VISUALIZING THE IMPACT OF EPISODIC AIR POLLUTION DURING OCTOBER 2018 TO FEBRUARY 2019 IN INDIAN CITIES

atmos
real-time air quality
Respirer Living Sciences

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

Project Title: Measurement & dissemination of air quality data using low cost monitors in 10 cities

Acknowledgement

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Shakti Sustainable Energy Foundation (Shakti) works to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following sectors: clean power, energy efficiency, sustainable urban transport, climate policy and clean energy finance.

Disclaimer

Data access

For feedback, suggestions, $PM_{2.5}$ datasets and API access to the data, email – research@urbansciences.in

For more technical details and to view the real-time dashboard, visit – http://atmos.urbansciences.in/dashboard/SSEF

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BACKGROUND

Air pollution is a major public health risk causing about 4.2 million deaths every year worldwide[1]. The Indo-Gangetic Plain has grabbed global headlines for severe and persistent pollution levels, making India the pollution capital of the world.

The Indo-Gangetic Plain suffers from an inherent disadvantage of being landlocked. During winters, the quality worsens due to slow moving winds and temperature inversions that trap particulate matter, leading to a toxic accumulation of smog[2]. Whilst vehicular and industrial emissions contribute their fair share throughout the year, winter-time episodes due to firecracker and crop stubble burning, however, remain the most toxic.

Cities across India witnessed high pollution episodes in winters 2018-19. These were extensively covered via media reporting, particularly for Delhi. Additionally, limited reference grade monitors in cities other than Delhi NCR have meant a dearth of air quality data.

Low-Cost Air Quality Monitoring across Indian Cities

To bridge this vital data gap, Respirer Living Sciences, as part of their UrbanSciences initiative and IIT Kanpur, with support from Shakti Sustainable Energy Foundation (SSEF) has deployed 50 low cost air quality monitors (Atmos) across Indian cities. These monitors were co-located and tested to assess their performance against reference grade monitors (E-BAM) and are primarily being deployed in residential and office buildings. The report attempts to visualise the impact of winter season and episodes on the pollution levels in the vicinity of deployed monitors. This report is second in a series of episode reports. The assessment period spans over 4.5 months, from October 15, 2018 to February 28, 2019, during which winter season 2018-19 was witnessed.

[1] World Health Organization. (2019). Ambient Air Pollution. Accessed from https://www.who.int/airpollution/en/

[2] Srivastava, Dey & Tripathi. (2012). Aerosol Characteristics over the Indo-Gangetic Basin: Implications to Regional Climate. Intech. Accessed from http://web.iitd.ac.in/~sagnik/Chapter.pdf

METHODOLOGY

The analyzed data has been derived from low-cost Atmos monitors manufactured and deployed by UrbanSciences.

Cities	No. of Monitors
Chandigarh*	**5**
Dehradun	**5**
Delhi-NCR	**2**
Jaipur	**4**
Kanpur	**5**
Patna	**5**
Varanasi	**5**
Ahmedabad	**5**
Raipur	**5**
Ranchi	**5**
Bhopal*	**4**

In North India, monitors were installed in **Chandigarh, Dehradun, Delhi-NCR, Jaipur, Kanpur, Patna and Varanasi.** In Central India, they were installed in **Ahmedabad, Bhopal, Raipur and Ranchi**.[3]

24-hour averages have been analyzed for Particulate Matter 2.5 ($PM_{2.5}$) to understand the pollution trends over a period of 137 days. The 24-hour $PM_{2.5}$ averages have been further categorized into a color-coded index based on the levels of pollution on that particular day.

Color-Coded Index

Our Code	GOOD		MODERATE		POOR	
$PM_{2.5}$	0-30	31-60	61-90	91-120	121-250	250+
Air Quality	Good	Satisfactory	Moderate	Poor	Very Poor	Severe

[3] The monitors in Bhopal and Chandigarh were deployed in February 2019, thus the data from these two cities is not covered in this episode report.

SUMMARY OF THE FINDINGS

During the period from October 2018 to February 2019, Delhi, Patna and Varanasi recorded the worst air quality, with 73 to 79 percent "Poor" air quality days.

Patna had ZERO "Good" air quality days, whereas Varanasi had 4 percent and Delhi had 7 percent.

