

VISUALIZING THE IMPACT OF  
**EPISODIC AIR POLLUTION DURING  
OCTOBER & NOVEMBER 2018**  
IN INDIAN CITIES

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

January 2019



## ACKNOWLEDGEMENT

Respirer Living Sciences Pvt. Ltd. would like to thank Shakti Sustainable Energy Foundation for providing funding and strategic assistance in the establishment of Atmos network in 10 Indian cities. The analyses this report presents is premised on the data from the Atmos monitors.

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

The views/analysis expressed in this report/document do not necessarily reflect the views of Shakti Sustainable Energy Foundation. The Foundation also does not guarantee the accuracy of any data included in this publication nor does it accept any responsibility for the consequences of its use.

*For Private Circulation Only.*

## DATA ACCESS

All data used in this report is freely available to view & download via the realtime dashboard at – <http://atmos.urbansciences.in>

For feedback, suggestions, PM<sub>2.5</sub> datasets and API access to the data, email – [research@urbansciences.in](mailto:research@urbansciences.in)

# TABLE OF CONTENTS

---

|   |           |
|---|-----------|
| .....   | 1         |
| Acknowledgement .....   | 2         |
| Disclaimer .....  | 2         |
| Data access .....   | 2         |
| <b>Table of Contents .....</b>  | <b>3</b>  |
| <b>Background .....</b>   | <b>4</b>  |
| Low-Cost Air Quality Monitoring across Indian Cities .....                        | 4         |
| <b>Methodology .....</b>  | <b>5</b>  |
| <b>Summary of the Findings .....</b>  | <b>6</b>  |
| Highest Daily Averages or Maximum Values Recorded .....                           | 7         |
| Ranking based on 45-Day Averages for Various Stations across the Ten Cities ..... | 8         |
| Firecount Data across Indian cities .....   | 9         |
| <b>City-wise Analysis .....</b>   | <b>10</b> |
| Daily Average of PM <sub>2.5</sub> Levels .....                                   | 10        |
| Ahmedabad - Gandhinagar .....   | 10        |
| Dehradun .....  | 11        |
| Delhi .....   | 12        |
| Jaipur .....  | 13        |
| Kanpur .....  | 14        |
| Patna .....   | 15        |
| Raipur .....  | 16        |
| Ranchi .....  | 17        |
| Varanasi .....  | 18        |

# BACKGROUND

---

Air pollution is ranked as the second highest public health risk in India (second only to heart disease). 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<sup>1</sup>. In addition, two key events – seasonal fires and burning of firecrackers during Diwali – cause an exponential spike in pollution levels during the winter months across the region. Whilst vehicular and industrial emissions contribute their fair share throughout the year, winter-time episodes, however, remain the most toxic.

Several measures have been taken: a Supreme Court verdict ahead of Diwali restricted the sale and use of polluting fireworks of a particular grade and category. The state and central government introduced alternative methods that incentivize farmers to curb crop burning. Nevertheless, the cities across Northern India continued to reel under severe pollution levels.

Despite these, cities across India witnessed high pollution episodes. 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.



November 7<sup>th</sup> 2018, New Delhi (Picture Courtesy – The Times of India)

## 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) is deploying 50 low cost air quality monitors (Atmos) across Indian cities. These monitors were calibrated against reference grade monitors (E-BAM) and are primarily being deployed in residential and office buildings. This report seeks to assess the impact of agricultural fire-burning and Diwali

---

<sup>1</sup> <http://web.iitd.ac.in/~sagnik/Chapter.pdf>

firecrackers on the pollution levels in the vicinity of deployed monitors. The assessment period spans 45 days, from October 15 to November 30, 2018, during which the episodes were witnessed.

## 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       | 2               |
| Jaipur      | 4               |
| Kanpur      | 5               |
| Patna       | 5               |
| Varanasi    | 5               |
| Ahmedabad   | 5               |
| Raipur      | 5               |
| Ranchi      | 5               |
| Bhopal*     | 4               |



\*Devices yet to be installed at final locations.

In northern India, monitors were installed in **Delhi, Varanasi, Patna, Kanpur, Jaipur and Dehradun**. In the Central Indian region they were installed in **Ahmedabad, Ranchi and Raipur**.

