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Study air pollution spectrum in and around industrial areas of District Shahdol (M.P.) India

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Abstract
Air pollution has emerged as one of the challenging problems before mankind in the past few decades. The ambient air quality survey was carried out at industrial areas with respect to SPM, SO_2 and NOx. The pollutant concentrations were used to calculate the Air Quality Index. It is observed that most of the predicted pollutants are violating the permissible values.
A quantitative analysis on the mean concentration of SO_2, NOX, and SPM in four different industrial zones at Shahdol was compared with that of non-exposed to control regions. These attributes were analyzed on the morbidity pattern of the exposed population for eleven various diseases and its hazardous effects are reported in the present study. Source studies of SPM may be carried out to ascertain the sources and put up relevant control measures in place.

Keywords: Industrial, pollution, ambient air, SPM, NOX, SO_2

Introduction

Air pollution is being exacerbate by four specific events namely rapid economic development, high levels of energy consumption, expansion of cities and increase in automobiles traffic that typically occur as countries industrialization (Guttikunda and Jawahar, 2012) [1]. An unplanned, instructed and unzoned growth of both industrial and residential areas, as happened with many cities of the developed and developing world, has further enhanced the air pollution problems. Transportation is the major source of air pollution in metropolitans' cities. Among the various pollutants emitted from vehicles Respirable Particulate Matter (RPM) and Suspended Particulate Matter (SPM) are the primary pollutants and are harmful to human being (Almbauer, *et al.* 2001) [2]. The road condition is also responsible for producing RSPM and SPM. The number of vehicles is increasing every year which in turn create severe air pollution problems and expose threat to human life and health (Anonymous, 1998 & 1994 [3,4]. The overall assessment of the air quality can provide useful insights for the development of the air quality management plan and generated data base which are at present affected by high levels of particulate matter which are responsible for noncompliance against air quality standards (Reddy and Roj, 2003) [5]. The data base also helps the regulatory agencies to identify locations where the natural resources and human health could be at risk

The degradation of air quality is a major environmental problem that affects many urban and industrial sites and the surrounding regions. There certainly exists a close relation between poor air and poor health, as pollution of air results in breathing difficulties, increased incidence of Asthma, Cancer and even death. Heavy industrialization and increased transportation has polluted the atmospheric air to such an extent that it is slowly losing its self-cleaning capacity (Agrawal, *et al.* 1991, Arnon, 1994, Britton, 1995) [6, 7, 8]. Deteriorating air quality is posing serious threats, of changing, even the composition of atmosphere. Indian metropolitan cities like Delhi, Mumbai, Kolkata, etc. have high emission of air pollutants, which is degrading the ambient air quality day by day. The degradation of air quality is a major environmental problem that affects many urban and industrial sites and the surrounding regions worldwide (Reddy, 2001& NEERI, 2000) [9, 10]. Air pollution can reach levels, where it significantly influences human health, diminishes crop yield, and destroys infrastructure and patrimony. The phenomena involved in air pollution are complex. Once emitted into the atmosphere, primary pollutants are trans-ported by wind, turbulence and diffusion, which can undergo chemical reaction, change phase and finally are removed from the atmosphere by dry and wet deposition. Health and environmental impact of secondary pollutants, i.e., those formed in the atmosphere can be or severe than their emitted precursor (Aquil, *et al.* 2003, Bartley and Scolnik, 1995, CPCB, 1994-95) [11-13]. The Standards prescribed by C P C B (Central Pollution Control Board, India) has been tabulated in Table1.

Table 1: Ambient air quality Indian standard (μg/m³)

Area	SPM	SO_2	NOx
Industrial	300	80	90
Residential,	140	60	60
Sensitive	70	20	20

Though respiratory system usually bears the main brunt of air pollutants, many other disorders involving other organ systems even cancers are attributed to air pollution. Some of the pollutants are toxic to the hematopoietic system. In addition to pollution, cigarette smoke contributes significant amounts of noxious substances rendering smokers more vulnerable in comparison to the non-smokers. Apart from ambient air, urban people also suffer from the problems of water pollution and the adversities of their living environment. Lack of sanitation and personal hygiene play the role of additives and contribute to the sufferings of the city dwellers. Many studies have already shown the adverse effects of pollution that have affected the health of urban

people. In urban area also, some localities are principally industrial and some others are mainly commercial or residential.

