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Study of AQI Data in Terms of NO_X, SO_2, PM10 and PM2.5 Present in the Ambient Air of Bhopal City

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Abstract - With an increased pace of industrialization especially in developing countries, environmental problems have also increased. At the same time, with growing population and economic development, there has been a rapid rise in air pollution sources. Due to this, a number of pollutants are released in the ambient air deteriorating its quality. The health effects caused by air pollution may include difficulty in breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions.

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The study investigates the concentration of the pollutants NOX, SO_2, PM10 and PM2.5 from various sources like automobiles, industries, construction sites, Sweeping etc over the ambient air quality of the Bhopal City. 7 sampling stations were selected including 2 industrial, 3 residential and 2 commercial. The ambient air quality data has been collected from MPPCB. The study was carried out in yearly and monthly basis. Yearly average AQI data was from 2011 to 2016 and Monthly daily monitored data was of November, December 2017 and January 2018. February and March, 2012. Sampling time was 24 hrs. At three different locations the relative AQI was found in severe air pollution range in terms of particulate matter.

Keywords: pollutants, particulate matter, AQI, relative AQI, pm10, pm2.5, SO_2, NO_X.

I. Introduction

Air pollution due to anthropogenic sources, is a matter of concern in whole world. The urban areas may be viewed as dense sources of enormous anthropogenic emissions of pollutants, which can alter the atmospheric composition, chemistry and life cycles in its downwind regimes, extending over several hundred kilometres (Gupta et al., 2008). Moreover, worldwide epidemiological study on the effect of air pollution has revealed that gaseous pollutants and particulate matter has enough potential to cause severe health effect like respiratory, cardiovascular diseases and cardio pulmonary mortality. Modernization and industrialization of developing countries has led to the increased use of fossil fuels and their derivatives. As such, developing countries are confronted with the great challenge of controlling the atmospheric pollution especially in the rapidly growing mega cities. Hence a systematic monitoring programme all over the world especially in urban cities is urgently needed.

India, a developing country, is one of the first ten industrial countries of the world (Sharma,2007). Because of the enhanced anthropogenic activities (Goyal and Sidhartha, 2003) in India, air pollution problems have become a topic of intense debate at all platforms. According to a study released by World Economic Forum in Davos, India has the worst air pollution in the entire world, beating China, Pakistan, Nepal and Bangladesh. Environmental

assets were surveyed of 132 countries, in which India ranked dead last in the Air (effects on human health) ranking. The World Health Organization estimates that about two million people die prematurely every year as a result of air pollution, while many more suffer from breathing ailments, heart disease, lung infections and even cancer.

From the discussion of the scope of present study, i.e. motor vehicles, large population density and industries present in this area produce huge amount of pollutant which pollute the environment. Thus, the ambient air quality of the city Bhopal is needed to be studied in detail as it is a major concern to care for the health of the people residing in Bhopal resulting due to air pollution. The aim of this thesis is to study how the concentrations of PM_{10} sized particles have developed in Bhopal city from 2011 to 2017. Further aim was to interpret air quality data obtained from the MPPCB.

II. Air Quality Index

An air quality index is defined as an overall scheme that transforms the weighed values of individual air pollution related parameters (for example, pollutant concentrations) into a single number or set of numbers (Ott, 1978). The result is a set of rules (i.e. most set of equations) that translates parameter values into a more simple form by means of numerical manipulation.

Air quality index values are divided into ranges, and each range is assigned a descriptor and a colour code. Standardized public health advisories are associated with each API range. There are six levels of health concern and what they mean are: Good API is 0-50. Air quality is considered satisfactory, and air pollution poses little or no risk. Moderate API is 51-100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.

Table : 1 Colour Codes Proposed For AQI (Source : CPCB)

AQI	REMARK	COLOUR CODE	POSSIBLE HEALTH IMPACT
0 - 50	GOOD		MINIMAL IMPACT
51 - 100	SATISFACTORY		MINOR BREATHING DISCOMFORT TO SENSTIVE PEOPLE
101 - 200	MODERATE		BREATHING DISCOMFORT TO THE PEOPLE WITH LUNGS, ASTHAMA AND HEART DISEASE
201 - 300	POOR		BREATHING DISCOMFORT TO MOST PEOPLE ON PROLONGED EXPOSURE
301 - 400	VERY POOR		RESPIRATORY ILLNESS ON PROLONGED EXPOSURE
401 - 500	SEVERE		AFFECT HEALTHY PEOPLE AND SERIOUSLY IMPACTS THOSE WITH EXISTING DISEASE

