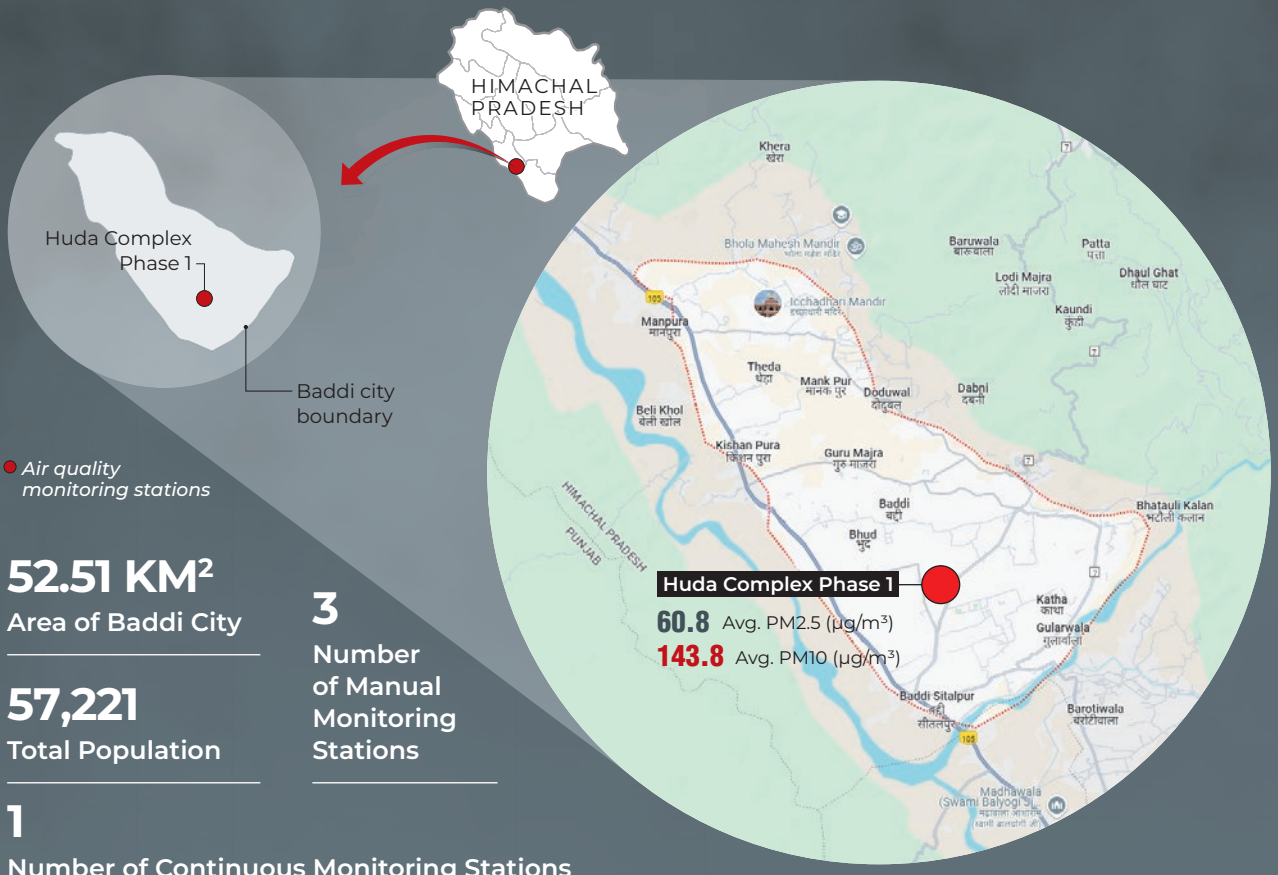
KNOW YOUR CITY AND WHAT YOU BREATHE

BADDI AIR POLLUTION FACT SHEET

Baddi city in Himachal Pradesh has one Continuous Ambient Air Quality Monitoring Station (CAAQMS) located at the southern part of the city.