24-hour averages have been analyzed for Particulate Matter 2.5 (PM<sub>2.5</sub>) to understand the pollution trends over a period of 45 days. The 24-hour PM<sub>2.5</sub> averages have been further categorized into a color-coded index based on the levels of pollution on that particular day. A week-long trend has been derived for all the cities during Diwali (Nov 5 - Nov 9, 2018).

### Color-Coded Index

| Our Code          | GOOD |              | MODERATE |        | POOR      |        |
|-------------------|------|--------------|----------|--------|-----------|--------|
| PM <sub>2.5</sub> | 0-30 | 31-60        | 61-90    | 91-120 | 121-250   | 250+   |
| Air Quality       | Good | Satisfactory | Moderate | Poor   | Very Poor | Severe |

# SUMMARY OF THE FINDINGS

---

During the period from October 15 to November 30, 2018, Patna, Varanasi and Kanpur recorded the worst air quality, with 70 percent “Poor” and “Very Poor” air quality days.

Patna had ZERO “Good” air quality days, Kanpur a close second with only 2 percent and Varanasi marginally better at 11 percent.

Following these three cities, Delhi and Jaipur were next in line to be the most polluted out of the nine cities monitored for PM<sub>2.5</sub> levels.

Delhi recorded 51 percent “Poor” and “Very Poor” days and 19 percent “Good” air quality days. It is important to note that the monitors located in Delhi 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%   | 30%      | 70%  |
| 2    | KANPUR    | 2%   | 28%      | 70%  |
| 3    | VARANASI  | 11%  | 19%      | 70%  |
| 4    | DELHI     | 19%  | 30%      | 51%  |
| 5    | JAIPUR    | 15%  | 66%      | 19%  |
| 6    | RAIPUR    | 17%  | 77%      | 6%   |
| 7    | RANCHI    | 21%  | 75%      | 4%   |
| 8    | AHMEDABAD | 30%  | 66%      | 4%   |
| 9    | DEHRADUN  | 52%  | 43%      | 5%   |

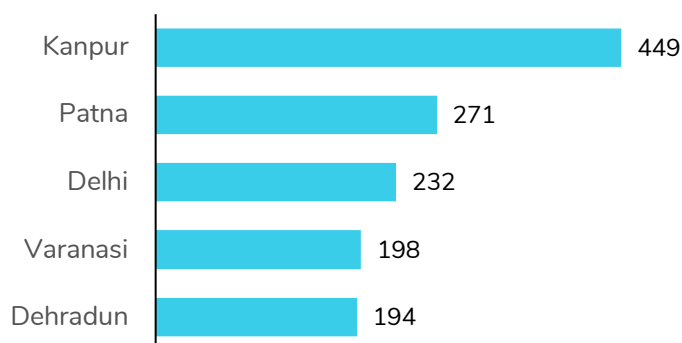
## HIGHEST DAILY AVERAGES OR MAXIMUM VALUES RECORDED

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

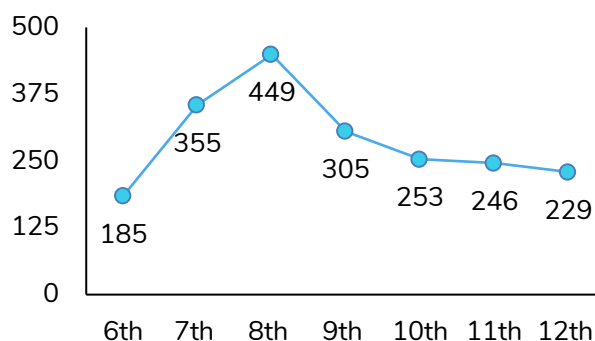
While the above rankings indicate the various category of days based on the air quality index for the PM<sub>2.5</sub> levels, the highest daily averages were recorded in the cities of Kanpur, Patna, Delhi, Varanasi and Dehradun during the Diwali week.

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

North India | Daily PM<sub>2.5</sub> Avg.

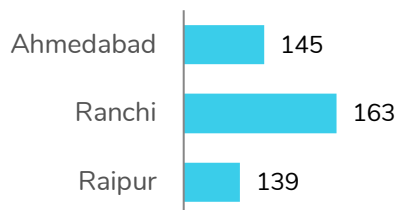


Kanpur | Diwali 2018 PM<sub>2.5</sub> Avg.



### Central India: Ranchi, Ahmedabad and Raipur

Central India | Daily PM<sub>2.5</sub> Avg.



