Chilly winters courtesy of La Nina, peak stubble burning to worsen air quality in North India

As La Nina makes an appearance for the second time in a row and meteorologists expect an intense winter, North India can expect to see prolonged spells of pollution over the coming months. While a lower number of crop residue burning incidents and widespread rain and snow in October kept pollution under check in the region until recently, the situation is already changing.

With temperature dropping -- and other meteorological factors like wind speed slowing down, wind direction, haze setting in -- pollution levels are again in the 'very poor' and 'hazardous' categories in most cities across the Indo-Gangetic plains (IGP). The seasonal factors of firecrackers and stubble burning have, as usual, added to the problem, as the peak of crop residue burning incidents coincide with Diwali.

Extended relation between La Nina and Air Pollution

With, second consecutive La Nina, Northwest India is gearing up for intense chilly weather this season. Meteorologists have been forecasting record low temperatures across IGP this year, with November and December expected to be colder than usual. According to a recent report by Bloomberg, temperatures in India are expected to fall to as low as 3 degrees Celsius (37 Fahrenheit) in some northern areas in January and February before recovering.

"There is a large probability of a second back-to-back La Nina, that may result in extreme cold from December 2021-February 2022. The oceanic phenomena is expected to peak during this period. Although there is no rule book, with El Niño-Southern Oscillation (ENSO) getting colder than earlier estimates, the confidence in this forecast has grown off late. But, it should be noted the winter forecast is affected by many other factors from other parts of the globe as well," **said G P Sharma, President-Meteorology and Climate Change, Skymet Weather.**

It has been clearly established that the winter season is the favourable time for increase in pollution. In the wintertime, cold air frequently settles over northern India. Wintertime temperature inversions contribute to the build up of haze. Inversions occur when cold air gets trapped under a layer of warm air. Since the cold air cannot rise above the warm air, pollution builds in the cold air as long as the temperature inversion lasts. The haze seen in the winter months is the result of a temperature inversion mostly. Usually, air high in the atmosphere is cooler than air near Earth's surface. Warmer air near the surface rises, allowing pollutants from the surface to disperse in the atmosphere.

More intense spells of Pollution ahead for Northwestern Plains

More number of colder days likely in the season will invariably lead to more number of 'poor' to 'severe' air quality days ahead for the entire IGP, especially Delhi NCR. Experts explain that wintertime is already conducive for pollution and further drop in mercury would worsen the situation.

"With drop in temperatures, there is potential for more stagnant conditions. However, this is assuming that winds do not change. If winds slow due to any reason and stubble or biomass burning increases during this period, the overall air quality situation may worsen in the Northern Plains including New Delhi. In a nutshell, all else remaining constant, cooler conditions inhibit vertical mixing within the atmosphere.

Therefore, possibilities are higher for poor air quality," **said Dr V Vinoj, Assistant Professor, School of Earth Ocean and Climate Sciences, Indian Institute of Technology Bhubaneswar.**

Vicious Smog Circle: Chilly days could trap the plains in the vicious smog circle, which means consecutive days of bad air quality would persist. **Prof S N Tripathi, Head of Department - Civil Engineering, IIT Kanpur and Steering Committee Member, National Clean Air Programme, MoEFCC** explained that the particulate matter (PM) changes its property after coming in contact with fog, paving way for more fog.

"Definitely, intense winters would aggravate the situation. It would mean more amount of haze which would lead to increased trapping of pollutants available over the surface. This might lead to formation of smog which would worsen the condition. All these conditions would result in a vicious smog circle, wherein we would not see clearance for days. Also more cold weather is associated with relatively high humidity, which increases the possibility of particulate matter (PM) holding more water. After the fog disappears, water vapour or droplets evaporate leaving the PM behind. However, a very tiny chemistry takes place here and thus, the PM is not the same as before. It is more oxidised by that time. There is a strong relation between oxidised PM and fog condensation nuclei as compared to non-oxidized components. In fact, smaller droplets oxidise faster and oxidised PM are more efficient and thus formation of fog would be much easier than the previous day," **said Dr Tripathi.**

Extra caution needed this season, reducing emissions the only way

Scientists have warned of extra caution this season as weather is beyond the control and thus focus still remains on curtailing local emissions.

"*We have to be more cautious this season, as pollution may get worse with chilly winters in the offing. Whatever extra we would see can be compensated only if we reduce the emissions, at least at the regional levels. But if we continue with the same amount of emissions along with unfavourable meteorological conditions, there could be some substantial increase in the pollution levels in the coming season. October had been fairly well in terms of pollution on account of extended Monsoon rains and reduced stubble burning. Though pollution might be less, it was still above the permissible limits. December and January are the core winter months and we do not expect stubble burning during that time. With record low temperatures likely, we are not left with any other option but to reduce emissions. Otherwise all clubbed together would multiply the impact and pollution would intensify manifolds. We have no control over meteorological conditions, but we can control emissions,"* **said Dr. Sagnik Dey, Associate Professor, Centre for Atmospheric Sciences, Indian Institute of Technology-Delhi and Coordinator, Centre of Excellence for Research in Climate Change and Air Pollution (CERCA).**

Delayed stubble burning peak and drop in mercury to worsen air pollution in Delhi-NCR

Delhi-NCR is inching towards some worse air quality days. On and off rains during October had pushed the peak season of stubble burning and the month recorded much fewer farm fire cases than 2020.