Following these three cities, Kanpur was next in line to be the most polluted out of the nine cities monitored for $PM_{2.5}$ levels.

Kanpur recorded 69 percent "Poor" days and 5 percent "Good" air quality days. It is important to note that the monitors located in Kanpur and other cities are not located at major traffic junctions, as in the case of regulatory grade monitors but are located across residential blocks, balconies of individual homes and roof tops.

The table below summarizes the percentage of "Good", "Moderate" and "Poor" air quality days across nine cities. The ranking is based on the maximum "Poor" air quality days.

RANK	CITY	GOOD	MODERATE	POOR
1	PATNA	0%	21%	79%
2	VARANASI	4%	18%	78%
3	DELHI-NCR	7%	20%	73%
4	KANPUR	5%	26%	69%
5	RAIPUR	12%	66%	22%
6	RANCHI	20%	61%	19%
7	DEHRADUN	34%	49%	17%
8	JAIPUR	20%	73%	7%
9	AHMEDABAD	26%	67%	7%

Highest Daily Averages or Maximum Values Recorded

Northern India: Kanpur, Patna, Delhi, Varanasi, Dehradun

While the above rankings indicate the various category of days based on the air quality index for the $PM_{2.5}$ levels, the highest daily averages were recorded in the cities of Kanpur, Patna, Delhi, Varanasi and Dehradun.

Kanpur in particular had several poor air quality days during Diwali with persistent pollution levels peaking at 355, 449 and 305 micrograms per cubic meter.

Central India: Ranchi, Ahmedabad and Raipur

In the cities across central India however, Ranchi topped the charts with Raipur and Ahmedabad after it.

The peaks experienced in these cities were significantly lower in comparison to most cities in the Northern part of the country.

Ranking based on 137-Day Averages for Various Stations across the Nine Cities

Varanasi has witnessed the maximum $PM_{2.5}$ levels amongst the cities. The city consistently topped the charts for poor air quality for more than a couple of weeks in a row, indicating a persistent problem of poor air quality across the city.

Contrary to the popular opinion in the media and in the general public, most monitoring locations spread across cities in the Indo-Gangetic Plain have recorded averages higher than that of Delhi and Gurugram. The top five locations were identified to be in Varanasi, Kanpur and Patna.

Rank	City	Area	$PM_{2.5}$
1	Varanasi	Town Hall	230
2	Patna	IGSC	223
3	Varanasi	Kamachcha	220
4	Patna	Mithapur	216
5	Kanpur	Govind Nagar	212
6	Delhi	Munirka	205
7	Patna	CECC ADRI	199
8	Kanpur	Chunniganj	192
9	Patna	Phulwari Sharif	190
10	Varanasi	Ordali Bazar	186
11	Delhi	Sector 30, Gurugram	169
12	Kanpur	Naubasta	163
13	Kanpur	Indira Nagar	148
14	Varanasi	IESD BHU	138

All the monitors spread across these cities recorded $PM_{2.5}$ averages in the “Moderate” and “Poor” category with air pollution levels exceeding the Indian safety norms i.e 40µg/m^3 and the World Health Organization’s safe air standards i.e 10µg/m^3. The monitors spread across central Indian cities had lower air pollution levels with $PM_{2.5}$ averages not reaching the “Poor” category but remaining in “Moderate” to “Poor” air quality range. This however does not mean that the severity of air pollution is to be downplayed in the cities of Raipur, Ahmedabad and Ranchi. It is important to note that among the two stations cited in the ranking below for Raipur, both the stations vary greatly in terms of the prevailing pollution levels. Therefore, this demands more monitoring and a better understanding of air quality across cities in India to comprehensively understand the extent of the problem concerning ambient air quality.

Ahmedabad – Gandhinagar

Ahmedabad recorded a 137-day average of 89 micrograms per cubic meter which falls into the moderate air pollution category. The monitoring exercise spread across three different locations yielded 7 percent of the total monitored days for air quality to be in poor category with peak pollution during Diwali reaching 2.5 times the Indian Safety limits for $PM_{2.5}$ on a 24-hour basis.

Ahmedabad recorded the second highest number of moderate air quality days in comparison to the other cities, 67 percent of the monitored days were found to be in the moderate category.