In the cities across central India however, Ranchi topped the charts with Ahmedabad and Raipur 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 45-DAY AVERAGES FOR VARIOUS STATIONS ACROSS THE TEN CITIES

Varanasi has witnessed the maximum PM<sub>2.5</sub> 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 <sub>2.5</sub> |
|------|-----------|---------------------|-------------------|
| 1    | Varanasi  | Kamachcha           | 208               |
| 2    | Kanpur    | Govind Nagar        | 189               |
| 3    | Kanpur    | Naubasta            | 188               |
| 4    | Patna     | Phulwari Sharif     | 169               |
| 5    | Patna     | Mithapur            | 168               |
| 6    | Delhi     | Sector 30, Gurugram | 166               |
| 7    | Kanpur    | Chunniganj          | 166               |
| 8    | Patna     | CEECC ADRI          | 153               |
| 9    | Kanpur    | Indira Nagar        | 146               |
| 10   | Kanpur    | Surendra Nagar      | 122               |
| 11   | Raipur    | Bharat Mata School  | 110               |
| 12   | Jaipur    | Malviya Nagar       | 100               |
| 13   | Ahmedabad | IIM                 | 89                |
| 14   | Delhi     | Munirka Phase III   | 86                |
| 15   | Raipur    | SHRC                | 85                |

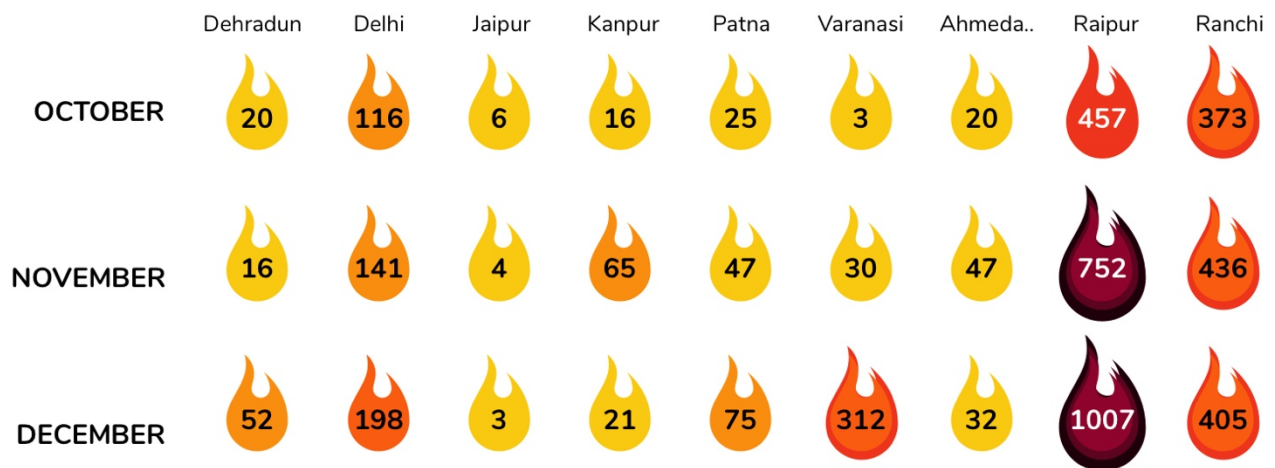
All the monitors spread across these cities recorded PM<sub>2.5</sub> averages in the “Very Poor” and “Severe” category with air pollution levels exceeding the Indian Safety norms by 4-5 times the annual limit and the World Health Organization’s safe air standards by 18-20 times. The monitors spread across central Indian cities had lower air pollution levels with PM<sub>2.5</sub> averages not reaching the “Very 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.

## FIRECOUNT DATA ACROSS INDIAN CITIES

The "Firecount" data is computed using an instrument on-board a polar satellite. The data presented gives the total number of fires occurring in a particular month.



The data are obtained from the medium resolution sensor Visible Infrared Imaging Radiometer Suite (VIIRS), which measures radiation in the middle and thermal infrared wavelength at 375 m spatial resolution. Although 750 m resolution data is also available from VIIRS, the 375 m resolution data is suitable for studies at point locations such as cities. An additional advantage of VIIRS is the measurement of fires both during day and night time. Comparison of VIIRS data with airborne and Landsat-8 data showed high level of agreement [Schroeder et al, 2014]<sup>2</sup>.

<sup>2</sup> Wilfrid Schroeder, Patricia Oliva, Louis Giglio, Ivan A. Csiszar (2014), The New VIIRS 375 m active fire detection data product: Algorithm description and initial assessment, Remote Sens. Environ., doi:10.1016/j.rse.2013.12.008.

