Assessment of Air Quality and its Impact in Jharsuguda & Rengali Industrial Area of Sambalpur & Jharsuguda Districts in Odisha, India

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Abstract: *Mass rum growth of industries as well as mining operation has accelerated in Jharsuguda and Sambalpur districts after the year 2000 due to construction of better super highway between Sambalpur and Rourkela. The unchecked pollution caused by the growing industries in the area deteriorated the air quality to an extreme stage. The SPM, SO_2, NO_X exceeded the permissible standard throughout the year. The pollutants not only affected human beings, but also plants and growing crops. Hence immediate remedial measures should be initiated right now to save the lifeline of the study area.*

Keywords: *Air quality, industrialization, lifeline, permissible level, plantation technique, pollutants.*

I. Introduction

Due to the rapid industrialization in Jharsuguda and Rengali areas in the western part of Orissa, severe changes in environmental conditions have been notified. This has affected not only the human activities but also the plants and animal kingdom of the region. In order to access the impacts of industrialization on flora, fauna and aquatic system of the region, impact monitoring has been carried out in the years 2013 to 2014. The collected data prevails that there is a gradual increase of SPM SO_2 and NO_X in the region. There are 26 sponge iron plants with power plants are working on the L&T main road from Rengali to Jharsuguda. Two aluminium sectors with large scale production are also going to be ready soon. One aluminium sector Vedanta has a captive power plant of 2400MW power. The underground and open cast coal mines are also disturbing the noise and air environment. There are many new power projects also coming shortly in Ib Valley area. The pollutions are due to urbanization, rapid industrialization, mineralization and other associate activities.

Now Rengali and Jharsuguda area are considered as the most polluted areas of Odisha. The major air pollutants are suspended particulate matters, sulphur dioxide, oxides of nitrogen and carbon dioxide. The particulate matter going to the atmosphere are generally of size 0.1 to 100 micron of particle size, which remains suspended for long time depending on its weights. But particulate matters going to the atmosphere greater than 100 micron settle on the nearby surface, soil, water, bodies, etc due to the gravity. Due to the air pollution human being are also effected mainly by respiratory disorders like black lung, bronchitis, asthma, pulmonary fibrosis, eye irritation, hypertension, lung cancer, etc.

To access the air pollution, noise pollution and its impact to public health, a detailed study is carried out systematically by the present piece of paper. This study helps to get some idea to the present threats to the environment resulting into climate change.

II. Experimental Method

In order to access the air pollution level due to rapid industrialization, mining activity, transportation & urbanization and deforestation of Jharsuguda and Sambalpur districts from Rengali to IB Thermal area, which is the most polluted area of Orissa during the last five years. Twenty sample survey stations in different directions were selected which are given in tables 2, 3 and 4. The month of May, September and December were chosen and taken into account the season i.e. summer, post monsoon and winter of the year 2013-14. In these months once in a week the samples were collected twice a day in an interval of 12 hours. To evaluate the pollution level in Rengali area, six sampling stations in different directions representing commercial, industrial and residential activities were selected. The locations are Ganesh Nagar, BSNL Office, Ram Chandar Nagar, Colony of Shyam DRI, Lapanga village and Thelkoloi Market area. In Jharsuguda eight sampling stations such as Vedanta Rehabilitation Colony, Sarbahal Residential area, Engineering School area, Proposed Air Port Durlaga, Roof of Proposed Navodaya School near Eastern Steel, Buxi Chowk Jharsuguda, Budhipadar Village Club and Badamal were chosen. Similarly in Belpahar area Bandhabahal Market Roof, IB Thermal Market Roof, Lakhanpur vilage Area and Lamtibahal petrol pump area were selected for sample collection.

