Environmental Impact Assessment of Daitari Iron Ore Mine in Odisha

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Abstract

The environmental impact assessment is very vital for any sites involved in extracting resources. There are nearly 257 iron ore mines in India and the maximum amount of iron ore extracted is from Chhattisgarh, followed by Goa and Jharkahand. The production of iron ore during 2017 in India was to the extent of 190 million metric tons and it is expected to rise in the coming years. It is well known that iron ore mines contribute substantially for the economy of our country. But it creates adverse effects on the environment. For every ton of iron ore extracted nearly about two and half tons of wastes are generated. These wastes when allowed to flow in to the rivers or nallas affect the water quality and also the aquatic lives. Further the ecology of the total area gets disturbed because of cutting of the forests, loss of vegetation and the top layer of the soil. This affects the agriculture adversely. Though every effort is made to maintain the ambient air quality in the work zone and also in the vicinity of the mining areas, but it is not possible in large scale mining operations inspite of the best of efforts. The measures taken to control the flow of mine wastes are not sufficient. In the absence of proper pollution control measures, the run-offs from the mines create pollution in the nearby streams as observed through its colour and turbidity. This water thus becomes unfit for human and animal consumption. Through tailing dams efforts are being made to settle the iron ore slimes and clear water discharges to down streams. But major effort is required for recycling of the solid wastes. Reclamation of waste is a way out. There is further a need for massive afforestation programme to create lush greenery areas which is a prerequisite sustainable mining operation.

Keywords: *Environmental impact assessment, iron ore, solid wastes, water pollution, aquatic lives.*

Introduction:

The history of mineral development and production in India dates back to almost 6000 years. The remains of some of the old mine working are lying witness to this phenomenon. In

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fact, some of these have led to the discovery of several large mineral deposits which are operational today like Lead & Zinc in Zawar, Copper in Khetri, and Gold in Karnataka etc. Despite the active past, the metal mining activities in the country remained dormant over a long period until the beginning of the last century. Modern mining industry in India started its journey long back in 1774, when East India Company permitted an English Company to undertake coal mining in Raniganj area. Later in 1880 gold mining was started in Kolar goldfield in Karnataka by M/S John Tylor and Sons.

At present India produces as many as 84 minerals comprising 4 fuels, 11 metallic, 49 non-metallic industrial and 20 minor minerals. The total number of mineral deposits are 13,000, occupying about 0.7 million hectares which is 0.21 percent of the total land mass of the country. Mining is carried out at more than 3100 locations in India for different minerals. The mining leases numbering 9244 are spread over 21 states. India is largely self sufficient in most of the minerals which includes barytes, bauxites, chromites, dolomite, fluorspar, gypsum, iron ore, lignite, limestone, manganese ore, magnesite, and sillimanite, etc. except some minerals like copper, asbestos, lead and zinc, natural phosphates, sulphur, and crude petroleum in which domestic production meets the demand only partially (National Mineral Inventory, 2010).

India is Asia's third and worlds eleventh largest economy. It has resources of 12745 million tons of Iron ore, 2525 million tons of bauxite, 76446 million tons of limestone; 233 million tons of magnesite, 167 million tons of lead & zinc ore, 70 million tons of barites, 176 million tons of manganese ore and 90 million tons of chromite. Of the total known global resources of the minerals, the reserves of iron ore, bauxite and manganese accounts for nearly 7 percent, 16 percent and 6 percent respectively. India is also the largest producer of mica blocks and mica splitting. It is also the third largest producer of coal & lignite and barites. In case of chromite production it stepped up and reached the third rank. It is among top 5 producers of iron ore in world and comes in top 6 producers of bauxite and manganese ore. India comes among the top 7 producer of steel and top 10 producer of aluminum. Growth in India has received a lot of attention in recent years with its GDP growing on average 7.5 percent and expected to increase to 10 percent. To sustain such growth rates there is substantial requirement for infrastructure development, which in turn increases the demand for coal, electricity, steel and cement. To increase production of these key inputs, India needs to improve productivity and efficiency of its coal, mining, minerals and energy sector. This growth and modernization of the

Indian mining sector has opened many opportunities for the minerals and mining industry (Singh et al, 2010).

Mining industry in India has been progressing at an annual rate of 4% to 5% during the last three decades. The overall value of minerals being extracted in India exceeds US $ 11.32 billion during 2011- 2012. Thus the contribution of mining to Gross Domestic Product has increased from 0.56 percent (pre independence period, before 1947) to 2 to 3 percent. Today India is one of the leading producers and exporters of several minerals in the world. Further Indian mining industry provides employment to over 1.1 million people with 16 percent share in India's export.

Under this backdrop mining industry is emerging as major contributor to India's economic growth as well as employment opportunities. However, their exploration, excavation and mineral processing directly infringe upon and affect the other natural resources like land, air, water, flora and fauna, which are to be conserved and optimally utilized in a sustainable manner. Mining is associated with different peripheral problems like dust, traffic, road, communication and other related problems. With mining, different industries like sponge iron, crushers and railway sidings set up in a radius of 5 Km to 500 Kms. As the roads of rural areas are mostly of village/block roads of low carrying capacity, the transportation of iron ore from mines to different locations creates dust laden atmosphere later on in the peripheral areas. Due to surge in iron ore production and transportation, the clumsy roads are laden with heavy traffic throughout the day and night which restricts the emergency services like supply of commodities and attending health care. Bad road condition discourages the public carrier owners like buses to ply in these conditions.

In iron ore mining & other allied activities including processing of ore, dust is the single largest air pollutant and can be a significant nuisance to surrounding land users as well as a potential health risk in some circumstances. Dust is being produced from a number of sources and through number of mechanisms such as land clearing, removal of top soil, overburden removal, drilling, blasting, crushing & screening, processing of ore, loading & unloading of material on site & subsequent transport off the site etc. In addition to this, wind action affecting stockpiles, dry tailings and exposed mining areas also generate significant amount of dust. Noise, vibration and air blast are unavoidable fallouts of mining operations, which involve using large mobile equipment, fixed plant and blasting. Noise, vibration and air blast are among the most significant issues for communities located near mining projects. The adverse impact of these needs to be contained.