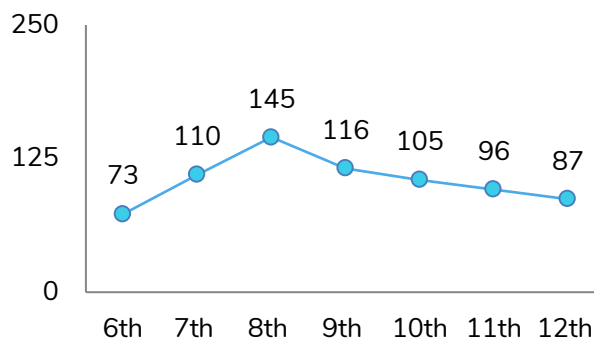
# CITY-WISE ANALYSIS

## Daily Average of PM<sub>2.5</sub> Levels

### AHMEDABAD - GANDHINAGAR

Ahmedabad recorded a 45-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 29 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 Safe limits for PM<sub>2.5</sub> on a 24-hour basis.

Ahmedabad | Diwali 2018 PM<sub>2.5</sub> Avg.



Ahmedabad recorded the maximum number of moderate air quality days in comparison to the other cities, 55 percent of the monitored days were found to be in the moderate category.

|     |         |      |       |       |       |          |       |        |        |  |
|-----|---------|------|-------|-------|-------|----------|-------|--------|--------|--|
| 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   |  |
|     | October |      |       |       |       | November |       |        |        |  |

Good Days: 30%

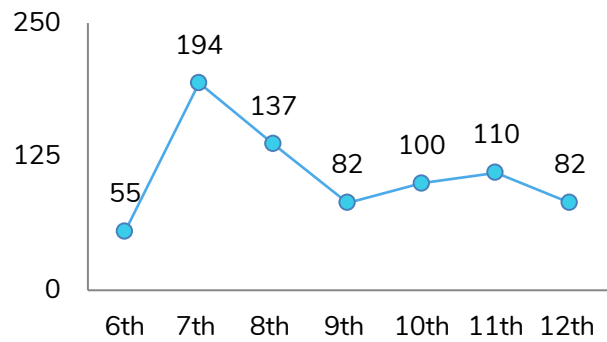
Moderate Days: 66%

Poor Days: 4%

# DEHRADUN

Despite its proximity to Delhi, the hill city of Dehradun has fared to be the least polluted among the 10 cities. It recorded 50 percent of the monitored days to be in the good/safe air quality limit. It also has the least number of poor air quality days with an exception of Diwali on the 6<sup>th</sup> and 7<sup>th</sup> of November where the city saw the season's maximum levels of PM<sub>2.5</sub>, 2-3 times the Indian Safety limits on a 24-hour basis.

Dehradun | Diwali 2018 PM<sub>2.5</sub> Avg.



|     |         |      |       |       |       |          |        |       |       |  |
|-----|---------|------|-------|-------|-------|----------|--------|-------|-------|--|
| 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  |  |
|     | October |      |       |       |       | November |        |       |       |  |

Good Days: 52%

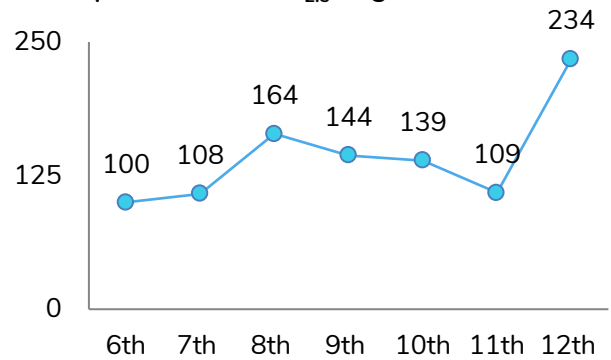
Moderate Days: 43%

Poor Days: 5%

# 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. 72 percent of the days monitored were found to be in the poor and very poor category with PM<sub>2.5</sub> values consistently being close to and above 200 micrograms per cubic meter for three consecutive weeks in the month of November. 234 is the highest recorded daily average for Delhi which is equivalent to 3.5 times the daily safe limit set by Indian government.