52.51 KM²
Area of Baddi City

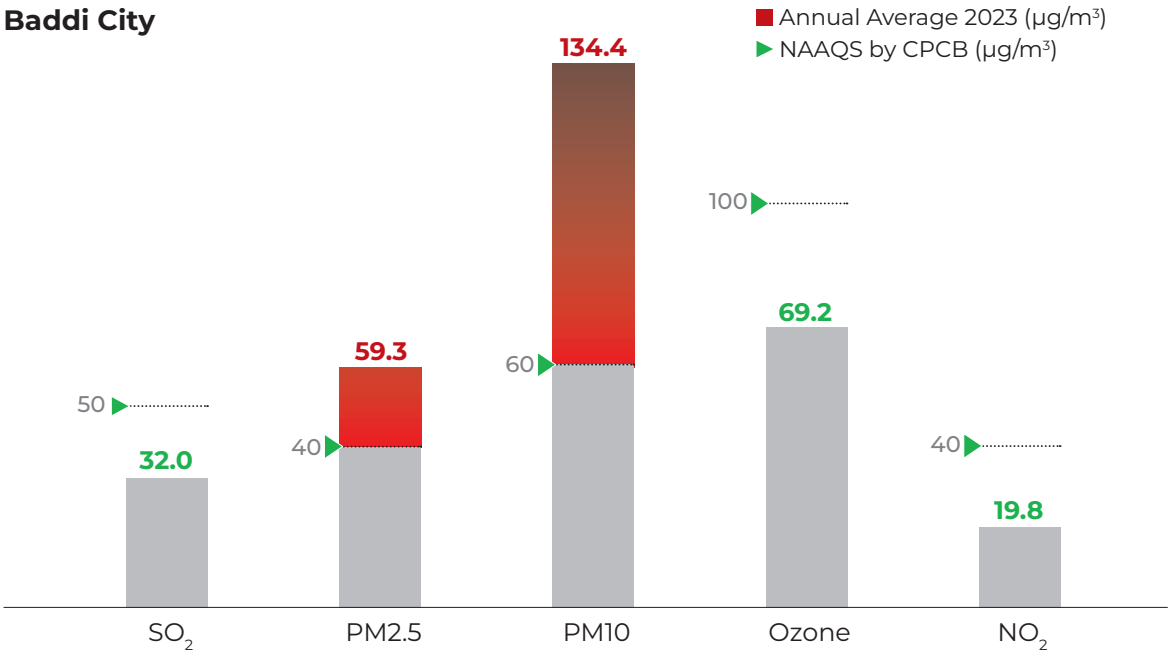
57,221
Total Population

3
Number of Manual Monitoring Stations

1
Number of Continuous Monitoring Stations

Pollutant Concentration

Baddi City



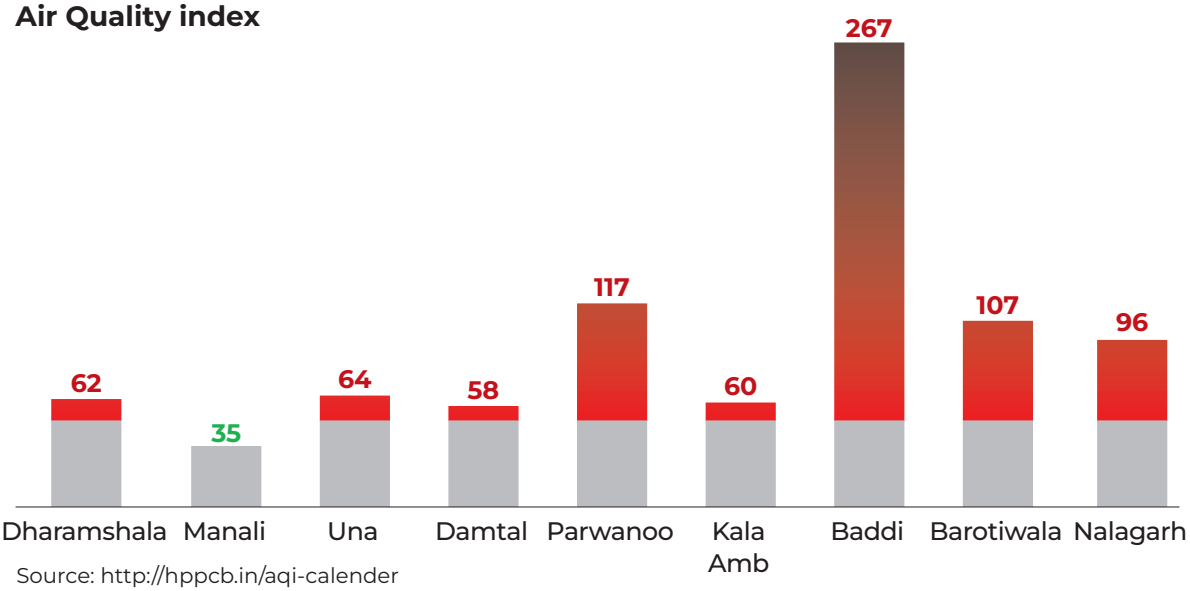
Source: iFOREST Analysis

The annual average PM2.5 and PM10 concentration for 2023 was found to be 59.3 µg/m³ and 134.4 µg/m³ respectively	The PM2.5 concentration levels is 1.5 times above the annual average standard of 40 µg/m³ as provided by CPCB	The PM10 concentration level was 2.2 times above the annual average standard of 60 µg/m³ as provided by CPCB

Comparison with other cities in Himachal Pradesh

Of all the 9 cities in Himachal Pradesh, where Air Quality Index (AQI) is monitored, Baddi city has the highest AQI. It is the most polluted city in the state.

