International Journal of Scientific Research in Civil Engineering
© 2022 | IJSRCE | Volume 6 | Issue 2 | ISSN : 2456-6667

Analysis of Pollution of Budhwara Area In Bhopal

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Article Info
Publication Issue :
Volume 6, Issue 2
March-April-2022

Page Number : 17-33

Article History
Accepted : 01 March 2022
Published : 05 March 2022

ABSTRACT

Man is taking fast steps in science and innovation. His enthusiasm to build his solace by using the normal assets came about quick industrialization and unusual urbanization, which thusly witness extreme air contamination. The Bhopal city because of its fast metropolitan turn of events, different development projects endorsed from the public authority and remarkable development in the vehicular use and fuel utilization came about poor surrounding air quality. Then again the diminishing timberland cover and existing climate example of the city isn't positive for the scattering of air toxins. A stock of air pollutants is the initial move towards the control of air contamination. The motivation behind the current review was to survey the current air quality status of BHopal city and to contrast the deliberate qualities and the suggested edge limit esteems. The review has been completed in Budhwara Road Bhopal. Air tests were gathered utilizing a High volume air sampler and examination was made for SPM, SO2, and NOx through BIS strategies. The outcomes showed higher worth of the relative multitude of boundaries for example SPM, SO2, and NOx past as far as possible. The review uncovered a huge connection between's SO2, NOx and SPM. To evaluate the Ambient Air Quality Index of Bhopal city of Madhya Pradesh, India, this study has been led during year 2020 to 2021. All out four areas were chosen at Budhwara Road Bhopal city for encompassing air quality observing of seven toxins mostly Particulate Matter under 10 μ size (PM10), Particulate Matter under 2.5 μ size (PM2.5), nitrogen dioxide (NO2), Sulfur dioxide (SO2), Ozone (O3), Ammonia (NH3) and Lead (Pb). The review uncovered that the normal convergence of vaporous contaminations for example NOx, SO2, O3, NH3 in surrounding air are well inside standard cutoff points at all chosen areas anyway Particulate Matter (PM10, PM2.5) levels were found surpassing the National Ambient Air Quality Standards 2009 at all observing areas. Air Quality Index was poor (202.26-218.05) at three areas and Moderate (106.08-184.75) at one area. Generally speaking surrounding Air Quality Index of Bhopal city was seen to be moderate during this study length.

Keywords- Industrialization, Ambient air, Threshold, High volume air sampler, Correlation, Ambient Air Pollution, PM10, PM2.5, Gaseous Pollutants, Pb, Air Quality Index.

I. INTRODUCTION

Air pollution is a one of the alarming environmental problem associated with urban areas. Various monitoring programmes have been undertaken to know the quality of air by creating vast amount of data on concentration of each air pollutant (e.g., SPM, CO, NOx, SO2, etc.) in different parts of the world. Bhopal is famous for its old heritage and one of the most important cities which was under the Mugal rule for a long period, famous for forts, lakes, natural beauty, light and festivals. Bhopal undergo from tremendous increase of population, number of vehicles, narrow roads, parking facility problems, ineffective achievement of laws etc. all these conditions responsible for jam like condition prevalent in almost all the traffic intersections of Old City Bhopal. Moreover there is huge numbers of three wheelers. Most of these three wheelers are carry overload of passengers, poor maintained and conditions besides this they driven by diesel engine. It is estimates that diesel combustion emits 84 g/km of particulates as compared to 11 g/km in CNG.

This research presents the concentration of pollutants such as sulfur dioxide, oxides of nitrogen and suspended particulate matter (SO2, NOx and SPM) at selected sites in budhwara Road of Bhopal (M.P) and their correlation analysis.

Air Pollution Pathway

Exposure to air pollution is a risk factor that causes health impacts. Epidemiological risk is the probability that a disease, injury, or infection will occur. The risk assessment of air pollution follows the air pollution pathway from sources through emissions, concentrations, exposures, doses, to health impacts. Sources are the origin of the pollutant, generally the quantity and quality of fuel used. Emissions are air pollutants released from the source and are characterised by the environment, transported, and transformed. Concentrations are the amount of an air pollutant in space and time. Exposures are concentrations of air pollutants that are breathed in and depend on pathways, durations, intensities, and frequencies of contact with the pollutant. Doses are how much of the exposure is deposited in the body. Health impacts accrue from doses, can be acute (short-term) or chronic (long-term), and are non-specific in that they have many risk factors. Monitoring and intervention can occur at any stage along this pathway. Health impacts are the primary risk indicators, though control measures at this stage are often too late and complicated due to their non-specific nature. Doses are also too late in the air pollution pathway and are poorly understood for many pollutants. Control measures and standards generally focus on sources, emissions, and concentrations, with recent efforts targeting exposures.

CAUSES OF AIR POLLUTION

- Burning of Fossil Fuel
- Industrial Emissions
- Indoor Air Pollution
- Wildfires
- Microbial Decaying Process
- Transportation
- Open Burning of Garbage Waste
- Construction and Demolition
- Agriculture Activities
- Use of Chemical and Synthetic Products

Type of pollutants in ambient air

The major concentration of pollutants in the India air is:-

1. Particulate Matter, RSPM and SPM (PM2.5 and PM10): The principle source of particulate matter in Delhi is vehicular emissions, particularly from heavy

motor diesel vehicle, kerb-side dust, thermal power plants, industrial and residential combustion processes. Respirable suspended particulate matter (PM2.5) is considered to be more hazardous to human health than PM10. The average limit of PM2.5 pollution is 60 microgram per cubic meter but all the areas of Delhi have the level of PM 2.5 exceeding 300 microgram per cubic meter.

2. Nitrogen Oxide (NOx): Oxides of Nitrogen are produced during industrial combustion processes and primarily as vehicular exhaust. NOx levels are highest in urban areas as it is related to traffic. It is an important ingredient in the generation of photochemical smog which envelops the urban air with a haze like blanket. It has harmful effects such as wide-range of respiratory problems in adults and children.

3. Sulphur Dioxide (SO2): It is formed mostly by the burning of fossil fuels particularly from the thermal power plant. This pollutant is the reason for acid rain and has adverse effects on lung functions.