The problems also differ in relation to the variations of the localities. A comparative analysis of these areas in relation to the morbidities of the dwellers can be important in assessing the real scenario of urban environmental health. In India, this kind of studies being very rare, an effort has been made through this study to evaluate the health status of urban community of two Indian cities viz. Trivandrum and Pune respectively keeping in view the possible role of pollution on human health.

Materials and Methods

The present study is carried in Orient paper mill (OPM), Amlai, Thermal power plant (TPP), Chachai, Hukumchand jute mill (HJM), Amlai and Coal field areas in Shahdol (M.P.). Each industrial area is divided into one zones to select sampling area.

Location of sampling points

The method of random sampling was adopted to collect air pollution samples area and around industrial areas of Orient paper mill (OPM), Amlai, Thermal power plant (TPP), Chachai, Hukumchand jute mill (HJM), Amlai and Coal field areas in Shahdol (M.P.). The location of sampling area should be such that it should be in the free atmosphere, without interferences from stagnant spaces or large buildings etc. The selected parameters are SPM, SO_2 and NOx. The high volume air sampler is used to collect the air samples at each sampling stations as standards, for each different parameters and chosen samples were analysed in the laboratory by following standard methods during the period of January 2012 to January 2013.

Study site

The Shahdol urban and rural parts are located in the East-south part of Madhya Pradesh. This district is situated between 23°00' N and 24 °18'N latitude and 81°00' E to 82°00' E longitude, extending 100 Kms**.** The climate of the study area is seasonally dry tropical savannah with four Seasons. The dry Season with clear bright weather is from December to February. The summer Season from March to May is followed by the Southwest monsoon season from June to September, October and November Constitute the Post monsoon. The temperature ranges between 33 ºC in April to 14 ºC in January. The mean annual rainfall is 1342 mm and number of rainy days is about 57, June to September is the principal rainy season. Air Quality Management System (AQMS) is a strategy to overcome the problems of air pollution and is most effective towards continuous improvements of air quality. It includes the evaluation of various sets of emission control schedules to determine consequences to air quality and the formulation of alternative emission control schedules to meet air quality goals. In this paper the attempt has been made to collect data of air pollution at a number of industrial areas and then shown in the form of an Air Quality Index.

The air quality index (AQI) is calculated with the help of following equation concerning air quality rating with respect to each air quality rating parameters.

Although ambient air quality standard gives an idea about the ambient status, it is possible represent the same later with air quality index as the cumulative effect of all the pollutants and related standard can be taken into account. Oak Ridge Air Quality Index (ORAQI) was chosen for relative ranking of different grids with respect to air quality status. The ORAQI formula is given below: -

$$\text{ORAQI} = \left[9.61 \left(\frac{CSPM}{SSPM} + \frac{CRSPM}{SRSPM} + \frac{CSO_2}{SSO_2} + \frac{CNOx}{SNOx} \right) \right]$$

C = Concentration of pollutants
S = Standard for pollutants

Oak Ridge Air Quality Index help in assessment of the ambient air quality status under six different categories ranging from excellent to dangerous. Where SPM, SO_2 and NOx are observed values of air Quality parameters. SSPM, SSO_2 and SNOx are Standard value of that very parameter recommended by CPCB. Based on the standard AQI values (Table2), air quality categories of the observed air samples are compared and inferred.