To protect the environment, mining sector in general, is regulated by the Environment (Protection) Act: 1986, the Forest Conservation Act: 1980, the Mines and Minerals Development and Regulation) Act: 1957, Wild Life Act: 1972, Water (Prevention & Control of Pollution) Act: 1974 and Air (Prevention & Control of Pollution) Act: 1981. In order to protect the environment from iron ore mines, environmental standards specific for Indian Iron Ore Mines are proposed under Environment (Protection) Act, 1986. The proposed standards are primarily based on the studies conducted, normal background information, (collected through actual site monitoring during the mines visit and collected from different mining authorities and regulatory bodies), comparison and evaluation of national and international standards as well as the presence of different harmful elements and their likely health effect. There is not much precedence of existing iron ore mine specific environmental standards, internationally. Only United States Environment Protection Agency has specified the discharge standards for iron ore mining, whereas the same is covered by Canada through a blanket standard for all the metalliferous mines. Also the World Bank has issued certain guidelines on pollution limits for air, water and noise.

The Study Area:

Occupying an important position on the country's map, Odisha's rich mineral reserves constitute 28% Iron ore, 24% coal, 59% Bauxite and 98% Chromite of India's total deposits. The state's comparative advantage on this account has attracted the attention of many mining and metallurgical companies. Iron ore is abundantly available in the districts of Mayurbhanj, Sundargarh, Keonjhar and Jajpur. The state is also India’s main supplier of valuable minerals such as chromites, nickel ore, coal, bauxite, iron ore and manganese. About 30% of its area is under forest cover, which provides for the livelihood of a large and growing tribal population. It is a co-incidence that, the forest area of the state is superimposed with its mineral deposit, richest biodiversity regions, and water catchment of major rivers and habitat of tribal community of state.

Daitari is situated in district of Keonjhar and Jajpur in the state of Odisha. With deposits of 50 million tonnes of ore, the Daitari mines at Talipada village under Keonjhar and Jajpur districts are OMC's flagship operations. The Daitari mines had recorded production of 703,440 tonnes of ore in the year 2013. It is under the control of the state. Units such as Vis Steel, Neelachal Ispat Nigam Ltd (NINL), Aarti Steels and Bhushan steel, are heavily dependent on iron ore supplies from the Daitari mines. The Daitari lease area falls under the Deogaon and Sukinda ranges of Rebana reserve forest. The area is a hilly terrain with RL difference of about 400 mtrs between quarry & town ship. The area comes under Rebena Reserve forest & Daitari protected forest.

The lease area is connected with Brahamnipal town at a distance of 12 km through a State road. Paradeep Express Highway passes at a distance of about 2.5 km from the leasehold area. Nearest rail head is at Daitari on Daitari - Jhakhapura section of East Coast Railway, which is located near to the leasehold area. Besides there some ancillary facilities, including town ship, crushing and screening plant, and water reservoir located in two nearby areas which are spread over 236.34 ha and 48.98 ha. The mineable reserves of iron ore in the lease-hold have been estimated to be 66.980 million tonnes (Mt). Cut-off grade of iron ore is considered to be 58% Fe. The mine has been in continuous operation since 1966.

Problem and method:

The mining sector has been facing severe criticism on several issues relating to its performance vis-à-vis sustainable development because of the following reasons. The minerals, forests and tribal tracts are concentrated in the same geographic areas. As seen from the mineral map of India, several areas with very high mining activity are in the poorest districts. The historical and ongoing conflict between mining mineral reserves and conserving environmental resources will continue to exist even in future as India's forests, mineral bearing areas, major river watersheds, tribal habitat regions and most backward regions overlap significantly.

A closer look shows that many of these share a common geography with the most ecologically rich and culturally sensitive areas in Odisha. This brings home the reality that in recent decades; mining activities have resulted in little local benefit, and in fact, has been at the cost of environmental degradation. This situation has greatly contributed to general social dissatisfaction and unrest in these mining belts; further exacerbated by undervaluation of lands that were acquired by the government for development of mines. Long pending and pertinacious resettlement (legacy) issues have contributed to a deep local mistrust of mining and all associated activities including exploration studies. This is not helped by the fact that the issue of land ownership is a highly complex one, layered with a variety of rights granted over its use-some of which are customary and traditional, and may not be recognised under law; this is perhaps most problematic in tribal areas. To illustrate, the recent provision for the settlement of forest rights for forest dwelling communities creates a whole new challenge for the mining companies and the administration to settle those rights, and a long demanded opportunity for the communities to claim those rights. The coincidence of rich biodiversity with mineral bearing areas is understood but not adequately factored into the comprehensive assessment and mitigation of long term impacts, leading to inadequate response from the project proponents and the regulators.

The recent boom in the demand for low grade iron ore has contributed to intensifying the above issues in addition to giving an impetus to illegal mining. Legal and regulatory loopholes and inadequate policing has allowed the illegal mining operations to flourish and grow. Commentators point out that the boom is also responsible for unforeseen profits across the board from small to large mining and associated operations, contributing a substantial increase, especially over the last 7 years. Internationally dropping standards of acceptable grades of iron ore have led to mines being re-opened, mine life being revised, even old over-burdens being mined (as what was previously waste, is now a resource). Even as it is hard to ignore the contribution that the resultant economic development has made it has been at a very high cost, the impacts of which, environmentalists and social activists feel have not been fully understood and appreciated. More intensive use beyond sustainable limits has been contributing significant pressures on land, air, water, forests, biodiversity , especially due to the increased pace resulting from market demands and made possible through newer, improved technologies.

Immediate and long term damages sustained as a result of this increase have already severely compromised the lives of the local communities (even as some sections have benefitted economically from it), and are set to manifest into longer term damages in terms of health, livelihoods and overall living quality; and Community benefit-sharing as managed by mining companies (e.g. Truck transport contracts for ore movement to local community) in several areas has resulted in severe environmental degradation which has come to be into a vicious circle that, on the one hand has become hard to break because it is profitable for the beneficiary community, and on the other, goes unregulated as part of the business of mining, has added to the list of conflicts associated with the sector. Enforcement is a key drawback with regulatory arrangements in the sector and is the biggest point of criticism from all stakeholder groups involved. It has been stated during several discussions on the subject that it is better enforcement, rather than more regulation that can begin to remedy the ills plaguing the sector today.

