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Study of Ambient Air Quality Trends in Paonta Sahib, Himachal Pradesh India

Naveen [1], Dr. Sanjay Kumar Sharma[2], Sabira javaid[3]

[1]M.E Scholar, Civil Engineering Department, NITTTR, Chandigarh
[2]Professor, Civil Engineering Department, NITTTR, Chandigarh
[3]M.E Scholar, Civil Engineering Department, NITTTR, Chandigarh

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Abstract - *Air pollution has become major cause of concern throughout the world, especially for developing countries. Advancement in the technologies, race for infrastructure development, Rapid increase in Industrial activities, Increase in traffic intensity are some of the reasons resulting into deterioration of air quality by releasing various harmful pollutants in the atmosphere. Inhaling polluted air may results into various disease. The goal of this research is to study air quality trends in Paonta Sahib Area, Sirmaur district, Himachal Pradesh, India, from 2010 to 2020. Owing to the rise in manufacturing operations, the city has increased in size and population. Data for review was collected from the official website of the State Pollution Control Board and was used without any modifications. Six pollutant thresholds were routinely assessed and RSPM, SPM, sulphur dioxide (SO2) and nitrogen dioxide (NO2) were investigated for air quality analysis for the longest period of time.*

***Key Words*: Developing Countries, traffic intensity, air quality, criteria pollutants.**

1. INTRODUCTION

The life of humans and other living creatures has been severely endangered by air pollution. Air pollution has been ranked as the world's 13th leading cause of death[1]. In 2016, outdoor air pollution in the world resulted in 4.2 million fatalities [2]. In 2017, long-term exposure to ambient PM2.5 resulted in 2.9 million deaths and 83 million DALYs (Disability-adjusted life year) were lost, making 5.2 percent of all global fatalities and 3.3 percent of all global DALYs responsible for PM2.5 exposure. [3]. Thus there is urgent need to check the increasing level of pollutants in the air. Sirmaur is the southernmost district of Himachal Pradesh. District consist of two major industrial towns namely Paonta Sahib and Kala Amb. Paonta Sahib has become a major industrial area of the district in recent times. The town consists of different types of Industries such as Pharmaceutical Industries, Steel Industry, Cement Industry and Stone crushers with mining activities. The increase in industrial activities has resulted into increase in the pollutants emission into atmosphere due to following reasons.

1. Increase in industrial activities has resulted into inflow of migrants from different parts of the country thereby increase population of the area

2. There is increase in the traffic intensity in the town due to rapid industrialization thus increase emission of pollutants.

3. Mining activities and stone crushers in the area is also a significant contributor for emission of particulate matters into atmosphere.

4. Road dust and Construction activities are also the major contributor for particulate matters emission into atmosphere.

This study is an attempt to understand the change in the air quality of the area in past 11 years. The objective of the current work is to study the annual average concentration of the different pollutants in the city and to find the level of pollution by using Exceedence factor technique of CPCB [4]

To protect public health from air pollution in a region, each country has issued air quality guidelines for pollutant concentration in the air. In India, the Central Pollution Control Board (CPCB) has established 12 standards for contaminants that are particulate matter (PM10, PM2.5), sulphur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, benzene, ammonia, pyrene benzo(a), arsenic and nickel to be assessed at national level through the National Air Quality Monitoring Programme in its 2009 notification[5]. The first eight parameters are short-term (1/8/24 hrs) and annual (with the exception of CO and O3) and the remaining four parameters are annual requirements only.

