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IMPACT ON THE AIR DUE TO INDUSTRIAL CLUSTER OF SAMBALPUR–JHARSGUDA DISTRICT OF ODISHA

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ABSTRACT

An industrial cluster area of 2827 Km^2 of the district of Sambalpur-Jharsguda wherein ten coal-fired thermal power plants and other small air polluting plants are located. The impact of these air polluting plants of cluster area in the surrounding have been studied by evaluating the SPM,SO_2, NO_2 and metals like Pb, Hg, Cd. Our finding on those parameters is that they decreases with respect to distance from segment-I to Segments-III.

Key words: Industrial cluster, Sambalpur-Jharsguda, Odisha.

INTRODUCTION

The environmental pollution in an industrial cluster is a national issue particularly in a period, which is witnessing a rapid industrial growth. The pollution in a cluster is a complex multi-dimensional problem, which is often difficult to measure and manage. In order to address such a problem, we have made an attempt to study a cluster of Odisha. It is located in the district of Sambalpur and Jharsguda (Fig. 1), which is considered as a critically polluted area. In the cluster area ten coal-fired thermal power plants are located and total area studied is 2827 Km^2. The total power production of all the plants is 4505 MW. Huge deposits of coal in the IB-Valley is also located in the area and a vast water reservoir (Hirakud) is in the close proximity of the cluster. The area is a most ideal site for the production of thermal power. Besides, there are many sponge iron, iron and steel plant aluminium smelter and cement industry are also located in this region. Small scale industries like rice mills, bricks kilns and stone crushers are also operating in the area. Hirakud reserviour is the life line of the entire industrialization process in the region. The major problem in the region is the runoff contamination, which is likely to be fluoride and cyanides

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since aluminum smelters are in the operation. Further, the runoff from various stock piles like coal, iron ore etc. also have potential for water pollution.

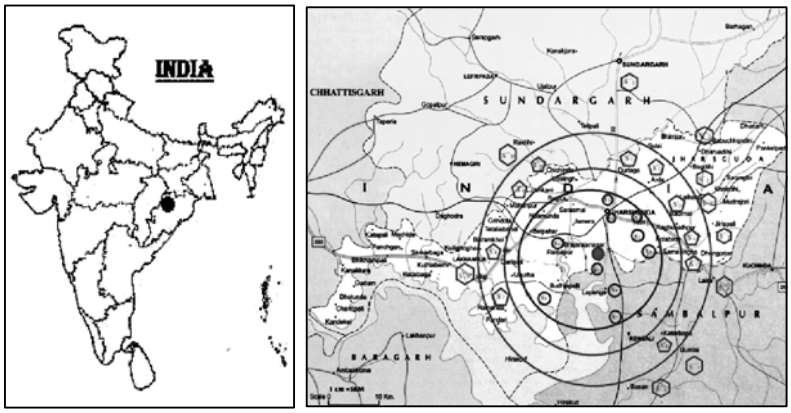

Fig. 1: Location of sampling stations in different segment

EXPERIMENTAL

The Kherual (84^0 $00^{'}$ $31^{''}$E and 21^0 $47^{'}$ $00^{''}$) is the center of the cluster, and at a radius of 30 Km from this place is the study area, which covers 2827 Km^2. This area is divided into three segments.

Segment-I: This segment covers 78.53 Km^2 around the center and in this area all the thermal power plants, smelter of iron and aluminium industry are located (~5 Km radius from the centering place, Kherual).

Segment-II: This covers the area 628.32 Km^2 beyond the boundary of the segment-I. In this area only one industry is located (Ultra Tech cement production unit) (~15 Km radius from the centering place, Kherual).

Segment-III: The area covers in this segment is, 2019.5 Km^2 and in this segment there is no production industry (~30 Km radiuses from the centering place, Kherual).

We have identified the location of ten sampling stations in each segment, which are denoted as $S^{'}$, $S^{''}$ and $S^{'''}$ for the segment-I, II, and III, respectively. The air samples were collected using high vacuum samplers five days per week for a period of three years 2008 to

2011 from November to April for determining the air parameters such as SPM, SO_2 and NO_2 and the three metals (Pb, Hg, Cd). The analysis of different parameters of the air samples are carried out following standard methods[1-4]. The averages of these three years data are considered for discussion and tabulated (Tables 1, 2 and 3). The mean values are graphically shown in Figs. 1-7.