Regulators at all levels are also severely limited by the lack of adequate and usable information/data, as also clarity and definition on several aspects pertaining to mining operations. This lack compounds the issue of inadequate enforcement and also creates the necessary gaps for illegal operations to carry on, unchecked. Several levels of illegality can flourish, in terms of boundary violations, over-extraction, under-reporting production and export, among others, though lesser degree violations are also rampant in other mining regions of the country. The rate of extraction is currently seen to be a function of market demand alone (and the capacity of the miner to extract) – not taking into account the stress on existing (and limited) network infrastructure. Fluctuations in the market make planning for peak flows on infrastructure networks difficult. Several mining areas in the country report more acute problems faced by the resident community, in terms of vehicular pollution, traffic jams, and dust & road conditions, than about the mining activity itself.

While there are some economic benefits that may be gained by the communities living around mining areas in terms of employment and business, it is the vulnerable sections: women, children and old people, who sustain several negative impacts, and have more limited coping mechanisms. These impacts range from health, reduced access to resources, increased drudgery, insecurity due to influx of outsiders and finally little benefits from mining. Mining companies are the biggest defaulters on issues like provision of safe working environment, labour health and safety and human rights issues especially in quarry sites. While mines provide the most significant employment opportunities, they also demonstrate a poor record on and commitment to these issues. Irregularities, illegality, under-reporting, widespread violations of labour and safety norms, persistence of child labour, poor working conditions, and a general disregard for environmental safeguards have all been reported in this segment.

The situation is made more difficult with multiple agencies responsible for regulation, the lack of proper documentation and approvals, where significantly more stringent regulations apply to the minor minerals segment, on paper. This wide gap has thrown up several suggestions for the proposed resolution and management of the emerging issues. They feel that state level specificities to do with minor minerals are better appreciated at the state level and will be better managed with more regulations and control. Some states have demonstrated improved administrative by using royalty-sharing arrangements to target fund provision for local area improvement, infrastructure finance, while also demonstrating a closer, consequent relation between mining and area improvement in the same geography. For example Gujarat provides for

90% of the royalties collected by the state (from the minor minerals segment) to flow back to the source district, and 20% of that to be allocated to the source tehsil for development of the area.

Mining operations, both open-pit and underground, typically produce large volumes of tailings deposits and waste rock piles. They may cause air pollution, water pollution and land degradation problems. These wastes can affect the environment through its chemical and mineralogical composition, its physical properties, its volume and the surface occupied, the waste disposal method, climatic conditions liable to modify the disposal conditions, geographic and geological location with existing targets liable to be affected (man and his environment). Thus, identification of the environmental risks associated with the exploitation of mines and quarries and with ore processing not only requires the characterization and quantification of the different types of waste, as well as a knowledge of the processes used, but also an assessment of the vulnerability of the specific environment contingent upon the geological and hydro geological conditions and peripheral targets. Meteoric precipitation also transfers pollutant from a tailings dam or a processing plant to the river if the waste management is not efficient.

The main objective of the study is to study the air, water, and noise level at different location of the mines. The research question is - what is the present air, water, and soil quality and noise level at different locations in comparison to safe limits? The universe of the study is jurisdiction of OMC mines engaged in mining iron ores. The Daitari mine is selected as the sample using purposive sampling procedure as part of the research process for selection of mine. This was based on location, topography, accessibility by the investigator and time frame of research.

Air, Water and Noise level at different location of the mines:

The present study presents the environmental related data in respect of, Ambient Air Quality, Work Zone Air Quality (Fugitive Emission), Noise Level, Work zone Noise Level, Surface Water Quality and Flow of Water Measurement in and around Daitari Iron Ore Mine in Keonjhar district of Odisha. The data was collected during October 2014, December 2014, Februray 2015, April 2015 and June 2015. The scope of work within the mine lease area was confined to Ambient Air Quality (6 locations) ,Work Zone Air Quality (6 locations), Ambient Noise Level (6 locations) Work zone Noise Level (3 locations) Surface Water Quality (4 locations) and Flow of Water Measurement (3 locations) . In order to assess the pollution level in and around the mining lease, different environmental attributes such as air quality, water quality, and noise level were monitored. M/s EDCPL has set up a site laboratory equipped with adequate instruments and equipments to monitor and analyze all the parameters of Air Quality i.e. PM10, PM2.5, SO2, NOX & CO and few physic-chemical parameters (10 parameters) of water samples.

The table 1 shows the PM_{10} concentration at six locations of Daitari mines. Data was collected from October 2014 to June 2015. The maximum PM_{10} concentration in the month of October 2014 was 74 µg/m^3 at location near Daitari Guest house and the minimum was 41 µg/m^{3}in location of Water Reservoir Pump House. In the month of December 2014, the maximum PM_{10} concentration was 78µg/m^3 at location Inside colony location and the minimum was 41 µg/m^3 in of Water Reservoir Pump House location.The maximum PM_{10} concentration in the month of February 2015 was 94 µg/m^3 at OMC Office location and the minimum was 35 µg/m^3 in location of Water Reservoir Pump House. In the month of April 2015, the maximum PM_{10} concentration was 92µg/m^3 at Balipahar Township location and the minimum was 41 µg/m^3 in Water Reservoir Pump House location. The maximum PM_{10} concentration in the month of June 2015 was 70 µg/m^3 at OMC Office location and the minimum was 36 µg/m^3 in location of Water Reservoir Pump House. Further the minimum concentration of PM_{10} at different locations varied from 41-55 µg/m^3 in the month of October 2014, 41-62 µg/m^3 in the month of December 2014, 35-66 µg/m^3 in the month of February 2015, 41-65 in the month of April 2015 and 36-53 µg/m^{3}in the month of June 2015.