2. Study Area

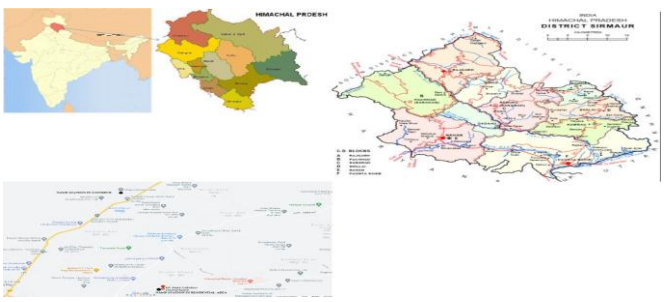

Fig-1: Map of Paonta Sahib, India showing air pollution monitoring stations (NAMP Stations)

Paonta Sahib is a Himachal Pradesh industrial town. It is also an important place of worship for Sikhs, hosting, on the banks of the Yamuna River, a huge Gurdwara called

Gurudwara Paonta Sahib. The river is the border of the Himachal Pradesh and Uttarakhand states. At Paonta Sahib, cement, pharmaceuticals and limestone are the main industries. At Paonta Sahib, there are about 4 red and orange types of air-polluting industrial units. Vehicle emissions, road dust, building operations and industrial emissions are the major sources of air pollution in the region.3. Air Pollution Measurement in Paonta Sahib

Air contaminants are assessed at 2 monitoring stations under the National Air Quality Program (NAMP) as shown on a regular basis in Figure 1 and HPSPCB publishes on its website the daily average of pollutants Sulphur dioxide (SO2), Nitrogen dioxide (NO2) PM10, PM2.5, O3 and NH3.

The variations in sulphur dioxide (SO2), nitrogen dioxide (NO2) PM10, PM2.5 and NH3 for the period 2010-2020 are being analysed in current work for residential and industrial areas on the basis of the available data.

4. Data Analysis

Annual average concentration of Sulphur dioxide, Nitrogen dioxide Particulate matter i.e PM_{10} and $PM_{2.5}$ was studied at the 2 Nos NAMP station installed in the town for the period of 11 years i.e 2010 to 2020. Data collected is represented in figure 2-5 and is taken from HP State Pollution Control Board website and no modification has been done in the data.

The quality of air is measured based on Exceedence factor. Exceedence factor is the proportion of the annual average concentration of individual pollutant in atmosphere with reference to its standard value as prescribed. Mathematically Exceedence factor can be calculated as

$$\text{Exceedence Formula} = \frac{\text{Measured annual average concentration of pollutant}}{\text{Annual standard for the pollutant}}$$

Based on the values obtained by above formula air pollution level is categorized as

- Low Pollution level (L)- When EF<0.5
- Moderate Pollution level (M)- When 0.5< EF<1.0
- High Pollution level (H)- When 1.0<EF<1.5 and
- Critical Pollution level (C) – When EF>1.5

From the categorization of pollution level given above it can be observed that areas where pollution level is in the category of Low and Moderate level, the air quality of the area is meeting the given standards of ambient air quality. However it may increase in the future if the level of pollution keep on increasing and strict measures for pollution control are not in place. The area with high pollution level and critical pollution level are those areas where air quality of the area has already exceeded the National air quality standards and require urgent attention of the authority to control the pollution level by implementation of strict policies and protect human health and ecosystem. The pollution level for based on individual pollutant annual average concentration is given in table 1.

Table 1 Classification of Pollution Level

Level of Pollution	Annual Average concentration Standards of pollutants Residential, Industrial area		
	SO_2	NO_2	PM_{10}
Low	0-25	0-20	0-30
Moderate	26-50	21-40	31-60
High	51-75	41-60	61-90
Critical	>75	>60	>90

CPCB under National Air quality monitoring program notified new sets of National Air quality standards for total 12 parameters [6]. Table 2 prescribed standards of CPCB for the pollution studied in current work.

Table 2 Indian National Air Quality Standards (units: µg/m3 unless mentioned otherwise

Pollutant	SO2	NO2	PM2.5	PM10
Annual	50	40	40	60
24 Hours	80	80	60	100

Based on the calculated values of the contaminants, the equation given by the CPCB is then converted into a numeric value. The value thus achieved is referred to as the Air Quality Index. CO, NO2, SO2, PM2.5, PM10, O3, NH3 and Pb are considered as the following contaminants within the AQI system. It is understood that air concentrations of Pb are not established in real-time and cannot relate to real-time. The AQI range and the emission category are represented in Table 3.