III. Study Area

Bhopal is the capital of the Indian state of Madhya Pradesh and the administrative headquarters of Bhopal district and Bhopal division. The city was the capital of the former Bhopal State. Bhopal is known as the *City of Lakes* for its various natural as well as

artificial lakes and is also one of the greenest cities in India. It is the 17th largest city in the country and 131st in the world. According to the 2011 census, the population of the Bhopal city (the area under Bhopal Municipal Corporation) is 1,798,218, with 936,168 males and 862,050 females. Bhopal city situated along 77025' E longitude and 23025' N latitude and has an altitude of 550/600 meters above mean sea level. The population of the Bhopal metropolitan area (the urban agglomeration that extends beyond Bhopal city) was 1,886,100 in 2011. Mandideep and Govindpura are industrial suburb of Bhopal.
Air pollution could soon become a problem in the state capital if immediate steps are not taken to curb the deterioration of the air quality in the city. Vehicular exhaust, untreated open sewage, construction activities and industrialization among others are leading to air pollution in the city. Leading urban planners, environmentalists, activists, research scholars, and representatives from state and union government took part in the meet that was organised by EMBARQ —a sustainable urban mobility initiative of World Resources Institute (WRI) India.

Bhopal, the capital city of Madhya Pradesh has 07 operational NAMP stations in industrial, residential & mixed area. So, a systematic monitoring programme on air quality is solicited for the benefit of the town

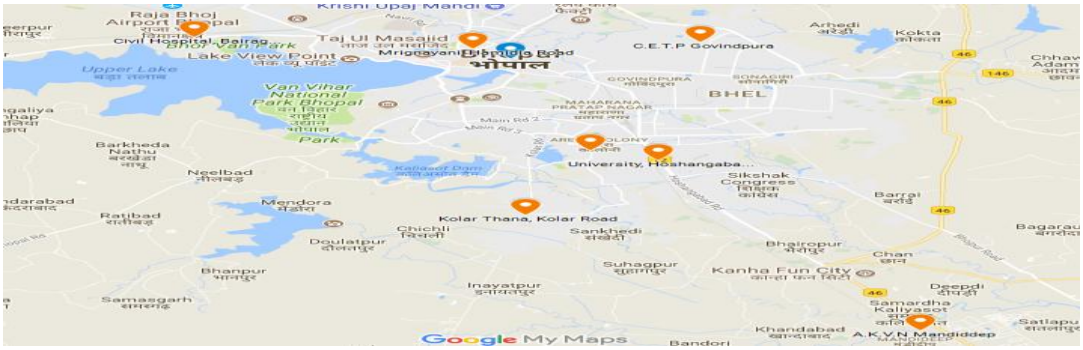

Fig-1 Map Showing Monotoring Stations in Bhopal City

IV. Methods and Instruments

According to the CPCB (Central pollution control board) the methods prescribed for the pollutant gases and the particulate pollutants are very sensitive ones yet percentage of errors are very less. The methods prescribed for the gases SO2, NO_X and the particulate pollutants TSP, PM10 are respectively:

(i) Modified West and Gaeke method for SO_2
(ii) Modified Jacob Hochheiser method for NO_X
(iii) High Volume method for PM2.5
(iv) Cyclonic flow technique for PM10

The purpose is to lay down an uniform and reliable method for sampling and analysis of SO2 and NO_X in the ambient air and also to lay down an uniform and reliable method for measurement of TSP and PM10 in the ambient air of Bhopal.

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Fig-2 Respirable dust sampler