	October					November				
Sun	- 30	- 07	- 14	43 21	54 28	94 04	96 11	113 18	64 25	
Mon	- 01	- 08	37 15	53 22	55 29	88 05	75 12	91 19	74 26	
Tue	- 02	- 09	47 16	84 23	55 30	78 06	93 13	83 20	62 27	
Wed	- 03	- 10	61 17	52 24	57 31	131 07	94 14	88 21	73 28	
Thu	- 04	- 11	54 18	67 25	66 01	154 08	71 15	87 22	109 29	
Fri	- 05	- 12	48 19	54 26	68 02	119 09	76 16	62 23	119 30	
Sat	- 06	- 13	53 20	72 27	87 03	107 10	87 17	59 24	- 01	

	December					January				
Sun	- 25	101 02	71 09	63 16	85 23	69 30	93 06	90 13	84 20	55 27
Mon	- 26	96 03	106 10	67 17	73 24	88 31	104 07	79 14	106 21	71 28
Tue	- 27	103 04	122 11	107 18	85 25	136 01	115 08	87 15	60 22	63 29
Wed	- 28	108 05	82 12	121 19	93 26	143 02	99 09	103 16	87 23	78 30
Thu	- 29	112 06	66 13	104 20	90 27	116 03	92 10	118 17	61 24	101 31
Fri	- 30	97 07	60 14	95 21	82 28	107 04	80 11	75 18	56 25	- 01
Sat	109 01	71 08	65 15	110 22	65 29	136 05	78 12	56 19	63 26	- 02

	February				
Sun	- 27	89 03	49 10	65 17	56 24
Mon	- 28	133 04	51 11	69 18	37 25
Tue	- 29	156 05	62 12	47 19	33 26
Wed	- 30	55 06	65 13	64 20	35 27
Thu	- 31	32 07	72 14	28 21	33 28
Fri	64 01	35 08	85 15	43 22	- 01
Sat	53 02	45 09	53 16	38 23	- 02

Good Days: 26% **Moderate Days:** 67% **Poor Days:** 7%

Dehradun

Despite its proximity to Delhi, the hill city of Dehradun has fared to be the least polluted among the 9 cities. It recorded 49 percent of the monitored days to be in the moderate air quality limit and 34 percent of good air quality days. It also has low proportion of poor air quality days i.e. 17 percent with an exception of Diwali on the 7th and 8th of November where the city saw the season's maximum levels of $PM_{2.5}$, 2-3 times the Indian Safety limits on a 24-hour basis.

	October					November				
Sun	- 30	- 07	- 14	44 21	58 28	38 04	110 11	64 18	82 25	
Mon	- 01	- 08	- 15	44 22	59 29	51 05	81 12	69 19	55 26	
Tue	- 02	- 09	- 16	45 23	61 30	55 06	74 13	88 20	61 27	
Wed	- 03	- 10	- 17	37 24	60 31	194 07	72 14	79 21	37 28	
Thu	- 04	- 11	45 18	38 25	39 01	137 08	74 15	72 22	32 29	
Fri	- 05	- 12	46 19	48 26	33 02	82 09	73 16	71 23	51 30	
Sat	- 06	- 13	51 20	39 27	30 03	100 10	74 17	71 24	- 01	

	December					January				
Sun	- 25	110 02	88 09	83 16	118 23	163 30	141 06	101 13	105 20	76 27
Mon	- 26	116 03	87 10	91 17	110 24	152 31	113 07	82 14	58 21	65 28
Tue	- 27	126 04	106 11	106 18	125 25	173 01	109 08	107 15	26 22	76 29
Wed	- 28	139 05	94 12	95 19	144 26	153 02	132 09	108 16	59 23	72 30
Thu	- 29	112 06	83 13	120 20	142 27	125 03	122 10	102 17	72 24	83 31
Fri	- 30	86 07	87 14	134 21	129 28	104 04	129 11	99 18	61 25	- 01
Sat	103 01	83 08	93 15	127 22	125 29	126 05	106 12	128 19	60 26	- 02

	February				
Sun	- 27	74 03	74 10	59 17	56 24
Mon	- 28	97 04	78 11	51 18	53 25
Tue	- 29	95 05	88 12	34 19	37 26
Wed	- 30	61 06	103 13	42 20	27 27
Thu	- 31	40 07	85 14	34 21	42 28
Fri	57 01	48 08	35 15	40 22	- 01
Sat	56 02	56 09	30 16	52 23	- 02

Good Days: 34% **Moderate Days:** 49% **Poor Days:** 17%

Delhi

India's capital city isn't the most polluted among the list even as it retains its position in the top five for having the maximum number of poor air quality days, after Patna, Kanpur and Varanasi. 20 and 73 percent of the days monitored were found to be in the moderate and poor categories respectively with $PM_{2.5}$ values consistently being close to and above 200 micrograms per cubic meter for three consecutive weeks in the month of November. 321 is the highest recorded daily average for Delhi which is equivalent to approximately 5 times the daily safe limit set by Indian government.