Table 3 IND-AQI Category and Range

AQI Category	AQI Range
Good	0 – 50
Satisfactory	51 – 100
Moderate	101 – 200
Poor	201 – 300
Very Poor	301 – 400
Severe	401 - 500

5. Analysis of Pollution Level

Table 4 Level of SO_2, Exceedence Factor and Pollution level

Exceedence Facor for SO_2 in Resdential and Industrial Area from 2010 to 2020						
	Residential Area			Industrial Area		
Year	SO_2	Exceede	Polluti	SO_2	Excee	Polluti

	(µg/m3)	nce Factor	on Level	(µg/m3)	dence Factor	on Level
2010	2	0.04	L	3.2	0.06	L
2011	2.0	0.04	L	3.3	0.07	L
2012	2.7	0.05	L	3.0	0.06	L
2013	2.4	0.05	L	2.9	0.06	L
2014	2.5	0.05	L	3.2	0.06	L
2015	2.8	0.06	L	3.4	0.07	L
2016	2.6	0.05	L	3.2	0.06	L
2017	2.5	0.05	L	3.0	0.06	L
2018	2.7	0.05	L	3.3	0.07	L
2019	2.9	0.06	L	3.6	0.07	L
2020	2.9	0.06	L	3.6	0.07	L
Permissible Limit (Annual Avg. µg/m3)	**50**			**50**		

Table 5 Level of NO_2, Exceedence Factor and Pollution level

Exceedence Factor for NO_2 in Resdential and Industrial Area from 2010 to 2020						
	Residential Area			Industrial Area		
Year	NO_2 (µg/m3)	Exceedence Factor	Pollution Level	NO_2 (µg/m3)	Exceedence Factor	Pollution Level
2010	15.2	0.38	L	17.1	0.43	L
2011	15.2	0.38	L	16.4	0.41	L
2012	14.9	0.37	L	15.9	0.4	L
2013	13.9	0.35	L	15.3	0.38	L
2014	13.8	0.35	L	14.7	0.37	L
2015	13.3	0.33	L	14.2	0.36	L
2016	13.2	0.33	L	14.9	0.37	L
2017	12.5	0.31	L	13.6	0.34	L
2018	13.1	0.33	L	14.9	0.37	L
2019	13.3	0.33	L	14.9	0.37	L
2020	12.4	0.31	L	14.7	0.37	L
Permissible Limit (Annual Avg in (µg/m3)	**40**			**40**		

Table 6 Level of PM_{10}, Exceedence Factor and Pollution level

Exceedence FacTor for PM_{10} in Residential and Industrial Area from 2010 to 2020						
	Residential Area			Industrial Area		
Year	PM 10 µg/m3	Exceedence Factor	Pollution Level	PM 10 µg/m3	Exceedence Factor	Pollution Level
2010	102	1.7	C	159	2.65	C
2011	110	1.83	C	149	2.48	C
2012	131	2.18	C	171	2.84	C
2013	96	1.6	C	136	2.27	C
2014	103	1.71	C	151	2.51	C
2015	90	1.5	C	147	2.45	C
2016	85	1.42	M	155	2.59	C
2017	74	1.24	M	95	1.58	C
2018	83	1.38	M	93	1.54	C
2019	74	1.24	M	84	1.41	M
2020	79	1.31	M	86	1.43	M
Permissible Limit (Annual Avg µg/m3)	**60**			**60**		

