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ASSESSMENT OF IMPACTS OF MINE FIRES ON AIR QUALITY -A CASE STUDY

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ABSTRACT: Jharia coalfield is the only source of prime coking coal in India.Mine fires in this coalfield spread over an area of 17.32 sq.km has given rise to severe environmental problems besides safety hazards and economic losses .The pollutants released from fire areas mainly comprise of Suspended Particulate Method (SPM), $S0_2$, $N0_2$, CO, $C0_2$, saturated and unsaturated hydrocarbons as a result of burning of coal affect the quality of life of the people living in the vicinity of fire areas.

In order to assess the magnitude of impacts of mine fires on air quality .present study was carried out for comparative evaluation of air quality in fire zone vis-a-vis non -fire zone.This paper presents the mean values of SPM, $S0_2$, NO2, CO, $C0_2$, dust fall rate and sulphation rate for the study period July-October (Rainy Season) 1996. Air quality in fire areas showed higher values of the above parameters in fire areas. Air quality index was developed for each study area and based on which, a rating scale for classifying each area based on degree of air pollution is proposed.

1. INTRODUCTION

Jharia coalfield İs the only source of prime coking coal in India. This coalfield has witnessed unparalleled fire problems since 1916 affecting seams IV to XVII. The total area affected due to mine fires is about 17.32 sq.km out of which 13 sq.km falls in opencast blocks and 4.32 sq.km in underground blocks (Chakraborty, 1995) .An estimate of Govt . of India (1991) revealed that about 37 MT of coal worth over Rs.3700 crores has been lost due to mine fires and about 1864 MT coal are rendered sterile(Chaudhury,1995). Most of the fires were mainly caused by spontaneous heating.

Mine fires cause major perturbations of the micro as well as macro -environment of the coalfield and give rise to severe environmental peoblems besides safety hazards. The effect s ofmine fires on air quality is alarming once fires become surface fires.The cracked strata acts as a chimney stack discharging various air pollutants viz. SPM, $S0_2$, $N0_2$, CO, CO2, hydrocarbons etc during the coal combustion process , that cause a lot of inconveniences and health hazards to the people residing in the proximity of the affected areas.

2. STUDY AREA AND DESCRIPTION OF AIR SAMPLING STATIONS:

The study area İs located in the eastern part of Jharia coalfield(JCF) .It is situated between latitude 23 ° 39 ' and 23 ° 48* and longitudes 86 ° 11 ' to 86 °27 Mt comprised of non-fire zone : BastacoIla(Al) and Bera (A2) collieries and fire zone: North Tisra (A3), LUJ (A4) and Joyrampur (A5) collieries. These have been selected to assess the comparative evaluation of major air quality parameters in each zone.The location and description of each air sampling station is presented in Table 1.

3. MATERIALS AND METHODS

For monitoring of Suspended particulate matter(SPM), $S0_2$, $N0_2$ concentrations in air, High Volume Samplers (Envirotech : APM-410) were stationed at each location and 24 hourly sampling was carried out thrice each week and twice each month .For sampling and measurement of SPM, $S0_2$ and $N0_2$, IS:5182 (part-IV), 197,3 ; IS:5182(part -II),1969 ; and IS: 5182(part.-VI) ,1975 were followed .The average values for rainy season(July-October) , 1996 were presented for each of the parameter.

Table 1. Location and description of air sampling stations

Zone	Station	Major category of the location	Sub-category that describes the location	Elevation of sampler above ground level
Non-fire Zone (No fire activity)	Al	Sub-urban	Industrial	4.5 m
	A2	Sub-urban	Industrial	4.0 m
Fire Zone (Areas affected by active fires)	A3	Sub-urban	Industrial	4.0 m
	A4	Sub-urban	Industrial	4.0 m
	A5	Sub-urban	Industrial	5.0 m

Dust fall rate(tonnes/km^2/month) and Sulphation rates(mg $S0_3$ /100 cm^2/day) were determined for one month period at Bera (A2) in non-fire zone and Joyrampur (A5) in fire zone asperIS:5182 (part-I), 1969 and IS:5182 (part-VIII), 1976 respectively.CO and $C0_2$ were sampled through 2 way sampling tubes (250 cc) and analysed using Graham-Lawrence and Haldane appratus and results were expressed in %.

4. RESULTS AND DISCUSSION

The results of the analysis of SPM, $S0_2$, $N0_2$, CO and CO; are presented in Table 2.It shows higher levels of all these parameters in fire areas compared to non-fire areas.Levels of SPM was higher than the permissible CPCB norms for industrial areas(360 micrograms/nr) in fire areas.It was due to release of lots of dusts from overburden dumps,release of smoke,soot,ash from fire areas apart from loading.drilling ,blasting and transport operations (common to both areas) .Higher concentration of SO2 was reported in fire areas as a consequence of increased oxidation of pyrites in coal .Values of $S0_2$ and NO2 were less than the prescribed CPCB norms in all the stations.CO was below detection limit at Al and A2.lt was 0.002 % at A5, 0.003 % at A3 and 0.004 % at A4.$C0_2$ varied between 0.21%(A1) to 0.33 % (A2) in non-fire zone and was 0.52 % (A3),0.61 % (A4) and 0.45 % (A5) in fire zone.

