40	60	90	165	212
in 2021	269	194	183	127	81	98	56	56	54	94	154	195
in 2022	197	182	186	124	106	62	81	66	80	128	219	230
in 2023	250	266	181	139	82	116	59	55	62	173	162	160

Table: Patna (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015									139	223	364	373
in 2016	401	290	198	161	137	104	76	78	85	247	355	379
in 2017	322	335	240	194	135	130	80	88	140	207	242	327
in 2018	328	299	252	197	185	147	91	101	124	233	353	392
in 2019	372	271	209	163	187	141	73	78	94	209	352	357
in 2020	251	184	141	109	103	69	54	50	67	151	228	309
in 2021	254	243	234	198	96	78	70	72	69	115	255	269
in 2022	260	224	238	240	143	133	93	84	81	148	287	368
in 2023	337	274	210	209	163	160	83	94	82	134	274	268

Table: Pune (all stations) monthly average AQI across all the reporting cities

Avg. AQI	J	F	M	A	M	J	J	A	S	O	N	D
in 2015								88	107	154	211	210
in 2016	194	173	158	119	106	101	111	99	113	135	228	155
in 2017	132	106	99	84	72	71	76	81	81	106	105	108
in 2018	79	117	113	101	95	64	57	55	64	105	143	170
in 2019	180	130	124	92	84	65	66	74	78	98	143	159
in 2020	155	124	86	54	67	61	57	50	52	64	91	130
in 2021	120	123	115	90	62	72	72	67	67	79	127	156
in 2022	139	126	140	119	128	84	68		77	88	120	167
in 2023	161	158	126	122	121	106	97	89	83	143	143	162

All the extracted data files from the 271 cities are available online as calendar plots and downloadable CSV files @ www.urbanemissions.info (search for AQI).

6. Conditional Pollutants

Every day, AQI is calculated for six criteria pollutants – $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and Ozone, using the methodology explained in Chapter 3. The daily bulletins listed the conditional pollutant(s) along with the AQI value of the day. This only indicates that the pollution due to this (or these) pollutant(s) was the highest based on the monitoring data collected in the last 24 hours.

Table: % number of days $PM_{2.5}$ was listed as the conditional pollutant across India

	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					47%	56%	47%	55%	51%	64%	68%	68%
in 2016	74%	64%	51%	54%	46%	44%	43%	40%	36%	50%	66%	60%
in 2017	64%	50%	45%	42%	35%	34%	31%	28%	33%	45%	56%	59%
in 2018	62%	52%	46%	36%	38%	32%	21%	22%	26%	43%	60%	65%
in 2019	66%	54%	42%	34%	31%	27%	22%	17%	18%	43%	61%	64%
in 2020	58%	48%	25%	19%	16%	14%	14%	12%	20%	41%	54%	55%
in 2021	59%	45%	31%	25%	18%	16%	14%	15%	11%	32%	56%	62%
in 2022	55%	43%	36%	25%	21%	19%	13%	13%	16%	31%	53%	57%
in 2023	59%	41%	32%	20%	16%	12%	11%	11%	13%	31%	53%	54%

Table: % number of days PM_{10} was listed as the conditional pollutant across India

	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					24%	11%	13%	24%	22%	17%	16%	18%
in 2016	16%	25%	36%	31%	24%	27%	19%	23%	25%	23%	17%	24%
in 2017	20%	29%	34%	36%	39%	33%	34%	35%	30%	30%	24%	26%
in 2018	26%	42%	47%	58%	53%	54%	52%	49%	55%	49%	34%	32%
in 2019	32%	41%	54%	61%	63%	61%	55%	52%	55%	42%	33%	30%
in 2020	34%	41%	48%	46%	50%	47%	46%	46%	53%	44%	32%	35%
in 2021	31%	46%	57%	58%	52%	53%	48%	53%	48%	46%	30%	31%
in 2022	36%	46%	54%	59%	60%	56%	48%	49%	50%	46%	37%	34%
in 2023	33%	49%	50%	59%	57%	61%	52%	66%	56%	54%	35%	36%

Between 2015 and 2023, the number of days reporting $PM_{2.5}$ as the conditional pollutant is decreasing, against an equivalent increase in reporting PM_{10} as the conditional pollutant. One conclusion that can be drawn from this trend is that the cities main source of particulate pollution could be shifting to resuspended dust from vehicle movement, construction, and open wind erosion.

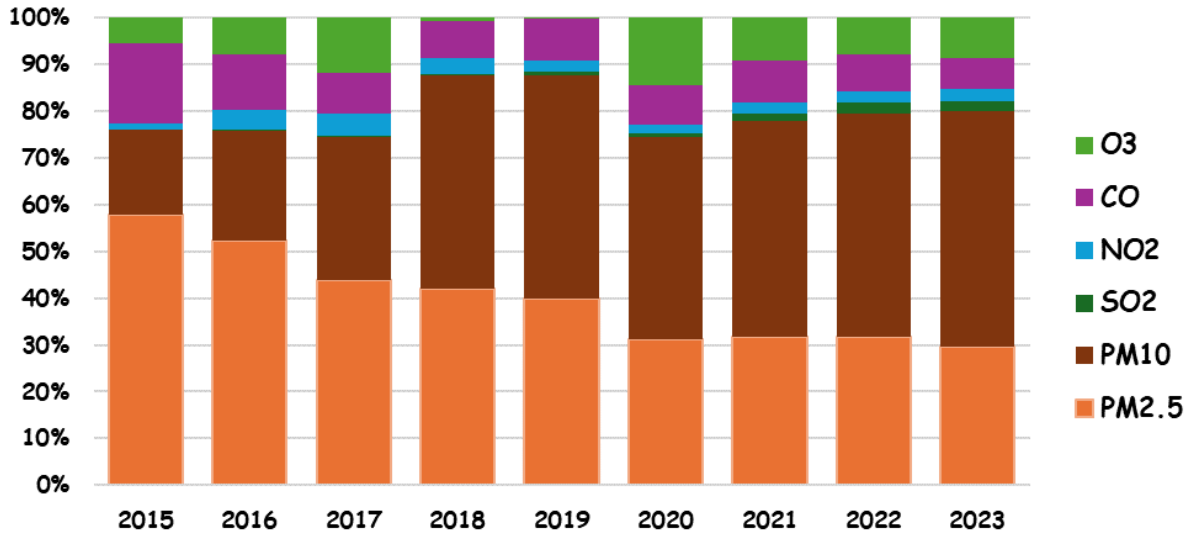
Table: % number of days gases were listed as the conditional pollutant across India

	J	F	M	A	M	J	J	A	S	O	N	D
in 2015					29%	32%	40%	21%	27%	19%	16%	15%
in 2016	10%	11%	13%	16%	29%	30%	38%	37%	40%	27%	17%	15%
in 2017	15%	21%	21%	21%	26%	34%	35%	37%	37%	25%	20%	15%
in 2018	12%	6%	6%	7%	10%	14%	27%	28%	19%	8%	6%	3%
in 2019	3%	5%	4%	5%	6%	12%	24%	31%	27%	14%	6%	7%
in 2020	9%	11%	27%	34%	34%	39%	40%	43%	27%	16%	14%	10%
in 2021	10%	9%	13%	17%	30%	30%	37%	32%	41%	22%	14%	7%
in 2022	9%	11%	10%	15%	19%	25%	39%	37%	34%	23%	10%	9%
in 2023	8%	10%	18%	21%	26%	27%	37%	23%	31%	15%	11%	10%

The gaseous pollutants (SO_2, NO_2, CO, and Ozone) played foul mostly during the summer/monsoonal months, which are marked with scavenging of aerosols with consistent rains. Highest share for gaseous pollutants is reported in year 2020, which witnessed a sharp decline in the overall particulate emissions due to COVID19 lockdowns.