For the study of air quality such as SPM, SO_2, NO_X were done by a high volume air sampler manufactured by Envirotech HVAS operated at an average flow rate of $1.0 m^2/min$ to $1.5 m^2/min$. Pre-weighted glass micro fiber filter size (GF/A of Whatman) were used and concentration was computed as per standard

method prescribed by BIS. Sulphur dioxide in air of the areas under study was absorbed in 35ml of sodium tetrachloromercurate and for oxides of nitrogen in air of the sampling area was absorbed in 35ml of sodium nitrite solution at a average flow rate of 0.2 to 0.5 liter per minute by standard method which is internationally accepted. Similarly dust fall rate was calculated for the formula:

$$\text{Dust fall rate} \ = \ \frac{W \ X \ 30 \, gm/m^2}{a \ X \ n}$$

where 'W' is total dust fall in gm; 'a' is cross sectional area in m² of the funnel; and 'n' is number of days over which sampling was done. The sample were collected periodically an analysed in Regional Pollution Control Board, Angul and Sambalpur, Environment Consultant BF Odisha, Department of Chemistry, VSSUT, Burla.

III. Observation

Table 1. Micro meteorological data of IMD Station, near Jharsuguda Airport

Parameters	Season		
	Summer	Post monsoon	Winter
Dominant wind direction	S and SW	SE, S and SW	NE, SE and S
Average wind speed, m/sec	1.92	1.56	1.42
Maximum ambient temp., °C	48.6	1.56	26.7
Minimum ambient temp., °C	30.8	29.1	7.6

Table 2. Ambient air quality during summer season (May 2014) in µg/m³

Area	Location	SPM		SO₂		NOₓ	
		Day	Night	Day	Night	Day	Night
		Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max
Rengali	Ganesh Nagar	290-490	282-497	90-95	89-97	62-64	28-58
	BSNL Office	282-502	272-482	44-58	44-94	42-50	28-52
	Ram Chandar Nagar	270-544	280-521	80-91	88-83	21-58	26-58
	Colony of Shyam DRI	292-540	280-530	80-94	79-92	60-65	22-40
	Lapanga Village	280-490	262-458	62-88	60-82	52-70	40-64
	Thelkoloi Market Area	310-580	304-565	72-98	70-95	60-70	42-52
Jharsuguda	Vedanta Rehabilitation	325-600	330-570	90-99	92-98	52-92	52-100
	Sarbahal Residential Area	305-530	280-540	74-93	60-90	52-82	42-80
	Engineering School Area	307-504	302-498	84-96	61-87	59-64	60-88
	Proposed Air Port Durlaga	290-560	288-555	80-97	80-96	59-77	52-76
	Roof of Proposed Navodaya School near Eastern Steel	290-600	287-590	82-94	80-93	60-80	52-80
	Buxi Chowk Jharsuguda	280-540	275-530	60-90	58-90	52-90	48-88
	Budhipadar Village Club	300-580	290-555	72-91	70-90	50-84	48-88
	Badamal	282-582	272-580	60-80	50-77	50-72	42-69
Belpahar	Bandhabahal Market Roof	280-520	265-510	71-90	68-88	58-72	50-62
	IB Thermal Market Roof	290-590	280-560	70-88	62-80	48-62	40-60
	Lakhanpur Vilage Area	265-500	258-480	52-82	42-80	42-62	27-52
	Lamtibahal Petrol Pump	311-611	52-92	48-92	47-88	28-66	28-52

Limits:
SPM :   200 µg/m³
SO₂ :   80 µg/m³
NOₓ :   60 µg/m³

Table 3. Ambient air quality during Post Monsoon season (September 2014) in µg/m³

Area	Location	SPM		SO₂		NOₓ	
		Day	Night	Day	Night	Day	Night
		Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max
Rengali	Ganesh Nagar	292-475	288-465	91-96	88-96	61-63	29-59
	BSNL Office	282-490	277-488	45-59	43-93	43-51	27-51
	Ram Chandar Nagar	266-455	257-467	81-90	87-82	20-59	25-57
	Colony of Shyam DRI	288-469	299-599	81-95	80-91	61-66	21-39
	Lapanga Village	258-425	254-523	61-87	59-81	53-71	41-65
	Thelkoloi Market Area	322-512	354-599	71-97	71-96	61-71	43-53
Jharsuguda	Vedanta Rehabilitation	300-457	298-485	91-100	91-97	53-91	53-101
	Sarbahal Residential Area	322-472	310-585	74-93	60-90	52-82	42-80
	Engineering School Area	345-555	300-572	85-	60-86	58-63	61-87
	Proposed Air Port Durlaga	300-475	312-588	79-96	81-97	58-76	51-75
	Roof of Proposed Navodaya	340-569	325-611	81-93	81-92	59-79	51-79