Table 1: Analytical data of air of samples of Segment-I

Parameters	S_1'	S_2'	S_3'	S_4'	S_5'	S_6'	S_7'	S_8'	S_9'	S_{10}'	Mean
Suspended particulate matters (SPM) ($\mu g/m^3$)	392	424	460	445	450	380	376	410	340	358	403.5
Sulphur dioxide SO_2 ($\mu g/m^3$)	102.2	110.6	120.5	115.4	115.6	96.6	98.6	105.6	80.2	92.8	103.81
Oxide of nitrogen NO_x ($\mu g/m^3$)	108.5	104.4	127.2	120.6	116.4	88.6	95.2	112.5	86.3	95.8	105.55
Lead (Pb) ($\mu g/m^3$)	2.16	2.14	2.86	2.16	2.56	1.78	1.82	2.12	1.44	1.83	2.087
Mercury (Hg) ($\mu g/m^3$)	2.04	2.86	3.06	2.88	3.06	2.76	2.66	2.97	1.98	2.85	2.712
Cadmium (Cd) ($\mu g/m^3$)	2.02	2.73	2.86	2.75	2.76	2.68	2.52	2.72	1.52	2.55	2.511

Table 2: Analytical data of air samples Segment-II

Parameters	S_1''	S_2''	S_3''	S_4''	S_5''	S_6''	S_7''	S_8''	S_9''	S_{10}''	Mean
Suspended particulate matters (SPM) ($\mu g/m^3$)	240	276	280	260	224	220	240	200	190	170	230
Sulphur dioxide SO_2 ($\mu g/m^3$)	100.6	109.8	114.8	108.8	91.5	79.7	99.8	80.7	68.8	71.8	92.63
Oxide of nitrogen NO_x ($\mu g/m^3$)	108.5	104.5	112.5	98.8	82.8	75.2	98.6	80.5	63.5	62.6	88.75
Lead (Pb) ($\mu g/m^3$)	1.82	1.71	2.24	2.02	2.14	1.64	1.82	1.42	1.42	1.31	1.754
Mercury (Hg) ($\mu g/m^3$)	1.95	1.91	2.22	2.1	1.62	1.86	2.1	1.5	1.48	1.1	1.784
Cadmium (Cd) ($\mu g/m^3$)	2.03	2.01	2.08	2.03	1.72	1.7	2.03	1.56	1.3	1.26	1.772

Table 3: Analytical data of air of the Segment-III

Parameters	S_1'''	S_2'''	S_3'''	S_4'''	S_5'''	S_6'''	S_7'''	S_8'''	S_9'''	S_{10}'''	Mean
Suspended particulate matters (SPM) ($\mu g/m^3$)	150	120	170	125	120	110	105	130	145	90	126.5
Sulphur dioxide SO_2 ($\mu g/m^3$)	100	100.5	103.1	90.3	80.4	78.5	66.5	82.6	82.6	70.5	85.5
Oxide of nitrogen NO_x ($\mu g/m^3$)	90.6	92.8	96.8	80.7	76.6	58.6	53.8	81.8	83.8	70.5	78.6
Lead (Pb) ($\mu g/m^3$)	1.16	1.03	1.33	1.01	1.01	0.84	0.84	1.02	1.02	0.43	0.969
Mercury (Hg) ($\mu g/m^3$)	1.08	1.03	1.16	0.86	0.86	0.81	0.75	1.02	1.02	0.41	0.9
Cadmium (Cd) ($\mu g/m^3$)	1.01	0.93	1.06	0.84	0.78	0.73	0.65	1.01	1.03	0.43	0.847

RESULTS AND DISCUSSION

Suspended particulate matters (SPM)

A survey of the data (Table 1) reveals that the annual average of the sampling stations of the Segment-I is 403.5 $\mu g/m^3$. Out of the ten stations the maximum SPM is 460 $\mu g/m^3$ at station S_3' and lowest is 340 $\mu g/m^3$ at the station S_9'. The vedant captive power plant where generation capacity is 1215 MW is nearer to S_3'. So there is every reason for generation of more SPM nearer the Station S_3'. Stations S_9' inside the Brajarajnagar township, where no power plant is closer to the town, hence, the SPM percentage is oveiously less (340 $\mu g/m^3$) in the town area. Among the other stations, the next higher SPM percentages are 450 $\mu g/m^3$at stations S_5' and 445 $\mu g/m^3$ at stations S_4' (Table 1 and Figs. 3, 4). These stations are closely to Sterllite power plant and Bhusan power plant respectively, which are producing 2400 MW and 376 MW, respectively. Hence, the SPM percentage also higher in those stations.