- There is a no clear increasing or decreasing trend in the share of gaseous pollutants being reported as the conditional pollutant across India.
- Ozone and CO had constant presence over the years (mostly summers)
- SO_2 started to show on the list since 2020.

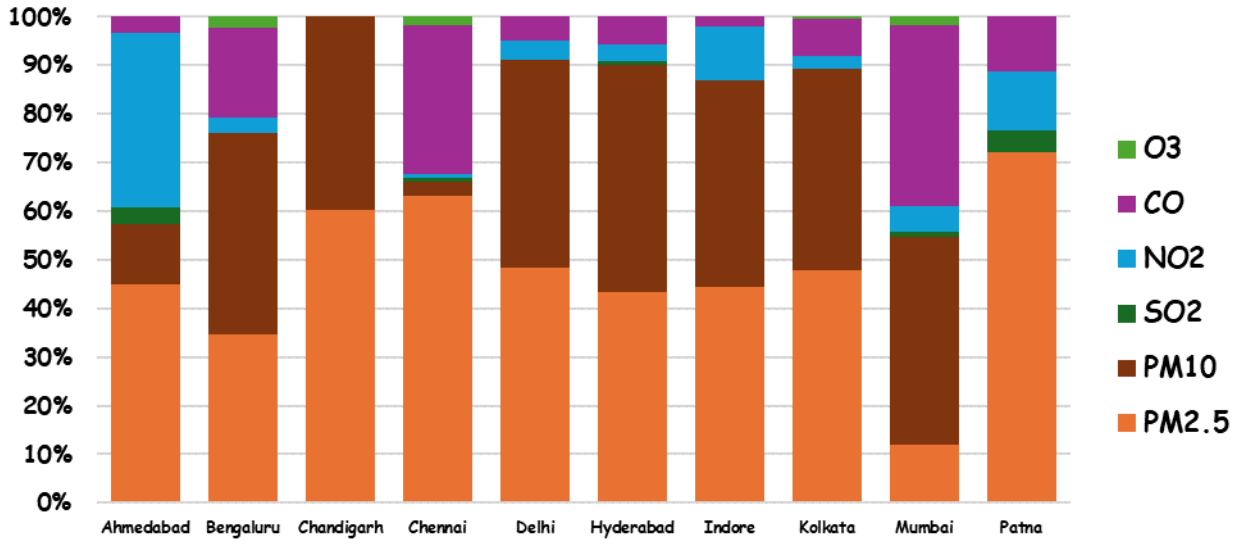
Graph: % number of days pollutants were listed as the conditional pollutant across India



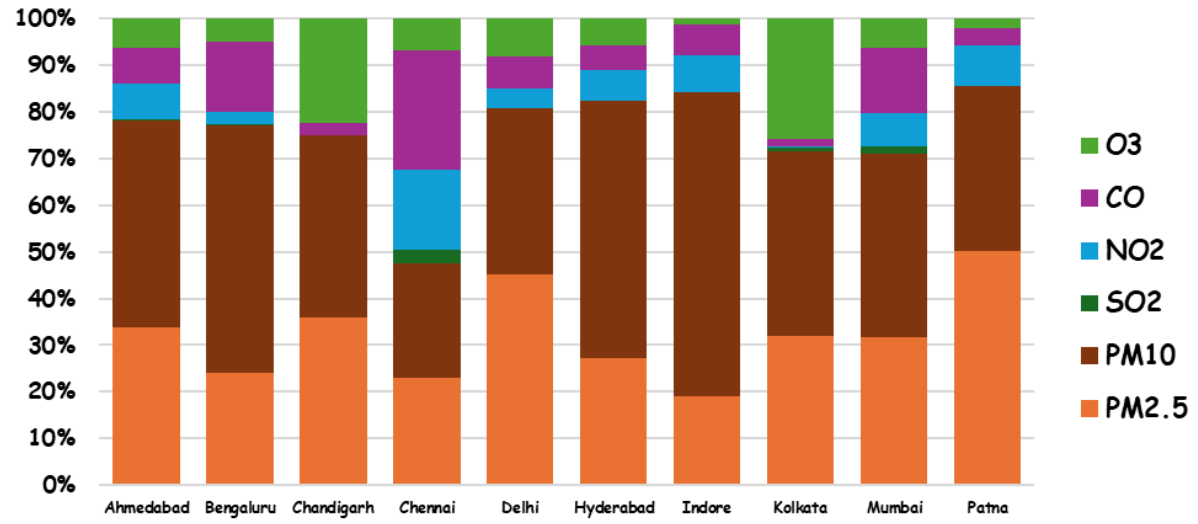
Similar changes in trends were noticed in the city profiles. The following graphs present a summary of the how often various pollutants were listed as the conditional pollutant.

- Share of PM_{10} has increased.
- Share of $PM_{2.5}$ has decreased.
- Share of Ozone and NO_2 are higher in the Tier-1 cities, compared to smaller cities.

Graph: % number of days pollutants were listed as the conditional pollutant in 2019



Graph: % number of days pollutants were listed as the conditional pollutant in 2023



7. Daily Reports

The essence of AQI is in its simplicity to convey the pollution and health alerts as simple colour codes in six bins – Good, Satisfactory, Moderate, Poor, Very Poor, and Severe. The bins values are summarized in Chapter 3.

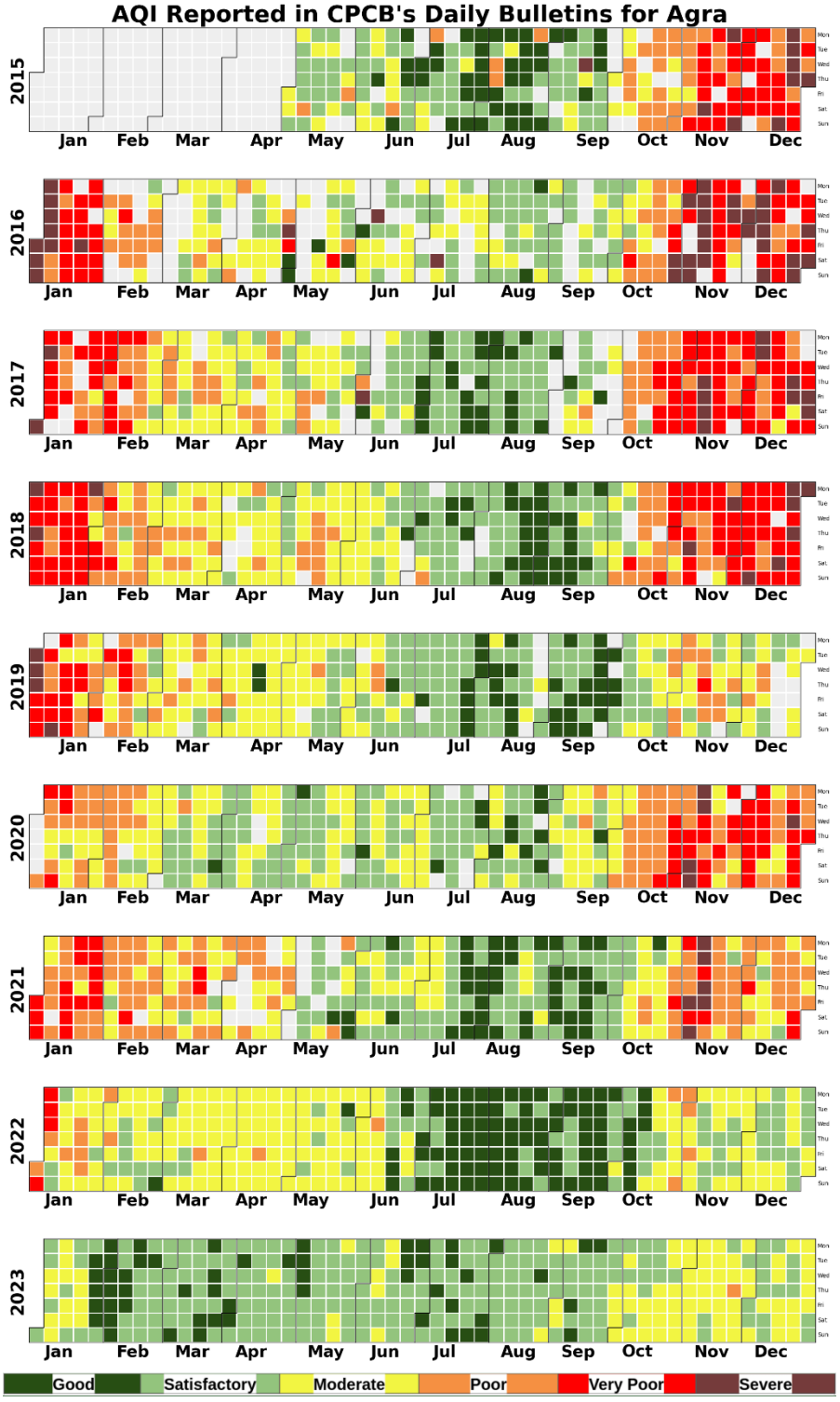
Across India, the share of these alerts has been consistent between 2015 and 2023, for Satisfactory, Moderate, and Poor categories, a doubling of the share of Good days, and fewer Very-Poor and Severe days reported at the end of 2023.