Fig-3 Gaseous sampling arrangement

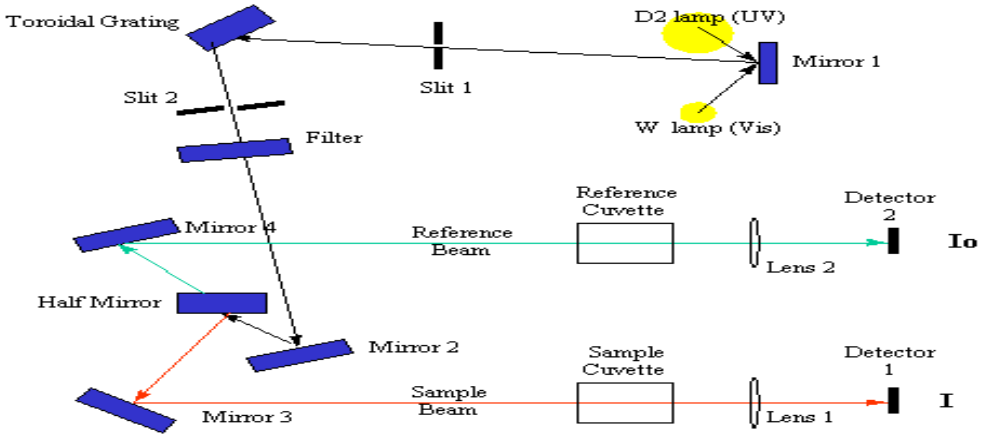
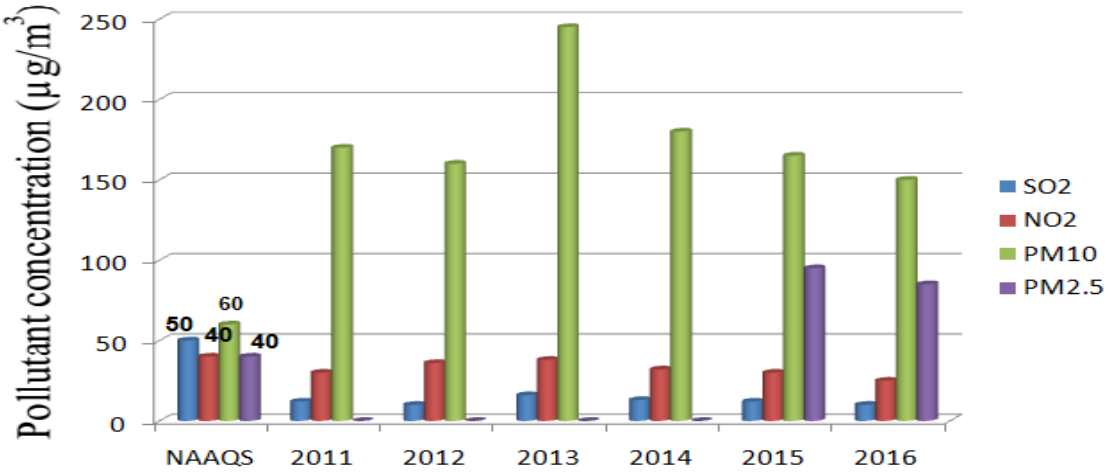


Fig-4 Spectrophotometer for Preparing calibration curve of SO_2 and NO_X

V. Result and Discussion

1. Yearly Air Quality Trends From 2011 - 2016



Air quality trends in Bhopal (2011– 2016) based on manual air quality monitoring stations (Source MPPCB)

As per the national ambient air quality standards, there are seven pollutants measured to find out ambient air quality. They are SO_2, NO_X, RSPM 10, PM 2.5, ozone, lead, carbon and ammonia. As of now, only SO_2, NO_X, RSPM 10, PM 2.5 and Ozone are measured in Bhopal.

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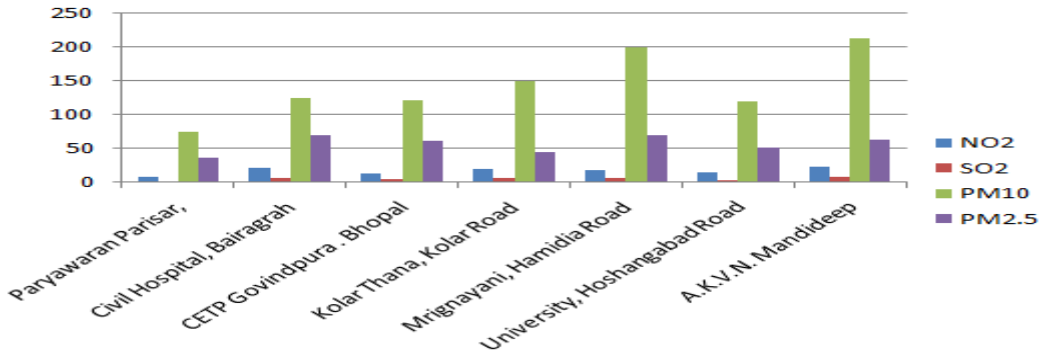
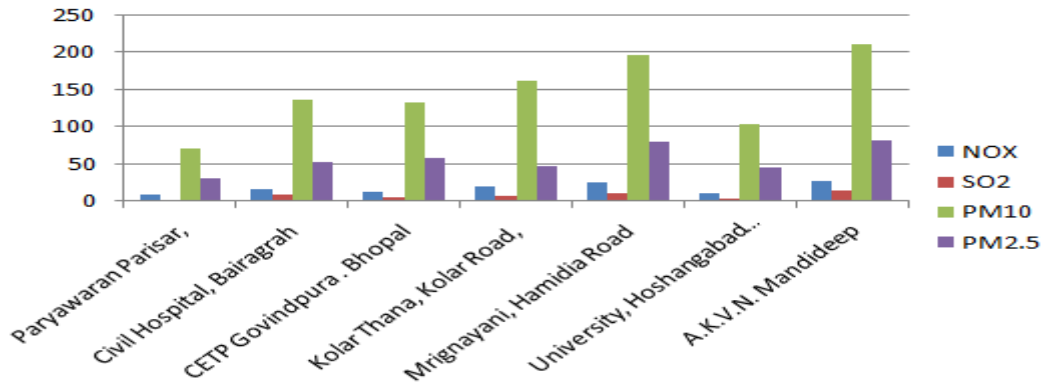
Air quality for the four major pollutants (SO_2, NO_X, and PM10 & PM2.5) is determined to understand the trend of pollution in Bhopal during recent years. On the basis of annual average concentration of pollutants, air quality trend has been seen for the years 2011 – 2016 along with the comparison with existing national ambient air quality standards (NAAQS), 2009.