Annual average of all sampling stations of segment-II is 230 $\mu g/m^3$ (Table 2). Out of the ten stations, the maximum percentage of SPM is 280 $\mu g/m^3$ at station S_3'' and lowest 170

µg/m^3 at the station S''_{10}. At the station S''_3 the percentage is maximum may be due to north-east (NE) direction of wind, which is the predominant direction of wind in the day time nearer to the sampling stations. Another reason for maximum SPM may be due to presence cement producing unit (Ultra Tech., Arda), which is just 03 Km away from the monitoring station. Station S''_{10}, which is 20 Km away from the reference point (Kherual) have the minimum SPM (170 µg/m^3). Among the other stations the SPM is 276 µg/m^3 at (S''_2) and the next one is 260 µg/m^3 of S''_4 (Table 2). These stations are also very close to Sterllite, Vedant and Bhusan Power plants and dominant direction of wind blow. Hence, the SPM percentage is quit high in these monitoring stations.

SPM value of sampling stations segment-III show annual average of 126.5 µg/m^3. Among all the sampling stations, segment-III area, S'''_3 shows the maximum of 170 µg/m^3 (Table 3). This sampling station is in the predominat direction of wind blow and the station is nearer to the railway line and market area. The sampling stations S'''_{10} at Raidhi shows minimum of 90.0 µg/m^3 at the distance 25 Km away from the reference point (Kherual) and also the locality is free from industries. The other stations S'''_1, S'''_4 and S'''_2 SPM concentrations are 150 µg/m^3, 125 µg/m^3 and 120 µg/m^3, repectively (Table 3). These stations are nearer to highway such as SH_{10}, NH_{200} and they are also nearer to the market area.

Based on the above discussion it is concluded that the SPM value decreses with respect to distance from the segment-I. The SPM of segment-I is 403.5 µg/m^3 > segment-II (230.5 µg/m^3) > segment-III (126.5 µg/m^3). The observation is also supported by graphical representation in Fig. 2.

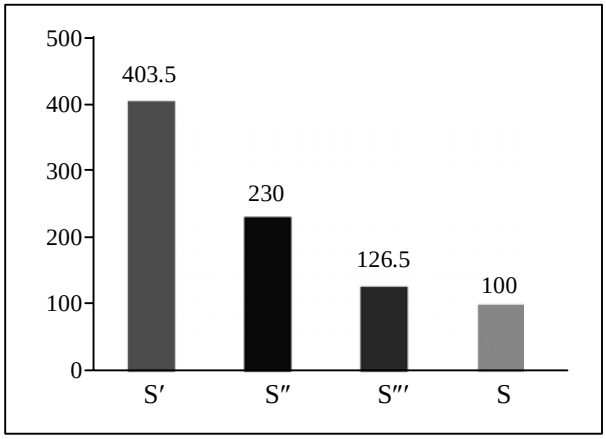

Fig. 2: Mean concentration of SPM µg/m^3

Sulphur dioxide (SO_2)

The analytical data recorded in the (Table 1) reveals that the three years annual average value of monitoring stations for SO_2 in the segment-I area is 103.81 µg/m^3. Among all the stations S_3' and S_5' have the higher concentration of 120.5 µg/m^3 and 115.6 µg/m^3 respectively. The minimum concentration is 80.2 µg/m^3 at S_9' (Table 1). The other monitoring stations such as S_4', S_2' have concentrations 115.4 µg/m^3 and 110.6 µg/m^3 and 105.6 µg/m^3 for S_8'. The concentration in the stations S_2', S_3', S_4' and S_5', are all in the range 105.6-120.5 µg/m^3 i.e. the density of SO_2 is the higher and this is due to all the major coal-fired power plants) are located in this region. Besides this, at stations S_8' the concentration of SO_2 is 105.6 µg/m^3, the higher value is due to the power-plant at OPGC, Banaharpali (420 MW).