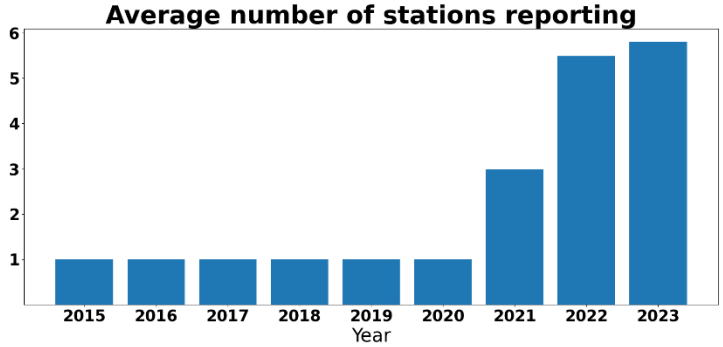
Table: % days across India with cities reporting various AQI categories

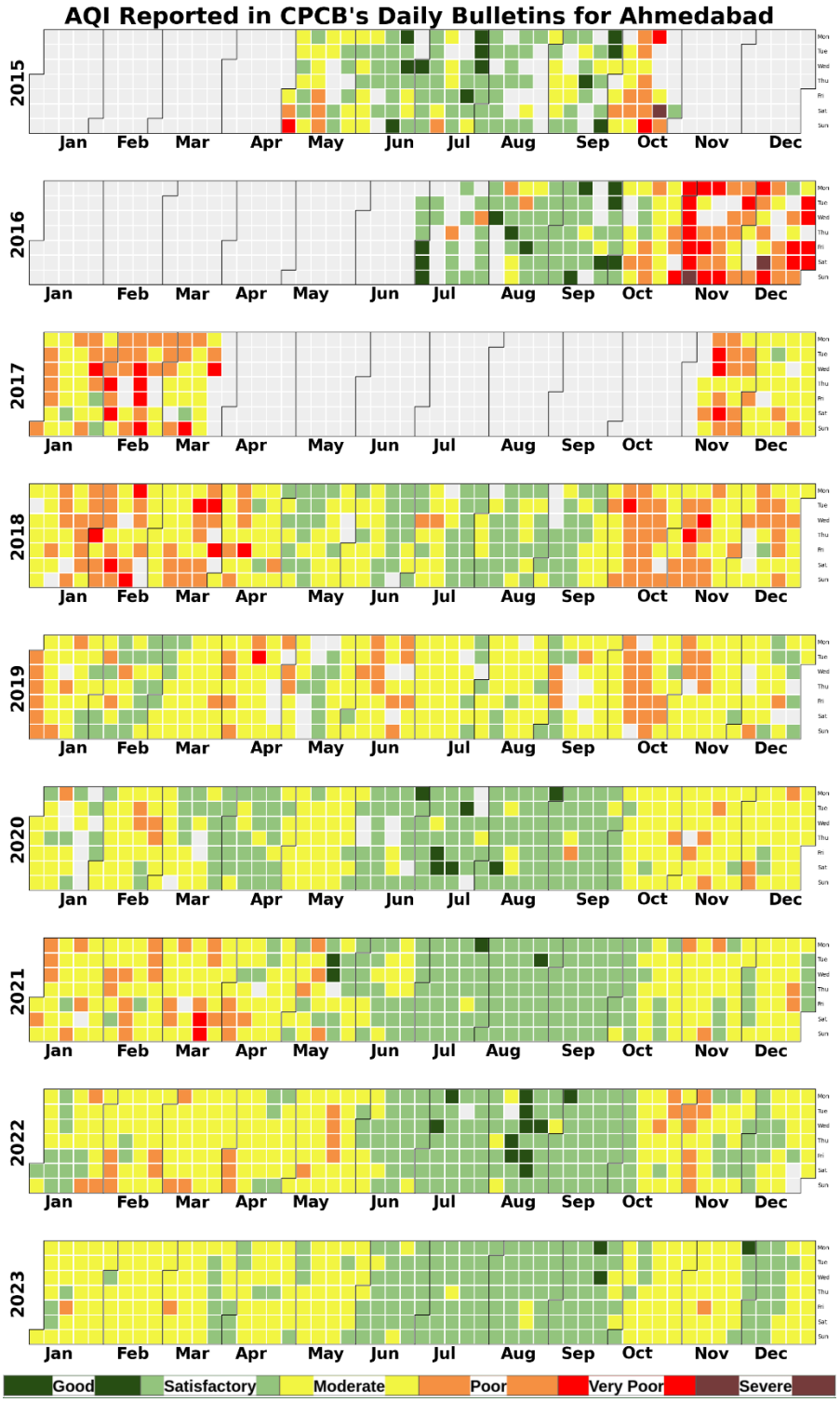
	Good	Satisfactory	Moderate	Poor	Very Poor	Severe
2015	8%	33%	31%	13%	11%	3.0%
2016	11%	27%	35%	14%	9.3%	3.9%
2017	8%	33%	34%	14%	8.7%	2.4%
2018	8%	31%	38%	14%	7.3%	1.5%
2019	11%	33%	36%	13%	5.3%	1.2%
2020	20%	38%	29%	10%	3.6%	0.7%
2021	19%	35%	29%	12%	4.8%	0.6%
2022	17%	34%	31%	12%	4.1%	0.5%
2023	17%	37%	32%	10%	3.2%	0.3%

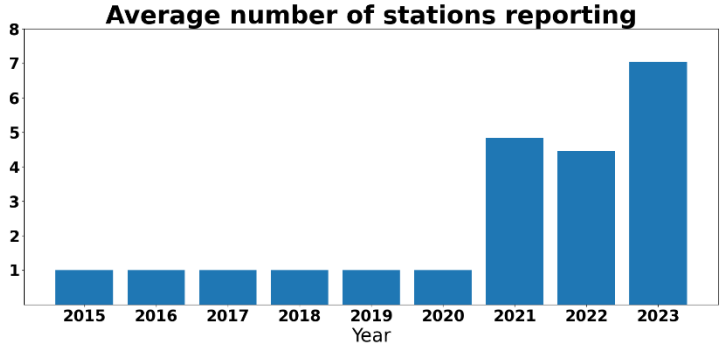
City-wise summaries of these values as downloadable CSV's of all the available data are @ www.urbanemissions.info