Table 1: PM_{10} concentration at six locations of Daitari mines

Sl. No	Location	Oct 2014			Dec 2014			Feb 2014			April 2015			June 2015		
		PM_{10}			PM_{10}			PM_{10}			PM_{10}			PM_{10}		
		max	min	avg	max	min	avg	max	min	avg	max	min	avg	max	min	avg
1	Inside Colony	65	46	57	78	62	70	84	44	63	72	49	61	59	47	52
2	Daitari Guest House	74	49	62	76	58	68	78	54	65	78	60	68	64	51	58
3	OMC office	73	52	60	74	57	66	92	44	71	84	56	68	70	53	62
4	Baliparbat Township	73	55	66	60	54	57	94	66	81	92	65	76	68	52	61
5	Water reservoir pump house	52	41	45	58	41	49	54	35	43	55	41	47	47	36	41
6	Near Hospital	64	47	56	67	47	57	68	38	28	81	57	69	62	44	54

	Daitari															
CPCB Standards		100µg/m^3			100µg/m^3			100µg/m^3			100µg/m^3			100µg/m^3		

Source: Tested in the EDCPL lab. BBSR(2014-15)

In different months the PM$_{10}$ concentration at different locations were found to be different. In the month of February the maximum concentration of PM$_{10}$ was 94 µg/m^3, followed by the month April where the PM$_{10}$ Concentration was 92 µg/m^{3,} followed by the month December where the PM$_{10}$ Concentration was 78 µg/m^{3,} followed by the month October where the PM$_{10}$ Concentration was 74 µg/m^{3,} and finally for the month of June wherein the maximum concentration was 70 µg/m^3. Thus the data reveal that the Maximum concentration of PM$_{10}$ was observed in the month of February followed by April, December and October,

The average concentration of PM$_{10}$ in different locations varied from a minimum of 45 µg/m^3 to a maximum of 66 µg/m^3 in the month of October 2014, of 57 µg/m^3 to a maximum of 70 µg/m^3 in the month of December 2014, of 28 µg/m^3 to a maximum of 81 µg/m^3 in the month of February 2015, of 47 µg/m^{3}to a maximum of 76 µg/m^3 in the month of April 2015, of 41 µg/m^3 to a maximum of 58 µg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of PM10 Concentration in the Air. However in none of the months the PM10 concentration exceeded the permissible limit of 100 µg/m^3 as prescribed by Central Pollution Control Board Standard.

Data on PM$_{2.5}$ was collected from October 2014 to June 2015 (table 2). The maximum PM$_{2.5}$ concentration in the month of October 2014 was 42µg/m^3 at Baliparbat Township and the minimum was 26µg/m^3 in location of Water Reservoir Pump House. In the month of December 2014, the maximum PM$_{2.5}$ concentration was 36µg/m^3 at location OMC office and the minimum was 24µg/m^3 in Water Reservoir Pump House location. The maximum PM$_{2.5}$ concentration in the month of February 2015 was 44µg/m^3 at Baliparbat township location and the minimum was 20µg/m^3 in location of Water Reservoir Pump House. In the month of April 2015, the maximum PM$_{2.5}$ concentration was 27µg/m^3 at OMC Office location and the minimum was 14µg/m3 in Water Reservoir Pump House location. The maximum PM$_{2.5}$ concentration in the month of June 2015 varied from 44µg/m^3 at Baliparbat location to 14µg/m^3 in location of Water Reservoir Pump House.

Further, the minimum concentration of PM$_{2.5}$ at different locations varied from 17-30 µg/m^3 in the month of October 2014, 14-22 µg/m^3 in the month of December 2014, 11-21 µg/m^3

in the month of February 2015, 11-18 in the month of April 2015 and 10-12 µg/m^3 in the month of June 2015 in different locations. In different months the $PM_{2.5}$ concentration at different locations were found to be different. In the month of February 2015 the maximum concentration of $PM_{2.5}$ was 27 µg/m^3, in the month April the $PM_{2.5}$ Concentration was 34 µg/m3, in the month December the $PM_{2.5}$ Concentration was 36 µg/m^3, in the month October the $PM_{2.5}$ Concentration was 39 µg/m3, and for the month of June the maximum concentration was 27 µg/m^3. Thus the data reveal that the maximum concentration of $PM_{2.5}$ was observed in the month of February, followed by October, December, April and June.

Table 2: $PM_{2.5}$ Concentration at six locations of Daitari mines

Sl. No	Location	Oct 2014			Dec 2014			Feb 2014			April 2015			june 2015		
		$PM_{2.5}$			$PM_{2.5}$			$PM_{2.5}$			$PM_{2.5}$			$PM_{2.5}$		
		max	min	avg	max	min	avg	max	min	avg	max	min	avg	max	min	avg
1	Inside Colony	32	23	28	30	22	26	38	11	22	21	11	16	18	11	14
2	Daitari Guest House	38	22	33	35	20	26	31	14	22	24	12	18	20	12	16
3	OMC office	39	25	31	36	18	28	41	11	26	29	12	20	27	12	20
4	Baliparbat Township	42	30	34	33	1	26	44	21	33	34	18	24	25	11	19
5	Water reservoir pump house	26	17	23	24	14	18	20	11	15	18	10	13	14	10	11
6	Near Hospital Daitari	31	20	27	31	21	25	28	18	23	28	13	20	22	12	17
CPCB Standards		60µg/m^3			60µg/m^3			60µg/m^3			60µg/m^3			60µg/m^3		

Source: Tested in the EDCPL lab. BBSR (2014-15)

The average concentration of $PM_{2.5}$ in different locations varied from a minimum of 23 µg/m^3 to a maximum of 34 µg/m^3 in the month of October 2014, of 18 µg/m^3 to a maximum of 28µg/m^3 in the month of December 2014, of 15 µg/m^3 to a maximum of 33 µg/m^3 in the month of February 2015, of 10 µg/m^{3}to a maximum of 18 µg/m^3 in the month of April 2015, of 11 µg/m^3 to a maximum of 20 µg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of $PM_{2.5}$ Concentration in the Air. However in none of the months the $PM_{2.5}$ concentration exceeded the permissible limit of 60µg/m^3 as prescribed by Central Pollution Control Board Standard.

The table 3 shows the SO_2 concentration at six locations of Daitari mines. The data was collected from October 2014 to June 2015. The maximum SO_2 concentration in the month of October 2014 was 7.6 µg/m3 at location Daitari Guest House and the minimum was 6.1 µg/m^3 in location of Water Reservoir Pump House. In the month of December 2014, the maximum SO_2 concentration varied from 9.7 µg/m3 to 6.9 µg/m^3 at location OMC office and Water Reservoir Pump House location respectively. The maximum SO_2 Concentration in the month of February 2015 varied from 6.8 µg/m^3 to 9.2 µg/m^3 at location Near Hospital Daitari and Baliparbat Township respectively. In the month of April 2015, the maximum SO_2concentration varied from 6.8 to 9.2 µg/m^3 and was found in Baliparbat Township and Near Hospital Daitari respectively. The maximum SO_2 concentration in the month of June 2015 varied from 10.2 µg/m3 at Baliparbat location to 8.2 µg/m3 in location Near Hospital Daitari.

