2024:Delhi at risk of losing its long term air quality gains

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At the onset of the new year, the assessment of the annual trend in PM2.5 during 2024 shows persistent and consistent rise for the second consecutive year since 2022. This cannot be seen as an annual aberration due to meteorological factors. Consistent rise indicates the impact of growing pollution in the region.

The annual PM2.5 concentration has increased to 104.7 µg/m³ in 2024, - a 3.4 per cent rise from 2023 and this is more than twice the national ambient air quality standard of 40 µg/m³. The PM2.5 levels have increased after consistent decline and stabilisation between 2018 and 2022.

Delhi seems to be losing its air quality gains from past action. Local and regional sources of pollution including vehicles, industries, open burning of waste, use of solid fuels, construction and dust sources have offset the gains -- undermining the longer term progress over the past decade. Delhi cannot hide behind the smoke screen of farm fires any more. Despite a 71.2 per cent drop in stubble fire incidents during the October–December 2024, the winter pollution has remained elevated, upsetting the annual trend.

Real-time data from Delhi's monitoring stations for the winter period (October 1–December 31) reveals a troubling 26 per cent surge in peak pollution levels compared to the previous year during the early phase of winter. The city has experienced 17 days of severe or worse air quality, alongside two extended smog episodes with average smog intensity of 371 µg/m³ and 324 µg/m³, respectively which has kept the average levels elevated.

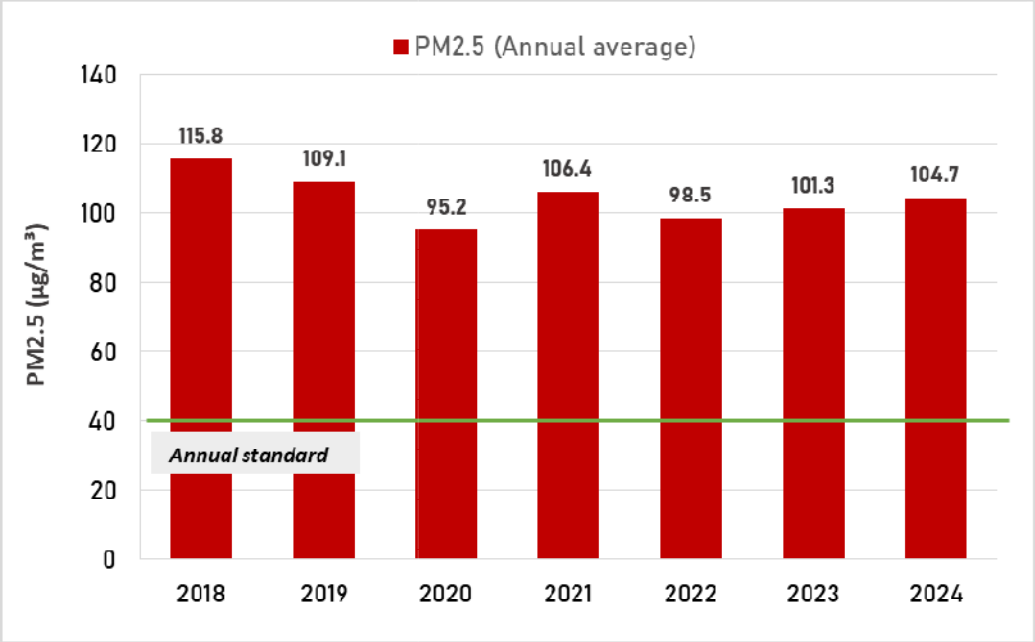
This is an assessment of annual and seasonal trends in PM2.5 concentration for the period 1 October to 31 December for 2018, 2019, 2020, 2021, 2022, 2023, and 2024. This analysis is based on the real time data available from the current working air quality monitoring stations in Delhi-NCR. A huge volume of data points has been cleaned and data gaps have been addressed based on the USEPA method for this analysis. This analysis covers 37 continuous ambient air quality monitoring stations (CAAQMS) spread across Delhi. Fire count data is sourced from NASA's Fire Information for Resource Management System, specifically Visible Infrared Imaging Radiometer Suite (VIIRS) product.

KeyHighlights

Delhi's air quality worsens in 2024: Annual PM2.5 levels shows an upward Trend: Delhi's annual PM2.5 levels have shown fluctuations over the years, with 2020 standing out as an exceptionally clean year due to the pandemic-induced lockdown that caused significant reductions in emissions. However, this improvement has not been sustained, and 2024 marks a concerning trend.