It can be seen in Bar Chart that among the four pollutants *viz. SO2, NO2, PM2.5 and PM10, the concentration of PM2.5 and PM10 are* far exceeding the prescribed standard limits. The concentration of SO2 & NO2 is within the standard limits. However, as far as NO2 & SO2 is concerned, continuous rise in concentration was observed in past 5 years. Moreover, the problem of particulate matter (PM10) is more critical. Since 2013, approximately 100 – 150% rise has been observed in PM10 concentration compared to the standards. Although the concentration has been slightly lowered down since 2014, but it is still far above the safe limits.

2. Monthly Air Quality Trend – November & December 2017



Air quality trends of November 2017 based on manual air quality monitoring stations (Source MPPCB)



Air quality trends of December 2017 based on manual air quality monitoring stations (Source MPPCB)

The study shows that the concentration of pollutants is continuously on the rise, especially in the case of particulate matter, where pollution level is critical. In all these places, SO2 and NO_X have registered below safe limit while RSPM 10 has increased over the years. The value

of PM2.5 is being taken in account in Bhopal since 2015 as a result of which there is not much comparative data available for years.

PM10: At all the locations, the major sources for PM10 during winter months are biomass burning, vehicular emission, soil and road dust secondary particles *etc. In* different proportions. Secondary particles originate from precursor gases such as, SO2 and NO2. Vehicles are largely responsible for NO2 emission. Apart from this, construction materials are also responsible for PM10. During summer months, soil and road dust secondary particles, solid waste burning, and vehicular emissions are largely responsible for PM10, along with minor contribution from construction activities. Role of industrial pollution in the overall concentration of PM10 is <1% at all industrial locations.

PM2.5: For the PM2.5, secondary particles, vehicular emissions, biomass burning, soil and road dust, and solid waste burning are largely responsible in winter months. Moreover, coal and fly ash, soil and road dust, secondary particles are the major factors responsible for PM2.5 during summer months along with the other sources. Industrial pollution contributes to <1 – 2% at all the locations. Large amount of dust during summer months may be due to high wind speed and high temperature leading to extremely dry conditions which make dust airborne. Further, dust storms may also result in the re-suspension of road/soil dust.

Sampling stations of Hamidia Road (commercial), Kolar Road (residential), Bairagarh (commercial)and A.K.V.M Mandideep (industrial) shows most pollution in terms of Particulate Matter. It is mainly due to heavy traffic load and dust

The major component of air pollution in Bhopal come from burning of waste giving rise to methane in the MSW dump sites. Vehicles and construction are largely responsible for NO2 emission, while SO2 emission is mainly attributed by large power plants and refineries situated in the upwind direction of Bhopal. Apart from this, construction materials are also responsible for PM10.

VI. Conclusion

Based on the above observations, it can be said that the air of Bhopal is polluted *esp.* in terms of particulates. According to the study, vehicular pollution alone contributes about 60% of the total air pollution load in Bhopal as estimated using emission factor and activity-based approach recommended by IPCC. However, present study finds that it is not only the vehicular pollution, rather, domestic pollution, industrial emission, road dust and garbage burning also have a large share in Bhopal's total pollution load. Furthermore, construction of infrastructure including large residential complexes potentially contributes to the Bhopal's air pollution load.

Study also finds that the concentration of SO_2 is well under control. This is due to phasing out of diesel driven buses, reduction of sulphur content in diesel by about 90%, and implication of Bharat Stage IV norms in vehicles of Bhopal. The major cause of rising NO_2 concentration in Bhopal is increased traffic load. In atmosphere, the combination of nitric oxide (NO), ozone (O_3), and hydrocarbons leads to the formation of NO_2. Therefore to minimize the NO_2 pollution, all the three components involved in its formation needs to be targeted.

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