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Air Quality Assessment of Dhanbad District, India - A Case Study

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Abstract: Ambient air pollution status in Dhanbad district is studied and presented in this article. The selection of Dhanbad is made considering its importance and the nature of activities taking place around the district. For the assessment of ambient air quality in Dhanbad, the following five locations were chosen: Main Gate of Indian School of Mines(ISM), Dhanbad: It is a site representing purely commercial activities and road traffic. Bankmore: It is one of the busiest marketing centres of the district and is surrounded by residential areas. All the vehicles going to Bokaro pass by this place and thus the traffic density is pretty high. Kusunda: It is a place 10.9 kilometres from Dhanbad Railway Station. It is just beside one of the coal mines, hence, all vehicles going to the mine passes through this place. Steel Gate: It consists of a small market. Trucks and other heavy vehicle are more frequent during night as this road connects to a highway. ISM Admin Block: It can be considered as a sensitive area since it is a very calm place where the usage of vehicles is minimum throughout the day. Monitoring of ambient air quality is done following the standard procedure prescribed in IS: 5182. In addition, the concentration of lead, zinc, cadmium, copper, manganese and iron metals in SPM is also monitored. The ambient air quality assessment was done in the month of June, 2009. The concentration of SPM was higher than the permissible limit in three locations namely ISM Main Gate, Bankmore and Steel Gate, while it was less than the permissible limit in other two locations, ISM Admin Block and Kusunda. Since the generation of SPM was mainly due to vehicular traffic it was expected to cross the limit in the above mentioned three locations as density of vehicular movement is very high.

Keywords: *Exceedence factor, Oxides of nitrogen (NOx), Respirable particulate matter (RPM), Sulphur dioxide (SO_2), Suspended particulate matter (SPM), traces metals.*

Introduction:

Air-borne particulate matter is an ensemble of solid particles suspended and dispersed in air. The properties of these particles vary in terms of chemical composition, morphology (size/shape) optical parameters (colour/light scattering), and electrical characteristics (charge, resistance). The particulate and gaseous wastes of various human activities e.g. burning of fossil fuels, transport, construction, mining etc. contribute various pollutants to atmosphere and when the presence of these pollutants starts affecting the human beings, plants and animals the matter becomes a cause of concern. Industrialization and urbanization have resulted in a profound deterioration of India's air quality. India's most severe environmental problem, come in several forms, including vehicular emissions and untreated industrial smoke. Apart from rapid industrialization, urbanization has resulted in the emergence of industrial centres without a corresponding growth in civic amenities and pollution control mechanisms. Urban areas in general been experiencing a higher concentration of air pollution due to extensive vehicular movements and other activities concentrated in comparatively similar areas and the cities have been

divided into four categories on the basis of exceedence factor (EF), which is the ratio of annual mean concentration of a pollutant with that of its standard. The standard four categories are given below:

1) Critical pollution (C): when EF is > 1.5;
2) High pollution (H): when EF is between 1 and 1.5;
3) Moderate pollution (M): when EF is between 0.5 and 1.0;
4) Low pollution (L): when EF is < 0.5

In India the national ambient air quality status of various cities and towns were decided on the basis of concentrations of pollutants given in the table below:

Table 1: *Basis of National Ambient Air Quality Status of Various Cities/Towns (Source: CPCB, NAAQMS)*

Pollution Level	Annual mean concentration range ($\mu g/m^3$)			
	Industrial		Residential	
	SO_2 & NOx	SPM	SO_2 & NOx	SPM
Low (L)	0-140	0-180	0-30	0-70
Moderate (M)	40-80	180-360	30-60	70-140
High (H)	80-120	360-540	60-90	140-210
Critical (C)	>120	>540	>90	>210

The air pollutants of immediate human concern are those which when in higher concentration affect the health and well being of the people. These are listed below:

- Suspended particulate matter (SPM)
- Respirable particulate matter (RPM)
- Sulphur dioxide (SO_2)
- Oxides of nitrogen (NOx)
- Lead (Pb)
- Heavy metals in SPM

Over View of Dhanbad:

Dhanbad is a city in the state of Jharkhand, and is also known as the 'Coal Capital of India'. Dhanbad is among the top 100 fastest growing cities of world. According to 2001 census, Dhanbad is among 35 cities of India with population more than 1 million. Among the Rail Divisions of Indian Railway, Dhanbad Rail Division is in second position in terms of revenue generation.