In 2024, the city's annual PM2.5 levels rose to 104.7 µg/m³, marking a 3.4 per cent increase compared to 2023 and standing at 2.6 times higher than the national annual standard of 40 µg/m³. While the 2024 average is still 9.6 per cent lower than the 2018 peak of 115.8 µg/m³, it is 3 per cent higher than the three-year average of 2021- 2023, indicating a gradual reversal of earlier gains. *(See Graph 1: Trend in annual PM2.5 for Delhi).*

Graph1:TrendinannualPM2.5forDelhi

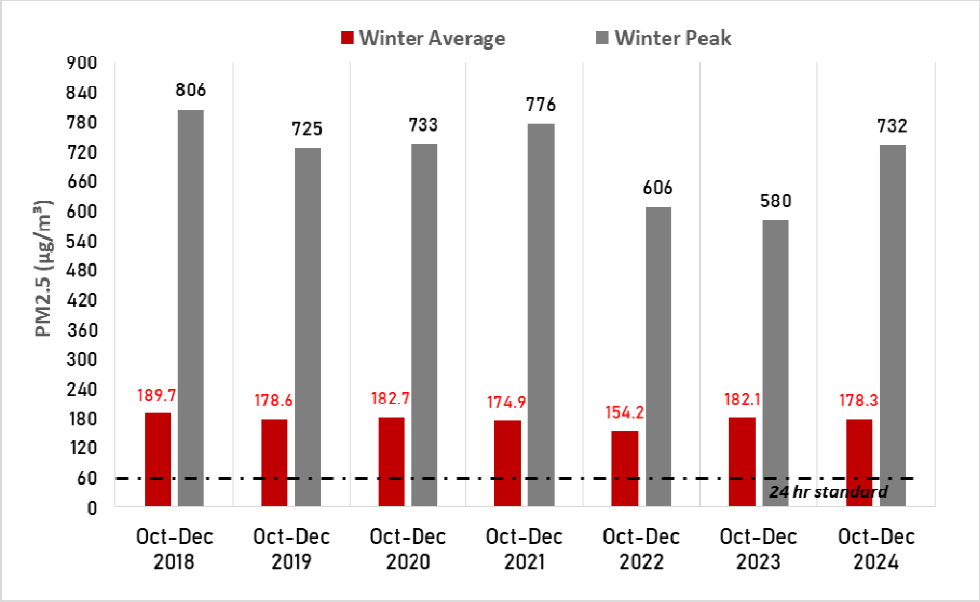


Note:37stationaverageincludesalltheDelhistationsexceptLodhi RoadIITM, ChandniChowkIITM,EastArjunNagar, and New Moti Bagh. 24-hour averages are calculated from midnight to midnight.
Source:CSEanalysisofCPCBreal-timedata

Delhi's winter air pollution stagnates, peak levels surge by 26 per cent in 2024: Delhi's citywide winter PM2.5 average for the October–December, 2024, stood at 178.3 µg/m³, a level consistent with the average since large-scale monitoring began in 2018–19 *(See Graph 2: Trend in winter average and peak pollution in Delhi).* This season's average was 0.2 per cent lower than the 2019 winter average, but 4.6 per cent higher than the three-year winter average (2021–2023), based on data from 37 Continuous Ambient Air Quality Monitoring Stations (CAAQMS) across the city.

However, a troubling trend emerges in peak pollution levels. The citywide winter peak for 2024 soared to 732 µg/m³, marking 26 per cent compared to last year's peak of 580 µg/m³. The citywide peak this year stood at 602 µg/m³ which was recorded on 18 November 2024. While the worst station-level peak this season was 9 per cent lower than the highest ever recorded at 806 µg/m³ during the 2018 winter. *(See Graph 2: Trend in winter average and peak pollution in Delhi)*