4. Benzene: The main sources of benzene are from vehicle exhaust and other industrial processes since it is an industrial solvent. Benzene is a component of crude oil and petrol. Apart from vehicle exhaust, evaporation from petrol filling stations can raise benzene levels.

5. Ozone (O3): Formed by chemical reaction of volatile organic compounds and nitrogen dioxide in the presence of sunlight, so the level of ozone is generally higher in the summer. Ground-level ozone also contributes to photochemical smog.

6. Toluene: Toluene is another industrial volatile solvent whose short term exposure causes irritation of the eyes and the respiratory tract. The substance is a known carcinogen and affects the central nervous system also.

7. Carbon Monoxide (CO): CO is a toxic air pollutant that is produced by incomplete combustion of carbon-containing fuels. Vehicle deceleration and idling vehicle engines are one of its main causes.

II. LITERATURE REVIEW

Reeta Kori et al (2019) the research paper aimed to access to assess the Ambient Air Quality Index of Bhopal city of Madhya Pradesh, India, during year 2017 to 2018. Total eighteen locations were selected in Bhopal city for ambient air quality monitoring of seven pollutants mainly Particulate Matter less than 10 μ size (PM10), Particulate Matter less than 2.5 μ size (PM2.5), nitrogen dioxide (NO2), Sulphur dioxide (SO2), Ozone (O3), Ammonia (NH3) and Lead (Pb).

Results revealed that overall ambient air quality index of Bhopal city was observed as moderate during study span. Air Quality Index was poor (202.26-218.05) at two locations, Moderate (106.08-184.75) at fourteen locations and satisfactory (63.90- 96.38) at two locations in Bhopal city. Although general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air. It may indication of increased risk of cardio respiratory symptoms in general population in Bhopal city of Madhya Pradesh, India.

Zaydoun Abusalem et al (2019) the research paper focuses on environmental issues that can be considered and modeled in order to be included in all generalized plans. In this study, concentrations of CO, NO, TVOCs and SO were monitored periodically at various sampling sites. The study revealed that the concentration of air pollutants showed a high correlation with traffic flow and prevailing road gradients. The concentrations of SO2, NO2, CO and TVOCs were highly correlated to key traffic flow parameters, such as road gradient, vehicular speed and traffic volume.

The characteristics of air pollutants under different traffic flow conditions and different road gradients were analyzed; SO2, NO2, CO and TVOCs' concentrations were measured under prevailing traffic conditions. The ratios of SO2, NO2, CO and TVOCs' concentrations for different road gradients were between 2.5 and 5.2. The air pollutant concentrations had a high correlation with traffic flow and road gradient. R-square values as well as relationships between SO2, NO2, CO and TVOC's concentrations and traffic speed. Results concluded the pollutant concentrations decrease with speed up to 60 km/h, while higher concentrations have been noticed with increasing gradient under the same traffic flow. This research project had introduced the average pollutant rate per gradient parameter. The values obtained are very much reflective of local conditions which are not typical when compared with other sampling locations in other recent studies by other researchers.

Objectives of the Study:

The primary objectives of the research are stated below:

- quantify the contributions of different emission sources to ambient PM2.5 concentrations and the related disease burden across India in the present day.
- Secondly, estimate the impact from different air pollution control pathways on ambient PM2.5 concentrations and human health in Target project location Hamidia Road Bhopal (M.P).
- Thirdly, understand the current and future disease burden from ambient O3 exposure in India, identifying critical contributing emission sources and the impacts of future policy scenarios.
- Conducting air quality for four different target locations and preparing comparative analysis and quantifying the pollutants.

III. PROBLEM STATEMENT

National Ambient Air Quality Standards

The Air (Prevention and Control of Pollution) Act 1981 was enacted by the Central Government with the objective of arresting the deterioration of air quality. The Air (Prevention and Control of Pollution) Act 1981 describes the main functions of the Central Pollution Control Board (CPCB) as follows:

- To advise the Central Government on any matter concerning the improvement of the quality the air and the prevention, control and abatement of air pollution.
- To plan and cause to be executed a nation-wide programme for the prevention, control and abatement of air pollution.
- To provide technical assistance and guidance to the State Pollution Control Board.
- To carry out and sponsor investigations and research related to prevention, control and abatement of air pollution.
- To collect, compile and publish technical and statistical data related to air pollution; and
- To lay down and annul standards for the quality of air

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Area (notified by Central Government)
Sulphur Dioxide (SO2), µg/m3	Annual* 24 hours**	50 80	20 80

Nitrogen Dioxide (NO_2), µg/m3	Annual* 24 hours**	40 80	30 80
Particulate Matter (size less than 10 µm) or PM10 µg/m3	Annual* 24 hours**	60 100	60 100
Particulate Matter (size less than 2.5 µm) or PM2.5 µg/m3	Annual* 24 hours**	40 60	40 60
Ozone (O_3) µg/m3	8 hours* 1 hour**	100 180	100 180
Lead (Pb) µg/m3	Annual* 24 hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m3	8 hours* 1 hour**	02 04	02 04
Ammonia (NH_3) µg/m3	Annual* 24 hours**	100 400	100 400
Benzene (C_6H_6) µg/m3	Annual*	5	5
Benzo(a)Pyrene (BaP)-particulate phase only, ng/m3	Annual*	1	1
Arsenic(As), ng/m3	Annual*	6	60
Nickel (Ni), ng/m3	Annual*	20	20

WHO air quality guidelines and interim targets for particulate matter: annual mean concentrations

WHOair quality guidelines and interim targets for particulate matter: annual mean concentrations			
	PM10 (µg/m3)	PM2.5 (µg/m3)	Basis for the selected level
Interim target-1 (IT-1)	70	35	These levels are associated with about a 15% higher long-term mortality risk relative to the AQG level.

Interim target-2 (IT-2)	50	25	In addition to other health benefits, these levels lower the risk of premature mortality by approximately 6% [2–11%] relative to theIT-1 level.
Interim target-3 (IT-3)	30	15	In addition to other health benefits, these levels reduce the mortality risk by approximately 6% [2-11%] relative to the -IT-2 level.
Air quality guideline (AQG)	20	10	These are the lowest levels at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to long-term exposure to PM2.5

WHO air quality guidelines and interim targets for particulate matter: 24-hour concentrations

WHO air quality guidelines and interim targets for particulate matter: 24-hour concentrationsa			
	PM10 (µg/m3)	PM2.5 (µg/m3)	Basis for the selected level
Iinterim target-1 (IT-1)	70150	75	Based on published risk coefficients from multi-centre studies and meta-analyses (about 5% increase of shortterm mortality over the AQG value).
Interim target-2 (IT-2)	100	50	Based on published risk coefficients from multi-centre studies and meta-analyses (about 2.5% increase of shortterm mortality over the AQG value).