Table 7 Level of $PM_{2.5}$, Exceedence Factor and Pollution level

Exceedence Factor for $PM_{2.5}$ in Residential and Industrial Area from 2010 to 2020						
	Residential Area			Industrial Area		
Year	$PM_{2.5}$ µg/m3	Exceedence Factor	Pollution Level	$PM_{2.5}$ µg/m3	Exceedence Factor	Pollution Level
2010		0	..		0	..
2011		0	..		0	..
2012		0	..		0	..
2013		0	..		0	..
2014	219	5.48	C	248.7	6.22	C
2015	191	4.77	C	192.25	4.81	C
2016		0	..		0	..
2017		0	..		0	..
2018	49	1.21	M	47.8	1.2	M
2019	46	1.16	M	55.6	1.39	M
2020	45	1.13	M	52.0	1.3	M

Permissible Limit (Annual Avg µg/m3)	**40**			**40**		

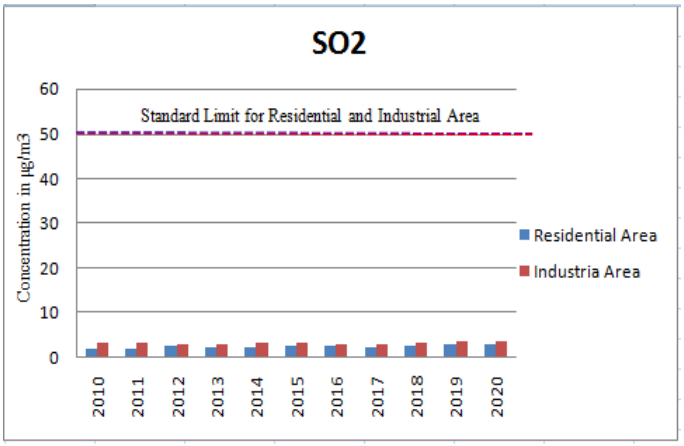

Fig.-5: SO_2 Levels at 2 locations 2010-2020

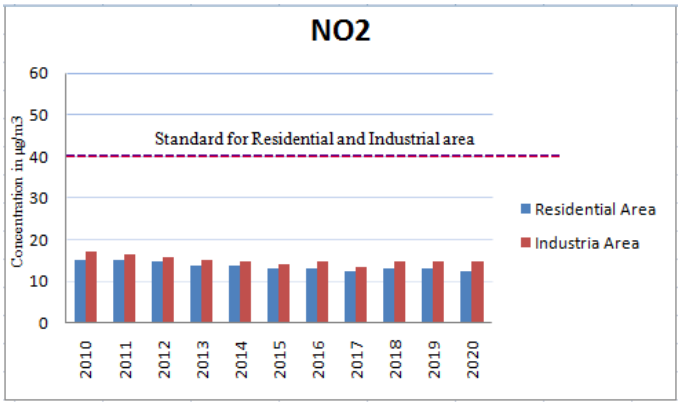

Fig- 6: NO_2 Levels at 2 locations 2010-2020

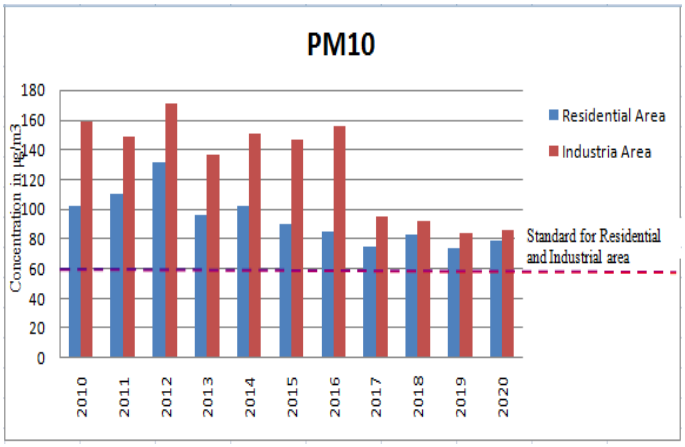

Fig- 7: PM_{10} Levels at 2 locations 2010-2020

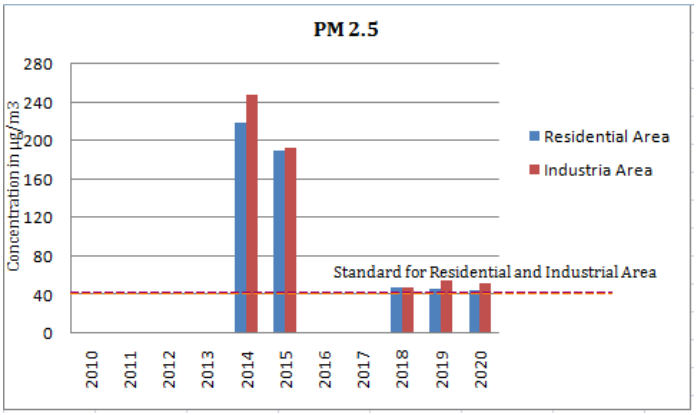

Fig.-8: $PM_{2.5}$ Levels at 2 locations 2010-2020

A. SO_2 Level Analysis

SO_2 is emitted into the atmosphere is mainly due to the traffic emission and solid waste and fossil fuel burning. And may leads to the problems like respiratory disease.[7]

From table 4 it can be observed that for residential area in the year 2010 the annual average concentration of sulphur dia oxide was 2.0 µg/m3 and it is increasing. However the increase in the concentration of pollutant is not significant. In the year 2020 the annual average concentration of pollutant is observed 2.9 µg/m3 indicating 45% increase. For industrial area similar trend was observed with sulphur diaoxide having annual average concentration equal to 3.2 µg/m3 in the year 2010 and it increase to 3.6 µg/m3 in the year 2020, an increase of 12.5%.The increase in concentration of SO_2 over the air may be attributed to the increase in traffic intensity in the town. It is to be noted that annual average concentration of SO_2 in both the locations is below the prescribed limit i.e 60 µg/m3. Hence the both areas falls under category of low pollution level for the given pollutants (Exceedence Factor< 0.5) . Variation of sulphur dioxide throughout the studies period for residential and industrial area is show in figure 5.

B. NO_2 Level Analysis

