International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 12 Issue 09 September- 2022
ISSN: 2249-7382 | Impact Factor: 8.018|
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

Assessment of Ambient Air Quality Status using Air Quality Indexin Hisar City, Haryana

Yash Lohan
Research Scholar,
Department of Earth Sciences,
Banasthali Vidyapith, Rajasthan.

Dr. Rajkumar Yadav
Associate Professor, Geography,
Department of Higher Education
Haryana.(Ph.D. Geography, Delhi School of Economics)

ABSTRACT

This research paper attempts to analyze the ambient air quality in Hisar city by using the air quality index (AQI). The 24-hourly average concentrations of major pollutants, viz. Particulate matter PM10, PM2.5, Sulphur Dioxide (SO_2), Carbon Monoxide (CO) and Nitrogen Dioxide (NO_2) for the year 2021 were selected. The Air Quality Index was calculated using IND-AQI procedure. It has been found that the average AQI of the year 2021 was 184, falling under the category ***"Moderately Polluted"****. The high values of AQI in winters (especially November & December) are of major health concern to the people of Hisar.*

KEYWORDS

AQI(Air Quality Index), Ambient air quality.

1. INTRODUCTION

Ambient air refers to the outdoor air which surrounds us and accessible to all. Air pollution is a matter of great concern throughout the world at ecological, epidemical, climatological and toxicological levels (McMichael et al, 2000). The ambient air quality in India too has been degrading at a very rapid rate. It is evident from the fact that 21 cities of India were among the most polluted 30 cities of the world in 2019.

According to WHO, air pollution causes 7 million premature deaths every year. International Agency for research on cancer (IARC) of WHO, reported in 2013 that outdoor air pollution can

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 12 Issue 09 September- 2022
ISSN: 2249-7382 | Impact Factor: 8.018|
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

cause sarcoma inhumans. $PM_{2.5}$ and PM_{10} are capable of penetrating deep into the lungs and $PM_{2.5}$ can even enter the bloodstream, primarily resulting in cardiovascular and respiratory impacts(WHO 2021).

In 2019, 99% of the world population was residing in places where the WHO air quality guidelines levels were not met(WHO 2021).In India, special emphasis is laid upon the ambient air quality of large & important cities whereas small urban centers most often lack the air quality data. The ambient air quality monitoring system was set up in the year 2019 in Hisar city (Haryana). It provides continuous ambient air quality monitoring report.

AQI (Air Quality Index) is a tool, introduced by Environmental Protection agency (EPA) in USA to measure the levels of pollution due to major air pollutants. It is an overall scheme that transforms weighted values of individual air pollution related parameters into a single number or set of numbers (Mukesh Sharma, 2003). The AQI value is directly proportional to the level of air pollution. In the present study the AQI was calculated using IND-AQI specified by CPCB.

Various Categories of IND-AQI (National Air Quality Index, CPCB)

AIR QUALITY INDEX	CATEGORY
0-50	GOOD
51-100	SATISFACTORY
101-200	MODERATE
201-300	POOR
301-400	VERY POOR
401-500	SEVERE

Source: Central Pollution Control Board, New Delhi. (Ministry of Environment, Forest and Climate Change)