Interim target-3 (IT-3)	75	37.5	Based on published risk coefficients from multi-centre studies and meta-analyses (about 1.2% increase in short-term mortality over the AQG value)
Air quality guideline (AQG)	50	25	Based on relationship between 24-hour and annual PM levels.

CASE STUDY

IV. MATERIAL AND METHOD

Materials and methods which are used in the research are described in detail. (Including chemicals, reagents, glassware's, instruments and filter papers etc.).

A. Instruments/Equipment

1) High volume sampler (Envirotech Pvt. Ltd., New Delhi)
2) Analytical Balance (Citizen, CY- 204), KEROY KM 2. (Least count 0.01 mg
3) Spectrophotometer (Elico
4) P H meter (RI RS-232 μC PH meter
5) Magnetic stirrer with Hot plate
6) Universal hot air Oven
7) Desiccators, etc.

CHEMICALS/REAGENTS-

For SOX:

Distilled water, Mercuric chloride, Potassium chloride/Sodium chloride, EDTA, 0.04 M Potassium Tetrachloro-mercurate (absorbing reagent), Sulphamic acid, formaldehyde, purified pararosaniline (PRA), Starch indicator solution, Sodium thio-sulphate, Potassium iodate, etc. For NOX: Distilled Water, Sodium hydroxide (absorbing reagent), Sodium Arsenite, Sulphanilamide, N- (1- Naphthyl)- ethylenediamene Di-hydrochloride (NEDA), Hydrogen Peroxide-30%, Phosphoric acid-85%, Sodium Nitrite, etc.

Glassware- Beaker, Measuring Cylinder, Volumetric flask, pipette, Amber color bottle, Glass bottles, Test tube, Burette, Funnel, Impingers, Wash bottle, etc.

Filter paper- Whatman GF/A filter papers of size (8'×10') for sampling of air pollutants, Whatman filter paper 40 NO.

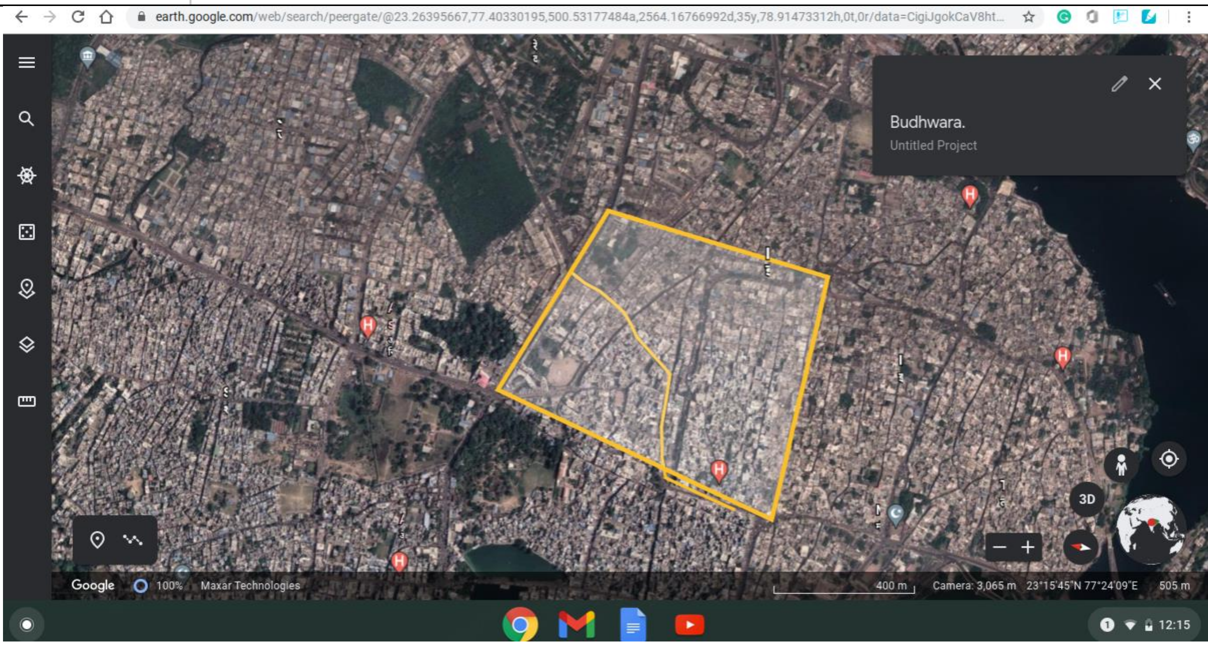
Pollutants	Method	IS code	Manual
SOX	West and Geake Method	IS:5182 (Part II) – 2001	CPCB Manual, 2009
NOX	Jacob and Hoccheiser	IS:5182 (Part VI) – 2006	CPCB Manual, 2009

	Method		
PM10	Gravimetric Method	IS:5182 (Part IV) – 1999	CPCB Manual, 2009

STUDY AREA

Bhopal city is the capital of Madhya Pradesh which is very well connected to all the corners of the country central part of India. It lies between N-latitude 23 23.020o and E- longitude 77.019o & 77 encompasses an area of 463 sq. km with 85 municipal wards. Bhopal is also known as the Lake City for its various natural as well as artificial lakes and is one of the greenest cities in India. The population of Bhopal Municipal Corporation as per census 2011 is 23, 71, 061.