The NO_2 gas released into the atmosphere from the exhaust of vehicles and various combustion processes. An increase in concentration of the pollutant may affect the health especially people suffering from asthma.

From table 5 it can be seen that there is slight reduction in the concentration of NO_2 in residential and industrial area. In the year 2010 annual average concentration of NO_2 in residential area and industrial area was 15.2 µg/m3 and 17.1 µg/m3 respectively. A decrease of 18.4% and 14.03% was observed in residential and industrial area respectively. In the year 2020 annual average concentration of NO_2 stood at 12.4 µg/m3 and 14.7 µg/m3 in residential and industrial area respectively. Overall both locations falls under low pollution level category for the given pollutant with Exceedence Factor less than 0.5. Variation of nitrogen dioxide throughout the

studies period for residential and industrial area is show in figure 6.

C. PM_{10} Level Analysis

RSPM/PM_{10} are the fine particles having size smaller than 10 µm. Road dust, mining activities. Stone crushers and automobile exhaust are the some of the common sources of these particles. An excess amount of such particles in atmosphere may lead to various problem such as asthma, high blood pressure etc.

Table 6 represent the variation of RSPM for the last 11 years in both residential and industrial area. it can be seen that there is significant reduction in the concentration of PM_{10} in residential and industrial area. In the year 2010 annual average concentration of PM_{10} in residential area and industrial area was 102 µg/m3 and 159 µg/m3 respectively. Over the years reduction of 22.5% and 45.9% was observed in residential and industrial area respectively. In the year 2020 annual average concentration of PM_{10} stood at 79 µg/m3 and 86 µg/m3 in residential and industrial area respectively indicating moderate air pollution in the area (i.e Exceedence Factor is between 0.5 to 1.0). From the data it was observed that throughout the study period i.e 2010 to 2020 average annual concentration of PM_{10} at both the location was observed above the prescribed limit. The reason for high concentration may be due to increase in traffic population , road dust and mining and construction activities in the town. Variation of PM_{10} throughout the studies period for residential and industrial area is show in figure 7.

