

Absence of winter rains keep pollution levels high across Indo-Gangetic Plains

Bad air quality days continue to haunt Indo-Gangetic Plains, with the Air Quality Index oscillating between 'poor' and 'severe' categories. Even the brightest days in Delhi-NCR during the first half of December have kept air quality in the 'poor' category.

As stubble burning subsided across the northwestern states of Punjab and Haryana after the sowing of the rabi crop, the burden of high air pollution levels rests on emissions from sources like industrial activities, transport, regional pollution corridors, and prevailing weather conditions. For dispersion of pollution, cities need to cut down on emissions across sectors and at source. However, weather conditions in the form of rains would bring some immediate relief but with increasing climate change these systems have also become inconsistent.

According to meteorologists, there has been an absolute absence of winter rains across the plains. In the wake of this, a stable wind pattern can be seen over the region and speed is also very slow. Minimum temperatures have been plunging continuously and settling in the range of 4°C-10°C. As the temperatures dip, cold north-westerly winds become heavier because of the increased moisture content. This also increases the capacity of the winds to capture pollutants close to the earth's surface.

"With unabated cold north-westerly winds reaching the plains, minimum temperatures will now drop and settle in single digits. With this, dispersing pollutants from the atmosphere would be very difficult. The more the minimum temperatures dip, thicker will be the inversion layer. And the thicker the inversion layer, it would be more difficult for sun rays or winds to penetrate through this layer and disperse the pollution level," **said Mahesh Palawat, Vice President - Meteorology and Climate Change, Skymet Weather.**

During winters, the air in the planetary boundary layer (the lowest part of the atmosphere) is thinner as the cooler air near the earth's surface is dense. The cooler air is trapped under the warm air above that forms a kind of atmospheric 'lid'. This phenomenon is called winter inversion. Since the vertical mixing of air happens only within this layer, the pollutants released lack enough space to disperse in the atmosphere.

A significant correlation was also found between the elevated levels of air pollutants (PM10, PM2.5, sulphur dioxide, nitrogen dioxide, and carbon monoxide) and low ozone levels in winter months and meteorological parameters such as air temperature (low values), air humidity (high values), and wind speed (high values) at the same time.

Usually by this time of the year, the region witnesses at least one or two spells of winter rains and snowfall. However, due to the absence of any strong Western Disturbance (WD) up in the Himalayas, rains have been evading entire plains. While on and off feeble Western Disturbances have been visiting but they were not capable of triggering any significant weather activity.

According to the state run India Meteorological Department, November saw the passage of five WDs across North India. Out of these, two WDs (November 2-5 and 6-9) caused

isolated to scattered rain or snowfall over Western Himalayan region and rainfall over adjoining areas. The remaining three were feeble (November 13-15, 18-21 and 22-24) located north of 30°N and did not affect the region.

Western Disturbances keep impacting the weather of Western Himalayas round the year. However, it is only by November, that intensity and frequency of Western Disturbances start picking up pace gradually. They also start travelling in the lower latitudes much closer to the hilly states, triggering the weather activities. Intensity and frequency is at the peak by January and February. According to a [study](#) by IMD, on an average during the months of November and December, 2 moderate to severe WD's cases were observed and 3 cases during January, February, March and April, respectively.

WDs govern the weather pattern over the North-western plains, especially during the winters. Arrival of a strong Western Disturbance triggers rain and snowfall across the hilly states and Indo-Gangetic Plains (IGP). It is only after the passage of this active system, which pushes icy winds across the plains, declaring the onset of the Winter season.

With the pattern missing this season so far, pollutants in the atmosphere are not able to clear up on account of no weather activity or change in wind pattern (increase in wind speed). Further in the IGP, the hub of winter air pollution, things seem to be getting worse with meteorologists predicting lesser rains in the remaining days of December.