POINT 1	Peergate Square
POINT 2	Budhwara Square
POINT 3	Jummerati
POINT 4	Ghoda Nakkas



MONITORING AND ANALYSIS

12 pollutants are listed in National Ambient Air Quality Standards (2009), Out of which 7 pollutants NO2, SO2, PM2.5, PM10, O3, Pb and NH3 were studied during this study. The concentration of each pollutant is converted to a number on a scale of 0–500. Sub index for each pollutant concentration is calculated by given equation 1:

$$I_P = \left[\left\{ \frac{(I_{HI} - I_{LO})}{(B_{HI} - B_{LO})} \right\} \times (C_P - B_{LO}) \right] + I_{LO}$$

Where

Ip= Sub Index for a given pollutant concentration,

BHI = Break point concentration greater or equal to given concentration (CP),

BLO= Break point concentration smaller or equal to given concentration (CP),

IHI = AQI value corresponding to BHI,

ILO = AQI value corresponding to BLO; subtract one from ILO, if ILO is greater than 50,

CP = Pollutant concentration, AQI = Max (Ip) (where p = 1, 2…n; whereas „n" denotes no. of pollutants)

Steps of Sample Collection and Analysis

a) Sample Collection

Samples are collected from selected sites daily (24 hour) for three days in three shifts (first two hour shift and remaining shifts are of four hour). Sampling was conducted during 4:00 AM to 11:00 PM daily (i.e. early morning (4:00 AM–6:00 AM), Day shift (7:00 AM –11:00 AM) and Evening shift (07:00 PM–11:00 PM)) and meteorological parameters like wind direction, wind velocity, humidity, pressure, cloud cover and temperature are also recorded to correlate impact on air quality. Sampling was done at a height of 2-3 m from ground level. The collection of samples of particulate matter (PM10), were carried out by high volume sampler (HVS) with constant flow rate and SOX, NOX samples are collected with the help of Gaseous attachment. HVS is operated at an average flow rate of 1.0 litre/minute for collection of SOX and NOX. The impingers were kept in iceboxes immediately after sampling and transferred to a refrigerator prior to analysis in the institute laboratory.

b) Gravimetric And Chemical Analysis

GF/A Filter papers were dried in oven at 102˚C for half an hour and cooled in desiccator to room temperature before loading it on HVS. The weight of filter paper was recorded prior to loading in HVS. Simultaneously impingers filled with suitable absorbing solution (30ml each) are also attached with HVS. The gable roof of the equipment was reseated before sampling. Impingers were jacketed in icebox to maintain the required temperature. Initial sampling rate of air was recorded though flow meter and sampling rate was recorded regularly after completion of one hour sampling. So that average sampling rate can be worked out for analysis of PM10. At the end of the work filter paper is taken out carefully from the filter holder gasket assembly and heated to 102˚C, to draw out the moisture if any. Subsequently filter paper was cooled to room temperature in dessicator and final weight is taken. For sampling of SOX & NOX as per CPCB guidelines the air flow rate was set at 1.0 lpm by adjusting gas manifold valve. At the end of the sampling the air flow rate was further recorded to find out the average rate of sampling. Final volume of each absorbent is also recorded for accurate calculation of volume of air passed through Gas manifold assembly. Impingers along with the icebox are immediately transferred to refrigerator before chemical analysis of sample. Chemical analysis of sample is conducted within 12-24 hrs in the laboratory.

c) Meteorological Measurements

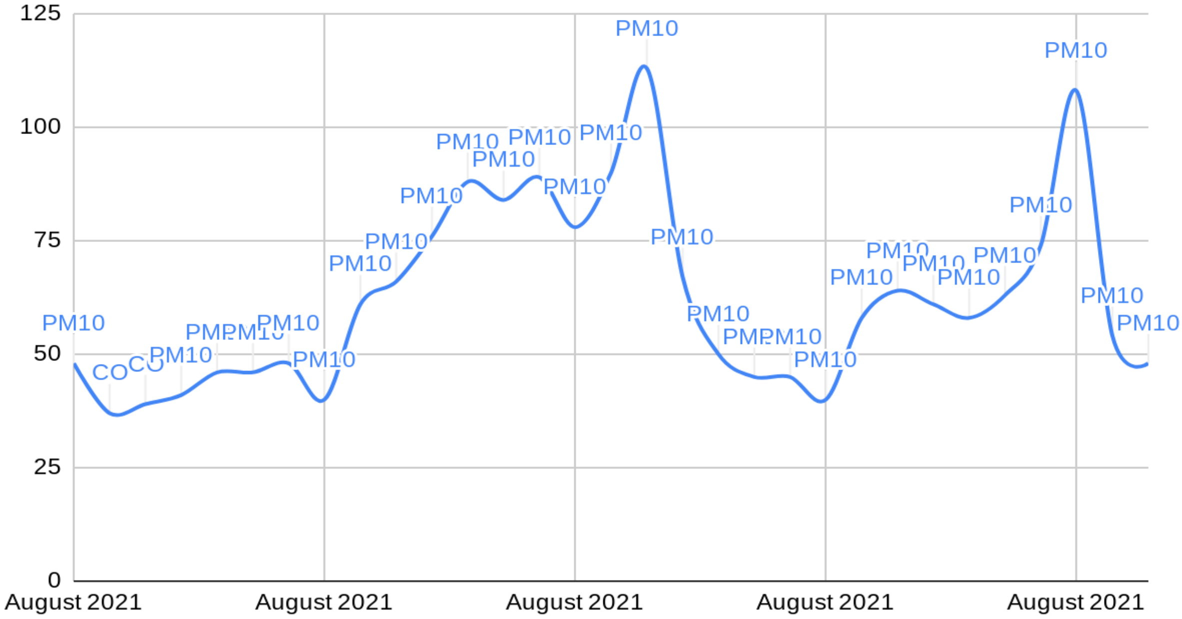
Besides anthropogenic sources, climate and natural sources too play an important role in the build-up of pollution levels WHO). Bhopal has a semi-arid climate, with an moderate summer, average rainfall and moderate cold winters (IMD). Meteorological data (such as Temperature, pressure, humidity, cloud cover, wind direction, wind speed). Periodic cleaning of the sampler was done to make the sampler dust free so that the reliability and reproducibility of the results can be ensured.