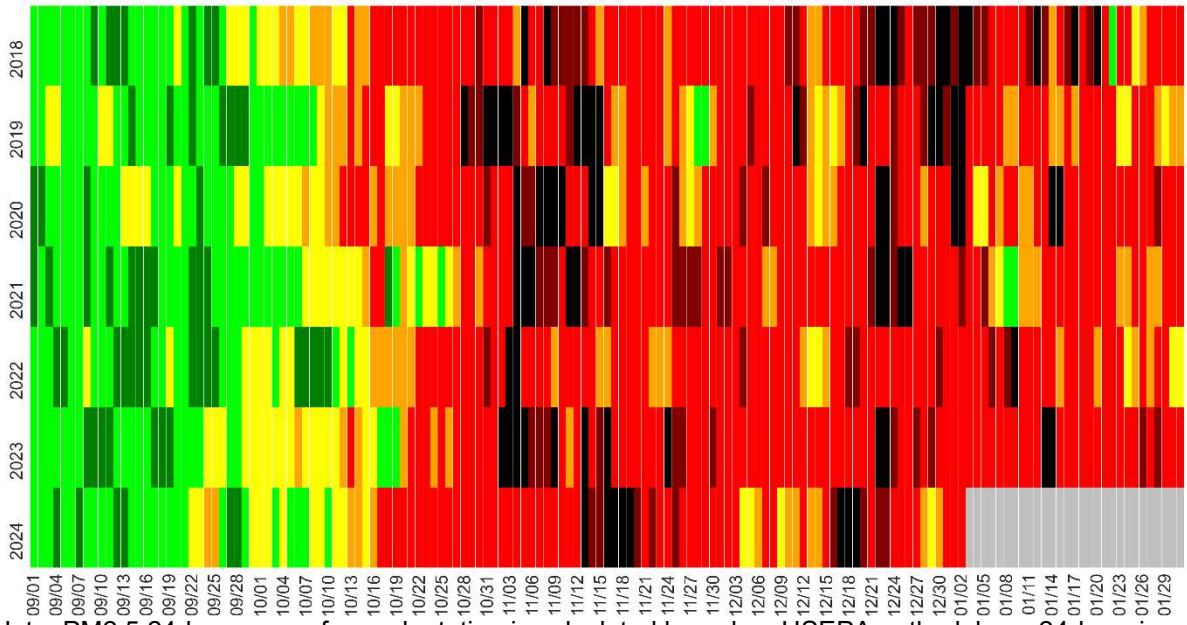
Graph 2: Trend in Winter Average and Peak Pollution in Delhi



Note: Average PM2.5 concentration is based on the mean of daily values recorded at 36 CAAQMS stations in the city that have adequate data for all winters.
Source: CSE analysis of CPCB's real-time air quality data.

Two smog episodes this winter: As is the global practice at least three continuous days of severe AQI is considered a smog episode. During previous winters such episodes have been recorded lasting 6-10 days. This winter two major smog episodes were recorded from 13-20 November – about 8 days; and 16-20 December – about 4 days (See Graph 3: Air quality calendar of Delhi). The average daily intensity of this smog stood at 371 µg/m³ and 324 µg/m³ *(See Graph 3: Air quality calendar of Delhi).*

Graph 3: Air quality calendar of Delhi



Note: PM2.5 24-hr average for each station is calculated based on USEPAmethodology. 24-hour is defined as midnight to midnight.CitywidePM2.5concentrationisbased on mean ofdailyvalues recordedat36 CAAQMstationsinthe citythathave adequate and continuous data from 2018 to 2024.AQI categorization is based on CPCB's IndianAQI formula. The cell color is based on the official colour

