



Quantifying the Cement Air Pollution related Human Health diseases in Maihar city, MP, India

Rai Priyanka, Mishra RM and Parihar Sarita

School of Environmental biology, A.P.S. University, Rewa MP, INDIA

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Abstract

This paper present air pollutants (suspended particulate matter, sulphur dioxide and oxide of nitrogen) emitted from Maihar cement plant and they may produce harmful effects on human health and his environment. This study was undertaken to investigate the quality of air in Maihar. Cement air pollution is rapidly becoming an environmental problem of public concern worldwide. It can influence public health and local or regional weather and climate. All the data were collected for a study period at five different locations (Bus stand, Labours colony, Maihar cement colony, Railway colony and Rewa road). In the present study at Maihar city, Primary pollutants such as SO₂ and NO_x were found within the standard value and SPM exceeding the standard value prescribed for residential and rural uses by CPCB, New Delhi. Maximum concentration of Suspended particulate matter, Sulphur dioxide and Oxide of nitrogen is found during winter months, moderate during summer and minimum during monsoon months indicate marked seasonal variation of pollutants under present investigation. Present study determines association between cement air pollution on one hand and occurrence of human health diseases on other hand. A questionnaire based survey was conducted to collect the data for incidence of air pollution linked diseases among the people of sampling sites. Result determine the maximum incidence of respiratory diseases (such as tuberculosis, bronchitis, cough, asthma etc.) compare to other diseases among the affected people.

Keywords: Ambient air pollution, human health diseases, Maihar cement plant, Maihar.

Introduction

Air pollution is a mixture of substances, including volatile organic compounds, nitrogen oxides, sulphur dioxide, carbon monoxide and particulate matter. The environment is an integral part of human life, the quality of which plays a critical role in human health. Air pollution has its own peculiarities, due to its transboundary dispersion of pollutants over the entire world. Therefore the study on air pollution and related impacts on human health have a special consideration today. Air pollution is related to serious health problems such as respiratory diseases, gastrointestinal diseases, blood pressure diseases, dental diseases, eye diseases, skin diseases and other diseases. The causal relationship of mortality and morbidity with air pollution has been found significant for a range of concentration levels¹⁻⁴.

Vehicular emission is responsible for higher levels of air pollutants like SPM, RSPM, SO₂, NO_x and other organic and inorganic pollutants including trace metals and their adverse effects on human health and environmental health^{5, 6}. Air pollution continues to receive a great deal of interest worldwide due to its negative impacts on human health and welfare. Several studies reported significant correlations between air pollution and certain diseases including shortness of breath, sore throat, chest pain, nausea, asthma, and bronchitis and lung cancer. One of the most critical impact of cement manufacturing is the dust generated during transport, storage, milling, packing

etc. Atmospheric dust is an important source of air pollution particularly in dry climates^{7,8}. Mineral dust contains high concentrations of many metals known to have toxic effect not only on plants and animals but also on humans^{9, 10}. Many international studies have shown that there are serious health risks associated with air pollution. According to the World Health Organization (WHO), air pollution is responsible for increase in outpatient visits due to respiratory and cardiovascular diseases, hospital admissions and mortality. This paper present the qualitative impairment of ambient air due to sulphur dioxide, oxides of nitrogen and suspended particular matter which is emitted from Maihar cement factory in Maihar city. The ill effect of these ambient air pollution on human health such as respiratory diseases, gastrointestinal diseases, blood pressure diseases, dental diseases, eye diseases, skin diseases and other diseases. Cement industry is a potential anthropogenic source of air pollution. It is a major contributor to dust, nitrogen oxides (NO_x), sulfur oxides (SO_x), and carbon monoxide (CO) in metropolitan areas. Furthermore, it contributes about 5% of the global CO₂, the famous green house gas¹¹. In cement industries, dust is emitted from stock piles, quarrying, transportation of raw materials, kilns operation, clinker cooling and milling.

Material and Methods

Maihar is situated in the North-eastern part of Madhya Pradesh. Maihar is developed tehsil of Satna. It is situated 24°17' latitude

North and 80°45' longitude East on National highway NH-7 and along the railway line of cement railway (Bombay –Howrah). For the present study five sampling sites were selected in Maihar city such as Bus stand, Labours colony, Maihar cement colony, Railway colony and Rewa road. Bus stand is situated at a distance of 10.5 km towards North west direction, Labours colony is also situated as cross section in cement factory area at a distance of 0.1 km towards East direction, Maihar Cement colony is a cross section in cement factory at a distance of 0.1 km. towards south direction, Railway colony is situated at a distance of 9.1 km towards North- west direction and Rewa Road is situated at a distance of 14 km towards North-west direction of Maihar cement factory.