Air Quality index

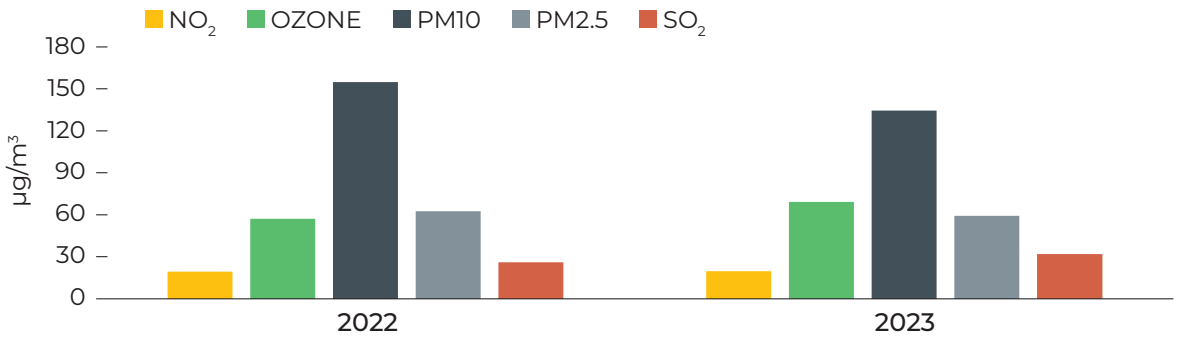


Source: http://hppcb.in/aqi-calender

Concentration trends

ANNUAL

Average Concentration of key pollutants in years 2022-2023



The **average PM10** and **PM2.5** concentration has **decreased by 13.3% and 6% respectively, since 2022**.

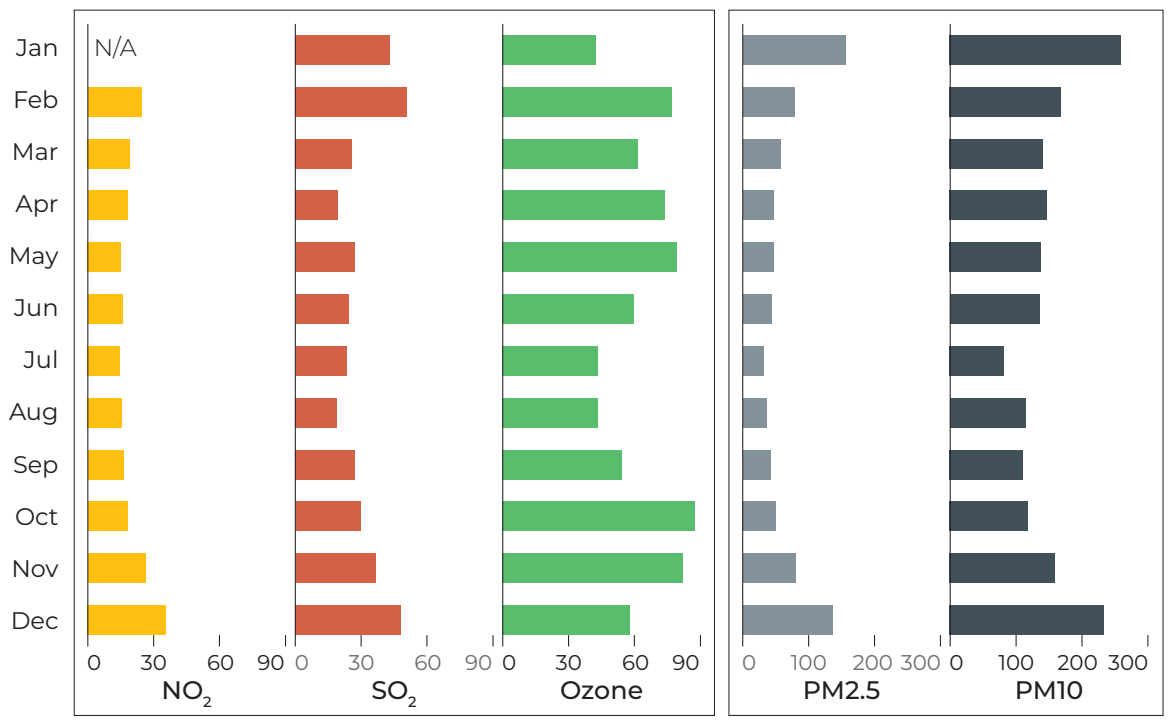
NO_2 concentrations are relatively **stable in the assessment years**.