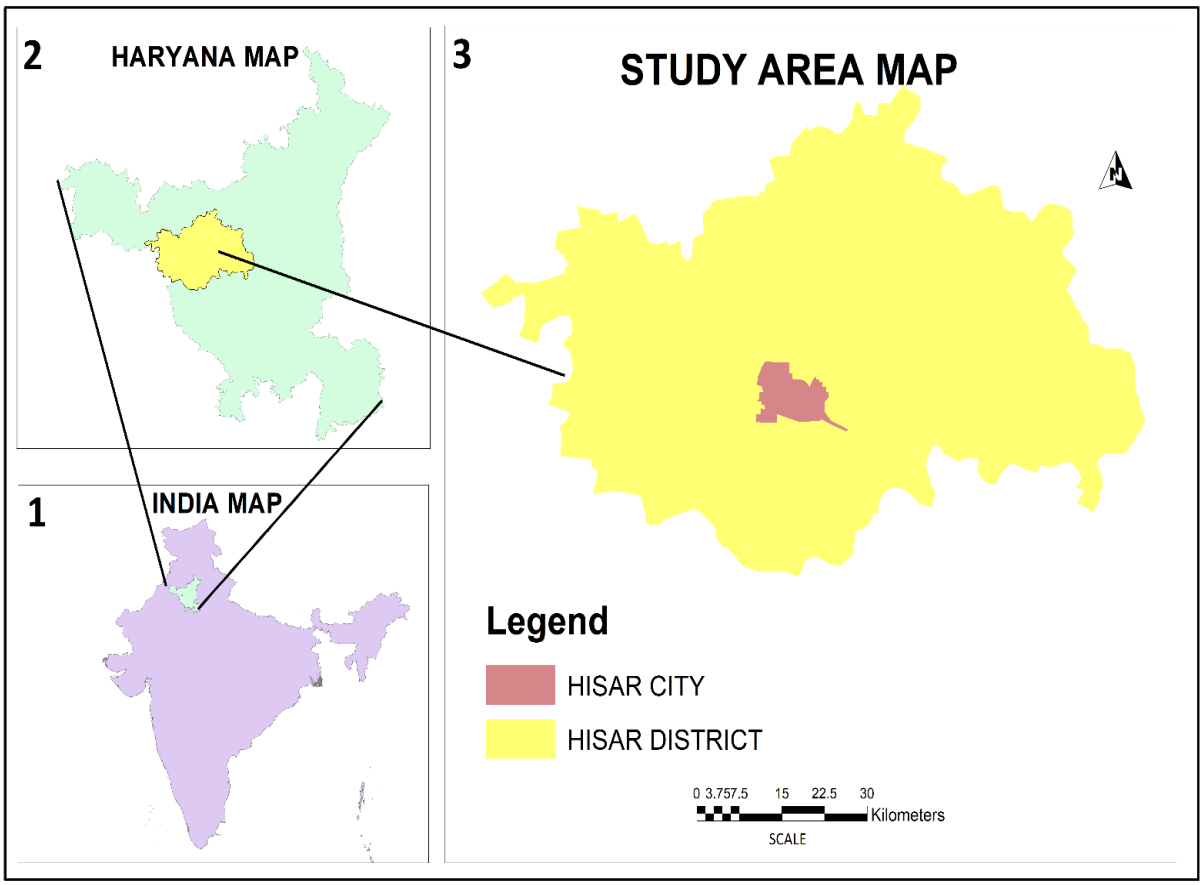
2. STUDY AREA

The city of Hisar, also known as Shehar-e-Firoza, at 210metres above sea level is located at 29˚5'5″N latitude and 75˚45'55"E longitude. Situated 165 kilometers west to Delhi on the National Highway number 9, Hisar city is one of the important growing urban centers of Haryana. The city is frequently visited by people of adjoining western states for medical treatment, agriculture equipmentsetc. Hisar has also emerged as an education hub. It is also known as 'the city of steel' due to the presence of renowned Jindal Steel Industry.

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 12 Issue 09 September- 2022
ISSN: 2249-7382 | Impact Factor: 8.018|
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

The climate of Hisar is marked by very hot summers and very cold winters. The maximum day temperature during the summer varies between 40˚ & 48˚ Celsius. During winter it varies between 1˚& 4˚ Celsius. Hisar receives its monsoon rainfall from south westerly branch from July to September. The western disturbances during winters also bring plenty of rainfall.As per reports of Census India, population of Hisar city in 2011 was 3,01,383; of which males and femaleswere 1,63,231 and 1,38,152 respectively. Major religionpractised in Hisar is Hinduism (97%), followed by Sikhism (0.97%). The third most popular religion is Islam (0.94%), followed by Jainism, Christianity and Buddhism.

Location Map of Study Area



Source: Prepared using GIS Software

3. OBJECTIVES OF STUDY-

1) To analyze the pattern of ambient air quality during months of the year 2021 in Hisar city.

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 12 Issue 09 September- 2022
ISSN: 2249-7382 | Impact Factor: 8.018|
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

2) To point out the major factors affecting air quality in Hisar city.