"It is not only about the Indo-gangetic plains but most of the country saw air quality deteriorating. PM 10 was not the only contributor but carbon monoxide levels were also high. This shows construction activities were not alone but combustion was also high. Besides this, large scale meteorological phenomena like La Nina are also contributing by slowing down the circulations. We need more 'Early Warning Systems' to predict air quality. These systems could let us know what is the relative contribution of slowed weather systems," said S N Tripathi, Professor, Civil Engineering dept, IIT Kanpur.

High levels of air pollution are reflecting in major cities across the Indo-Gangetic Plain. For instance, in November 2022, the PM 2.5 concentration in the capital city of Delhi was 183.38 ug/m³ which is three times higher than the Central Pollution Control Board's daily safe limit of 60 ug/m³. Similarly, other cities like Ghaziabad, Kanpur, Gurugram, Sonapat all recorded PM 2.5 levels around double the safety limits.

With meteorology at play, PM 2.5 levels in 2022 were higher than safe limits but lower compared to 2021.

Despite the missing rains this year, PM 2.5 levels in November 2022 were lower as compared to 2021. While October was rain surplus for both the years on account of the delayed withdrawal of Monsoon, it was the wind patterns and La Nina that defined the pollution levels for each year differently.

The delayed monsoon pushed the harvesting of the Kharif crop and stubble burning episodes to November for both 2021 and 2022. However, meteorology thereafter played out differently in the two years.

In 2021, the passage of active western disturbances on account of prevailing La Nina conditions brought some good spells of rain and snow across Northwest India at regular intervals. This washed away the pollutants briefly but winter rains also kept the temperatures low and increased humidity levels. Thus, the pollutants were trapped in the atmosphere for a longer period of time, resulting in smog. Besides this, the wind pattern was also from a north-westerly direction, which meant pollutants from the stubble burning episodes in Haryana were carried into the cities. All this collectively aggravated the pollution levels across the plains in 2021.

Meanwhile in 2022, the Indo-Gangetic plains have been witnessing westerly winds from Rajasthan, instead of north-westerly winds from Punjab and Haryana. This was due to the absence of any weather system which could alter the wind pattern. Hence, winds carrying pollutants triggered from stubble burning, could not reach the plains as much as last year. Additionally, according to the Indian Agricultural Research Institute (IARI) stubble burning episodes in the states of Punjab and Haryana in 2022 were down by 30% (78,291 to 53,583) as compared to 2021. Furthermore, winter rains have also been deficit so far, keeping the temperatures above average across the region. Due to this, humidity levels were not very low, which were not able to trap the pollutants in the atmosphere. However, as temperatures dip and rains continue to be elusive in the region, the pollutants currently suspended in the air are less likely to be washed away any time soon.

“Given that meteorological and reduced emission factors are both at play, AQI levels across the Indo-Gangetic basin should have been better had winter rains occurred as expected. With temperatures dipping across the plains in the last couple of days, pollution levels have directly and proportionately gone up. It is clear that while there is no substitute for reducing pollutants at source for better air quality, meteorology plays an intricate role in air quality levels. While it is heartening to see that air pollution in November 2022 might be relatively better in some cities across the IGP, it still remains much higher than the CPCB’s safety levels, which in any case are more relaxed in comparison to the WHO’s stringent air quality guidelines,” **said Aarti Khosla, Director, Climate Trends.**

City	PM 2.5 Levels 2021		PM 2.5 Levels 2022	
	October	November	October	November
Ghaziabad	104.34	264.63	106.39	145.44
Kanpur	57.46	143.39	58.75	106.1
Lucknow	56.76	124.5	58.82	94.48
Chandigarh	41.2	57.62	49.93	83.13
Jaipur	58.83	101.57	55	69.05
Patna	45.25	120.61	66.27	135.1
Gurugram	77.62	215.04	99.38	152.72
Kolkata	50.02	77.5	33.32	87.07
Delhi	74.88	236.89	100.29	183.38
Sonipat	49.07	140.79	55.79	109.51

Source: CPCB

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