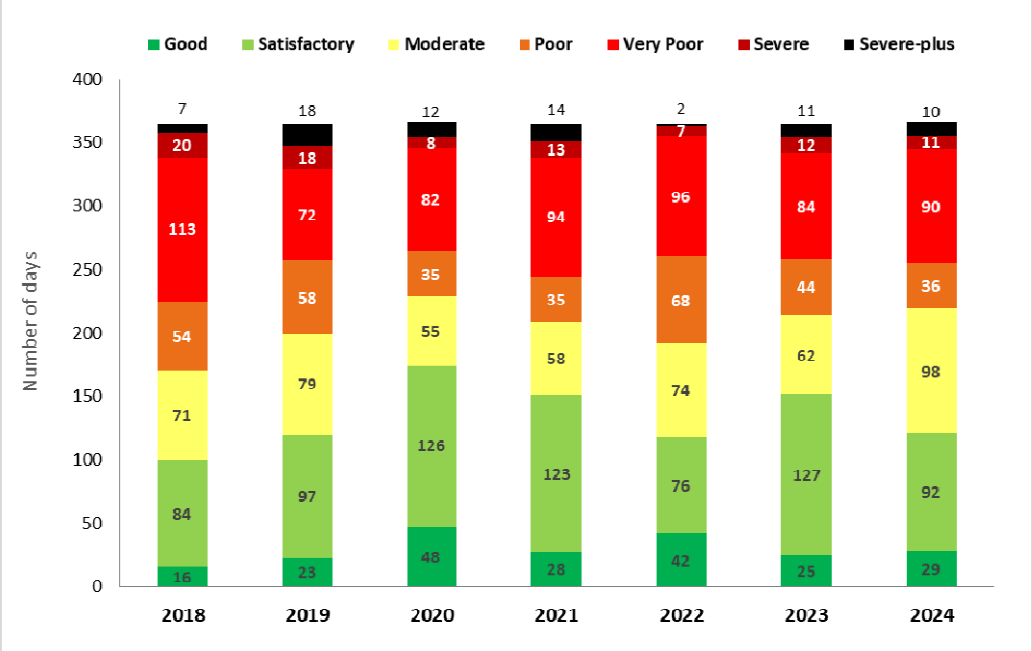
scheme of IndianAQI sub-categories. Good (0-30 µg/m³): Dark Green; Satisfactory (31-60 µg/m³): Light Green; Moderate (61-90 µg/m³): Yellow; Poor (91-120 µg/m³): Orange; Very Poor (121-250 µg/m³): Red; Severe (>250 µg/m³): Maroon; and SeverePlus (>300 µg/m³): Black.
Source:CSEanalysisofCPCB'srealtimeairqualitydata

The trend in good and bad air days: In 2024, approximately 121 days met the National Ambient Air Quality Standards, a trend similar to 2019, when the second-worst annual average was recorded at 109.1 µg/m³. However, there has been a noticeable decline in the number of good air quality days, dropping from 152 days in 2023 to 121 days this year. *(See Graph 4: Annual trend in PM2.5 sub-AQI distribution).*

Annually, while the number of "good" air quality days increased slightly from 25 in 2023 to 29 in 2024, this improvement was overshadowed by a marginal rise in the combined numbers of overall "very poor" or worse category days including "severe" and "severe-plus" categories, which climbed from 107 in 2023 to 111 days this year. *(See Graph 4: Annual trend in PM2.5 sub-AQI distribution).*

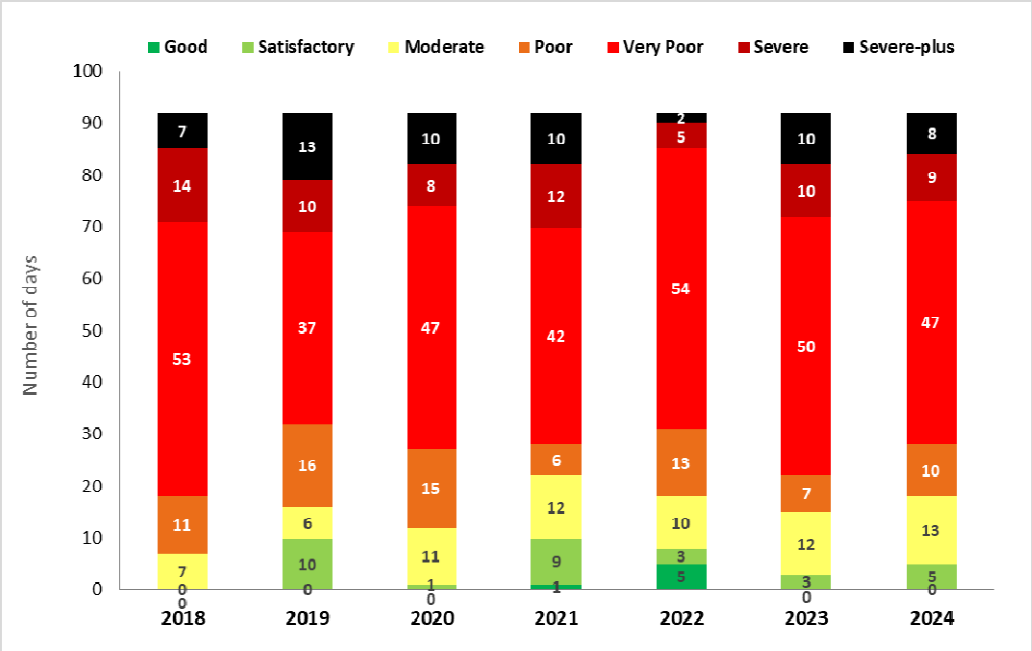
During the winter months (October to December), there were 5 days of "satisfactory" air quality—up from 3 days recorded in the previous two years but there were no "good" air quality days. Meanwhile, the number of days categorized as "poor" and "very poor" remained unchanged at 57, reflecting no progress in air quality during this critical period. (*See Graph 5: Distribution of October-December days by AQI category for Delhi).*