CO and $C0_2$ were generated İn higher quantities in fire areas to coal combustion.

Table 2.Mean values of SPM, $S0_2$, $N0_2$, CO and $C0_2$ at different stations in rainy season

Station	SPM, ug/nr'	$S0_,$, ug/m^J	NOÎ, ug/m^3	CO, %	COî, %
Al	292.25	16.12	17.2	BDL	0.21
A2	434.25	14.72	14.7	BDL	0.33
A3	600.00	30.82	28.0	0.003	0.52
A4	739.25	34.92	28.9	0.004	0.61
A5	590.5	42.5	34.175	0.002	0.45
CPCB (lndia),1994. Limits for 24 hrs avg.	360	80	90		

Results of dustfall rate and suplphation rate in the study areas are presented in Table 3. The dustfall rate was about twice in fire zone compared to non-fire zone. It was higher than prescribed NEERI standard : 10 tonnes/km^2/month in both the zones. Sulphation rate in fire zone was about 2.4 times that in non-fire zone.It was below NEERI standard : 0.5 mg SO3/IOO cm^2/day at A2 ,but was higher at A5.Sulphation ratewas higher in fire areas due to increased release of $S0_2$ from coal burning.

Table 3. Variation in dustfall rate and sulphation rate İn non-fire and fire zone

Zone	Station	Dustfall rate (tons/km^2/month)	Sulphation rate (mg SOV100cm^2/day)
Non-fire	A2	21.39	0.452
Fire	A5	42.02	1.027
NEERI standard		10.0	0.5

5. AIR QUALITY INDEX

In order to assess the air quality status.the Air Quality Index(AQI) of the study areas were evaluated by giving equal importance of all the major pollutant parameters namely: SPM,$S0_2$ and $N0_2$.Air quality ratings for all the pollutant parameters were initially calculated by the following expression:

$$q_i = \frac{OV_i}{SV_i} \times 100 \qquad (1)$$

where q_i = is the quality rating
OV_i = observed value of the parameter
SV_i = standard value recommended for the parameter

The AQI was then evaluated by the geometric mean of these air quality ratings (Patnaik et al., 1998) .Ambient air quality standards of CPCB,1994 for industrial area were used as standard values for calculation.Based on AQI, air quality status of the study area can be categorised as per Table 4 as proposed by the author.Using this procedure AQI was evaluated for each study area and the status of the same has been summarised in Table 5. It shows AQI was lowest at Al and highest in A4.Its values at different stations were A1.31.4 ; A2 : 33.0 ; A3 :58.47 ; A4 :66.4 and A5 : 63.14.In non-fire areas (Al and A2) the air was slightly polluted and in fire areas (A3,A4 and A5) it was moderately polluted (refer Table 4).

Table 4. Rating scale for air quality index

Index value	Rating
0-25	Clean air
26-50	Slight air pollution
51-75	Moderate air pollution
76-100	High air pollution
101-125	Very high air pollution
> 125	Severe air pollution

Table 5. AQI and air quality category for different stations

Station	SPM	SO,	NO	AQI	Rating
Al	81.18	20.15	19.11	31.4	Slight air pollution
A2	120.62	18.4	16.35	33.0	Slight air pollution
A3	166.66	38.52	31.18	58.47	Moderately polluted
A4	205.35	43.65	32.71	66.4	Moderately polluted
A5	164.0	53.125	32.97	63.14	Moderately polluted

6. CONCLUSION

From the present study,fol lowing conclusions can be înfered:

- Levels of SPM,SO_2,$N0_2$, CO,$C0_2$,Sulphation rate and Dust fall rates were higher İn fire areas than non-fire areas.

- AQI in fire areas were higher than that of non-fire areas. It varied between 31.4 to 33.0 in non-fire areas (slightly polluted) and between 58.47 to 66.4 in fire areas(moderately polluted) in the rainy season.

REFERENCES

Chakraboity, P. K. 1995.*Underground fires and explosions*^ lst edn,CMPDl Publications, Ranchi.

Chaudhury, S.D. 1995 .Mine fires in Jharia coalfield and their management. Nat. Seminar on Mine fires. Rakesh(ed) .BHU, Varanasi : 107-116.

Kali, A. et al. 1998. Impacts of mine fires at Sudamdih on air pollution and social spectrum. *J. of Env. Studies and Policy* (June) : 11-19.

Patnaik, K. N. et al .1998. Air quality index and its -wariations in Paradeep area. *IJEP(Iu\y):9\3-9\6.*

Tripathy,D.P.; Singh.Gurdeep and Panigrahi.D.C. 1997: Environmental impacts of mine fires-A case study of a parfaof Jharia coalfield . *2"* WOMEC, Krackow, Poland(May).