	School near Eastern Steel						
	Buxi Chowk Jharsuguda	356-587	312-592	59-89	57-89	51-91	47-87
	Budhipadar Village Club	352-564	322-599	71-90	69-89	49-83	47-87
	Badamal	321-597	297-497	59-79	49-76	49-71	41-68
Belpahar	Bandhabahal Market Roof	266-444	256-426	70-89	67-87	57-71	49-61
	IB Thermal Market Roof	287-452	274-444	69-87	61-79	47-61	39-59
	Lakhanpur Vilage Area	300-511	291-501	51-81	43-81	40-60	25-50
	Lamtibahal Petrol Pump	354-599	333-587	47-91	46-87	27-65	26-50

Table 4. Ambient air quality during Winter season (December 2014) in µg/m³

Area	Location	SPM		SO₂		NOₓ	
		Day	Night	Day	Night	Day	Night
		Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max
Rengali	Ganesh Nagar	292-492	283-498	93-98	88-98	61-65	29-59
	BSNL Office	285-505	274-484	45-59	45-95	44-52	30-54
	Ram Chandar Nagar	272-546	282-523	81-92	89-84	22-59	28-60
	Colony of Shyam DRI	294-542	282-532	81-95	80-91	62-67	25-43
	Lapanga Village	282-492	263-459	63-89	61-83	53-71	41-64
	Thelkoloi Market Area	311-581	305-566	73-99	71-96	61-71	43-54
Jharsuguda	Vedanta Rehabilitation	326-601	331-572	91-98	93-99	53-93	54-102
	Sarbahal Residential Area	306-531	281-541	75-94	61-91	54-84	43-82
	Engineering School Area	308-505	300-496	88-98	63-89	61-65	62-89
	Proposed Air Port Durlaga	291-561	287-554	81-98	81-95	60-78	53-77
	Roof of Proposed Navodaya School near Eastern Steel	292-602	288-591	83-95	81-94	61-81	53-81
	Buxi Chowk Jharsuguda	282-542	276-531	61-91	57-91	51-89	49-87
	Budhipadar Village Club	301-582	291-556	71-92	72-92	52-86	50-90
	Badamal	283-583	273-581	61-81	51-78	51-73	43-70
Belpahar	Bandhabahal Market Roof	281-521	266-511	72-92	67-87	59-73	51-63
	IB Thermal Market Roof	291-591	281-561	73-89	63-81	49-63	42-62
	Lakhanpur Vilage Area	267-502	260-490	55-85	43-82	43-63	29-51
	Lamtibahal Petrol Pump	313-613	522-922	49-93	49-89	29-68	27-51

Table 5: Ambient air quality during Summer season (May 2015) in µg/m³

Area	Location	SPM		SO₂		NOₓ	
		Day	Night	Day	Night	Day	Night
		Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max
Rengali Sambalpur District	Market Area	265-422	281-442	91-99	91-97	59-61	50-55
	Shyam DRI Guest house	344-575	365-557	93-102	90-99	60-63	50-62
	Ganesh Nagar	302-499	292-483	90-97	89-97	49-55	49-52
Lapanga Sambalpur District	Aluminum Colony area	305-484	265-465	79-96	75-91	60-65	58-62
	Lapanga village	269-395	223-378	64-78	62-71	58-62	55-60
	Bhushan market area	383-618	377-605	94-109	93-103	78-90	75-88
	Sripura school	291-525	281-504	91-98	81-95	48-73	45-62
Jharsuguda	Badmal, Concast Steel road	299-516	282-489	89-91	80-90	63-66	58-63
	Hirma school SMC plant	290-502	278-465	82-91	80-89	60-63	56-62
	Sarasmal Action Steel area	282-505	272-489	81-94	78-89	62-66	55-62
	Navodaya School ESPL plant	302-515	278-475	82-98	78-95	60-65	55-63
	Engg. School Vedanta gate side	299-569	299-559	89-103	88-100	66-73	60-70