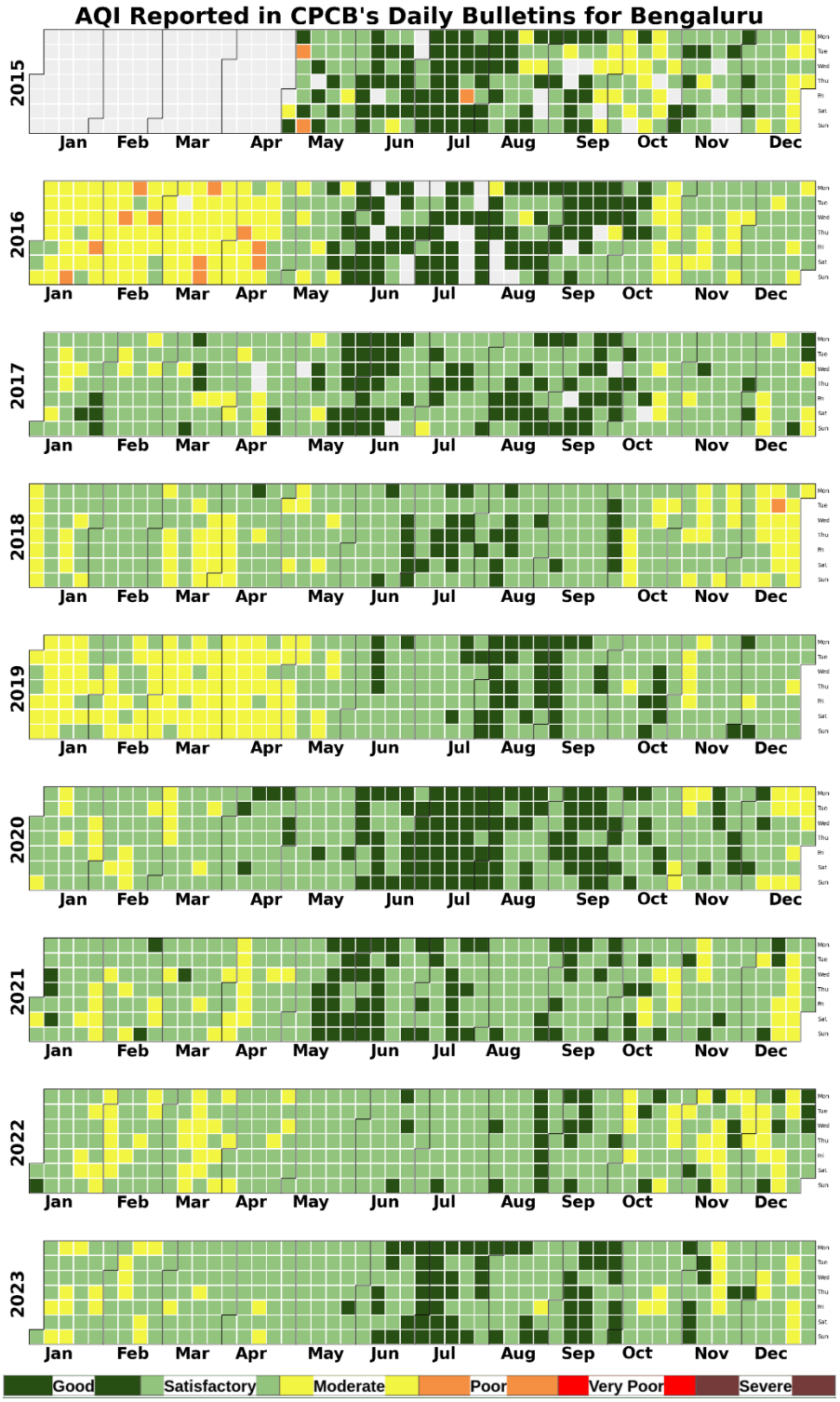
For select cities, data is presented as calendar plots on the following pages.

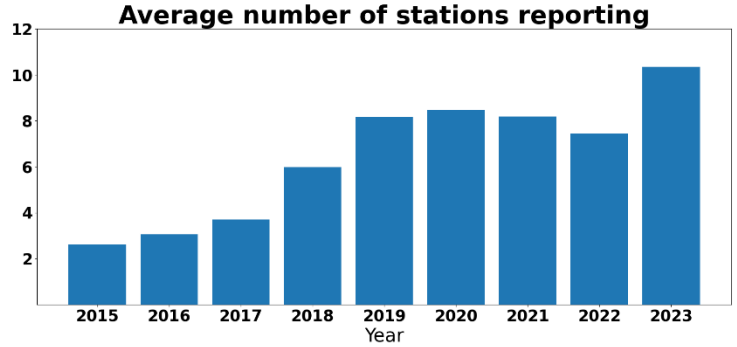

AQI Reported in CPCB's Daily Bulletins for Agra
2015
2016
2017
2018
2019
2020
2021
2022
2023
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe

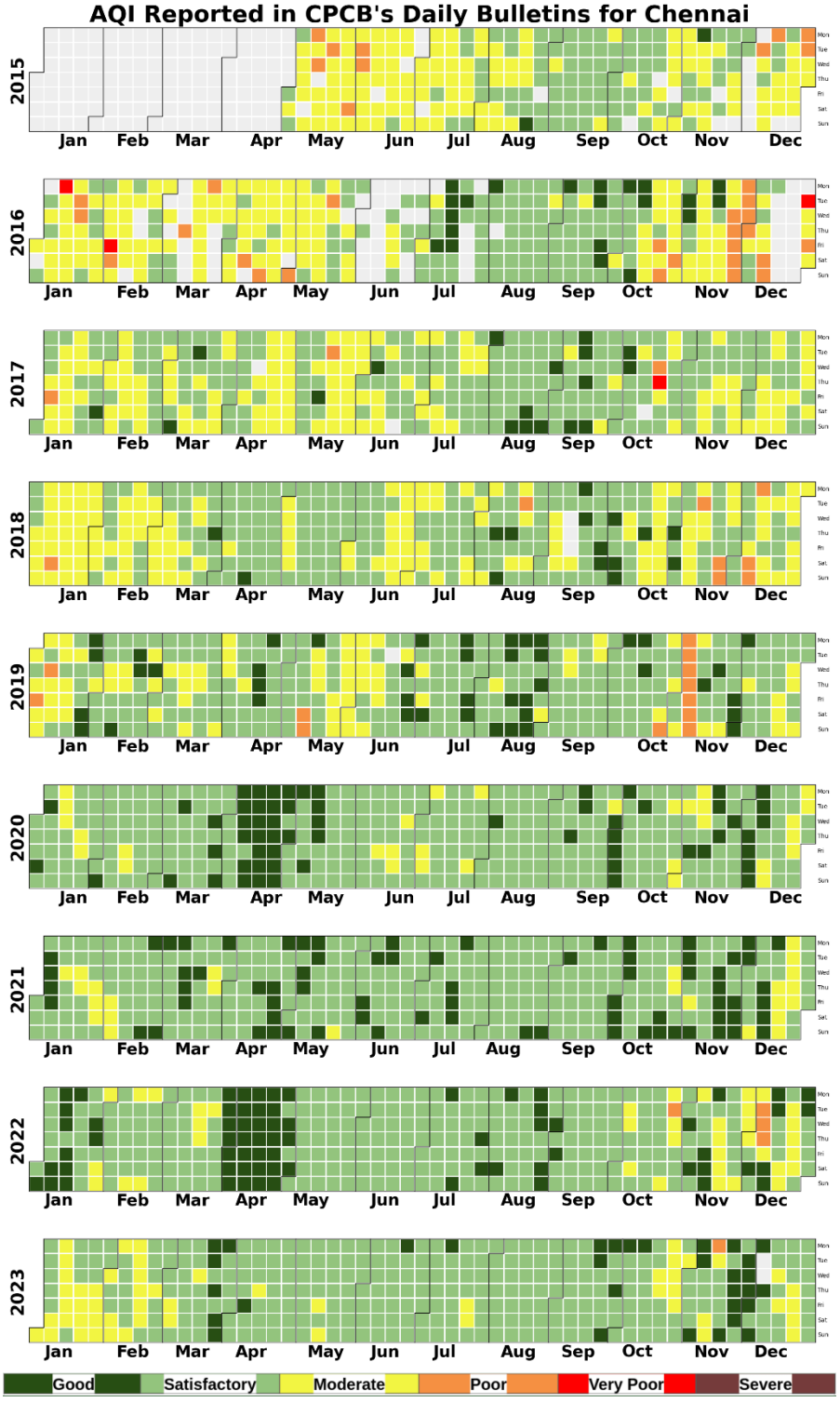

Average number of stations reporting
6
5
4
3
2
1
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