SO_2 concentration has **increased by 23% since 2022**.

Ozone concentration has **increased by 21% since 2022**.

MONTHLY

Average Concentration (µg/m³) of key pollutants in year 2022-2023



Winter months (January and December) experience **highest PM10 and PM2.5 concentration** (2022-23).

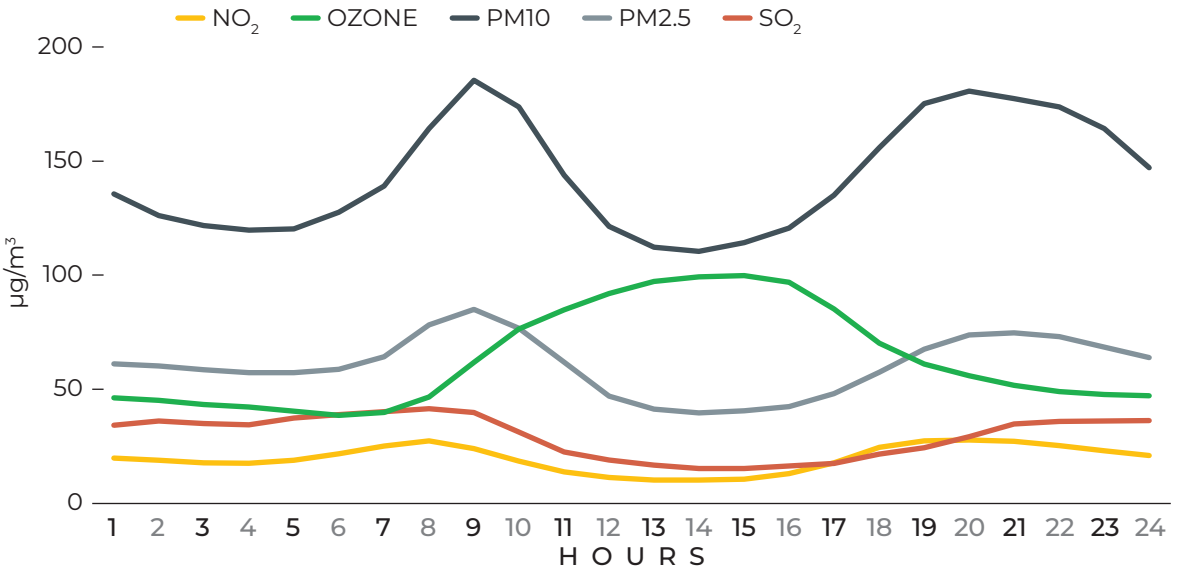
Average winter concentration was observed to be **around 112 µg/m³** for **PM2.5** and **205 µg/m³** for **PM10**.

Compared to winter season, **summer months saw a 57% drop** and **monsoon months saw a 70% drop** in **PM2.5** pollution concentration.

Compared to **winter season**, **summer months saw a 32% drop** and **monsoon** months saw a **52% drop** in **PM10** pollution concentration.

HOURLY

Average Concentration (µg/m³) of key pollutants in year 2020-2023



PM2.5 and PM10 show peak hours around 8-10AM in the morning and 7-9PM in the evening.	NO_2 and SO_2 are observed to be low during the day time 11AM to 5PM	Ozone was observed to be high during afternoons (1-4PM)

What does PM2.5/PM10 reveal?

The PM2.5/ PM10 value is around 0.4. A lower value (<0.5) indicates existence of higher size PM particles.

Air pollution data availability in Baddi

ANNUAL AVERAGE (2019 - 2023)

Years	NO_2	OZONE	PM10	PM2.5	SO_2
2019	0%	0%	0%	0%	0%
2020	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%
2022	73%	75%	75%	75%	74%
2023	82%	89%	87%	87%	88%

MONTHLY AVERAGE (2021-2023)

Months	NO_2	OZONE	PM10	PM2.5	SO_2
January	0%	39%	39%	37%	39%
February	48%	48%	48%	48%	47%
March	79%	79%	79%	80%	78%
April	94%	96%	96%	96%	95%
May	86%	90%	90%	90%	91%
June	93%	94%	92%	93%	93%
July	86%	89%	85%	86%	89%
August	90%	91%	89%	89%	89%
September	94%	93%	94%	93%	94%
October	93%	94%	89%	90%	92%
November	83%	84%	82%	82%	82%
December	86%	87%	86%	86%	84%

Refer to the methodology adopted in *page 7*.