Dhanbad is famous for coal mining. Tata Steel, BCCL, ECL and IISCO are some of the companies having coal mines in the district. Coal-mining, Coal washing and coke making are the main coal related industries in the city. IISCO (Indian Iron And Steel Company) is now owned by SAIL, BCCL & ECL comes under CIL (Coal India Ltd), these two companies are the largest operators of coal mines in Dhanbad, and have open cast mines as well as underground mines, whereas Tata Steel has mostly underground mines. These companies have developed townships for their employees.

Ambient Air Quality Standards:

In the year 1994, under the section 16(2)(h) of the Air Act(1981), CPCB laid down and notified the ambient air quality standards for industrial, residential and sensitive areas for various air pollutants namely; sulphur dioxide, nitrogen dioxide, suspended particulate matter, Respirable particulate matter, Respirable lead and carbon monoxide. These standards provide the basis for protecting the public health from adverse effects of air pollution and limiting those contaminants of air that are known or likely to be hazardous to human beings, vegetation, animals and national

heritage within the adequate margin of safety. National Ambient Quality Standards with the method of monitoring are listed in the Table 2:

Table 2: *National Ambient Quality Standards with the Method of Monitoring are listed below in the Table*

Pollutant	Time Weighted average	Concentration in ambient air			
		Sensitive area	Industrial area	Residential, Rural and Other areas	Method of measurement
Sulphur Dioxide SO_2 (µg/m^3)	Annual*	15	80	60	Improved West and Gaeke Method
	24 hrs **	30	120	80	Ultraviolet Fluorescence
Oxides of Nitrogen NO_2 (µg/m^3)	Annual*	15	80	60	Jacob & Hochheiser modified(Na arsenic method)
	24 hrs **	30	120	80	Gas phase chemiluminescence
SPM (µg/m^3)	Annual*	70	360	140	High volume Sampling (Av. Flow rate less than 1.1 m^3/min)
	24 hrs **	100	500	200	
RPM(size less than 10 µm) (µg/m^3)	Annual*	50	120	60	Respirable Particulate Sampler
	24 hrs **	75	150	100	
Lead (µg/m^3)	Annual*	0.5	1.0	0.75	AAS method after sampling using EPM 2000 or equivalent filter paper
	24 hrs **	0.75	1.5	1.0	
CO (µg/m^3)	8 hrs **	1.0 mg/m^3	5.0 mg/m^3	2.0 mg/m^3	Non-dispersive infrared spectroscopy
	1 hrs	2.0 mg/m^3	10.0 mg/m^3	4.0 mg/m^3	

**Annual Arithmetic Mean of Minimum 104 Measurements in a Year taken twice a Week 24 hourly at Uniform Intervals.*

***24 hourly/8 hourly values should be met 98% of the Time in a Year however, 2% of the Time, it may exceed but not on Two Consecutive Days.*

Study Area and Monitoring Stations:

As stated earlier the study area was Dhanbad District. The area under study included one of busiest roads in Dhanbad with vehicles moving around all the time. In addition, there are numerous commercial and industrial activities along. In order to monitor the air pollution status in Dhanbad district, five monitoring stations were selected keeping in view the general characteristics of the areas, care in monitoring i.e. location, availability of round the clock electricity, safety of monitoring

equipment etc. The monitoring stations thus selected were as listed below:

1) **Main Gate Indian School of Mines(ISM) - Dhanbad:**

It is a site representing purely commercial activities and road traffic.

2) **Bankmore:** It is one of the busiest marketing centres of the district and is surrounded by residential areas. All the vehicles going to Bokaro passes by this place and thus the traffic density is pretty high.

3) **Kusunda:** It is a place 10.9 kilometres from Dhanbad main city. It is just beside coal mine, all vehicles going to mine passes through this place.

4) **Steel Gate:** It is site consisting of small market. Trucks and other heavy vehicle numbers are more during night since this road connects to highway.

5) **ISM Admin Block:** It can be considered as a sensitive area since it is a very calm place where the usage of vehicles is minimum throughout the day.

As we see, the monitoring stations selected represent the various mixes of air pollution source situations.