Table 3: SO_2 Concentration at six locations of Daitari mines

Sl. No	Location	Oct 2014			Dec 2014			Feb 2014			April 2015			june 2015		
		SO_2			SO_2			SO_2			SO_2			SO_2		
		max	min	avg	max	min	avg	max	min	avg	max	min	avg	max	min	avg
1	Inside Colony	7.1	5.9	6.4	9.5	6.2	7.8	8.6	5.2	6.7	8.6	5.2	6.7	8.8	4.8	6.6
2	Daitari Guest House	7.6	6.7	7.0	9.6	6.3	7.6	9.1	4.2	6.5	9.1	4.2	6.5	9.2	5.1	6.9
3	OMC office	7.3	4.7	6.1	9.7	5.4	8.1	8.7	4.4	6.6	8.7	4.4	6.6	8.8	4.6	6.4
4	Baliparbat Township	6.2	5.2	5.7	7.2	4.2	5.7	9.2	6.4	7.5	9.2	6.4	7.5	10.2	6.2	8.3
5	Water reservoir pump house	6.1	BDL	4.8	6.9	4.3	5.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
6	Near Hospital Daitari	6.7	4.7	5.8	9.4	4.8	6.9	6.8	4.1	5.3	6.8	4.1	5.3	8.2	5.4	6.5
CPCB Standards		80µg/m^3			80µg/m^3			80µg/m^3			80µg/m^3			80µg/m^3		

Source: Tested in the EDCPL lab. BBSR(2014-15)

Further, the minimum concentration of SO_2 at different locations varied from 4.7 to 5.9 µg/m3 in the month of October 2014, 4.22 to 6.3 µg/m^3 in the month of December 2014, 4.1 to 6.4 µg/m3 in the month of February 2015, 4.1 to 6.4 µg/m3 in the month of April 2015 and 4.6 to 6.2 µg/m3 in the month of June 2015 in different locations.

In different months the SO_{25} concentration at different locations were found to be different. The maximum concentration of $SO_{2.5}$ was 7.6 µg/m3 in the month October 2014, the SO_2 Concentration was 9.7 µg/m3 in the month December 2014, the SO_2 concentration was 9.2 µg/m3 in the month February 2015, the SO_{25} Concentration was 9.2 µg/m in the month of April 2015, and for the month of June 2015 the maximum concentration was 10.2 µg/m3. Thus the data reveal that the maximum concentration of SO_2 was observed in the month of June, followed by December, February, April and October.

The average concentration of SO_2 in different locations varied from a minimum of 4.8 µg/m3 to a maximum of 7.0 µg/m^3 in the month of October 2014, of 5.6 µg/m^3 to a maximum of 8.1 µg/m3 in the month of December 2014, of 5.3 µg/m3 to a maximum of 6.6 µg/m3 in the month of February 2015, of 5.3 µg/m^3 to a maximum of 7.5 µg/m3 in the month of April 2015, of 6.4 µg/m^3 to a maximum of 6.9 µg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of SO_2 Concentration in the Air. However in none of the months the SO_2 concentration exceeded the permissible limit of 80 µg/m3 as specified by Central Pollution Control Board Standard.

The maximum NO_X concentration (table 4) in the month of October 2014 was 15.6 µg/m3 at location Baliparbat Township and the minimum was 5.8 µg/m3 in location near Daitari Hospital .In the month of December 2014, the maximum NO_x concentration varied from 15.1 µg/m3 to 12.1 µg/m3 at location OMC office and Water Reservoir Pump House location respectively. The maximum NO_x concentration in the month of Februray 2015 varied from 14.4 µg/m3 to 13.2 µg/m3 at location Daitari guest house, OMC office and Baliparbat Township respectively. In the month of April 2015, the maximum NO_x concentration varied from 12.8 to 14.8 µg/m3 and was found in Daitari Guest house and Baliparbat Township respectively. The maximum NO_X concentration in the month of June 2015 varied from 9.9 µg/m3 at Daitari Hospital to 11.9 µg/m3 in location Daitari Guest House.

Further the minimum concentration of NO_X at different locations varied from 12.1 to 13.2 µg/m3 in the month of October 2014, 9.2 to 10.8 µg/m3 in the month of December 2014, 9.2 to 10.1 µg/m3 in the month of February 2015, 8.4 to 11.5 µg/m3 in the month of April 2015 and 9.1 to 10 µg/m^3 in the month of June 2015 in different locations.

In different months the NO_X concentration at different locations were found to be different. The maximum concentration of NO_X was 15.6 µg/m3 in the month October 2014, the NO_X concentration was 15.1 µg/m3 in the month December 2014, the NO_X concentration was

14.4 μg/m^3 in the month February 2015, the NO_X Concentration was 12.8 μg/m in the month of April 2015, and for the month of June 2015 the maximum concentration was 11.9 μg/m^3. Thus the data reveal that the maximum concentration of NO_X was observed in the month of October, followed by December, February, April and June.

The average concentration of NO_X in different locations varied from a minimum of 10.4 μg/m3 to a maximum of 13.5 μg/m^3 in the month of October 2014, of 10.6 μg/m^3 to a maximum of 12.9 μg/m^3 in the month of December 2014, of 11.3 μg/m^3 to a maximum of 12.3 μg/m^3 in the month of February 2015, of 10.7 μg/m^3 to a maximum of 13 μg/m^3 in the month of April 2015, of 9.5 μg/m^3 to a maximum of 11.5 μg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of NO_X Concentration in the Air. However in none of the months the NO_X concentration exceeded the permissible limit of 80 μg/m3 as specified by Central Pollution Control Board Standard.