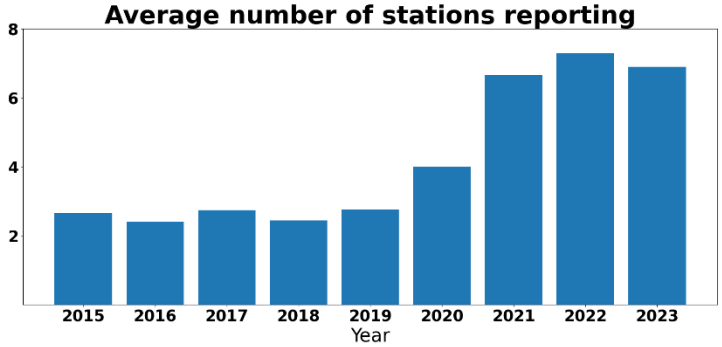

AQI Reported in CPCB's Daily Bulletins for Ahmedabad
2015
2016
2017
2018
2019
2020
2021
2022
2023
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe

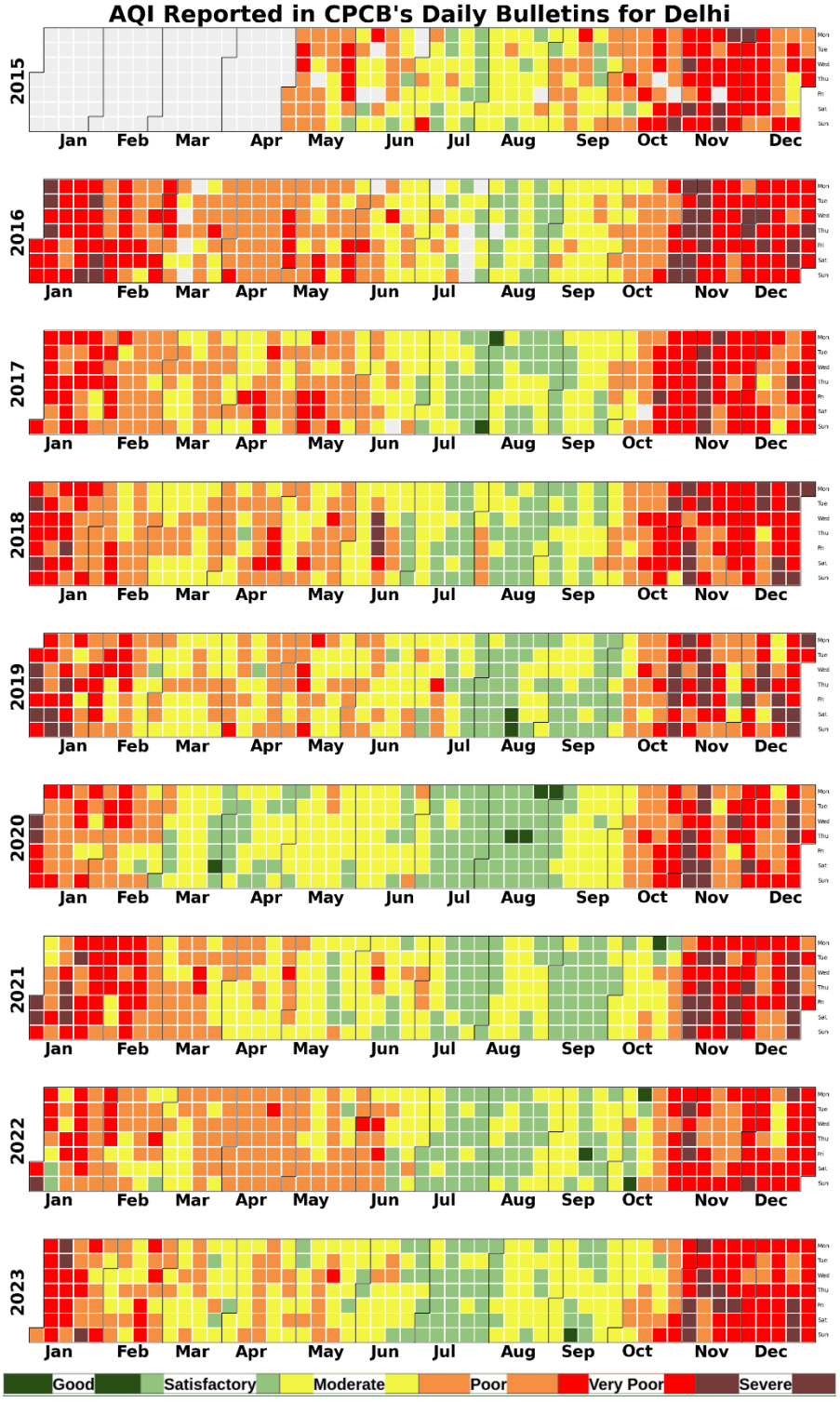

Average number of stations reporting
1
2
3
4
5
6
7
8
2015 2016 2017 2018 2019 2020 2021 2022 2023
Year


AQI Reported in CPCB's Daily Bulletins for Bengaluru
2015
2016
2017
2018
2019
2020
2021
2022
2023
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe


Average number of stations reporting
12
10
8
6
4
2
2015 2016 2017 2018 2019 2020 2021 2022 2023
Year


AQI Reported in CPCB's Daily Bulletins for Chennai
2015
2016
2017
2018
2019
2020
2021
2022
2023
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe


Average number of stations reporting
8
6
4
2
2015 2016 2017 2018 2019 2020 2021 2022 2023
Year