Air quality parameters, SPM, RPM, SO2, and NOx are monitored by using High Volume Samplers and Respirable Dust Samplers (Envirotech Instrument APM 460 NL)following standards procedure laid down by the Central Pollution Control Board(CPCB) in IS: 5182

1) Suspended Particulate Matter (SPM)
2) Respirable Particulate Matter (RPM)
3) Sulphur Dioxide (SO2)
4) Nitrogen Oxides (NOx)
5) Lead

Presence of Heavy Metals in Air Borne Dust:

The air borne dust collected during monitoring was analysed to assess the presence of the fallowing heavy metals and their concentration. The dust collected during monitoring of the SPM and RPM is analysed in the laboratory using atomic absorption spectrophotometer (AAS) to assess the presence and concentration of lead and other heavy metals in the dust.

- Zinc (Zn)
- Iron (Fe)
- Copper (Cu)
- Cadmium (Cd)
- Cobalt (Co)

Air Quality Parameters:

Observations and Results, Trace Element Concentration in SPM:

Unit: $\mu g/m^3$ BDL- Below Detectable Level

Table 3: *Observations and Results, Trace Element Concentration in Spm*

Locations	Lead(Pb)	Copper(Cu)	Iron(Fe)	Cadmium(Cd)	Cobalt(Co)
ISM Main Gate	1.4	0.215	0.45	BDL	BDL
ISM Admin Block	0.25	BDL	0.19	BDL	BDL
Bank More Jain trading Co.	2.8	0.657	3.75	BDL	BDL
Kusunda	3.4	0.975	1.72	BDL	BDL
Steel Gate	1.2	0.220	0.55	BDL	BDL

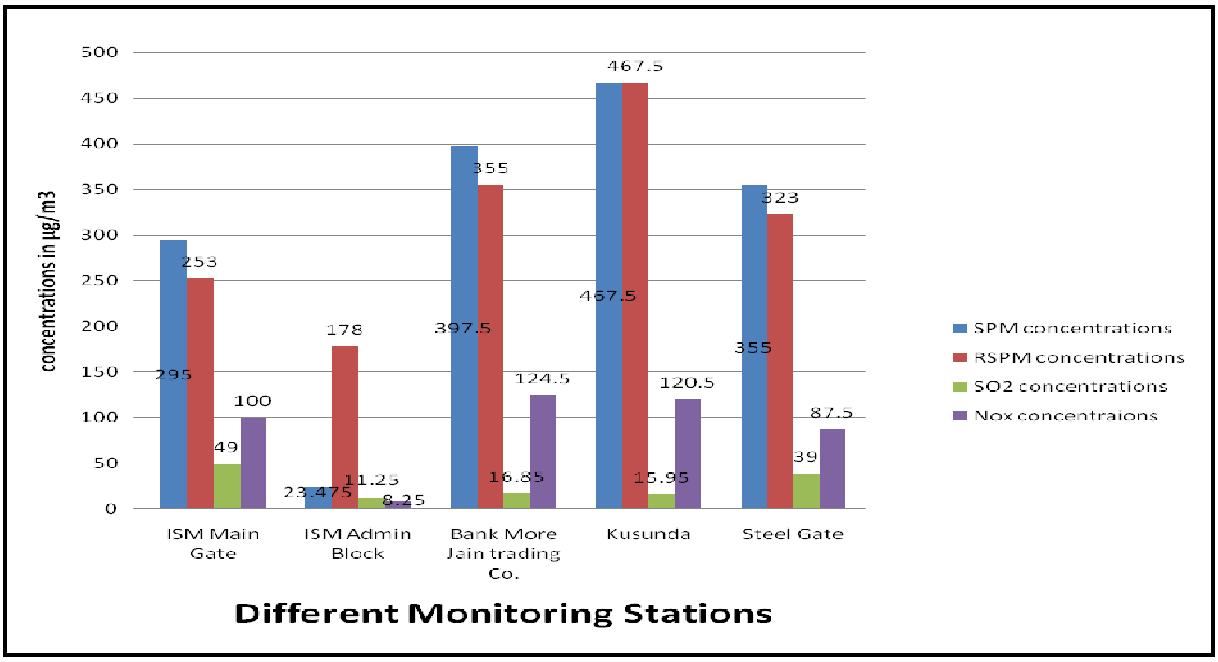
Table 4: *A Comparison of the 24 Hourly Average Concentrations of SPM, RPM, SO_2, and NOx at Five Stations and their Permissible Limits*