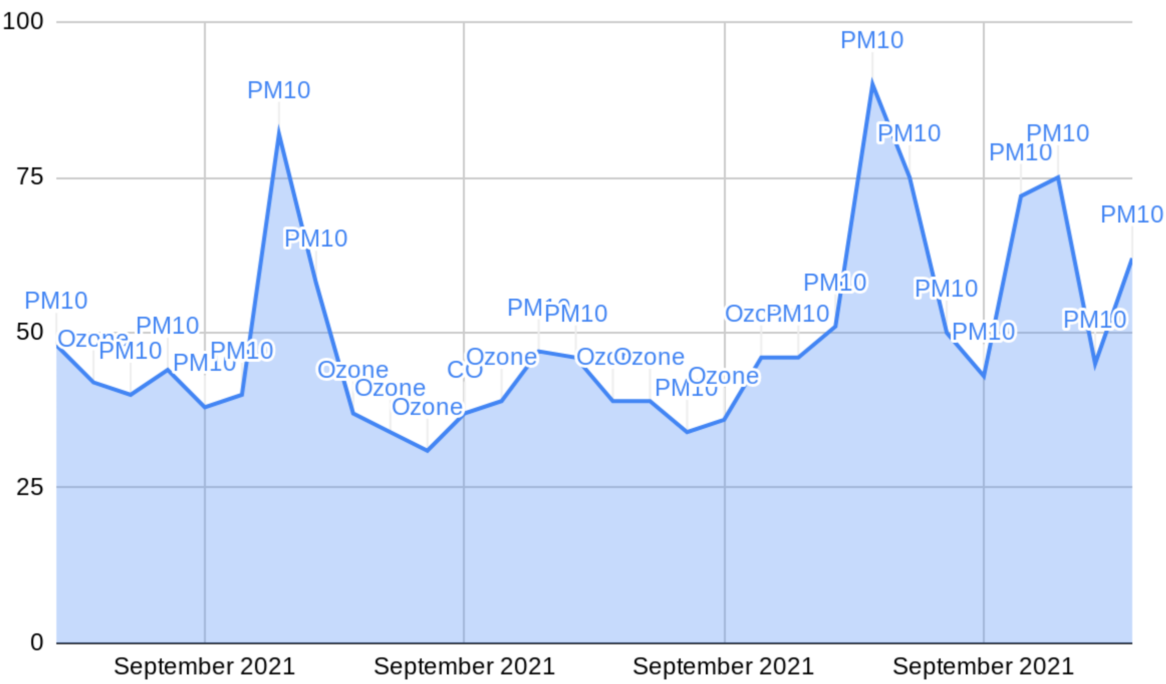
d) Air Monitoring and Analysis

SO2 and NOx samples collected by bubbling air sample in a specific 30ml absorbing solution (potassium tetrachloromercurate (TCM) for SO2 and mixture of sodium hydroxide and sodium arsenite for NOx) at an average flow rate of 1.0-1.5 M3 per minute (Ipeaiyeda et. al, 2018). The impinger samples were put in ice boxes immediately after sampling and transferred to a refrigerator until analyzed. The concentration of NOx was measured with standard method of Modified Jacobs- Hochheiser method. The apparatus was kept at a height of 2 m from the surface of the ground.

V. RESULTS AND DISCUSSION

Average air pollutants concentration in (µg/m3):