Delhi | Diwali 2018 PM<sub>2.5</sub> Avg.



|     |         |      |        |        |        |          |        |        |        |  |
|-----|---------|------|--------|--------|--------|----------|--------|--------|--------|--|
| 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   |  |
|     | October |      |        |        |        | November |        |        |        |  |

Good Days: 19%

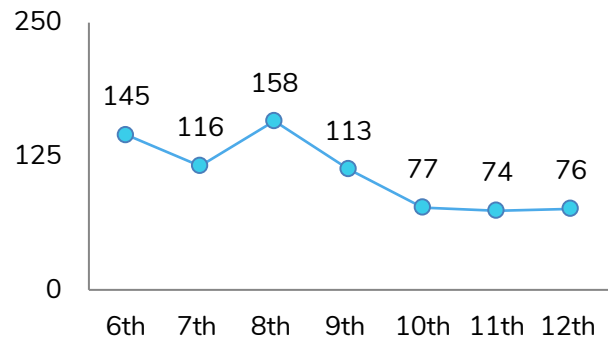
Moderate Days: 30%

Poor Days: 51%

# JAIPUR

Rajasthan's capital Jaipur recorded a similar percentage of good, moderate and poor air quality days to that of Raipur. With 45 percent of days in poor category and 40 percent in moderate category, the city recorded its maximum PM<sub>2.5</sub> value for 24-hour on the 8<sup>th</sup> of November post Diwali at 158 micrograms per cubic meter which is equivalent to 2.5 times the Indian safe limit.

Jaipur | Diwali 2018 PM<sub>2.5</sub> Avg.



|         |      |      |       |       |          |        |        |        |        |
|---------|------|------|-------|-------|----------|--------|--------|--------|--------|
| 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 |        |        |        |        |

Good Days: 15%

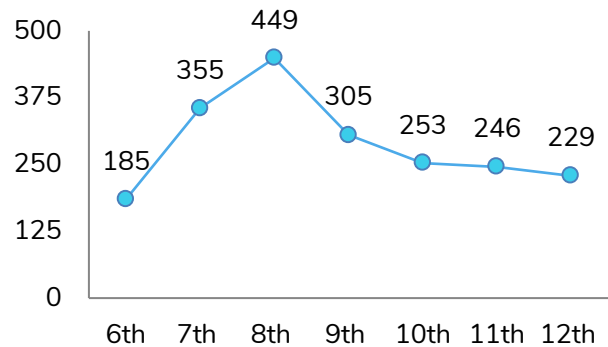
Moderate Days: 66%

Poor Days: 19%

# KANPUR

Kanpur scored third after Patna and Varanasi for having the maximum number of poor air quality days. The city recorded very poor pollution averages for the whole of November with some of the days even recording severe air quality for three to four days in a row. The maximum 24-hour value for PM<sub>2.5</sub> is noted in Kanpur at 449 micrograms per cubic meter, more than 7.2 times the Indian safety limit.

Kanpur | Diwali 2018 PM<sub>2.5</sub> Avg.



|     |         |      |        |        |          |        |        |        |        |
|-----|---------|------|--------|--------|----------|--------|--------|--------|--------|
| 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 |        |        |        |        |

Good Days: 2%

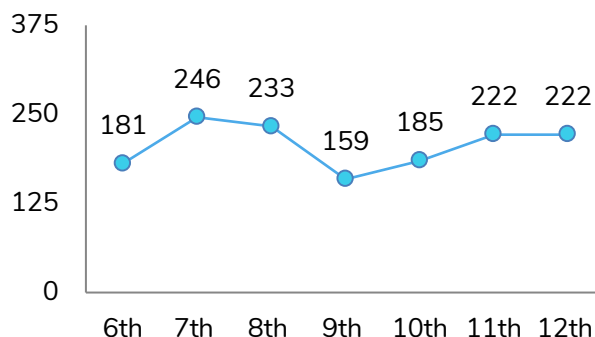
Moderate Days: 28%

Poor Days: 70%

# PATNA

Patna remains the most polluted of the 10 cities monitored as it recorded the maximum number of poor air quality days with 98 percent of the total monitored days in poor to severe category. The city also recorded 'zero' good air days with the daily PM<sub>2.5</sub> averages ranging between 140 to 270 micrograms per cubic meter for most days in November 2018.

Patna | Diwali 2018 PM<sub>2.5</sub> Avg.



The maximum PM<sub>2.5</sub> value was recorded on 19<sup>th</sup> November at 271. The levels consistently crossed the India safe limits for PM<sub>2.5</sub> by 4-5 times.