Graph 4: AnnualtrendinPM2.5sub-AQIdistribution



Note: Average PM2.5 concentration is based on mean of daily values recorded at 37 CAAQMS stations in the city that have adequate data for all years.
Source: CSE analysis of CPCB's real time air quality data

Graph 5: Distribution of October-January days as per AQI category for Delhi

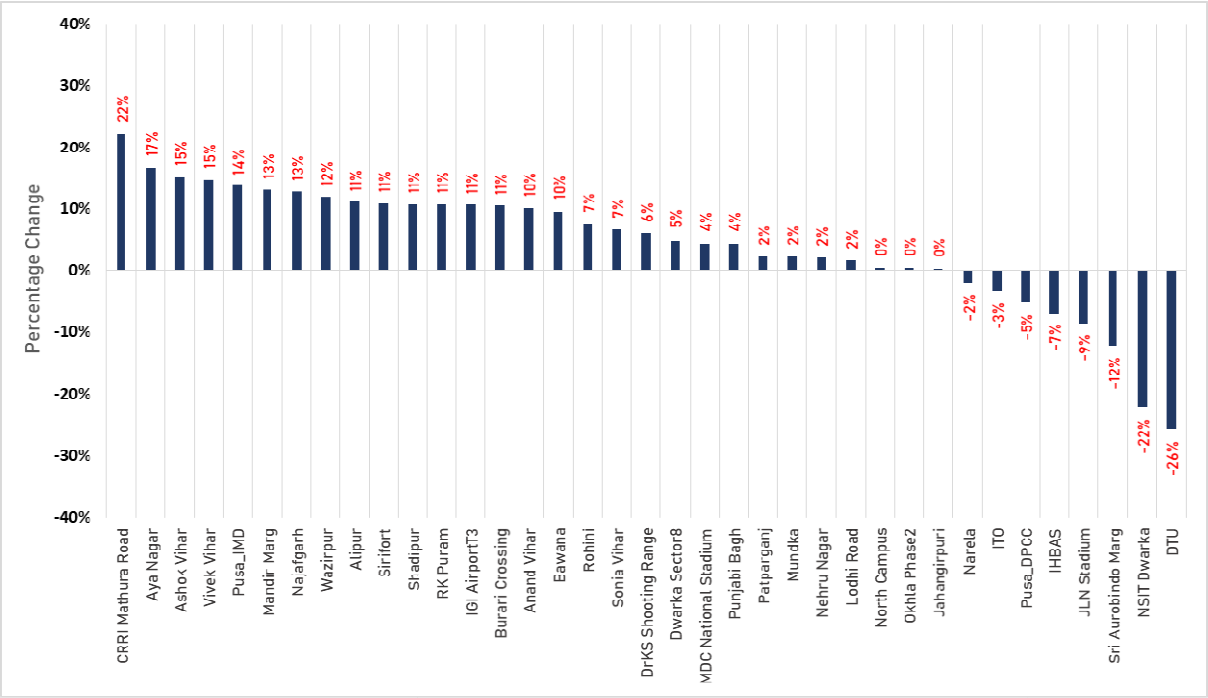


Note: Average PM2.5 concentration is based on mean of daily values recorded at 37 CAAQMS stations in the city that have adequate data for all winters.
Source: CSE analysis of CPCB's real time air quality data

Variation in pollution level among city's stations remain significant: This winter, only 8 out of 37 CAAQMS stations showed improvement in their seasonal averages compared to the last three years. The most notable improvements were observed at DTU and NSIT Dwarka, which recorded 26 per cent and 22 per cent lower seasonal averages this winter, respectively, compared to the mean of the previous three winters. On the other hand, three stations—North Campus, Okhla Phase 2, and Jahangirpuri—showed no change in their seasonal averages *(See Graph 6: Change in seasonal PM2.5 levels among stations of Delhi compared to the mean of the previous three winters).*