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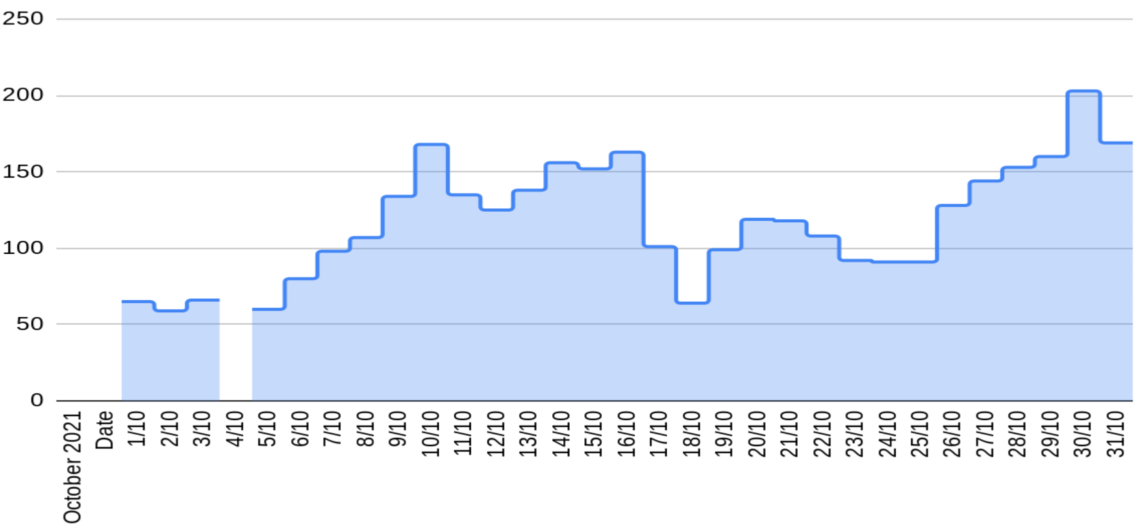
PM10
Ozone
September 2021
September 2021
September 2021
September 2021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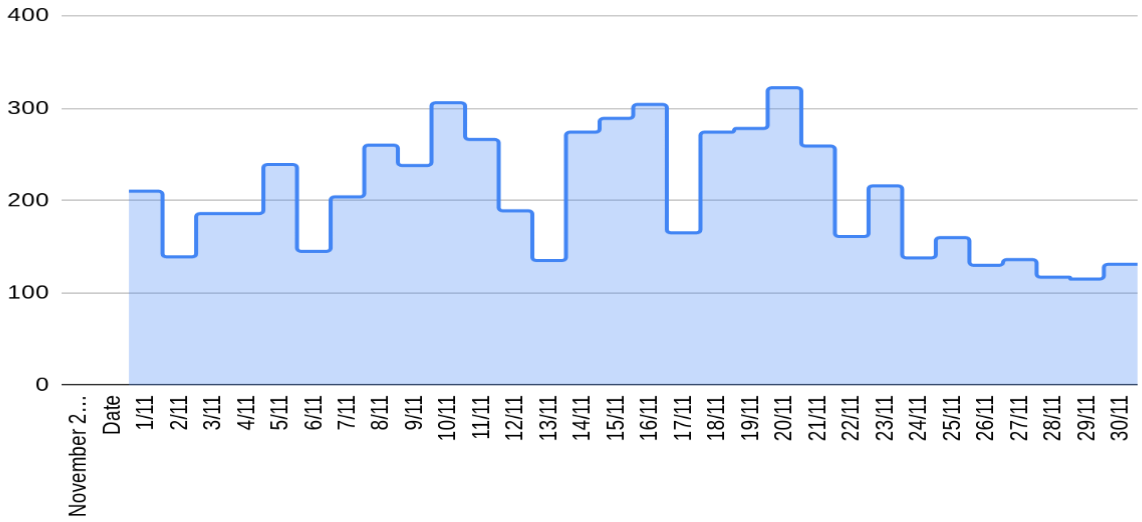
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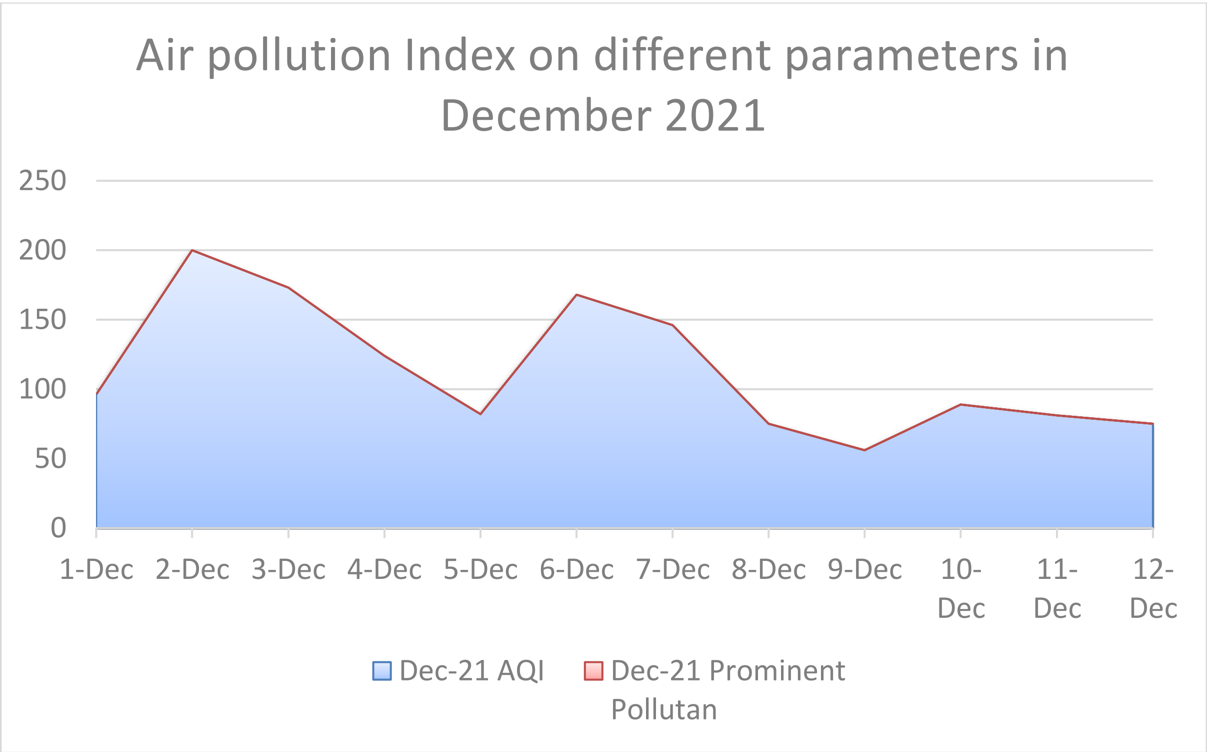