AQI Reported in CPCB's Daily Bulletins for Delhi
2015
2016
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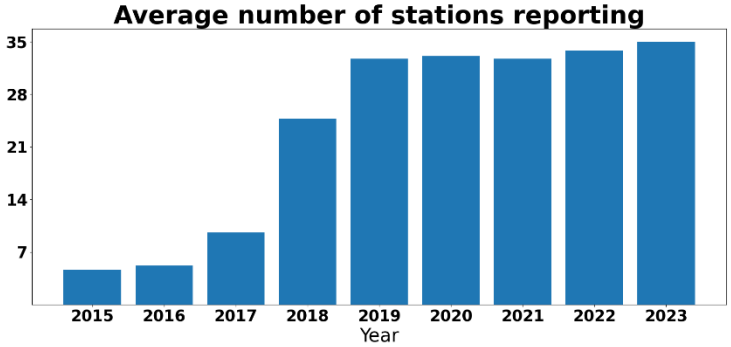
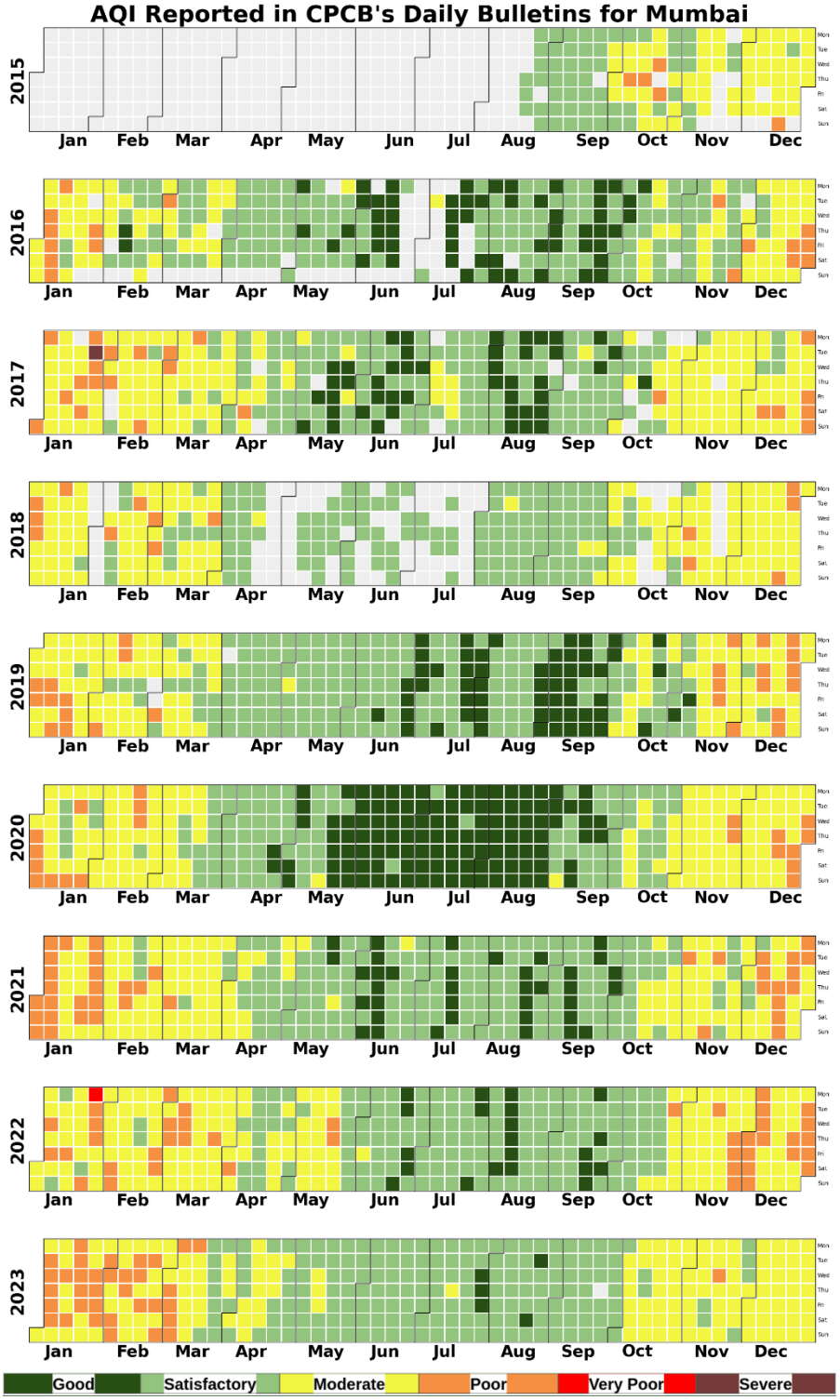
2018
2019
2020
2021
2022
2023
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe


Average number of stations reporting
35
28
21
14
7
2015 2016 2017 2018 2019 2020 2021 2022 2023
Year


AQI Reported in CPCB's Daily Bulletins for Mumbai
2015
2016
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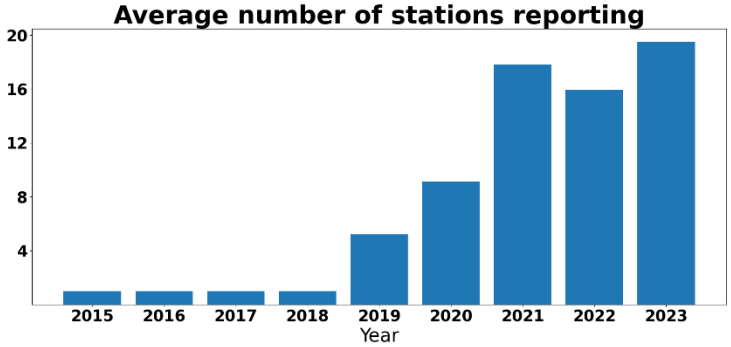
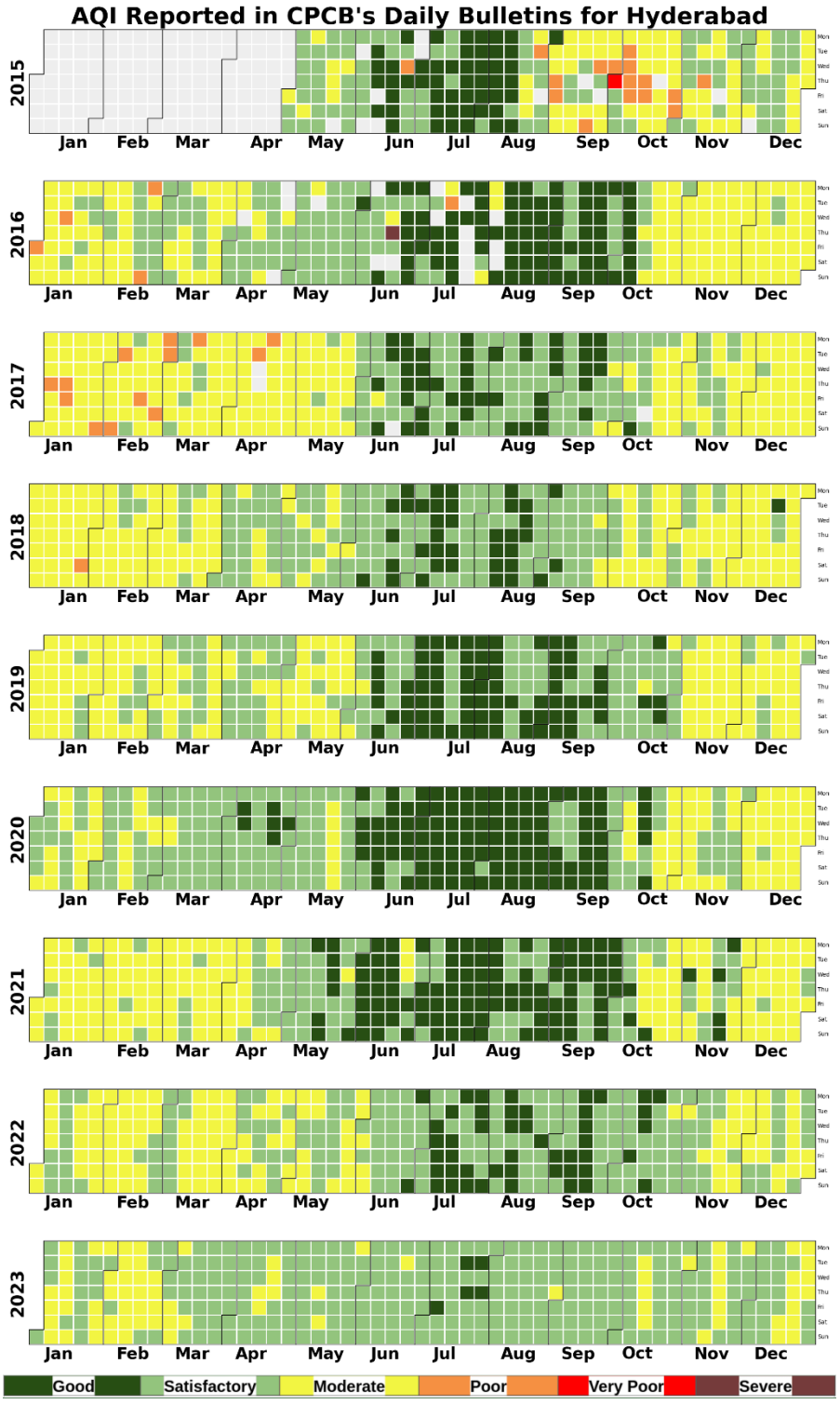
2021
2022
2023
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe


Average number of stations reporting
20
16
12
8
4
2015 2016 2017 2018 2019 2020 2021 2022 2023
Year