Table 4: NO_X Concentration at six locations of Daitari mines

Sl. No	Location	Oct 2014			Dec 2014			Feb 2014			April 2015			june 2015		
		NO_X			NO_X			NO_X			NO_X			NO_X		
		max	min	avg	max	min	avg	max	min	avg	max	min	avg	max	min	avg
1	Inside Colony	14.2	12.4	13.2	m/c Breakdown	13.3	10.1	11.6	14.6	11.2	12.9	12.8	10	11.5	14.2	12.4
2	Daitari Guest House	14.8	12.1	13.5	14.2	10.8	12.4	14.4	9.8	12.1	12.8	9.8	11.3	11.9	14.8	12.1
3	OMC office	13.8	12.2	13	15.1	10.7	12.9	14.4	10.1	12.3	13.8	10.6	12.1	11.0	13.8	12.2
4	Baliparbat Township	15.6	12.8	13.8	m/c Breakdown	13.2	9.2	11.3	14.8	11.5	13.0	BDL	BDL	BDL	15.6	12.8
5	Water reservoir pump house	10.1	BDL	BDL	12.1	9.2	10.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10.1	BDL
6	Near Hospital Daitari	5.8	13.2	10.4	14.1	9.6	11.9	13.4	9.7	11.3	12.8	8.4	10.7	9.9	5.8	13.2
CPCB Standards		80μg/m^3			80μg/m^3			80μg/m^3			80μg/m^3			80μg/m^3		

Source: Tested in the EDCPL lab. BBSR(2014-15)

The maximum CO concentration (table 5) in the month of October 2014 was 0.6 μg/m3 at location near Daitari Hospital and the minimum was 0.5 μg/m3 in location OMC office. In the month of December 2014, the maximum CO concentration was 0.4 μg/m^3 OMC office and Daitari Guest House. The data was not available in other months because of Below Detection Limits (BDL). In different months the CO concentration at different locations were found to be different. The maximum concentration of CO was 0.6 μg/m^3 in the month October 2014, and CO Concentration was 0.4 μg/m^3 in the month December 2014.

The average concentration of CO in different locations varied from a minimum of 0.2 μg/m^3 to a maximum of 0.3 μg/m^3 in the month of October 2014, and December 2014 respectively. The data reveal that during different seasons there is variation of CO Concentration in the Air. However in none of the months the CO concentration exceeded the permissible limit of 80 μg/m3 as specified by Central Pollution Control Board Standard.

Table 5: CO Concentration at six locations of Daitari mines

Sl.No	Location	Oct 2014			Dec 2014			Feb 2014			April 2015			June 2015		
		CO			CO			CO			CO			CO		
		max	min	avg	max	min	avg	max	min	avg	max	min	avg	max	min	avg
1	Inside Colony	0.2	BDL	BDL	m/c Breakdown	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.2	BDL
2	Daitari Guest House	0.6	BDL	0.3	0.4	BDL	0.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.6	BDL
3	OMC office	0.5	BDL	0.3	0.4	BDL	0.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.5	BDL
4	Baliparbat Township	0.4	BDL	0.2	m/c Breakdown	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.4	BDL
5	Water reservoir pump house	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
6	Near Hospital Daitari	0.4	BDL	0.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.4	BDL
CPCB Standards		4.3μg/m^3			4.3μg/m^3			4.3μg/m^3			4.3μg/m^3			4.3μg/m^3		

Source: Tested in the EDCPL lab. BBSR (2014-15)

The table 6 shows the summarized results of noise monitoring in six different locations from 9^{th} to 14^{th} December 2014. It was found from the data that from 6 a.m. to 10 pm the minimum noise recorded was 44.3 db in the industrial area (inside colony) and the maximum was 51.5 db with an average of 49.5 decibel. In the night time from 10 p.m. to 6 a.m. the maximum decibel recorded was 43.4 with an average of 36.2 db.

In the Residential area (Daitari Guest house) the minimum noise recorded was 36.7 db and the maximum was 48.7 db with an average of 44.7 decibel. In the night time from 10 p.m. to

6 a.m. the maximum decibel recorded was 42.5 with an average of 36.2 db. In the commercial area (OMC office) the minimum noise recorded was 36.8 db and the maximum was 57.8 db with an average of 45.3 decibel. In the Residential area (Baliparbat Township) the minimum noise recorded was 51.5 db and the maximum was 55.6 db with an average of 39.5 decibel. In the night time from 10 p.m. to 6 a.m. the maximum decibel recorded was 43.3 with an average of 34.8 db. In the Residential area (Water Reservoir pump house) the maximum noise was 41.6 db with an average of 34.3 decibel. In the night time from 10 p.m. to 6 a.m. the maximum decibel recorded was 34.8 with an average of 33.7 db. In the silence Zone area (Near Daitari Hospital) the maximum noise was 48.6 db and the minimum was 35.8 db with an average of 34.3 decibel. In the night time from 10 p.m. to 6 a.m. the maximum decibel recorded was 35.6 with an average of 37.6 db.

It was found from the data of six locations that the minimum noise of 37.6 db recorded during day time from 6 a.m. to 10 p.m (from 9-14th Dec 2014) was in the residential areas located near Daitari Guest House and the maximum was 57.8 db in the commercial areas located near OMC office. The maximum average noise was 49.5 db in the industrial area and the minimum average was 34.3 db in residential areas located near water reservoir pump house. In the night period from 10 p.m. to 6 p.m (from 9th to 14th December) the highest noise of 43.3 db was recorded in the residential area located at Baliparbat Township and the minimum was 33.7 db recorded in the residential areas near water reservoir pump house. The average maximum of 37.6 db was recorded in silence zone located near Daitari Hospital.

Table 6: Summarized Results of Noise Monitoring in six different locations

Sl.No	Location	Results (9-14th Dec 2014)						Type of area
		Day(0600-2200hrs)			Night(2200-0600hrs)			
		max	min	avg	max	min	avg	
1	Inside Colony	44.3	51.5	49.5	BDL	43.4	36.2	Industrial area
2	Daitari Guest House	37.6	48.7	44.7	BDL	42.5	35.6	Residential area
3	OMC office	36.8	57.8	45.3	BDL	NA	NA	Commercial area
4	Baliparbat Township	51.5	55.6	39.5	BDL	43.3	34.8	Residential area
5	Water reservoir pump house	BDL	41.6	34.3	BDL	34.8	33.7	Residential area
6	Near Hospital Daitari	35.8	48.6	45.7	BDL	35.6	37.6	Silence Zone

Source: Primary source

The table 7 shows the CPCB norms in respect of Ambient Noise in Industrial Areas, commercial areas, residential Areas and in silence zones. The permissible limits for industrial areas during day time (0600-2200hrs) is 75 db, for commercial areas is 65 db, for residential areas is 55 db and in silence zone it is 50 db. Similarly in night between 2200-06 hrs for industrial areas it is 70 db, for commercial areas is 55 db, for residential areas is 45 db and in silence zone it is 40 db.