Air pollution Index on different parameters in December 2021
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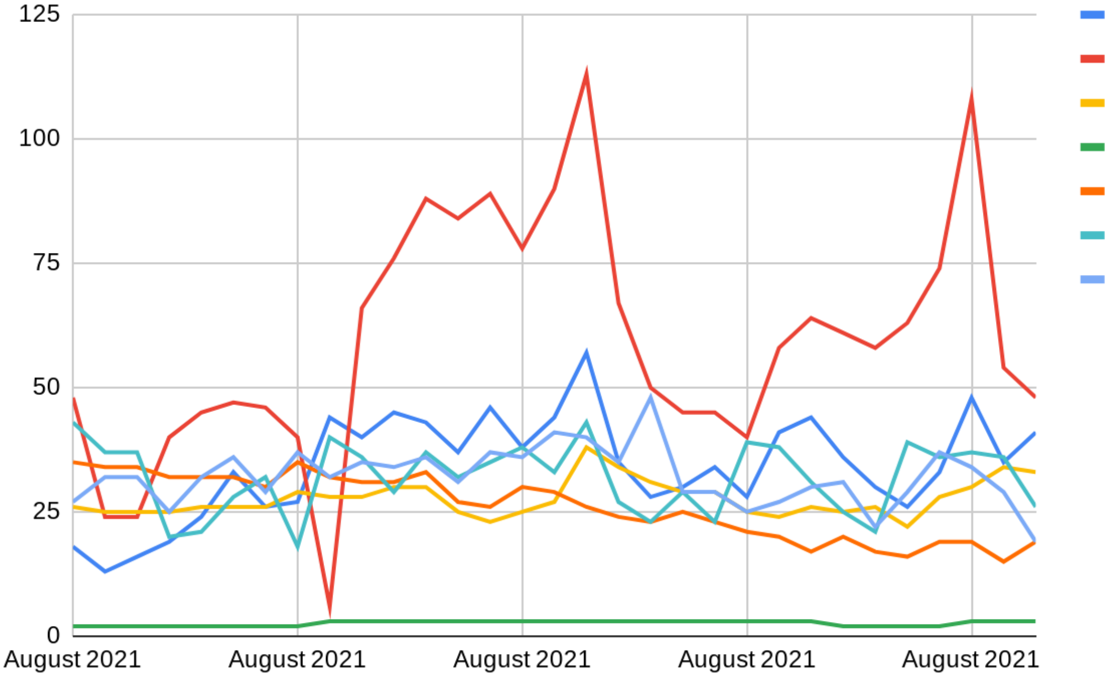
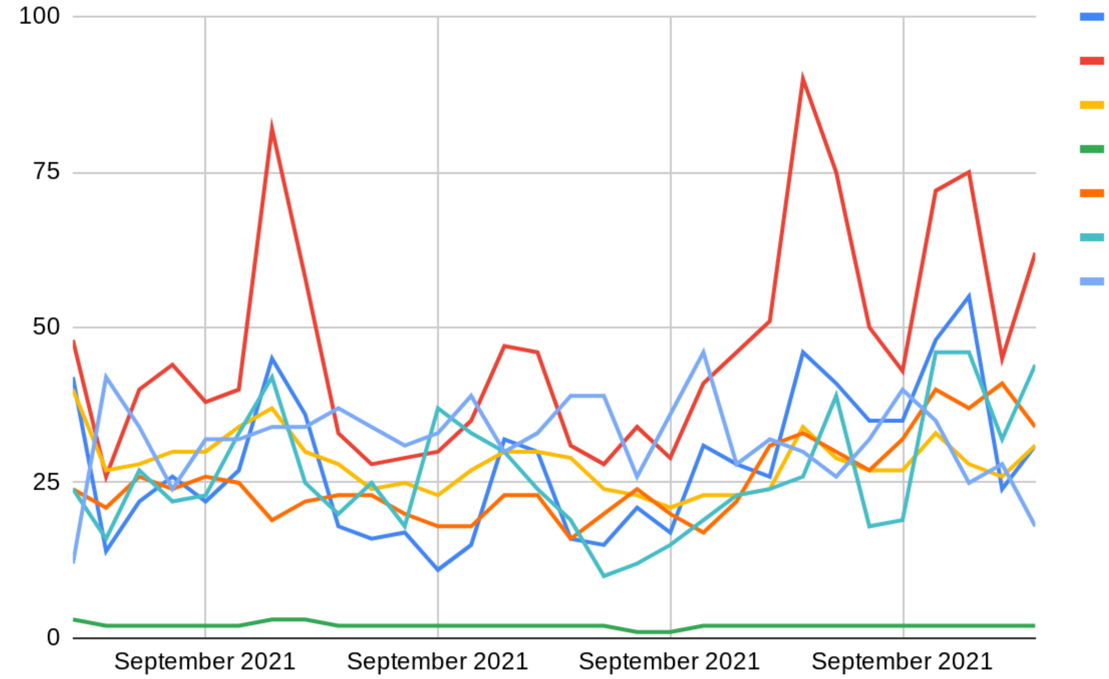
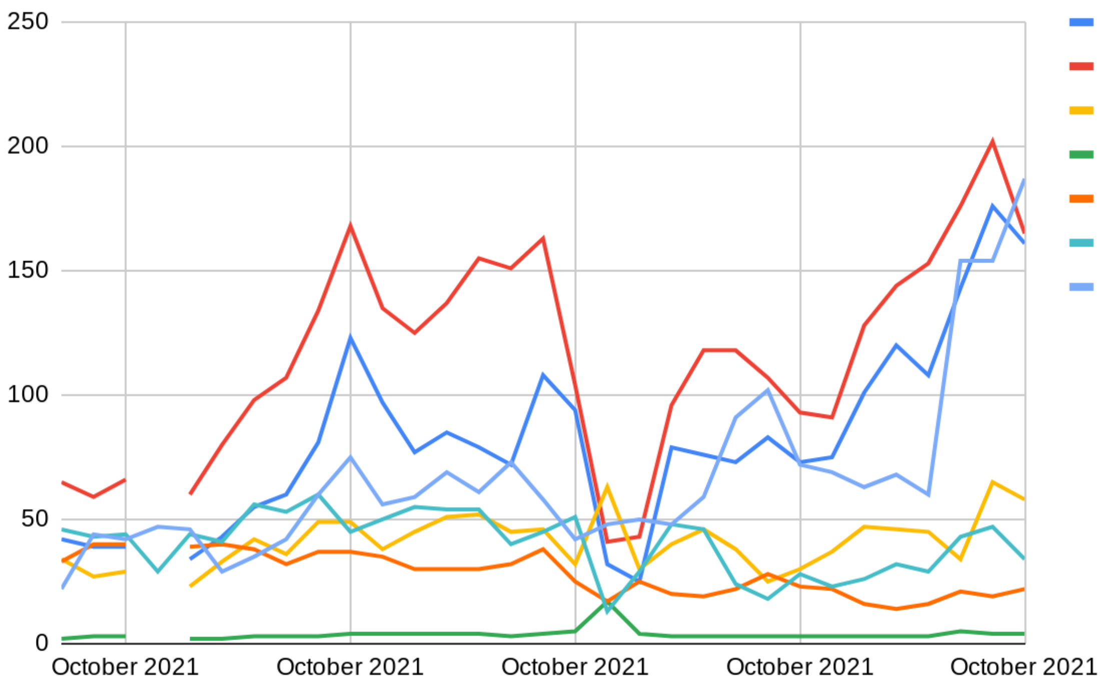
11-Dec
12-Dec
Dec-21 AQI
Dec-21 Prominent Pollutan