In segment-II, the annual average concentration of SO_2 is 92.63 µg/m^3. The maximum and minimum concentration in the area are 114.8 µg/m^3 at S_3'' and 68.8 µg/m^3 at S_9'', respectively (Table 2). The average concentration of SO_2 of the stations S_1'', S_2'', S_3'' and S_4'' is 108.5 µg/m^3 which is less by 3.7 µg/m^3 from the average value of the same stations of the segment-I. The air samples collected from all sampling stations, which are at a distance of 20 Km from the boundary of the segment-I area. The annual average of SO_2 concentration of those stations is 85.5 µg/m^3. The concentration is maximum at S_3''' (103.1 µg/m^3) and minimum at S_7''' (66.5 µg/m^3) (Table 3). The stations which show higher concentration are 100.5 µg/m^3 and 100.0 µg/m^3 at S_2''' and S_1''', respectively.

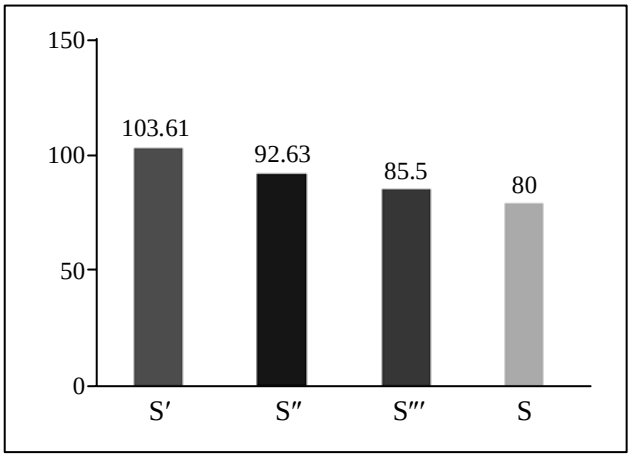

Fig. 3: Mean concentration of SO_2 µg/m^3

So it is clear, even at distance places from the segment-I the SO_2 concentration persists in the ambient air. However, when we compare the concentration of all the three areas the concentration of SO_2 is in the order (103.81 µg/m^3) > Segment-II (92.63 µg/m^3) > Segment-III (85.5 µg/m^3). The observation is also supported by graphical representation in Fig. 3.

Nitrogen dioxide (NO_2)

The analytical data of nitrogen dioxide are recorded in (Table 1). It is noticed from the three years annual average value of all the monitoring stations for NO_2 in the segment-I is 105.55 µg/m^3. Among all the monitoring stations $S_3^{'}$ is having maximum concentration of NO_2 (127.2 µg/m^3) and next to that $S_4^{'}$ is 120.6 µg/m^3. The minimum concentration is 86.3 µg/m^3 at $S_9^{'}$. (Table 1). The higher concentration of NO_2 in the segment-I around the stations $S_3^{'}$, $S_4^{'}$ and $S_5^{'}$ are most reasonable, since the mega coal-fired power stations are around those stations i.e more coal burning in the plants. At $S_8^{'}$ the NO_2 concentration is also higher. Since there is also a major plants. The minimum concentration is around the stations $S_9^{'}$ as the station is located inside the Brajrajnagar town. Since no power plant nearer the township, it is natural NO_2 concentration is low.

In segment-II area the annual average concentration of NO_2 is 88.75 µg/m^3. The maximum concentration is at $S_3^{''}$ (112.5 µg/m^3) and minimum is at station $S_{10}^{''}$ (62.6 µg/m^3) (Table 2). The other monitoring stations which are having higher concentration of NO_2 are 108.5 µg/m^3 and 104.5 µg/m^3 at $S_1^{''}$ and $S_2^{''}$, resepectively because they are also nearer to mega power plants and they are also nearer to highways and rail lines.

Air samples were also collected from an average distance of 20 Km from the boundary of the segment-I. The analytical data were recorded in (Table 3). The annual average of all the stations is 78.6 µg/m^3. Maximum concentration is shown at $S_{\downarrow}3^{\uparrow'''}$ (96.8 µg/m^3) and minimum at $S_7^{'''}$ (53.8 µg/m^3) (Table 3). Other monitoring stations, which show higher concentration are 92.8 µg/m^3 and 90.6 µg/m^3 at $S_2^{'''}$ and $S_1^{'''}$, respectively.

Based on the maximum concentration of NO_2 it can be said that the values are in the order segment-I > segment-II > segment-III (Fig. 4).