	October					November				
Sun	- 30	- 07	- 14	49 21	131 28	56 04	109 11	162 18	130 25	
Mon	- 01	- 08	111 15	25 22	118 29	199 05	234 12	189 19	211 26	
Tue	- 02	- 09	55 16	53 23	118 30	100 06	226 13	232 20	170 27	
Wed	- 03	- 10	74 17	43 24	105 31	108 07	139 14	195 21	179 28	
Thu	- 04	- 11	63 18	55 25	106 01	164 08	136 15	121 22	201 29	
Fri	- 05	- 12	43 19	47 26	106 02	144 09	171 16	183 23	221 30	
Sat	- 06	- 13	73 20	133 27	87 03	139 10	154 17	112 24	- 01	

	December					January				
Sun	- 25	137 02	212 09	121 16	234 23	223 30	197 06	277 13	189 20	192 27
Mon	- 26	167 03	231 10	168 17	240 24	254 31	223 07	109 14	145 21	168 28
Tue	- 27	188 04	234 11	171 18	217 25	214 01	213 08	141 15	91 22	168 29
Wed	- 28	166 05	116 12	159 19	160 26	210 02	168 09	259 16	200 23	198 30
Thu	- 29	183 06	119 13	203 20	158 27	298 03	176 10	321 17	153 24	186 31
Fri	- 30	188 07	127 14	203 21	195 28	260 04	270 11	231 18	120 25	- 01
Sat	147 01	194 08	123 15	229 22	150 29	268 05	216 12	209 19	146 26	- 02

	February				
Sun	- 27	154 03	217 10	166 17	143 24
Mon	- 28	200 04	241 11	147 18	100 25
Tue	- 29	255 05	274 12	191 19	73 26
Wed	- 30	222 06	244 13	125 20	56 27
Thu	- 31	103 07	194 14	78 21	85 28
Fri	219 01	70 08	158 15	101 22	- 01
Sat	187 02	127 09	140 16	82 23	- 02

Good Days: 7% **Moderate Days:** 20% **Poor Days:** 73%

Jaipur

Rajasthan's capital Jaipur recorded a similar percentage of good, moderate and poor air quality days to that of Ahmedabad. With 7 percent of days in poor category and 73 percent in moderate category, the city recorded its maximum $PM_{2.5}$ value for 24-hour on the 8th of November post Diwali at 158 micrograms per cubic meter which is equivalent to 2.5 times the Indian safe limit.

Sun	- 30	- 07	- 14	65 21	105 28	115 04	74 11	76 18	71 25		
Mon	- 01	- 08	62 15	46 22	116 29	72 05	76 12	68 19	66 26		
Tue	- 02	- 09	47 16	45 23	125 30	145 06	61 13	63 20	96 27		
Wed	- 03	- 10	41 17	45 24	111 31	116 07	63 14	125 21	142 28		
Thu	- 04	- 11	45 18	49 25	102 01	158 08	130 15	93 22	129 29		
Fri	- 05	- 12	66 19	67 26	74 02	113 09	152 16	106 23	129 30		
Sat	- 06	- 13	62 20	83 27	72 03	77 10	107 17	102 24	- 01		
	October				November						

Sun	- 25	81 02	85 09	70 16	103 23	95 30	141 06	118 13	67 20	85 27	
Mon	- 26	79 03	80 10	93 17	118 24	86 31	75 07	67 14	83 21	97 28	
Tue	- 27	76 04	88 11	81 18	107 25	100 01	89 08	76 15	54 22	72 29	
Wed	- 28	91 05	95 12	101 19	93 26	86 02	90 09	56 16	67 23	64 30	
Thu	- 29	77 06	92 13	106 20	73 27	82 03	74 10	84 17	85 24	54 31	
Fri	- 30	85 07	64 14	103 21	87 28	89 04	60 11	109 18	53 25	- 01	
Sat	91 01	91 08	63 15	98 22	97 29	88 05	94 12	84 19	56 26	- 02	
	December					January					