Table 6: Ambient air quality during post mansoom season (Sept 2015) in µg/m³

Area	Location	SPM		SO₂		NOₓ	
		Day	Night	Day	Night	Day	Night
		Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max
Rengali Sambalpur District	Market Area	240-385	255-401	70-85	73-81	51-55	41-51
	Shyam DRI Guest house	310-501	299-512	85-90	83-93	54-65	45-57
	Ganesh Nagar	275-442	278-440	80-90	81-91	40-50	42-53
Lapanga Sambalpur District	Aluminum Colony area	286-453	250-420	70-80	67-85	55-60	51-59
	Lapanga village	252-374	205-359	60-65	53-67	53-61	50-58
	Bhushan market area	365-537	350-580	80-90	77-91	72-87	70-80
	Sripura school	267-489	263-470	80-75	81-83	45-71	40-55
Jharsuguda	Badmal, Concast Steel road	279-510	269-489	85-89	75-87	59-62	55-62
	Hirma school SMC plant	275-497	288-460	81-91	77-85	55-62	54-64
	Sarasmal Action Steel area	277-500	260-490	75-90	74-85	57-60	50-60
	Navodaya School ESPL plant	298-502	265-480	78-93	72-90	55-60	55-63
	Engg. School Vedanta gate side	290-550	290-555	85-99	80-91	60-69	65-69

Table 7: Ambient air quality during Winter season (Dec 2015) in µg/m³

Area	Location	SPM		SO₂		NOₓ	
		Day	Night	Day	Night	Day	Night
		Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max
Rengali Sambalpur District	Market Area	255-405	263-415	78-90	78-88	53-59	45-55
	Shyam DRI Guest house	315-525	305-520	88-101	88-94	59-63	49-60
	Ganesh Nagar	278-440	282-444	81-93	86-93	47-53	48-53
Lapanga Sambalpur District	Aluminum Colony area	292-465	262-445	75-89	72-87	58-60	55-60
	Lapanga village	260-385	213-370	60-70	59-72	58-60	50-60
	Bhushan market area	380-580	368-590	80-97	81-95	73-88	72-86
	Sripura school	282-505	270-480	82-92	82-88	46-71	41-57
Jharsuguda	Badmal, Concast Steel road	289-525	280-491	87-93	80-91	60-65	58-63
	Hirma school SMC plant	281-498	282-465	82-93	79-90	59-63	55-63
	Sarasmal Action Steel area	281-510	273-490	81-97	76-91	62-65	55-64
	Navodaya School ESPL plant	302-505	275-490	79-97	79-99	59-68	57-62
	Engg. School Vedanta gate side	299-565	300-565	90-105	86-99	65-72	59-68

Table 8. Dust fall Rate in t/sq.km/ month (2013-14)

Area	Station	Value Of Summer(May)	Value Of Post Monsoon (Sept.)	Value Of Winter(Dec.)
Rengali	Ganesh Nagar	21.90	20.99	22.77
	Thelkoloi Market Area	22.6	21.96	23.10
Jharsuguda	Vedanta Rehabilitation Colony.	24.7	23.77	24.22
	Proposed Air Port Durlaga	23.88	23.11	22.99
	Kantapali Village	22.75	22.17	22.66
Belpahar	Ib Thermal Market Roof	19.99	19.67	20.14
	Lamtibahal Petrol Pump	20.72	20.64	19.99

IV. Plantation Techniques

Trees are woody plants grown for various purposes like specimen tree, shady tree, avenue, screening fragrant and checking air and noise pollution. The selected trees should be best branching habits, arrangement of leaves, size, shape, surface(smooth / hairy / waxy), high proline content, ascorbic acid content, cationic peroxidase and suphite oxidase activity to trap the pollutants.