Monthly SPM and gaseous pollutant such as SO₂ and NO_x were monitored by respirable dust sample (Envirotech model APM 460 BL-441) for 8 hour in a day as per the standards of central pollution control boards (India). Suspended particulate matters were collected on the dust cup where as gaseous pollutants (SO₂ and NO_x) collected in sodium tetrachloromercurate and sodium hydroxide arsenate solution respectively. After sampling the samples were analyzed as per methods described in manual of RDS and NEERI. AQI (air quality index) is then calculated with the concentration values using the following equation¹².

$$AQI = \frac{1}{3} \times (ISPM / SSPM + ISO_2 / SSO_2 + INO_x / SNO_x) \times 100$$

The questionnaire based survey was conducted in Maihar of evaluation of diseases due to air pollution.

Results and Discussion

The present study indicates the air pollutants concentrations and its impact on human health at five monitoring sites of Maihar city.

Seasonal variation of ambient air pollution: It is observed from the table -1, that the concentration of air pollutants such as suspended particulate matter, sulphur dioxide and nitrogen oxides for three seasons of the study period. Result determined the SPM concentration in the ambient air of all sampling sites varied between 281.07 µg/m³ to 342.25µg/m³, 322.29µg/m³ to 387.20µg/m³ and 172.25µg/m³ to 213.03µg/m³ during summer, winter and monsoon months respectively, sulphur dioxide concentrations were recorded in the range of 28.21µg/m³ to 38.17µg/m³, 34.36 µg/m³ to 52.69µg/m³ and 15.13µg/m³ to 28.78µg/m³ at five sampling sites during summer, winter and rainy season respectively. At all monitoring site NO_x concentration were recorded in the range of 35.27µg/m³ to 42.75 µg/m³, 41.20µg/m³ to 48.72 µg/m³ and 21.72 µg/m³ to 28.02µg/m³ during summer, winter and monsoon seasons. Highest concentration of SPM, SO₂ and NO_x was recorded during winter, moderate in summer and lower in monsoon months at all sampling stations. In summer months the low humidity and high winds facilitate concentration of SPM in the

ambient air. During winter months, due to calm condition there is trapping of all atmospheric pollutants near the ground level. Falling rain drops are known to prompt a washing out; solid material is dragged towards the ground and the air is thus cleaned to some extent during rainy months¹³. Cement dust and associated chemicals can spread over a large area through wind and rain, becoming accumulated in lichens, plants, animals and soils, and consequently, negatively affect in environment and human health¹⁴⁻¹⁶.

Annual concentration of ambient air pollution: The average concentration of SPM in the ambient air of monitoring sites are above the standard values (200µg/m³) for residential and rural user. Table-2, denoted the higher concentration of SPM (314.04µg/m³) was recorded at Maihar cement colony and lower concentration (261.66µg/m³) was recorded at Bus stand. The highest concentration of SPM have been reported in various part of India¹⁷⁻¹⁹ and in Haridwar region²⁰⁻²² and also in Rewa¹³. According to present study, the gaseous pollutants (SO₂ and NO_x) are well within standard value (80µg/m³) prescribed by CPCB, New Delhi for residential and rural uses. Out of five sampling sites the higher concentration of SO₂ was recorded at Railway colony (37.36µg/m³) followed by Maihar cement colony (37.07µg/m³), Bus stand (33.67µg/m³), Labour colony (32.77µg/m³) and Rewa road (29.50µg/m³). Whereas maximum NO_x concentration in the ambient air of Maihar cement colony (39.07µg/m³) to be followed by Labours colony (37.44 µg/m³), Railway colony (37.35 µg/m³), Rewa road (34.83 µg/m³) and Bus stand (33.65 µg/m³). In the present study, the gaseous pollutant SO₂ and NO_x concentration in Maihar city are found to be decreasing order.