D. $PM_{2.5}$ Level Analysis

These are very fine particles having size less than 2.5 µm. Exposure to such particles are serious threat to human health. As they have tendency to penetrate deep into the lungs thereby creating various respiratory disease, other problems include irritation in eyes, throat, Nose etc.

Table 7 represent the status of concentration of $PM_{2.5}$ in both the locations. It can be observed that in there has been large reduction in the $PM_{2.5}$ concentration in residential as well as industrial area. Due to availability of limited data, study was carried out from the period 2014. In the year 2014 annual average concentration of $PM_{2.5}$ was found equal to 219 µg/m3 and 248.7 µg/m3 at residential and industrial area respectively which is above the prescribed limit. Over the year there has been significant reduction in the pollutant concentration. Areduction of 79.4% and 79% was recorded in residential and industrial area respectively. In the year 2020 annual average concentration $PM_{2.5}$ was recorded as 45 µg/m3 and 52.0 µg/m3 at residential and industrial area respectively which is above the prescribed limit of 40 µg/m3 at both the locations. Variation of $PM_{2.5}$ throughout the studies period for residential and industrial area is show in figure 8.

5. Summary

In general all two sites under study have particulate matter (PM_{10} and $PM_{2.5}$) concentration above the prescribed standard level of 60 µg/m3 and 40 µg/m3 for PM_{10} and $PM_{2.5}$ respectively. For particulate matters, based on the exceedence factor at present the residential area as well as industrial area fall under medium pollution level. Being very fine in size the particulate matter has major impacts on mortality and morbidity rates [1]. Particulate matter especially $PM_{2.5}$ due to very fine size penetrate deep into lungs thus cause damage to human health. However there is need to establish a relation between increase in concentration of particulate matter and its relation with the Cardiovascular disease for the city.

6. Conclusion

Paonta Sahib in recent times has seen rapid increase in industrial activities, traffic intensity and various infrastructure development activities. This has resulted in rapid change in the air quality of the area. Low level of gaseous pollutants may be as a result of intervention of State Board such as restricting emission from the industries, monitoring of vehicles, guiding industries for using latest pollution control devices. However particulate matter in the town is still a major cause of concern there is urgent need to address this issue. Planting some specific types of trees can help reducing indoor and outdoor air pollution. Some of these trees include Aloe vera, Spider Plant and rubber plant can help reducing indoor air pollution. Similarly Peepal, Arjun and Amla are some of the examples of the trees which help in reducing outdoor pollution. Apart from plantation, rregular sprinkling on katcha roads till they are paved, covering the construction activities areas and stone crusher units can be some of the measures to reduce particulate matter concentration in the town.

7. References

1. World Health Organisation, "Air Quality and Health," World Health Organisation, Geneva 2008.

2. Ambient (outdoor) air pollution, who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health, 2018

3. State Of Global Air/2019- A Special Report On Global Exposure To Air Pollution And Its Disease Burden, https://www.stateofglobalair.org/sites/default/files/soga_2019_report.pdf.

4. National Ambient Air Quality Status & Trends In India-2010, National Ambient Air Quality Monitoring Naaqm/ 35 /2011-2012.

5. National Air Quality Index, https://app.cpcbccr.com/ccr_docs/FINAL-REPORT_AQI_.pdf

6. https://app.cpcbccr.com/ccr_docs/FINAL-REPORT_AQI_.pdf

7. Air Pollution in Bangalore, India: A Six-Year Trend and Health Implication Analysis, https://www.researchgate.net/publication/257816315_Air_Pollution_in_Bangalore_India_A_Six-Year_Trend_and_Health_Implication_Analysis, 2014