Close plantation of 3 to 4 rows of Alstonia scholaris intermixed with Ficus cunea should be planted towards the dust source as these are evergreen in nature and will act as dust collector and protect the green belt from grazing. As Alstonea and Ficus cunea are slow growing plants, some fast growing evergreen plats having good dust removing capacity should be planted. Evergreen M-indica and Derris indica are most suitable for this purpose. Next Typically hardy, fast growing plats like Leucanea, Acacia, Auriculiformis, Eucalyptus, Casia fistula, C-siamea, Laga duclcis should be planted. It is recommended that 8m wide green belts between road and buildings can reduce dust by 2-3 times. Trees like Sal, etc, deflect or refract sound waves.

Engineering methods and plantation techniques are adopted according to the speed of vehicles, machines used in industries and mine blasting, green belts of 18m to 30m width, 15-27m for traffic lane with central row of at least 13m-15m tall are necessary for high speed vehicles, while for moderate speed, green belt of 6m-15m width within the edge of the belt 6m-15m from the centre of nearest traffic lane; shrubs of 1.8m to 4m high should be planted to traffic lane.

Table 9. Trees Tolerance to Pollutants (Power Plant)

Sulphur Dioxide and Oxides of Nitrogen	Suspended Particulate Matter
Albezia lebbeck	Alstonia maccrophylla
Aolanthus excelsa	Cassia siamea
Alstonia scholaris	Dalbergia sissoo
Azadirachta indica	Ficus benghalensis
Ficus religiosa	Magifera indica
Lagestroemia flosreginae	Peltophorum ferrugineum
Mimusops elangi	Polyathia longifilia
Polyatthia longifolia	Syszygium cumini
Teminalia arjuna	Alnus viridis
Acer platanoides	Picea sp.
Quercus palustris	Braya purpurascens
Q. rubba	Salix plainfolia

Dust arresting capacity of plant was analyzed in lab by the method adopt by S.K.Mait, CM Dhanbad and D.K.Sahu (Ph.D.Thesis 2002).

Table 10. Dust collection capacity of some trees (2012)

Botanical Name	Common Name	Dust Arresting Capacity, in gm/m²	Distance From Road, in m
Alostonia scholarisis	Chhatiana	2.01	10
H-Indica	Mango	14.3	8
Ficus cunea	-	16.12	8
Caesalplnia pulcherria	Radhachuda	28.01	8
Anacardium acidemtalis	Kaju	4.92	12
Acacia arabacia	Babul	10.88	7
Butea fonsoa	Palasa	4.80	10
Azadractia indica	Neem	4.06	10
Aegl mevmelos	Bel	3.22	10
Albizzia lebberk	Siris	8.88	8
Pongemic slabra	Karanj	3.88	10
Cssie fistula	Sunari	3.11	10
Carthiamus tinctorius	Kusum	3.18	10
Evgenia cuniri	Jamu	3.28	10
Tectona grandis	Saguana	4.66	10
Terminalia arjuna	Arjun	4.02	8
Shuree rohuste	Sal	6.44	8
M.indica	Mahul	6.28	10
P.amblica	Amla	3.21	8

The noise level was studied in 1998-1999 in 12 locations of Ib valley area and the average value in opencast area was 72 – 92 dB I day time and 58 – 69 in night time. The value in Jharsuguda area is 60-80 dB and Belpahar it is 50-70 dB respectively(D.K.Sahu in Ph.D. thesis) the noise level has been increased now 2012-13 it is 80-98dB in mine areas, 70-88 dB in Jharsuguda and 60-80 in Belpahar area. This is due to rapid industrialization from Rengali to Belpahar, heavy transportation, more urbanization etc. which can impact damage of hearing, mental tension, fatigue, arrogance, blood pressure, neurological problem, abnormal behavior of child birth, etc. This can be controlled by both engineering technology and plantation method (sal tree)(D.K.Sahu, P.Srinivas, K.C.Satpathy-1997) Maiti S.K. 1992 data collected of plant S.K.Maiti, Nepak S.P. Sahu D.K., Sinha B.K. 2000, noise pollution and its control by trees.