CRRI Mathura Road (22 per cent), Aya Nagar (17 per cent), Ashok Vihar and VivekVihar (each 15 per cent), and Pusa IMD (14 per cent) were the top five stations that recorded an increase in seasonal PM2.5 levels compared to previous winters *(See Graph 6: Change in seasonal PM2.5 levels among stations of Delhi compared to the mean of the previous three winters).* The seasonal averages ranged from 97 µg/m³ at DTU to 226 µg/m³ at Wazirpur, with AnandVihar emerging as the second most polluted location in the city, recording a seasonal average of 224 µg/m³.

Graph 6: Change in seasonal PM2.5 levels among stations of Delhi compared to the mean of the previous three winters



Note: Average PM2.5 concentration is based on mean of daily values recorded at 37 CAAQMS stations in the city that have adequate data for all three winters.
Source: CSE analysis of CPCB's real-time air quality data

Farm stubble fires this winter about half of last winter: Farm stubble burning is widely regarded as a major contributor to elevated PM2.5 levels during the early winter months. However, this year a noticeable improvement has been reported, with the number of fire incidents in Punjab and Haryana declining significantly compared to previous years.

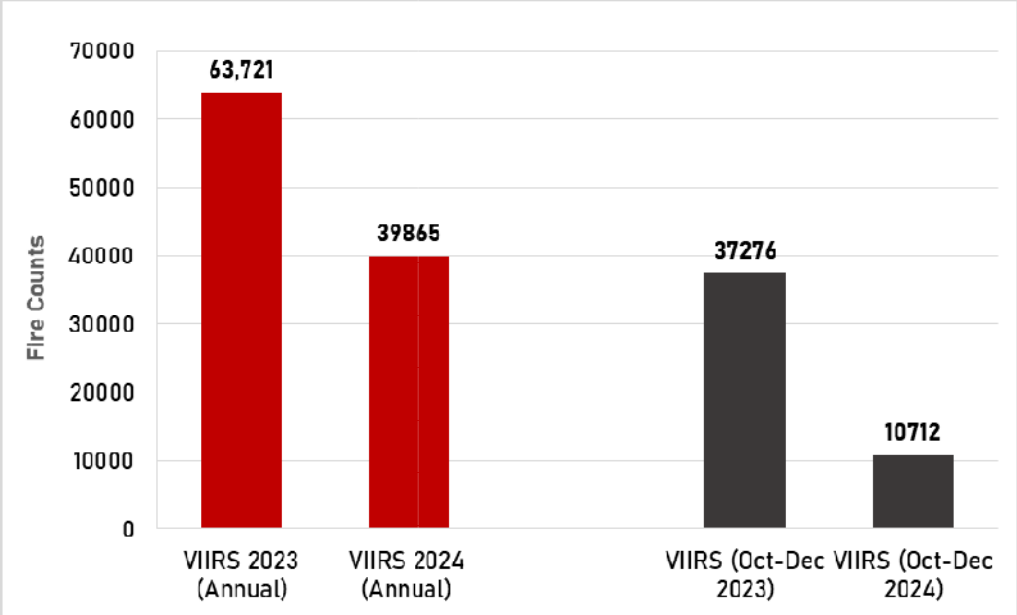
A VIIRS (Visible Infrared Imaging Radiometer Suite) data reveals a significant decline in fire counts across Punjab and Haryana during the critical October-December period in 2024 compared to 2023. The overall annual fire counts in three states (Delhi, Punjab, and Haryana) have also shown a notable reduction.
In 2024, the total annual fire counts (Delhi, Punjab, and Haryana) dropped from 63,721 in 2023 to 39,865, marking a decline of 37.5 per cent. The seasonal fire activity during October-December saw an even steeper reduction, from 37,276 in 2023 to 10,712 in 2024—a remarkable 71.2 per cent decrease *(See Graph 7: Annual and seasonal Trend in farm stubble fire counts in Punjab, Haryana, and Delhi).*