Air quality index (AQI): Air quality index (AQI) is developed to provide the information about air quality. Air quality index (AQI) was introduced by Environmental Protection Agency (EPA) in USA to measure the level of pollution due to major air pollutant. It is one of the important tools available for analyzing and representing air quality status uniformly. Table-3, indicate the concentrations of the major pollutants are monitored and subsequently converted into AQI. Whereas, table-4, using standard formula and rating scale was also calculated. Result indicate the higher Air Quality Index (32.81) at Maihar cement colony to be followed by Railway colony (31.08), Labours colony (30.51), Rewa road (29.22) and Bus stand (28.27) and rating scale as LAP “Light air pollution” during study period. The high SO₂ concentrations of about 20 – 40 µg/m³ in most of the city in developing countries and the daily average values rarely exceed 125 µg/m³²³ and annual mean concentrations of NO₂ recorded in most cities across the globe, not exceeding 40 µg/m³²³.

Human health diseases: As the most common route for pollutants to enter the human body is by inhalation, the most common effect of air pollution is damage to the respiratory system. Exposure to air pollutants can cause respiratory diseases (such as lung cancer, tuberculosis, asthma, bronchitis

and emphysema), gastrointestinal diseases, blood pressure diseases, dental diseases, eye diseases, skin diseases and other diseases may also suffer when the air is polluted. A questionnaire based survey was conducted to get the statistics for incidence of various diseases among the people of sampling sites. Survey was conducted for general incidence of various diseases among the people of five sampling sites. figure-1, indicate that about 93.26 % male, 82.22 % female and 40.06 % children at Bus stand, 75.13% male, 65.35% female and 35.27% children at Labours colony, 87.38% male, 61.49% female and 38.11% children at Maihar cement colony, 67.49% male, 58.93% female and 41.50% children at Railway colony Whereas 51.40% male, 35.75% female and 39.11% children at Rewa road were affected due to cement air pollution in Maihar city (figure-1).

Table-5 Represent the percentage of person suffering from respiratory diseases was found in the range of 28.35 % to 52.54 % at all sampling sites, The estimated gastrointestinal percentage at five sampling sites varied between 20.07 % to 40.65%, blood pressure diseases was found in the range of 13.47% to 33.61% at the sampling sites, dental diseases varied between 15.99% to 28.00% at five sampling sites. All the sampling sites exhibited eye diseases in the range of 13.80% to 25.03%, out of five sampling sites skin diseases found in the range between 13.44% to 35.59% whereas other diseases found in the range of 9.76% to 23.10% at all sampling sites during survey period. Out of five sampling sites, showed maximum percentage of person suffering from respiratory disease which is higher at Labour colony (52.54%) to be followed by Bus stand (46.90%), Maihar cement colony (46.32%), Railway colony (42.27%) and Rewa road (28.35%).

Health effects of SPM in humans depends on particle size, concentrations and exposure time. Exposure to 200 µg/m³ of particulate matter can cause upper respiratory diseases and 294-470 µg/m³ depress immune function in children. Our results confirmed what has already been argued in the literature. The

analysis certifies the harmful effects of air pollution and weather parameters mostly SO₂ was positively correlated with health admission for every additional 100 µgr/m³ and 25µgr/m³, respectively. Significant also seemed to be the results for other pollutants, such as NO₂ and CO. In other studies^{24,25}. NO₂ was positively associated with cardiovascular admissions and death increased risk ranging from 14% (admissions for every 10 PPhm) to 1% (death for every 10 µgr/m³). International studies have conformed association between elevated levels of particulate air pollution and increase in respiratory symptoms such as cough, shortness of breath, wheezing and asthma attacks. The resulting exposure to cement dust has led to impairment of respiration and a prevalence of respiratory symptoms amongst workers²⁶⁻²⁸ culminating in what has been described as a “Cement factory lung disease”²⁶. The severity of the impairment of respiratory function has been shown to depend on years of exposure²⁶.

Conclusion

The main environmental issue associated with cement production is the emission of pollutants (SPM, SO₂ and NO_x) in the atmosphere. These air pollutants have long been associated with prevalence of various diseases in human beings. Results revealed higher concentrations of SPM in the ambient air of all the selected villages than permissible limit of 200µg/m³, prescribed by central Pollution Control Board, New Delhi. Contrarily, the ambient air SO₂ and NO_x concentration have been estimated below the permissible limit of 80µg/m³, Prescribed by CPCB, New Delhi. Result indicated higher SPM, SO₂ and NO_x concentrations in the ambient air during winter months to be followed by summer and monsoon months. The human populations of all selected sites were surveyed for prevalence of various diseases such respiratory diseases, gastrointestinal diseases, blood pressure, dental diseases, eye diseases, skin diseases and other diseases. Result indicated maximum people of all selected sites suffering with respiratory diseases than other problems.