AQI Reported in CPCB's Daily Bulletins for Hyderabad
2015
2016
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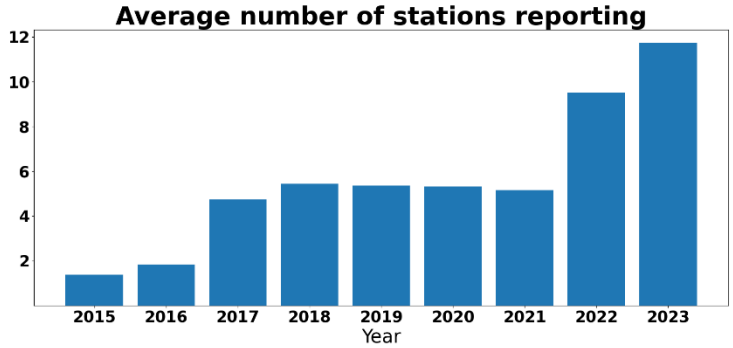
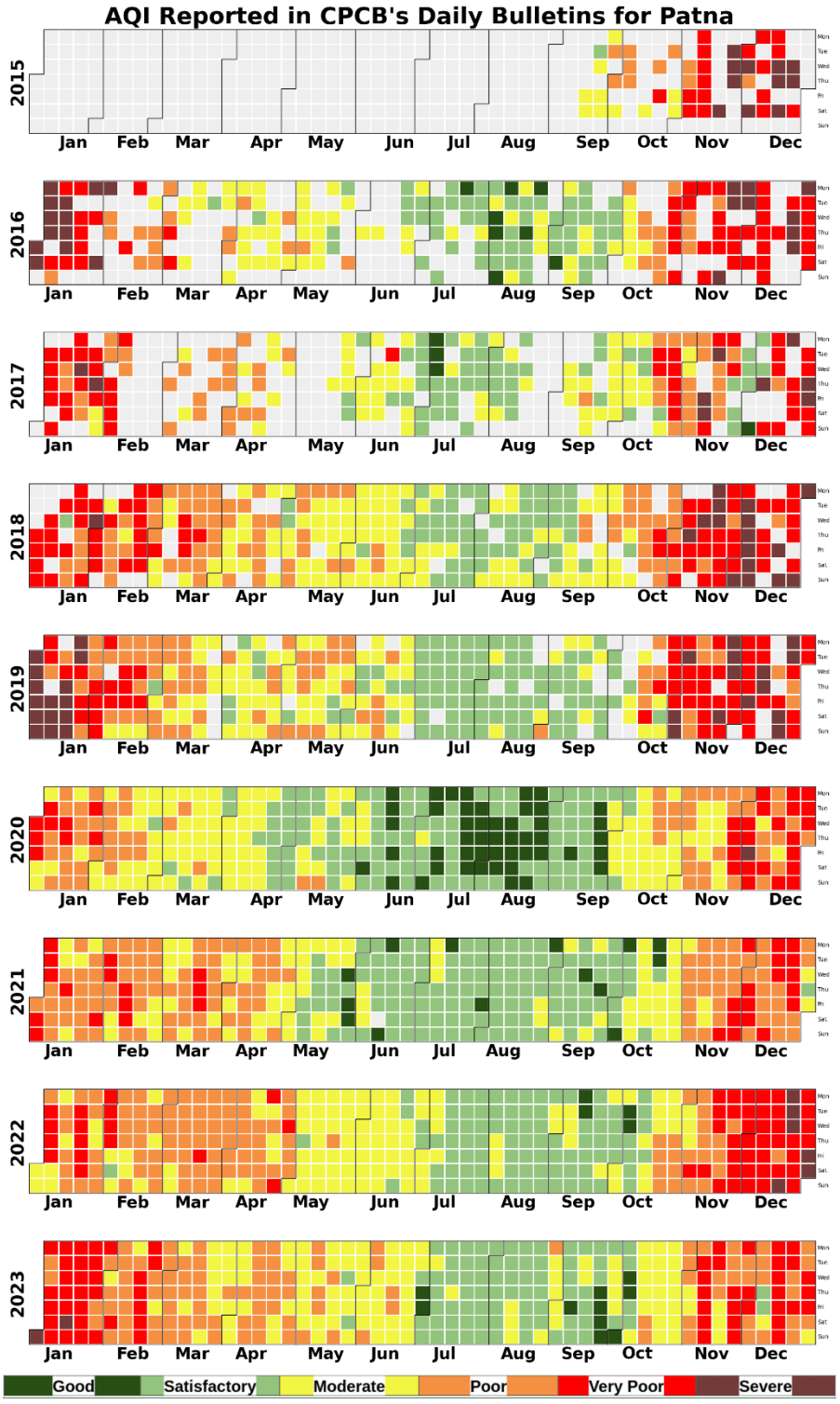
2021
2022
2023
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe


Average number of stations reporting
12
10
8
6
4
2
2015 2016 2017 2018 2019 2020 2021 2022 2023
Year


AQI Reported in CPCB's Daily Bulletins for Patna
2015
2016
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2018
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2020
2021
2022
2023
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Feb
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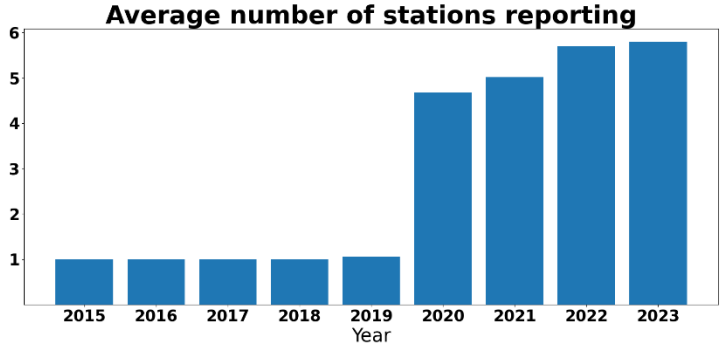
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe