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

Good Days: 0%

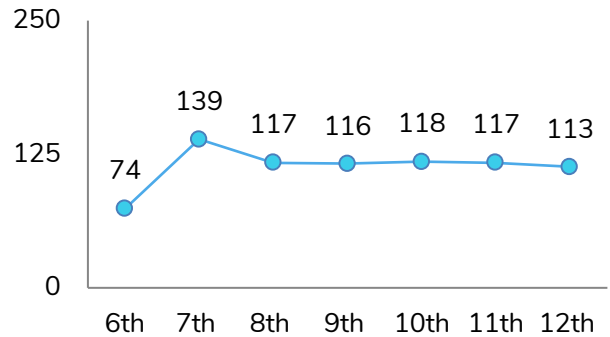
Moderate Days: 30%

Poor Days: 70%

# RAIPUR

The central Indian city of Raipur fared at number 6 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 45 percent of its monitored days with poor air quality; the maximum PM<sub>2.5</sub> concentration was observed on the day of Diwali at 139 micrograms per cubic meter.

Raipur | Diwali 2018 PM<sub>2.5</sub> Avg.



|     |         |      |       |       |       |          |        |       |        |  |
|-----|---------|------|-------|-------|-------|----------|--------|-------|--------|--|
| 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 |        |       |        |  |

Good Days: 17%

Moderate Days: 77%

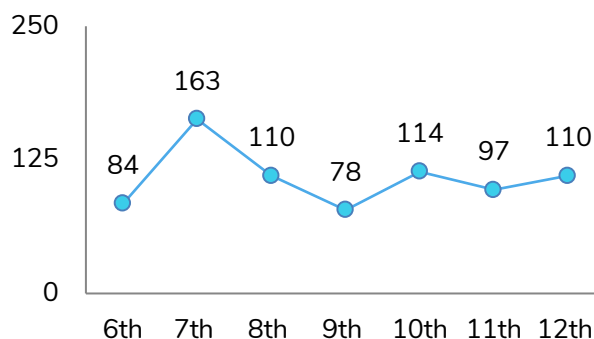
Poor Days: 6%



# RANCHI

Ranchi ranked 7<sup>th</sup> out of the 10 cities for the number of poor air quality days. It is one of the cities after Ahmedabad to record the maximum number of moderate air quality days. 49 percent of the monitored days were found to have moderate air quality. The city recorded its highest daily value for PM<sub>2.5</sub> on the day of Diwali at 163 micrograms per cubic meter, 2.5 times the Indian safety limits.

Ranchi | Diwali 2018 PM<sub>2.5</sub> Avg.



|     |         |      |       |       |        |          |        |       |        |  |
|-----|---------|------|-------|-------|--------|----------|--------|-------|--------|--|
| 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 |        |       |        |  |

Good Days: 21%

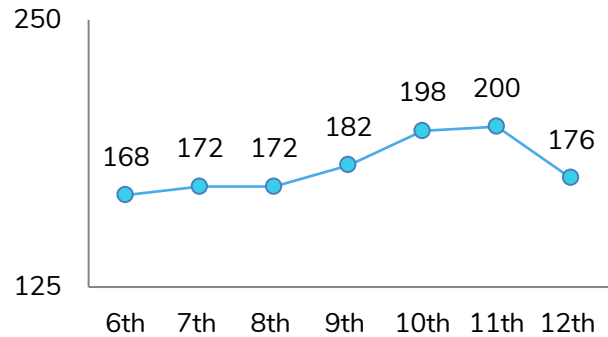
Moderate Days: 75%

Poor Days: 4%

# VARANASI

The country's spiritual capital remained one of the most unsafe city to live in with very poor to poor PM<sub>2.5</sub> levels being recorded for 89 percent of the days monitored. The city consistently recorded very poor air quality levels from the third week of October and remained so till the end of November. The peak levels were recorded on the 11<sup>th</sup> November at 200 micrograms per cubic meter, exceeding the Indian safe air limits by 3.5 times.

Varanasi | Diwali 2018 PM<sub>2.5</sub> Avg.



|     |         |      |        |        |          |        |        |        |        |  |
|-----|---------|------|--------|--------|----------|--------|--------|--------|--------|--|
| 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   |  |
|     | October |      |        |        | November |        |        |        |        |  |

Good Days: 11%

Moderate Days: 19%

Poor Days: 70%