Table 11. Daily capacity (Sambalpur)

	DRI TPD	Coal	Fly ash	Dolomite	Iron ore	CPP/MW	Coal/ DRI	SPM released DRI
Aryan Ispat and Power, Bomaloi, Rengali	550	266.4	107	4.4	825	18	715	463
Bhushan Steel and Power, Thelkuli	4500	7518.4	3007/3648	36	6750	508	5850	3791
Jay Jagannath Steel & Power	400	-	-	3.2	600	-	520	337
RB Sponge Iron, Jayantpur	100	-	-	0.8	150	-	130	84.3
Samleawari Ferro Metal, Bishalkhinda	100	-	-	0.8	150	-	130	84.3
Shyam Metallics and Energy, Pandaloi	800	814	326	6.4	1200	-	1040	674
Vijay Steel and energy, Gurupali	350	118.4	47.9	2.8	525	55	453	294.8
Hindalco, Hirakud	-	5439	21756/3528	-	-	367.5+100 (Proposed)	-	-
Hindalco Aditya Aluminum	-	-	-	-	-	-	-	-

Table 12. Daily capacity (Jharsuguda)

	DRI TPD	Coal	Fly ash	Dolomite	Iron ore	CPP/MW	Coal/ DRI	SPM released DRI
Action Ispat & Power	700	533	213	5.6	1050	8	910	589.6
Bhagbati Steel, Badmal	50	-	-	0.4	75	36	65	42.1
Thakur Sons & Sons, Kutapali	350	177.6	71.4	2.8	525	-	455	294.8
Jai Hanuman, Raghunathpali	100	-	-	0.8	150	12	130	84.3
LN Metallics, Sripura	200	-	-	1.6	300	-	260	168.6
MSP Metallics, Marakuta	600	355.2	142.1	4.8	900	-	780	505.4
Concast Steel & Power	800	-	-	6.4	1200	24	1040	674
SMC Power, Hirma	600	488.4	195.4	4.8	800	-	780	505.4
Seven Star, Grindola	200	118.4	47.4	1.6	300	33	260	165.4
Srimadhab, Siriapali	200			1.6	300	8	260	165.6
IB thermal Power, OPGC, Banharpali	-	6261 (Proposed ¾ phase 75000)	2486.4 (Proposed ¾ phase 70000)	-	-	420+	-	-
Sterlite Energy, Jharsuguda	-	35520	14208	-	-	-	-	-

Vedenta Aluminium	-	17982	7192.8	-	-	2400	-	-
Indbarat, Tilia	-	100000	40000	-	-	700 (Proposed)	-	-

*DRI: Direct reduced iron

It is experimentally estimated that to get 1 ton of sponge iron, approximately 1.3 ton of coal of semi bituminous type having fly ash about 40%, 1.5.tons of iron ore having Fe_2O_3 65% and 8Kg of dolomite is required in a DRI kiln. To get 1 ton of iron approximately 2.88 ton of total raw material is required which release 30% of the pollutants to the atmosphere as dust. The Shyam Metalik plant and Biraj steel is attached to the Hirakud reservoir near Lapanga reservoir area. A black layer of suspended particles is seen on the water which is a problem for aquatic animals.