4. METHODOLOGY

The concentrations of various pollutants have been recorded by the monitoring agency (under Haryana State Pollution Control Board) on hourly basis. The 24-hourly average data of pollutants is provided by the agency, which is further used in the present study to calculate daily AQI. The secondary data has been provided by CAAQMS (Continuous Ambient Air Quality Monitoring System) at Urban Estate-II in Hisar. To calculate the daily AQI, a sub-index for each pollutant is calculated using the following table and mathematical equation:

Breakpoints of Various Pollutants (National Air Quality Index, CPCB)

AQI Category	AQI	Concentration range*							
		PM_{10}	$PM_{2.5}$	NO_2	O_3	CO	SO_2	NH_3	Pb
Good	0 - 50	0 - 50	0 - 30	0 - 40	0 - 50	0 - 1.0	0 - 40	0 - 200	0 - 0.5
Satisfactory	51 - 100	51 - 100	31 - 60	41 - 80	51 - 100	1.1 - 2.0	41 - 80	201 - 400	0.5 - 1.0
Moderately polluted	101 - 200	101 - 250	61 - 90	81 - 180	101 - 168	2.1 - 10	81 - 380	401 - 800	1.1 - 2.0
Poor	201 - 300	251 - 350	91 - 120	181 - 280	169 - 208	10 - 17	381 - 800	801 - 1200	2.1 - 3.0
Very poor	301 – 400	351 - 430	121 - 250	281 - 400	209 - 748*	17 - 34	801 - 1600	1200 -1800	3.1 - 3.5
Severe	401 - 500	430+	250+	400+	748+*	34+	1600+	1800+	3.5+

* CO in mg/m^3 and other pollutants in $\mu g/m^3$; 2h-hourly average values for PM_{10}, $PM_{2.5}$, NO_2, SO_2, NH_3, and Pb, and 8-hourly values for CO and O_3.

Source: Central Pollution Control Board, New Delhi. (Ministry of Environment, Forest and Climate Change)

The mathematical equation for calculating sub indices is as follows-

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} * (C_p - BP_{Lo}) + I_{Lo}$$

I_p= sub index or AQI for pollutant 'P' (Rounded to the nearest integer)

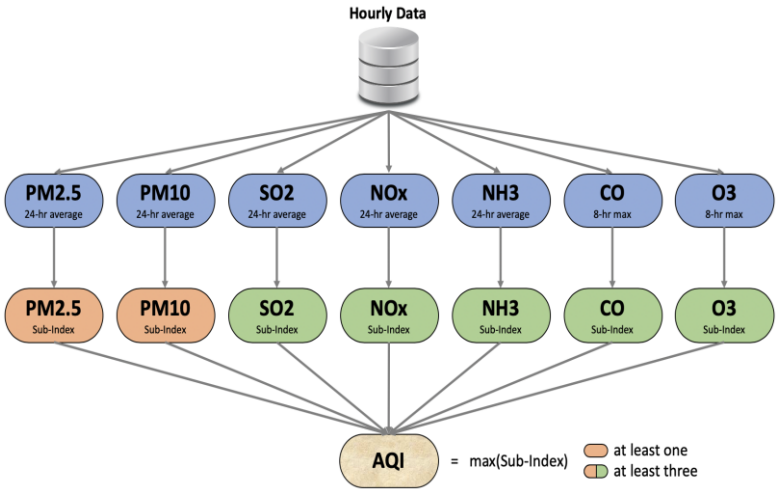
C_p= Actual ambient concentration of pollutant 'P'

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 12 Issue 09 September- 2022
ISSN: 2249-7382 | Impact Factor: 8.018|
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

BP_{Hi}= The upper end breakpoint concentration that is ≥C, BP_{Lo}= The lower end breakpoint concentration that is ≤C

I_{Hi}= The sub index or AQI value corresponding to $BP_{Hi,}$ I_{Lo}= The sub index or AQI value corresponding to BP_L

After calculating sub index for each pollutant, the pollutant with the highest value of it's respective sub index is considered as overall and final AQI. It may be explained through following flow diagram-



5. RESULTS AND DISCUSSIONS

The monthly average AQI values are shown using line graph in figure 1. It is clearly visible that the best ambient air quality was in September, with AQI value=62, which falls under **satisfactory** category and the worst was recorded in November with AQI value= 384, which falls under **very poor** category. It may be pointed out that the last quarter of the year is marked with poor air quality. In contrast to this, the second and third quarter of the year 2021 are marked with better air quality.