Sun	- 27	102 03	51 10	67 17	47 24	
Mon	- 28	85 04	49 11	41 18	45 25	
Tue	- 29	103 05	73 12	35 19	41 26	
Wed	- 30	91 06	77 13	63 20	57 27	
Thu	- 31	65 07	79 14	56 21	42 28	
Fri	91 01	40 08	70 15	41 22	- 01	
Sat	116 02	44 09	48 16	39 23	- 02	
	February					

Good Days: 20% **Moderate Days:** 73% **Poor Days:** 7%

Kanpur

Kanpur scored fourth after Patna, Varanasi and Delhi for having the maximum number of poor air quality days. The city recorded poor pollution averages for the whole of November with some of the days even recording poor air quality for three to four days in a row. The maximum 24-hour value for $PM_{2.5}$ is noted in Kanpur at 449 micrograms per cubic meter, more than 7.2 times the Indian safety limit.

Sun	- 30	- 07	- 14	67 21	155 28	122 04	246 11	230 18	169 25	
Mon	- 01	- 08	102 15	68 22	127 29	148 05	229 12	198 19	230 26	
Tue	- 02	- 09	96 16	121 23	73 30	185 06	153 13	217 20	206 27	
Wed	- 03	- 10	89 17	115 24	125 31	355 07	130 14	220 21	207 28	
Thu	- 04	- 11	117 18	112 25	146 01	449 08	155 15	196 22	136 29	
Fri	- 05	- 12	46 19	107 26	149 02	305 09	115 16	175 23	170 30	
Sat	- 06	- 13	64 20	137 27	110 03	253 10	167 17	131 24	- 01	
	October				November					

Sun	- 25	170 02	226 09	177 16	241 23	295 30	175 06	228 13	209 20	89 27
Mon	- 26	201 03	216 10	176 17	223 24	265 31	148 07	103 14	162 21	104 28
Tue	- 27	244 04	206 11	168 18	186 25	279 01	142 08	101 15	171 22	107 29
Wed	- 28	226 05	186 12	194 19	218 26	292 02	124 09	230 16	80 23	155 30
Thu	- 29	226 06	150 13	218 20	219 27	218 03	170 10	233 17	112 24	129 31
Fri	- 30	193 07	130 14	223 21	145 28	220 04	278 11	188 18	106 25	- 01
Sat	196 01	214 08	141 15	247 22	189 29	177 05	280 12	209 19	110 26	- 02
	December					January				

Sun	- 27	141 03	87 10	78 17	64 24
Mon	- 28	147 04	122 11	76 18	92 25
Tue	- 29	208 05	175 12	76 19	41 26
Wed	- 30	129 06	150 13	96 20	30 27
Thu	- 31	67 07	131 14	76 21	36 28
Fri	128 01	81 08	69 15	60 22	- 01
Sat	134 02	59 09	76 16	39 23	- 02
	February				

Good Days: 5% **Moderate Days:** 26% **Poor Days:** 69%

Patna

Patna remains the most polluted of the 9 cities monitored as it recorded the maximum number of poor air quality days with 79 percent of the total monitored days in poor category. The city also recorded 'zero' good air days with the daily $PM_{2.5}$ averages ranging between 140 to 270 micrograms per cubic meter for most days in November 2018.

The maximum $PM_{2.5}$ value was recorded on 5th January at 395. The levels consistently crossed the India safe limits for $PM_{2.5}$ by 5-6 times.