Punjab, a significant contributor to fire events, recorded a substantial 75 per cent decline in fire counts during the October-December period, dropping from 33,737 in 2023 to 8,449 in 2024. This improvement is reflected in the annual figures as well, which fell by 45.3 per cent, from 54,956 in 2023 to 30,081 in 2024 *(See Graph 8: Annual and Seasonal Trend in farm stubble fire counts in Punjab, and Haryana).*

Haryana demonstrated a 37 per cent reduction in fire incidents during the October-December period, with fire counts decreasing from 3,479 in 2023 to 2,189 in 2024. However, the annual fire counts increased slightly from 8,576 in 2023 to 9,532 in 2024. *(See Graph 8: Annual and Seasonal Trend in farm stubble*

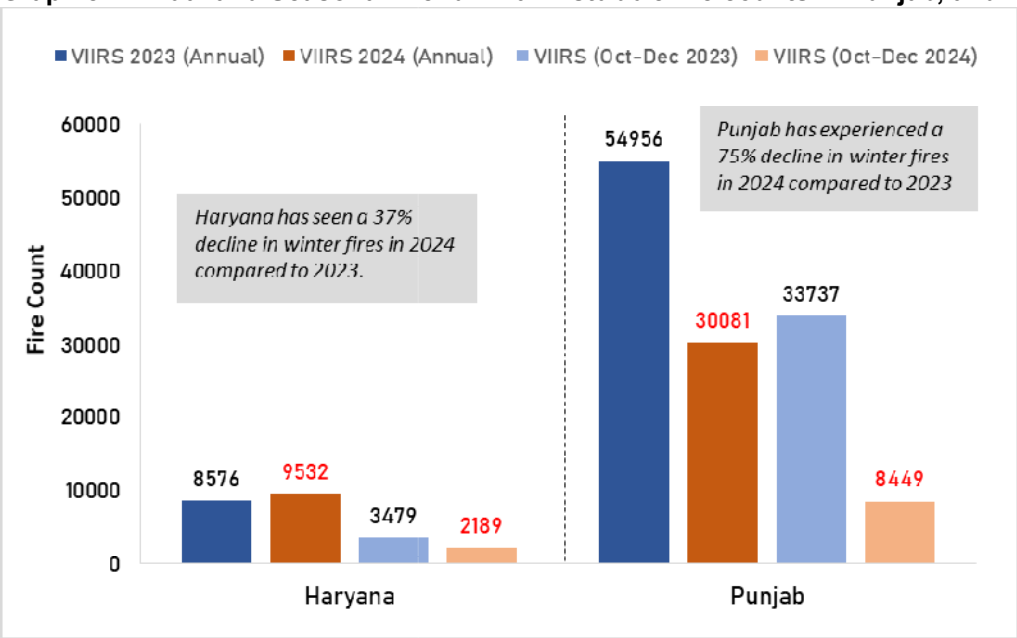
fire counts in Punjab, and Haryana). However, there have been observations from different authorities that the area affected by burning could have been large.

Graph 7: Annual and seasonal Trend in farm stubble fire counts in Punjab, Haryana, and Delhi



Note: Fire data is based on NASA's Visible Infrared Imaging Radiometer Suite (VIIRS) products. It covers Punjab, Haryana and Delhi.
Source: CSE analysis

Graph 8: Annual and Seasonal Trend in farm stubble fire counts in Punjab, and Haryana



Note: Fire data is based on NASA's Visible Infrared Imaging Radiometer Suite (VIIRS) products. It covers Punjab and Haryana.

Source: CSE analysis

Take away

This 2024 round up assessment of the annual PM2.5 trends has come as a resounding warning about the heightened risk from the rising air pollution levels and loss of air quality gains from the past action. Delhi could stabilize annual PM2.5 levels since 2018 (if the existing air quality monitors are considered) and even recorded a declining trend since 2013 (if the oldest 5 stations are considered) following the implementation of the directives from the Supreme Court on energy transition in transport and industry sectors.

The action has to move much beyond the reactive emergency measures during winter. The fact, that the annual trends have risen for two consecutive years despite the decline in farm fire incidents during winter, shows much deeper systemic changes are required to cut the round the year emissions from explosive traffic, industry, open burning of waste and biomass, construction activities, use of solid fuels for cooking, and dust sources in Delhi and the surrounding region.

It is now more important for Delhi to provide the details with respect to the scale of the problem in each sector, gaps in action, targets to be achieved in each sector along with the strategies, and the resources to be mobilized to enable implementation with a strong compliance framework.