Table 7: CPCB Norms in respect of Ambient Noise

Type of Area	Day (0600-2200hrs)	Night (2200-0600hrs
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

All Values in dB(A)

The table 8 shows the noise produced in different sites i.e. Narayani crusher site, excavation site and at drilling points in three different dates in the month of December 2014 from 8 a.m. to 3 p.m. The data show that in station 1, the maximum noise level was recorded at 12 noon with a decibel of 77.1 and the minimum was at 8 a.m. with 68.1 decibel. In station 2, i.e. at excavation site the maximum noise level was recorded at 3 p.m. with a decibel level of 64.8 and the minimum was at 8 a.m with a decibel level of 54.5. In station 3, i.e. at Drilling point site the maximum noise level was recorded at 11 a.m. with a decibel level of 63.7 and the minimum was at 8 a.m with a decibel level of 56.9.

Table 8: Result of Work Zone noise monitoring

Sl. No	Station 1		Station 2		Station 3	
	Narayani Crusher (KCC)		Excavation site		Drilling point	
Date	15th Dec 2014		16th Dec 2014		17th Dec 2014	
	Time	dB(A)	Time	dB(A)	Time	dB(A)
1	08:00AM	68.1	08:00AM	54.5	08:00AM	56.9
2	09:00AM	70.9	09:00AM	60.2	09:00AM	59.1
3	10:00AM	76.4	10:00AM	63.1	10:00AM	61.4
4	11:00AM	76.9	11:00AM	63.9	11:00AM	63.7
5	12:00AM	77.1	12:00AM	64.2	12:00AM	62.1
6	01:00PM	76.7	01:00PM	63.5	01:00PM	58.2
7	02:00PM	74.3	02:00PM	63.0	02:00PM	57.4

8	03:00PM	75.2	03:00PM	64.8	03:00PM	61.8

Source: Noise monitoring equipment by OMC in the site (2014)

It was found that noise is produced in the mines mainly due to crushing, excavation process and drilling process. Maximum noise is produced because of crushing followed by excavation of ores and drilling operations. However as recoded, the level of noise pollution was above 75 db in the crushing site with a variation from 68 to 77db during the day time. Whereas in the excavation site and drilling point site, the noise level was within the permissible limit of 75 db.

The table 9 shows the permissible sound pressure level according to CPCB per day according to number of hours. It was found that in a day for 8 hrs exposure the sound pressure level allowed should not be more than 90 db, for six hours in a day it should be in the limit of 92 db, for 4 hours exposure the sound pressure level should not exceed 95 db, for three hours in a day it should not exceed 97 db and for 2 hours a day it should not exceed 100 db.

Table 9: Permissible sound pressure level according to CPCB

Duration per day(hr)	Sound pressure level dB(A) allowed response
8	90
6	92
4	95
3	97
2	100

The table 10 shows the results of Surface water analysis for the month of December 2014. The surface water analysis was carried out in Daitari Dam site, Strem flowing near Pichida, Stream flowing near Old market and Stream flowing near Baliparbat. It was found that the colour of the water was colourless in all the three sites. The turbidity of water in Daitari Dam site was 19 NTU with a pH value of 7.43 & total hardness of 52 *mg/l* , turbidity of water in the Strem flowing near Pichida was 16 NTU with a pH value of 7.21 & total hardness of 39 *mg/l*, turbidity of water in the Stream flowing near Old market was 14 with a pH value of 6.89 & total hardness of 57 *mg/l* and turbidity of water Stream flowing near Baliparbat was 12 with a Ph value of 6.74 & total hardness of 63*mg/l*.

With regard to iron content, it was observed that the iron content of water in Daitari Dam site was 0.24 mg/l, Stream flowing near Pichida was 0.38 mg/l, Stream flowing near Old market was 0.25 mg/l and Stream flowing near Baliparbat was 0.28 mg/l. With regard to chloride content, it was observed that the chloride content of water in Daitari Dam site was 17 *mg/l*, Stream flowing near Pichida was 14 *mg/l*, Stream flowing near Old market was 19 *mg/l* and Stream flowing near Baliparbat was 16 *mg/l*. With regard to fluoride content, it was observed that the fluoride content of water in Daitari Dam site was 0.17 *mg/l*, Stream flowing near Pichida was 0.11 *mg/l*, Stream flowing near Old market was 0.08 *mg/l* and Stream flowing near Baliparbat was 0.10 *mg/l*.

Table 10: Results of Surface Water Analysis (Dec 2014)

Sl. No.	Parameters	Unit	Daitari Dam site	Strem flowing near Pichida	Strem flowing near Old market	Strem flowing near Baliparbat
			05.12.2014	05.12.2014	05.12.2014	05.12.2014
1	Colour	Hazen	Colourless	Colourless	Colourless	Colourless
2	Turbidity	NTU	19	16	14	12
3	pH value	-----	7.43	7.21	6.89	6.74
4	Total Hardness (as CaCO3)	mg/l	52	39	57	63
5	Iron (as Fe)	mg/l	0.24	0.38	0.25	0.28
6	Chloride (as Cl)	mg/l	17	14	19	16
7	Fluoride (as F)	mg/l	0.17	0.11	0.08	0.10
8	Total Dissolved Solids	mg/l	99	108	88	92
9	Calcium (as Ca)	mg/l	14.8	19.2	15.1	13.9
10	Magnesium (as Mg)	mg/l	9.2	9.7	8.9	7.1
11	Nitrate (as NO3)	mg/l	0.42	0.48	0.46	0.39
12	Sulphide (as S)	mg/l	<1.0	<1.0	<1.0	<1.0
13	Mercury (as Hg)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001
14	Alkalinity (as CaCO3)	mg/l	48	39	51	57
15	Dissolved Oxygen as O_2	mg/l	5.2	5.9	6.4	6.1
16	BOD, 3 days at 27^0C	mg/l	2.7	1.6	1.5	2.1
17	Coli form Organism	MPN/100ml	217	298	314	269
18	Electrical Conductivity (EC)	µmhos/cm	164	191	165	152
19	CO_2	mg/l	4.6	5.8	5.4	5.2