Data from the ICAR – Indian Agricultural Research Institute shows that total crop residue burning events recorded in the six states this year are 54.8% less than in the same period in 2020. As a result, most of the cities in the six states reported lower concentration of PM 2.5 in September and October 2021 as compared to the last year. Similarly, average fire counts data in Punjab, Haryana & UP from NASA for the

months of September and October in the past five years show that the average PM 2.5 levels in Delhi were the highest in 2017 when the average fire counts were the highest too (see fig 2).

Fig1: Total 20,729 burning events were detected in six states between 15-Sept-2021 and 01-Nov-2021

State	Number of residue burning events between 15-Sept-2021 and 01-Nov-2021	Number of residue burning events between 15-Sept-2020 and 01-Nov-2020	Percentage change in fire counts in the same period
Punjab	15065	37078	-59.4%
Haryana	3038	2495	+21.8%
UP	1217	1255	-3%
Delhi	0	8	-100%
Rajasthan	129	707	-81.8%
MP	1280	4273	70%
Total	20,729	45,816	-54.8%

Data Courtesy: ICAR – Indian Agricultural Research Institute

Fig 2: Fire Count data (Punjab, Haryana & UP) and PM2.5 (Delhi) for last 5 years (2017-2021) of two months (September & October)

Year	Average PM2.5	Average Fire count	Total Fire count
2017	124.1	11440	34320
2018	108.4	4126	9726
2019	97.2	7767	23301
2020	101.9	6754	20262
2021	69.4	5379	16137

However, biomass burning has started picking up pace now. There has been a significant increase in the crop residue burning incidents, especially in northwestern plains. In fact, the above data suggests Haryana has already surpassed the cases registered last year, followed by Uttar Pradesh which is catching up fast with the count in 2020. Seeing the trend in other states, Punjab will likely pick up pace in the coming days. Experts are expecting the next two weeks to be crucial for Delhi's air quality as stubble burning is likely to peak across Indo-gangetic plains.

Also, changing weather patterns on account of climate change are also contributing to an increase in Air Pollution this season. Monsoon 2021 had an extended stay in the country, and started retreating only after October 6, which was 20 days later than the normal date of commencement of withdrawal of Monsoon. Presence of monsoon till October 24 kept giving rains across northwestern plains pushing the stubble burning season as well as polluted days ahead to November.

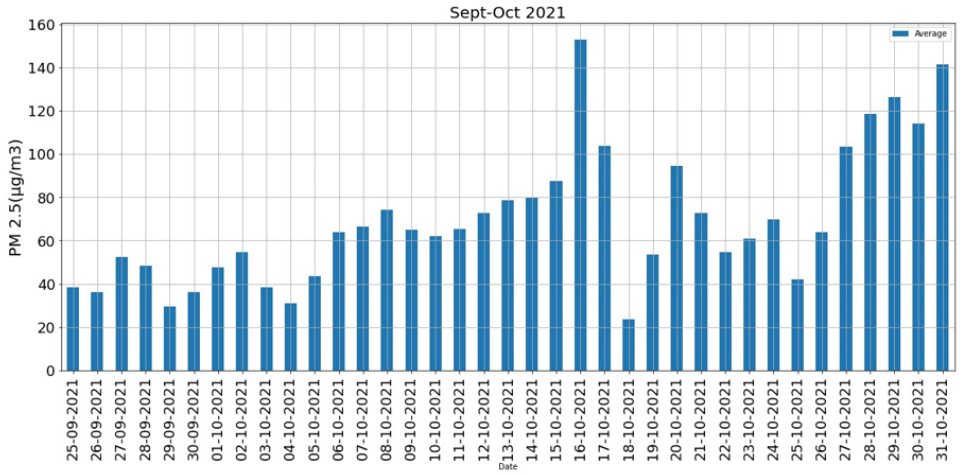

Figure 2. Showing daily average PM2.5 for 2021 from 25th September to 31st October.

Now as we enter November, the combination of drop in mercury and reducing wind speed in the coming days will put Delhi-NCR in a tight spot. *"Had the peak of stubble burning been witnessed in October, the impact would have been less over Delhi-NCR. Neither the wind speed would have been slow nor the temperatures were so down. However, November is a changeover month from spring to winters, wherein we would see drop in temperatures as well as wind speed. This coupled with early arrival of winters seems to set up a stage for unhealthy air quality days for the national capital,"* **said Mahesh Palawat, VP-Meteorology and Climate Change, Skymet Weather.**

Experts at **Council on Energy, Environment and Water (CEEW) - Tanushree Ganguly, Programme Lead, and L. S. Kurinji, Programme Associate** have warned of some tough days ahead for Delhi-NCR. *"Earlier this season, daily fire counts reported in Punjab and Haryana were less than 1000. But in the last four days, more than 2000 fires per day were reported in Punjab and Haryana combined. As we are in the peak burning window, fires are likely to rise as high as 3000-4000 fires per day in the coming days. This*

coupled with unfavourable meteorological conditions such as falling temperatures, reducing wind speeds may compound the impact of stubble burning on Delhi's air quality".

They further added, "While the current share of stubble on Delhi's particulate levels is less than 10 per cent, it is expected to reach 35-45 per cent on 5th November on account of northwest winds. Furthermore, since Diwali coincides with the peak stubble burning window this year, SAFAR's forecast suggests that the additional load from firecrackers could further deteriorate the air quality in Delhi NCR. Therefore, it is important for Delhi NCR to refrain from bursting firecrackers to avert unhealthy AQ conditions."

Diwali PM2.5 analysis for Delhi (averages for RK Puram and Indira Gandhi International Airport) over the last 5 years (2017-2020), and pre-Diwali 2021