Locations	Unit: $\mu g/m^3$							
	SPM		RPM		SO_2		NOx	
	24 hourly average	Perm* limit	24 hourly average	Perm* limit	24 hourly average	Perm* limit	24 hourly average	Perm* limit
ISM Main Gate	295	200	253	100	49	80	100	80
ISM Admin Block	23.475	100	178	75	11.25	30	8.25	30
Bank More Jain trading Co.	397.5	200	355	100	16.85	80	124.5	80
Kusunda	467.5	500	467.5	150	15.95	120	120.5	120
Steel Gate	355	200	323	100	39	80	87.5	80

**permissible.*

Table 5: *A Comparison of the 24 Hourly Average Concentrations of Heavy Metals and their Permissible Limits*

Locations	Unit: $\mu g/m^3$									
	Lead		Copper		Iron		Cobalt		Cadmium	
	24 hourly average	Permissible limit	24 hourly average	Permissible limit	24 hourly average	Permissible limit	24 hourly average	Permissible limit	24 hourly average	Permissible limit
ISM Main Gate	1.4	1.0	0.215	_	0.45	_	BDL	_	BDL	_
ISM Admin Block	0.25	0.5	BDL	_	0.19	_	BDL	_	BDL	_
Bank More Jain trading Co.	2.5	1.0	0.657	_	3.75	_	BDL	_	BDL	_
Kusunda	3.2	1.5	0.975	_	1.72	_	BDL	_	BDL	_
Steel Gate	1.2	1.0	0.220	_	0.55	_	BDL	_	BDL	_



Conclusions and Recommendations:

After assessing the ambient air pollution status in Dhanbad district presented and discussed earlier, the following conclusions and recommendations have been made:

Conclusions:

1) The concentration of SPM was higher than the permissible limit in three locations namely ISM Main Gate, Bankmore and Steel Gate, while it was less than permissible limit in other two locations, namely, ISM Admin Block and Kusunda. Since the generation of SPM is mainly due to vehicular traffic, it was expected to cross the limit at the above mentioned three locations as density of vehicular movement was very high.
2) The RPM level in all the five locations was higher than the permissible limit. Even though ISM Admin Block was considered to be a sensitive area the concentration of RPM was higher than the permissible limit, this can be accounted since the day which monitoring took place was very windy and construction of a building was taking place beside the Admin Block. It was expected in other four locations since they are very busy and dusty areas.
3) The SO_2 concentration was less than the prescribed limit in all the five locations.
4) The NOx concentration was higher than the permissible limit in four locations except ISM Admin block. This is mainly due to the heavy traffic in those four locations.
5) The concentration of Cadmium and Cobalt in the SPM at all the locations was below the detection limit of 0.01 µg/m^3 indicating insignificant presence of these heavy metals.
6) The concentration of lead at all the locations except ISM Admin block was higher than the permissible limits as per Indian standards. The main cause for this is petrol vehicles whose density was high in the four locations and it was negligible at ISM Admin block.
7) According to the above mentioned concentrations the locations where monitoring was done can be classified as per exceedence factor as shown in table 6:

Table 6: *According to the above mentioned Concentrations the Locations where Monitoring was done can be classified as Per Exceedence Factor:*

Locations	SPM	RPM	SO2	NOx
ISM Main Gate	H	C	M	H
ISM Admin Block	L	C	L	L
Bank More Jain trading Co.	C	C	L	C
Kusunda	M	C	L	M
Steel Gate	C	C	L	M

Recommendations:

From the above observations and results of the areas which were studied, it should be considered as polluted and actions should be taken to reduce the concentrations of SPM, RPM, NOx and Pb. On the basis of this situation the following suggestions are made:

1) The roads had a large number of bad patches which increase dust generation and slow down the traffic. Hence, this condition was the main contribution to air pollutants, which can be minimised by repairing the roads and maintaining proper smooth condition.

2) Due to high traffic density in main roads vehicles invariably go out to the unpaved sides of the road which causes huge amounts of dust generation which becomes air borne. One solution for this is to increase the width of the road to accommodate high traffic density and if this is not possible the other solution is to make footpaths or some raised platforms by the side of the road so that vehicles cannot move to the side of the road and generate dust.

3) It is advisable to use unleaded petrol since the vehicular movement was more which uses ordinary petrol. Petrol driven vehicles emit lead from their exhaust which is very harmful.

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