Average mean for the Pollutants :



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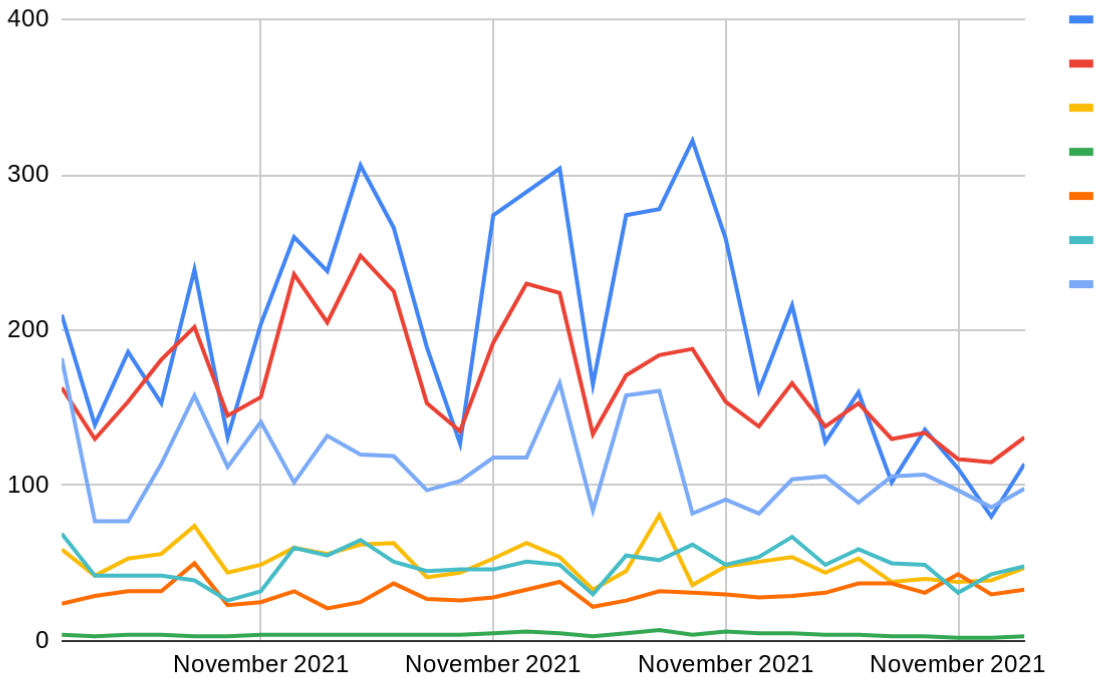
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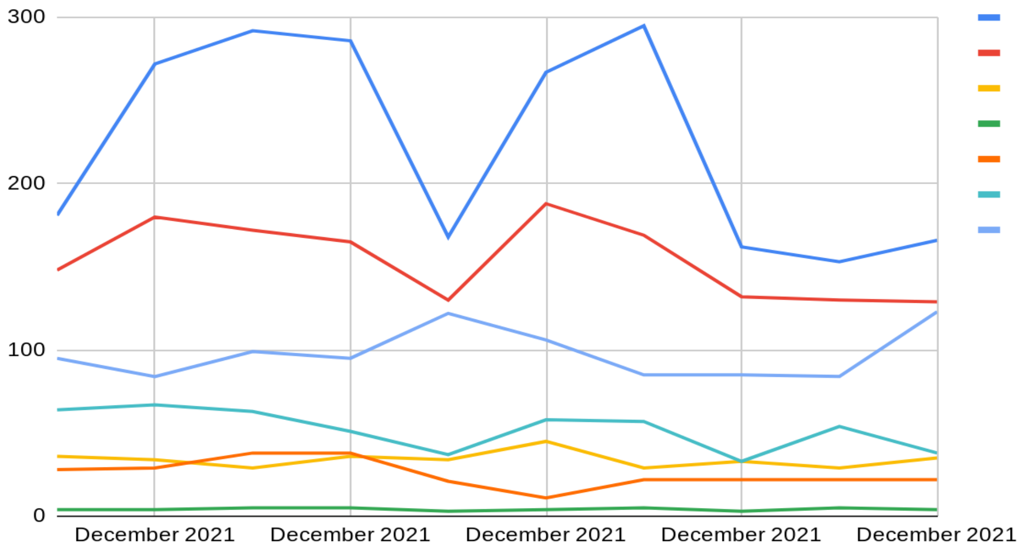

VI. CONCLUSION

Air pollution and air quality measured at Bhopal city indicates that PM10 and PM2.5 always found beyond the permissible limit but SO2 and NOx were always below the permissible limit at all the sampling site in both the months. The relative AQI was found in severe air pollution range. It may cause serious aggravation of heart or lung disease, it is indication of increased risk of cardio respiratory symptoms in general population.

Traffic came to a screeching halt on Hamidia Road from Bharat Talkies to Bhopal Talkies as commuters were stranded for three hours in 2019. The digits were valuated till 10th of december 2021.

The commuters had a hard time as the traffic moved at snail's pace. Even ambulances moving towards Sultania hospital were stuck in the jam. Long queues of vehicles were seen till Talaiya police station and Pul Bogda. The cops at Mangalwara and Hanumanganj police station along with traffic police struggled hard to clear the jam. They claim that traffic jams have become a regular feature in the area, especially during the peak hours. Traffic jams are a major problem on the peergate, budhwara and chauk.

The main reason for jam in the area are the mini trucks, which transport goods from shops in the area. As the whole area is commercial and the main market has many mini trucks and other small loading vehicles, traffic jams are the order of the day. Citing reason for traffic jam at Bhopal Talkies square due to the lack of left turns on two sides of the square causes jam. He said that there is no left turn for vehicles coming from Shahjehanabad side. Similarly, there is no left turn for vehicles coming from Saifia College side. This leads to traffic jam at the square.

This study summarizes the mitigation strategies that can be adopted by different stakeholders (citizens, companies, and committees) to obtain public health co-benefits with air pollution reduction. In particular, specific guidelines were provided in various sectors: transportation, industry, household, energy generation, agriculture, and shipping sector. These guidelines can be considered a basis for governments for the implementation of a strategic plan focused on the reduction of multipollutant emission, as well as of the overall air pollution related risk. Individuals can also adopt environmental friendlier behaviors that together with mitigation policies, can obtain health and environment co-benefits.

VII. FUTURE SCOPE

Following future scopes can be considered:

a) Short-term drivers to pollution episodes could be explored in terms of the impact on human health. For example, in November 2016, daily-mean PM2.5 concentrations in Delhi were over 900 g m-3 , many times higher than the WHO AQG of 25 g m-3 . This pollution episode coincided with large agricultural burning of rice residues across northwest India, though the impact on PM2.5 concentrations and human health has not been quantified. Another study could analyse the impacts of the Indian solid fuel intervention to promote LPG to over 90% of households by early 2020's (Section 1.1.3.2) on air quality and human health, considering stove stacking and stove usage patterns.

b) Simulations could be performed using WRF-Chem with chemical data assimilation, especially for AOD and PM2.5, to improve the accuracy of simulated particulate air quality. Previous studies have developed and explored the use of chemical data assimilation in WRF-Chem.

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Cite this article as :

Rahul Kumar Mandrai, Charan Singh Thakur, "Analysis of Pollution of Budhwara Area In Bhopal", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 6 Issue 2, pp. 17-32, March-April 2022. URL : https://ijsrce.com/IJSRCE22624