Table 13. Coal mines of Jharsuguda area (in acres)(2012)

Coal mines		project in acres
Underground mines	Ib river colliery	82.3
	Ib property	270.5
	Orient-I	487.5
	Orient-III	601.5
	Ib block 5th	254.6
	Gandaghora	121.7
	N-workshop Gandaghora	397.7
	Rampur colliery	1095.7
Open cast projects	Belpahar Opencast Project	2123.8
	Lajkura opencast	270.2
	Lilari opencast	224.3
	Samlaswari opencast	1095.5
	Lajkura opencast	4708

Environmental Problem

The fugitive emission of SPM during drilling, blasting, movement of heavy earth moving machinery on haul road, collection , transportation, handling of coal, screening, segregation. CH_4 gas is released in underground mines which tends to raise the temperature.

V. Result And Discussion

It is observed that in the average sample of post monsoon seasons, the atmosphere is relatively clean due to the precipitation effect of rain. The values of SPM, SO_2 and NO_2 are less as compare to winter and summer. The collected data revel sampling is done in the month of summer on the study area and its surrounding having more concentration of SPM, SO_2 and NO_2 are on higher side. This is due to the continuous operation of the plants close to the Sambalpur - Jharsuguda highway. Due to the release of coal dust, fly ash, etc, from the 11 mini steel plants and power including Bhushan steel plant, the area is polluted day by day. The companies are necessary to take required action, measure to stop pollution of the environment. But not much care is taken to control the pollution by the industries as per the view of the local people, social workers, even the pollution control board of Sambalpur, Jharsuguda. Travels and other heavy vehicles are engaged in transportation of coal, iron ore and other materials. They are generating a lot of dusts, sulphur dioxide and oxide of nitrogen. Jharsuguda and Rengali belt is on the 8 critical cluster zone due to improper environment planning of concern industry and government. Presently government has signed more that 45 companies out of its 39 companies started partial production till now. If all the 45 company start daily production 86642.92 metric ton and 31624662y/mt tons of fly ash may be generated. These is no such planning to proper disposal and use of fly ash. The water holding of river Mahanadi, Ib, Bheden rivers is going to be decreased. The best solution is to start many cement plants, bricks, mine filling and heavy plantation. Recently government declared to build all government offices with fly ash bricks.

- As per CPCB, two sponge iron factories should be operated at least one km apart from each other.
- Due to ash and pollution control load in pond, temperature increases up to 47°C, rice production and fertility of soil decreased as there is no nitrogen fixation.
- Due to Bhushan, 46.18 acres of land was deforested. 20862 big trees and 5423 small tress were cut.
- Due to Shyam DRI, 94.87 acre land was deforested, 905 big trees were cut.

So a massive afforestation program is required. Presently Government declared all the industries of Jharsuguda to plant 300 000 trees in 2014-15.

VI. Remedial Measures

1. Electrostatic precipitator (ESP), cyclone separate, dust collector, continuous humidifier should be used to control the dust generated. Installation of such equipment and their running must be made compulsory.
2. Deforestation should be stopped by the industries and social forestry should be given more priority by the industries.
3. Plantation should be done in vacant place like road sides, railway lines, school areas, hospitals and vacant village areas.
4. Alostonia scholarsis with Ficus conia should be planted in road sides towards the dust source.
5. Fast growing plants like M-indicia, Derris indicia (suitable for dust collection) should be planted at ash dumping and heavy loading unloading dusts area.
6. Water sprinkler should be installed at regular intervals with in the industrial complex.
7. The main stack of the industries should be minimum 250 meter height as per the rule of central pollution control board.
8. Regular monitoring of the area to measure the pollution load (sampling station establishment) and regular health camp with a mobile van to check the health of local people is required.

VII.   Conclusion

Due to uncontrolled operation of mining industries as well as metallic industries in the Jharsuguda and Sambalpur districts, huge amount of air pollutants are released to the atmosphere every day. The SPM, SO_2 and NO_X are exceeding the permissible limit of CPCB guidelines. The pollutants are not only affecting the living beings, but also affecting the structures, buildings and other materials due to precipitation of pollutants in the form of acid rain. Hence the regulatory agencies should initiate steps right now to reduce the release the pollutants to the atmosphere.

Acknowledgement

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