Table 2: Rating of Oak Ridge Air Quality Index (ORAQI)

Category	ORAQI	Description
1	< 20	Excellent,Very clean
2	20 – 39	Very good, Clean
3	40 – 59	Good, Fairly clean
4	60 – 79	Poor, Polluted
5	80 – 99	Bad, Heavily polluted
6	> 100	Dangerous, Severely polluted

In this study for estimation of assimilative capacity of atmosphere (ACA) three method can be used. In the first method, secondary ambient air quality data available for different grid has to be analyzed and maximum concentration occurring is a grid was determined. ORAQI is to be estimate to assess the cumulative effect of three pollutants *viz.* SPM, RSPM, SO_2 and NOx. This index has to be determined all grid classified under different categories viz. dangerous, bad, poor, fair, good and excellent with respect of air pollution on the basis of the above. The same can be utilized can be as the basics for identification of hot spot.

Results and Discussion

Most of the sampling stations exceed the residential standard limits of 140 µg/m³ but within the range of 300 µg/m³ for commercial areas in 24 hours. It is found that SPM values were very high in all directions. The maximum SPM was found near the close periphery of the highway line, which is due to the addition of ground dust by the moment of vehicles due to poor maintenance of roads. Table 2 shows the values of air quality index in different areas.

Table 3: Annual average of SPM, SO2 and NOx in ambient air at study site of Shahdol region – 2012.

S. No.	Study area	SPM µg/m³	SO_2 µg/m³	NOx µg/m³
1.	Orient Paper Mill, Amlai	531.68	21.34	40.88
2.	Thermal Power Plant, Chachai	527.78	21.03	40.38
3.	Hukumchand Jute Mill, Amlai	519.78	20.50	40.43
4.	Coal Field Area, Shahdol	543.95	20.84	40.63
	Average	533.79	24.07	41.52

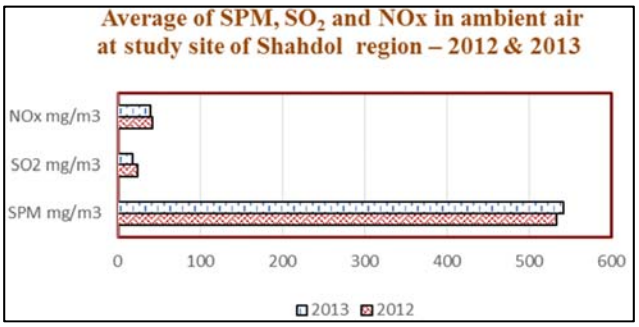
ORAQI = 58.59 = Good

Table 4: Annual average of SPM, SO_2 and NOx in ambient air at study site of Shahdol region – 2013.

S. No.	Study area	SPM µg/m³	SO_2 µg/m³	NOx µg/m³
1.	Orient Paper Mill, Amlai	532.12	21.22	41.81
2.	Thermal Power Plant, Chachai	547.52	21.25	40.78
3.	Hukumchand Jute Mill, Amlai	514.95	20.82	40.47
4.	Coal Field Area, Shahdol	551.15	21.14	40.44
	Average	541.43	18.17	39.34

ORAQI = 55.79 = Good

The table shows that Coal field area higher polluted area compared to the other three industrial areas in the year 2012 and 2013. The results of air quality monitoring indicate that the pollutants concentration were highly variable at different sampling area depending on stationary and density of mobile pollution sources. Particulate matter exceeded the permissible standard values due to stone cutting and stone polishing industries etc. and automobile effect where the national highway is passing and due to constructional activities in the vicinity of industrial areas. The present study shows that the value of SPM is on the threshold limit whereas the other parameters in the atmosphere of the study area is not creating any hard threat to the civic life. It is found that sounding people of study area suffered from respiratory and other health problems.



Conclusion

The present study clearly indicates that particulate matter is the fairly clean air pollutant in the study area. In the entire study area, particulate pollutants exceeded the permissible standards, but gaseous pollutants were within the permissible limits. The industrial activities and transportation activities are mainly responsible for the high pollution load in the ambient air of the area. The present study further suggests that public awareness can play a major role in planning and developing innovative ways to solve health, transport and related air pollution problems and the strategic plan for the their implementation.

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