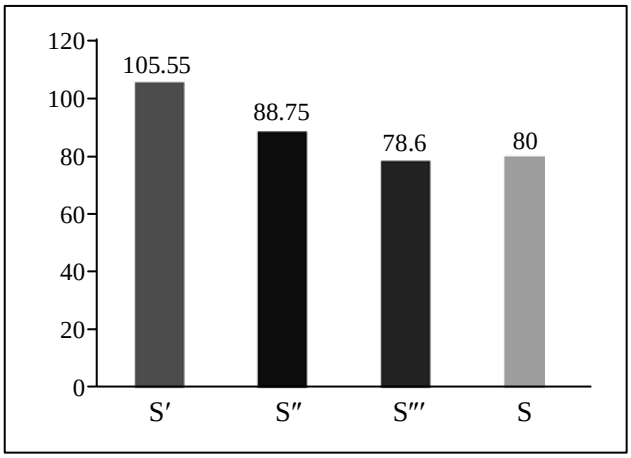

Fig. 4: Mean concentration of NO_2 in µg/m^3

Metals (Pb, Hg, Cd)

The percentage of metals in the ambient air are recorded in Tables 1, 2 and 3 of the three segment respectively. The graphical representation of mean value of metal are shown in Figs. 5, 6 and 7, respectively. From the analytical data and graphical representation the metal percentage decrese with increse in distance. Basing on the result and discussion on SPM, SO_2, NO_2 and metals (Pb, Hg, Cd) it can be concluded that impact of power plants in the cluster region is much higher than outside the boundary of the cluster area and the load decreses at a distance of more than 25 Km.

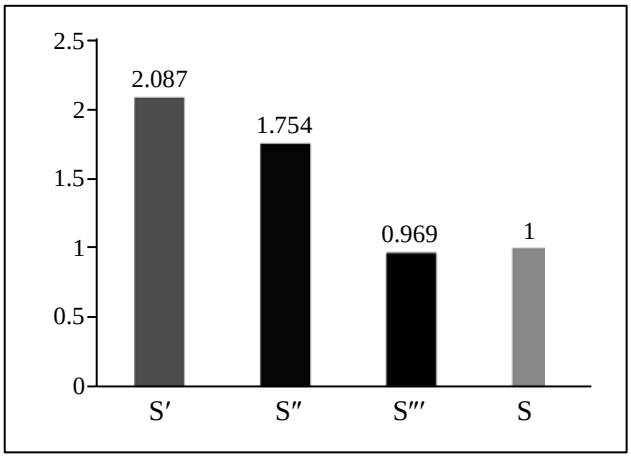

Fig. 5: Mean concentration of Pb in µg/m^3

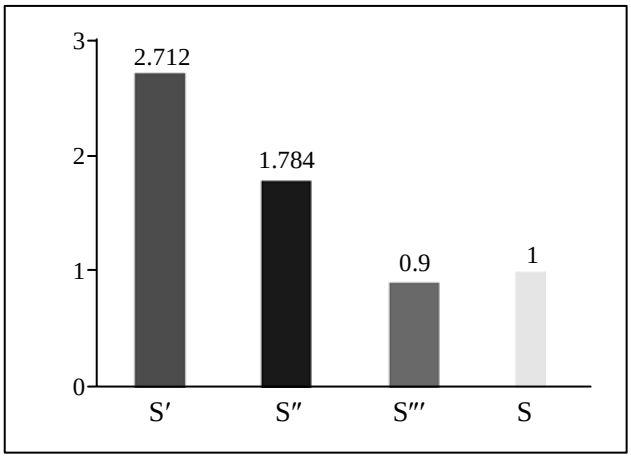

Fig. 6: Mean concentration of Hg in µg/m^3

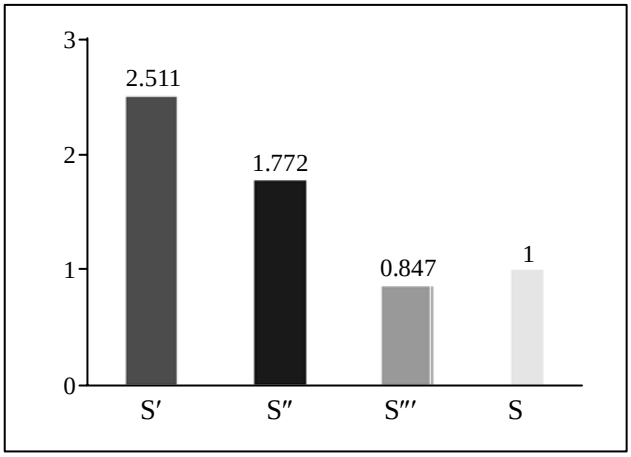

Fig. 7: Mean concentration of Cd in µg/m^3

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