Overall data for Baddi City **is 'Good'** for **year 2022-2023**.

Data for the year **2019 to 2021 was not available** and hence the **yearly trend analysis was not considered for pollutant concentration**.

Month wise **data availability is 'Good'** for the **assessment year 2022-2023**.

January and February recorded data in **'Poor to Moderate'** Category.

ANNEXURE

Context and significance of big data analytics for air pollution

- Understanding air pollution phenomena using big data analysis techniques helps support critical decision making for improving air quality
- The real time and continuous pollutant concentration data recorded by the ground air pollution monitoring stations in the city, typically known as Continuous Ambient Air Quality Monitoring Stations (CAAQMS), can be aggregated to form the big data that can be analysed to understand pollution patterns.
- CAAQMS record concentration of various pollutants at an average frequency of 15 seconds. Data recording at such short intervals of 15 seconds provides rich data for correlation with economic activities for source mapping.
- Big data regarding concentration of pollutants can also help policy makers understand the trends- Yearly, Monthly and Hourly of different pollutants in different locations and identify hot spots for suitable action.
- However, data cleaning to remove biases and poor quality data, is a critical step while using big data analysis before calculating average pollutant concentrations at every location.
- Recommendations based on this assessment can help in formulation of hyper-local action plans for the city.

Guidelines available for Air Pollution measurements

PM10	PM2.5	NO_2	SO_2	Ozone

- The key pollutants, as per the CPCB guidelines, for calculation of Air Quality Index and consideration of a zone as non-attainment or polluted zone are PM10, PM2.5, NO_2, SO_2 and Ozone .
- According to CPCB, the region or location is considered as polluted or is considered as a non-attainment region, if the annual average, taken of 104 measurements, that is 2-day data for each week, 4-hour sample for gaseous and 8-hour sample for PM, exceeds the values mentioned in the National Ambient Air Quality Standards (NAAQS). The permissible level or standard for the key pollutants are:
  - PM 10 : 60 µg/m^3.
  - PM2.5 : 40 µg/m^3.
  - NO_2 : 40 µg/m^3.
  - SO_2 : 50 µg/m^3.
  - Ozone : 100 µg/m^3.
- According to World Health Organization (WHO), a region or a zone is considered as prone to health risks, if the Annual average concentration and 99th percentile of day's average, particularly in case of SO_2, exceeds the values mentioned in the guidelines. The WHO guidelines for the key pollutants are :
  - PM 10 : 15 µg/m^3.
  - PM2.5 : 5 µg/m^3.
  - NO_2 : 10 µg/m^3.
  - SO_2 : 40 µg/m^3.
- According to National Centre for Biotechnology Information PM2.5/ PM 10 ratio is an important factor in understanding the source of pollution in the region. A high PM2.5/PM10 ratio (>0.5) typically suggests that fine particles and secondary particulates such as NO^3-, SO^42- NH4+, and organics, are major contributors. Conversely, a lower PM2.5/ PM10 ratio indicates the dominance of coarse particles.

METHODOLOGY ADOPTED

For Continuous Ambient Air Quality Monitoring Station (CAAQMS) data to be reliable, especially in cases where pollutant concentrations and meteorological parameters like wind speed are being recorded, a robust methodology for data cleaning, aggregation, and analysis is crucial. This ensures accurate yearly, monthly, and hourly trend analysis as well as hot spot identification based on 'Good' quality data.

Methodology

Collection of time series data (15 minute frequency) of pollutants recorded at different CAAQMS in the city from Central Pollution Control Board website.

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Aggregating data to form big-data of the complete city.

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Clearing out the monthly data points of pollutant, if the data recorded in any month for any year is less than 60%.

↓

Clearing out daily data points of pollutant, if the data recorded on any day is less than 60%.

↓

Data Visualisation and Analysis.

Data Quality Based on clean data availability

Data Availability %	Data Quality
>80%	Excellent
60%-80%	Good
40%-59%	Moderate
<40%	Poor

Major pollutant hots pots have been identified in this factsheet on the basis of relative average annual concentration of the pollutants across locations and the guidelines specified by Central Pollution Control Board.

Cleaned data → Relative pollutant concentration analyzed by taking an average of the pollutant for available data points

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