Sun	- 30	- 07	- 14	122 21	132 28	140 04	222 11	186 18	256 25	
Mon	- 01	- 08	95 15	136 22	120 29	161 05	222 12	271 19	253 26	
Tue	- 02	- 09	95 16	121 23	107 30	181 06	207 13	267 20	195 27	
Wed	- 03	- 10	99 17	103 24	89 31	246 07	189 14	268 21	160 28	
Thu	- 04	- 11	115 18	135 25	116 01	233 08	158 15	192 22	190 29	
Fri	- 05	- 12	96 19	143 26	120 02	159 09	98 16	209 23	196 30	
Sat	- 06	- 13	117 20	128 27	130 03	185 10	118 17	205 24	- 01	
	October				November					

Sun	- 25	219 02	267 09	167 16	268 23	271 30	214 06	246 13	240 20	112 27
Mon	- 26	233 03	307 10	243 17	238 24	323 31	227 07	190 14	269 21	116 28
Tue	- 27	235 04	262 11	292 18	229 25	373 01	147 08	125 15	241 22	131 29
Wed	- 28	276 05	258 12	209 19	234 26	361 02	167 09	194 16	151 23	154 30
Thu	- 29	242 06	258 13	283 20	224 27	344 03	227 10	227 17	158 24	210 31
Fri	- 30	227 07	227 14	279 21	203 28	325 04	251 11	238 18	212 25	- 01
Sat	224 01	255 08	160 15	303 22	243 29	395 05	264 12	223 19	202 26	- 02
	December					January				

Sun	- 27	208 03	101 10	93 17	63 24	
Mon	- 28	188 04	114 11	92 18	86 25	
Tue	- 29	165 05	126 12	133 19	142 26	
Wed	- 30	181 06	160 13	124 20	77 27	
Thu	- 31	187 07	174 14	108 21	69 28	
Fri	250 01	110 08	148 15	141 22	- 01	
Sat	240 02	95 09	94 16	68 23	- 02	
	February					

Good Days: 0% **Moderate Days:** 21% **Poor Days:** 79%

Raipur

The central Indian city of Raipur fared at number 5 for having the maximum number of poor air quality days. The average values derived for the 45-day period for two different monitoring locations varied from poor to moderate. The city recorded close to 22 percent of its monitored days with poor air quality; the maximum $PM_{2.5}$ concentration was observed on December 6th at 158 micrograms per cubic meter.

Sun	- 30	- 07	- 14	79 21	56 28	71 04	117 11	83 18	57 25	
Mon	- 01	- 08	63 15	79 22	82 29	81 05	113 12	92 19	64 26	
Tue	- 02	- 09	74 16	96 23	80 30	74 06	113 13	72 20	61 27	
Wed	- 03	- 10	67 17	73 24	50 31	139 07	107 14	73 21	104 28	
Thu	- 04	- 11	60 18	98 25	45 01	117 08	92 15	78 22	134 29	
Fri	- 05	- 12	71 19	80 26	64 02	116 09	75 16	55 23	134 30	
Sat	- 06	- 13	85 20	79 27	60 03	118 10	72 17	51 24	- 01	
	October				November					

Sun	- 25	142 02	140 09	86 16	115 23	155 30	118 06	87 13	111 20	84 27
Mon	- 26	148 03	129 10	63 17	153 24	148 31	114 07	119 14	89 21	76 28
Tue	- 27	119 04	142 11	53 18	155 25	111 01	112 08	85 15	64 22	62 29
Wed	- 28	143 05	124 12	92 19	117 26	137 02	167 09	98 16	91 23	68 30
Thu	- 29	158 06	116 13	130 20	113 27	150 03	161 10	143 17	80 24	82 31
Fri	- 30	135 07	130 14	145 21	118 28	122 04	101 11	119 18	45 25	- 01
Sat	153 01	111 08	92 15	109 22	80 29	121 05	117 12	111 19	65 26	- 02
	December					January				

Sun	- 27	109 03	57 10	68 17	- 24
Mon	- 28	81 04	66 11	46 18	- 25
Tue	- 29	104 05	91 12	58 19	- 26
Wed	- 30	78 06	103 13	57 20	- 27
Thu	- 31	66 07	124 14	69 21	34 28
Fri	79 01	71 08	85 15	60 22	- 01
Sat	95 02	73 09	50 16	- 23	- 02
	February				

Good Days: 12% **Moderate Days:** 66% **Poor Days:** 22%

Ranchi

Ranchi ranked 7th out of the 9 cities for the number of poor air quality days. It is one of the cities after Jaipur to record the maximum number of moderate air quality days. 61 percent of the monitored days were found to have moderate air quality. The city recorded its highest daily value for $PM_{2.5}$ on January 4th at 214 micrograms per cubic meter, 3-4 times the Indian safety limits.