Table- 1
Seasonal variation of air pollutants in the ambient air of sampling sites

Sl. No.	Sampling site	SPM(µg/m ³)			SO ₂ (µg/m ³)			NO _x (µg/m ³)		
		S	W	R	S	W	R	S	W	R
1.	Bus stand	287.65	325.07	172.25	38.05	42.71	20.26	37.02	42.21	21.72
2.	Labour colony	326.87	387.02	213.03	38.17	45.01	15.13	40.22	44.75	27.36
3.	Maihar cement colony	342.25	287.20	212.69	38.14	44.30	28.78	42.75	48.72	25.75
4.	Railway colony	289.26	378.76	202.72	35.72	52.69	23.67	39.75	46.70	25.60
5.	Rewa road	281.07	322.29	184.06	28.21	34.36	25.92	35.27	41.20	28.02

Table -2
Annual concentration of different air pollutants in the ambient air of sampling sites

Sl. No.	Sampling sites	SPM($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)
1.	Bus stand	261.66	33.67	33.65
2.	Labour colony	308.97	32.77	37.44
3.	Maihar cement colony	314.05	37.07	39.07
4.	Railway colony	290.25	37.36	37.35
5.	Rewa road	262.47	29.50	34.83

Table - 3
Air Quality index of Sampling sites

Sl. No.	Sampling sites	AQI
1.	Bus stand	28.27
2.	Labour colony	30.51
3.	Maihar cement colony	32.81
4.	Railway colony	31.38
5.	Rewa road	29.22

Table -4
Rating scale of AQI value

Sl. No.	Index value	Remarks
1.	0-25	Clean air pollution (CAP)
2.	26-50	Light air pollution (LAP)
3.	51-75	Moderate air pollution (MAP)
4.	76-100	Heavy air pollution (HAP)
5.	Above 100	Severe air pollution (SAP)

Table- 5
Percentage of air pollution oriented diseases among the people of sampling sites.

Sl. No.	Diseases	Sampling sites				
		Bus stand	Labour colony	Maihar cement colony	Railway colony	Rewa road
1.	Respiratory diseases	46.90	52.54	46.32	42.27	28.35
2.	Gastrointestinal diseases	35.46	40.65	31.43	26.31	20.07
3.	Blood pressure	33.61	18.19	28.16	26.48	13.47
4.	Dental diseases	16.65	15.99	28.00	18.60	16.14
5.	Eye diseases	24.23	13.80	22.73	17.31	25.03
6.	Skin diseases	35.59	17.56	17.03	21.09	13.44
7.	Other diseases	23.10	17.02	13.24	15.86	9.76

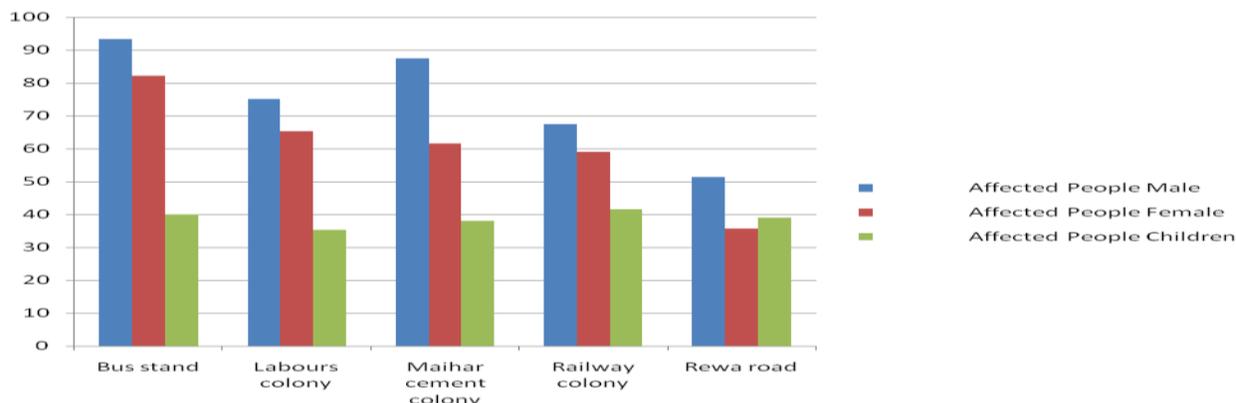


Figure- 1
Occupational health diseases among the people due to air pollution

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