Average number of stations reporting
6
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3
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2015
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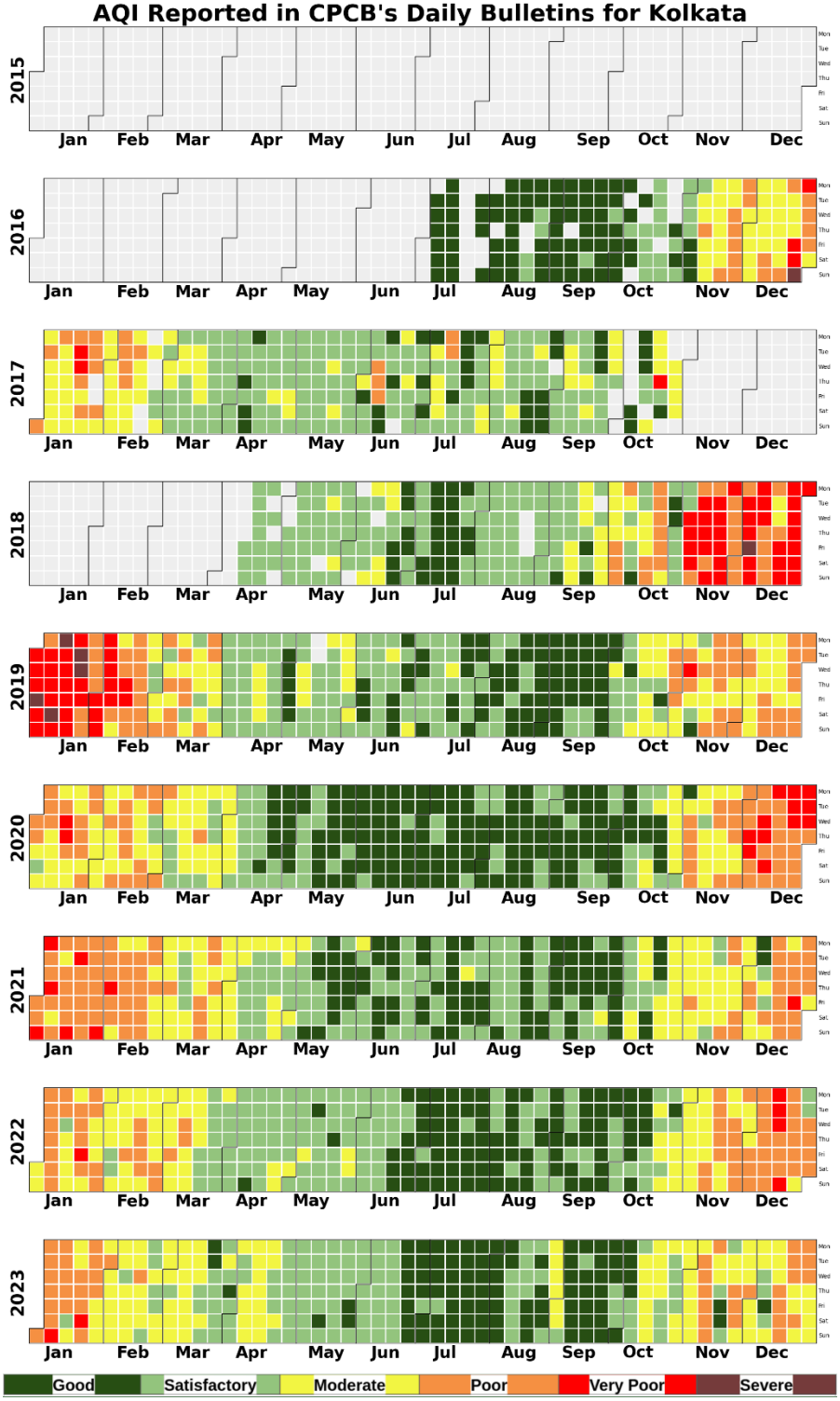
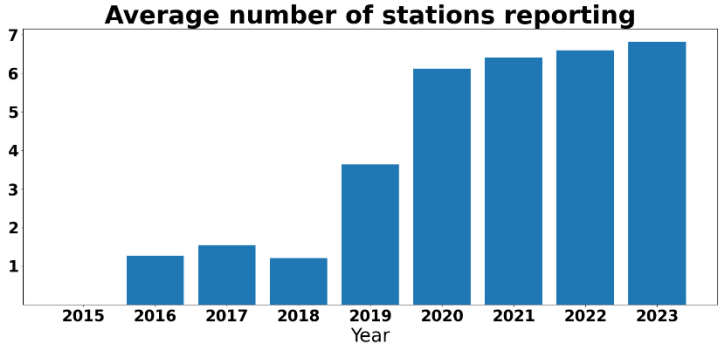
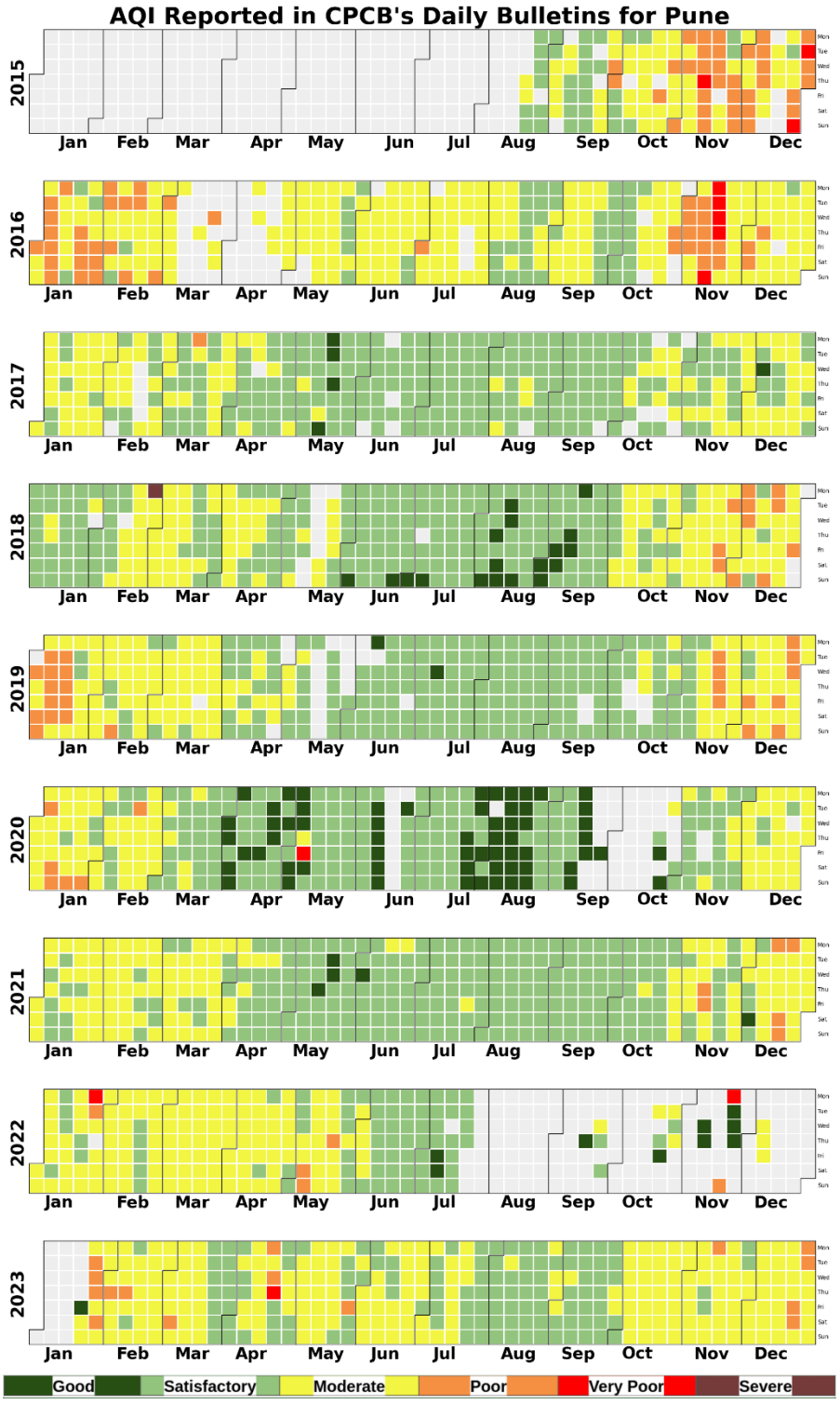
2023
Year

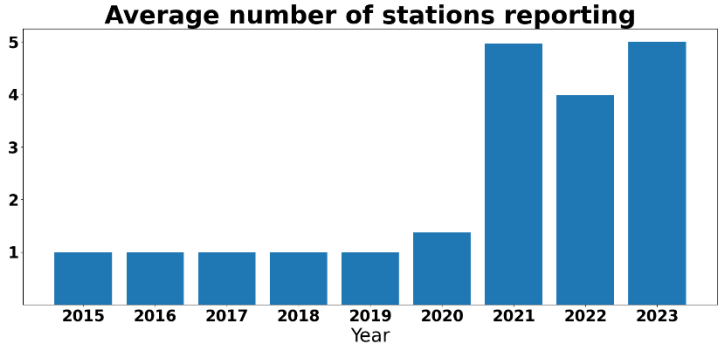
AQI Reported in CPCB's Daily Bulletins for Kolkata



Average number of stations reporting




AQI Reported in CPCB's Daily Bulletins for Pune
2015
2016
2017
2018
2019
2020
2021
2022
2023
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Good
Satisfactory
Moderate
Poor
Very Poor
Severe


Average number of stations reporting
1
2
3
4
5
2015 2016 2017 2018 2019 2020 2021 2022 2023
Year

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