Sun	- 30	- 07	- 14	54 21	79 28	113 04	97 11	90 18	82 25	
Mon	- 01	- 08	51 15	64 22	103 29	91 05	110 12	85 19	104 26	
Tue	- 02	- 09	60 16	67 23	64 30	84 06	118 13	61 20	101 27	
Wed	- 03	- 10	49 17	54 24	88 31	163 07	88 14	53 21	101 28	
Thu	- 04	- 11	49 18	48 25	79 01	110 08	67 15	80 22	126 29	
Fri	- 05	- 12	46 19	79 26	74 02	78 09	67 16	94 23	117 30	
Sat	- 06	- 13	43 20	69 27	77 03	114 10	77 17	87 24	- 01	
	October				November					

Sun	- 25	125 02	110 09	102 16	102 23	135 30	195 06	158 13	82 20	- 27
Mon	- 26	128 03	136 10	89 17	111 24	129 31	118 07	140 14	76 21	- 28
Tue	- 27	120 04	175 11	42 18	95 25	163 01	138 08	75 15	90 22	- 29
Wed	- 28	123 05	187 12	96 19	88 26	131 02	90 09	65 16	79 23	- 30
Thu	- 29	91 06	158 13	108 20	88 27	106 03	99 10	87 17	- 24	- 31
Fri	- 30	102 07	110 14	134 21	70 28	214 04	127 11	84 18	- 25	- 01
Sat	110 01	121 08	100 15	130 22	109 29	161 05	131 12	105 19	- 26	- 02
	December					January				

Sun	- 27	43 03	45 10	45 17	40 24
Mon	- 28	- 04	68 11	69 18	39 25
Tue	- 29	- 05	73 12	84 19	60 26
Wed	- 30	- 06	82 13	53 20	48 27
Thu	- 31	- 07	74 14	57 21	48 28
Fri	- 01	- 08	68 15	45 22	- 01
Sat	- 02	75 09	35 16	58 23	- 02
	February				

Good Days: 20% **Moderate Days:** 61% **Poor Days:** 19%

Varanasi

The country's spiritual capital remained one of the most unsafe cities to live in with poor to moderate $PM_{2.5}$ levels being recorded for 78 percent of the days monitored. The city consistently recorded poor air quality levels from the third week of October and remained so till the end of January. The peak levels were recorded on the 1st January at 324 micrograms per cubic meter, exceeding the Indian safe air limits by 5 times.

	October				November				
Sun	- 30	- 07	- 14	25 21	142 28	109 04	200 11	156 18	111 25
Mon	- 01	- 08	110 15	105 22	157 29	145 05	176 12	138 19	122 26
Tue	- 02	- 09	110 16	103 23	131 30	168 06	160 13	132 20	140 27
Wed	- 03	- 10	25 17	112 24	125 31	172 07	141 14	137 21	138 28
Thu	- 04	- 11	23 18	136 25	128 01	172 08	190 15	116 22	143 29
Fri	- 05	- 12	19 19	128 26	132 02	182 09	149 16	132 23	166 30
Sat	- 06	- 13	24 20	106 27	129 03	198 10	136 17	123 24	- 01

	December					January				
Sun	- 25	234 02	269 09	161 16	234 23	236 30	226 06	253 13	195 20	140 27
Mon	- 26	211 03	266 10	224 17	202 24	306 31	158 07	194 14	215 21	151 28
Tue	- 27	245 04	199 11	164 18	156 25	324 01	204 08	122 15	196 22	124 29
Wed	- 28	265 05	225 12	163 19	177 26	330 02	157 09	178 16	152 23	128 30
Thu	- 29	254 06	230 13	254 20	181 27	277 03	188 10	232 17	163 24	152 31
Fri	- 30	273 07	172 14	185 21	169 28	253 04	279 11	221 18	182 25	- 01
Sat	239 01	216 08	139 15	208 22	207 29	262 05	282 12	211 19	130 26	- 02

	February				
Sun	- 27	179 03	75 10	75 17	66 24
Mon	- 28	163 04	127 11	78 18	94 25
Tue	- 29	174 05	145 12	76 19	117 26
Wed	- 30	173 06	164 13	122 20	67 27
Thu	- 31	125 07	147 14	102 21	73 28
Fri	211 01	103 08	91 15	85 22	- 01
Sat	204 02	78 09	84 16	61 23	- 02

Good Days: 4% **Moderate Days:** 18% **Poor Days:** 78%