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 12 Issue 09 September- 2022
ISSN: 2249-7382 | Impact Factor: 8.018|
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

Figure 1: Variation of AQI in year 2021

Factors leading to variations in AQI in Hisar City

- **Temperature Inversion:** It can be concluded from figure 1 that the air quality is far better during summers than winters in Hisar & it is a generalized concept as well. During winters, the temperature inversion occurs. Hence, accumulation of heavier cold air near the surface does not allow the pollutants to disperse in the upper layer of atmosphere. It will surely lead to increase in AQI value near ground level.
- **Wind Speed:** High wind speed disperse the pollutants effectively. Wind speed is more in summers than winters in Hisar.
- **Wind Direction:** October is marked by withdrawal of monsoon in northwest India. During monsoon the direction of winds is easterly and south westerly but during withdrawal, it changes to north westerly. During summers too (before monsoon), the

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 12 Issue 09 September- 2022
ISSN: 2249-7382 | Impact Factor: 8.018|
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

direction of winds is north westerly. Hence, sometimes the storms carrying dust arrive from Rajasthan and adjoining countries.

- **Rainfall:**The pollutants & dust particles constituting the air of atmosphere are washed off by rain showers. The months of July and August in Hisar are characterized by monsoon & post monsoon showers, which results into good ambient air quality. Winter rainfall also purifies the air, but its impact is overshadowedby very low temperature conditions, which recreate the former situation (i.e. poor air quality) in a short period and also the frequency & periodicity of western disturbances is very less.
- **Farm fires:** It has emerged as a major factor in last years which deteriorates the ambient air quality at an alarming rate in last quarter of the year. The stubble burning season is around 45 days long. The maximum AQI value of the year has also been recorded during these days. Stubble burning causes sudden surge in PM 2.5 levels in air resulting into sudden surge in AQI.

References

[1] *Air Pollution: What Is Air Quality Index, How Is It Measured And Its Health Impact*. NDTV. (2019). Retrieved 23 May 2022, from https://swachhindia.ndtv.com/air-pollution-what-is-air-quality-index-how-is-it-measured-and-its-health-impact-40387/.

[2]*Ambient (outdoor) air pollution*. WHO. (2021). Retrieved 12 May 2022, from https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health#:~:text=The%20Guidelines%20indicate%20that%20by,ozone%20(O3).

[3] Assessment of ambient air quality in Northern India using AirQuality Index method. (2013), *2*(2-3), 12. http://besr.org.in/index.php/besr/article/view/39/21.

[4] *AQI Calculation Update*. Airveda. (2019). Retrieved 29 May 2022, from https://www.airveda.com/blog/AQI-calculation-update.

[5] *Calculating AQI (Air Quality Index) Tutorial*. kaggle. (2021). Retrieved 19 June 2022, from https://www.kaggle.com/code/rohanrao/calculating-aqi-air-quality-index-tutorial/notebook.

[6] *District Hisar*. Retrieved 13 June 2022, from https://hisar.gov.in/about-district/.

[7]*Explained: Why does air pollution rise in October every year?*. Indian Express. (2021). Retrieved from https://indianexpress.com/article/explained/explained-why-does-air-pollution-rise-in-october-each-year-6759030/.

[8] *Hisar City Population 2011 - 2022*. Census 2011. Retrieved from https://www.census2011.co.in/census/city/41-hisar.html.

[9] *Hisar City*. Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Hisar_(city)#Culture%5C.

[10] "*India Air Quality Index (AQI) And Air Pollution Information | Airvisual"*.IQair. Retrieved 9 May 2022, from https://www.iqair.com/us/india.

[11] McMichael AJ, Kovats RS. (2000) Climate change and\climate variability: adaptations to reduce adversehealth impacts. Environmental Monitoring andAssessment. 61:49–64.

[12] Sarella, G. (2015). Ambient Air Quality Analysis Using Air Quality Index – A Case Study Of Vapi. *International Journal For Innovative Research In Science & Technology*, *1*(10), 2. Retrieved 11 June 2022.

[13] Sharma, M. (2003). Interpretation of air quality data using an air quality index for the city of Kanpur, India. *Journal Of Environmental Engineering And Science*, *2*(6), 2. https://doi.org/https://doi.org/10.1139/s03-047