Source: Tested in the EDCPL lab. BBSR(2014)

With regard to total dissolved solids, it was observed that the total Dissolved Solids in water of Daitari Dam site was 99 *mg/l*, Stream flowing near Pichida was 108 *mg/l*, Stream flowing near Old market was 88 *mg/l* and Stream flowing near Baliparbat was 92 *mg/l*. With regard to Calcium content, it was observed that the calcium content in water of Daitari Dam site was 14.8 *mg/l*, Stream flowing near Pichida was 19.2 *mg/l*, Stream flowing near Old market was 15.1 *mg/l* and Stream flowing near Baliparbat was 13.9 *mg/l*. With regard to Magnesium content, it was observed that the magnesium content in water of Daitari Dam site was 9.2 *mg/l*, Stream flowing near Pichida was 9.7 *mg/l*, Stream flowing near Old market was 8.9 *mg/l* and Stream flowing near Baliparbat was 7.1 *mg/l*. With regard to Nitrate content, it was observed that the Nitrate content in water of Daitari Dam site was 0.42 *mg/l*, Stream flowing near Pichida was 0.48 *mg/l*, Stream flowing near Old market was 0.46 *mg/l* and Stream flowing near Baliparbat was 0.39 *mg/l*. With regard to Sulphide content, it was observed that the sulphide content in water of Daitari Dam site, Stream flowing near Pichida, Stream flowing near Old market and Stream flowing near Baliparbat was less than 1.0 *mg/l*. With regard to mercury content, it was observed that the Mercury content in water of Daitari Dam site , Stream flowing near Pichida, Stream flowing near Old market and Stream flowing near Baliparbat was less than <0.00001. With regard to Alkalinity content, it was observed that the Alkalinity content in water of Daitari Dam site was 48 *mg/l*, Stream flowing near Pichida was 39 *mg/l*, Stream flowing near Old market was 51 *mg/l* and Stream flowing near Baliparbat was 57 *mg/l*. With regard to Dissolved Oxygen as O_2 content, it was observed that the Dissolved Oxygen as O_2 content in water of Daitari Dam site was 5.2 *mg/l*, Stream flowing near Pichida was 5.9 *mg/l*, Stream flowing near Old market was 6.4 *mg/l* and Stream flowing near Baliparbat was 6.1 *mg/l*.

With regard to BOD, 3 days at 27^0C content, it was observed that the BOD, 3 days at 27^0C content in water of Daitari Dam site was 2.7 *mg/l*, Stream flowing near Pichida was 1.6 *mg/l*, Stream flowing near Old market was 1.5 *mg/l* and Stream flowing near Baliparbat was 2.1 *mg/l*. With regard to Coli form Organism content, it was observed that the Coli form Organism content in water of Daitari Dam site was 217 *MPN/100ml*, Stream flowing near Pichida was 298 *MPN/100ml*, Stream flowing near Old market was 314 *MPN/100ml* and Stream flowing near Baliparbat was 269*MPN/100ml*. With regard to Electrical Conductivity, it was observed that the Coli form Organism in water of Daitari Dam site was 164 µmhos, Stream flowing near Pichida was 191 µmhos, Stream flowing near Old market was 165 µmhos and Stream flowing near Baliparbat was 152µmhos. With regard to CO_2, it was observed that the CO_2 in water of Daitari

Dam site was 4.6 mg/l, Stream flowing near Pichida was 5.8 mg/l, Stream flowing near Old market was 5.4 mg/l and Stream flowing near Baliparbat was 5.2mg/l.

Main Findings on Air, Water, and Noise pollution:

1. In different months the PM_{10} concentration at different locations were found to be different. In the month of February the maximum concentration of PM_{10} was 94 µg/m^3, followed by the month April where the PM_{10} Concentration was 92 µg/m^3, followed by the month December where the PM_{10} Concentration was 78 µg/m^3, followed by the month October where the PM_{10} Concentration was 74 µg/m^3, and finally for the month of June wherein the maximum concentration was 70 µg/m^3. Thus the data reveal that the Maximum concentration of PM_{10} was observed in the month of February followed by April, December and October. The average concentration of PM_{10} in different locations varied from a minimum of 45 µg/m^3 to a maximum of 66 µg/m^3 in the month of October 2014, of 57 µg/m^3 to a maximum of 70 µg/m^3 in the month of December 2014, of 28 µg/m^3 to a maximum of 81 µg/m^3 in the month of February 2015, of 47 µg/$m^3$to a maximum of 76 µg/m^3 in the month of April 2015, of 41 µg/m^3 to a maximum of 58 µg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of PM_{10} Concentration in the Air. However in none of the months the PM_{10} concentration exceeded the permissible limit of 100 µg/m^3 as prescribed by Central Pollution Control Board Standard.

2. In different months the $PM_{2.5}$ concentration at different locations were found to be different. In the month of February 2015 the maximum concentration of $PM_{2.5}$ was 27 µg/m^3 , in the month April the $PM_{2.5}$ Concentration was 34 µg/m3, in the month December the $PM_{2.5}$ Concentration was 36 µg/m^3, in the month October the $PM_{2.5}$ Concentration was 39 µg/m3, and for the month of June the maximum concentration was 27 µg/m^3. Thus the data reveal that the maximum concentration of $PM_{2.5}$ was observed in the month of February, followed by October, December, April and June. The average concentration of $PM_{2.5}$ in different locations varied from a minimum of 23 µg/m^3 to a maximum of 34 µg/m^3 in the month of October 2014, of 18 µg/m^3 to a maximum of 28µg/m^3 in the month of December 2014, of 15 µg/m^3 to a maximum of 33 µg/m^3 in the month of February 2015, of 10 µg/$m^3$to a maximum of 18 µg/m^3 in the month of April 2015, of 11 µg/m^3 to a maximum of 20 µg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of $PM_{2.5}$ Concentration in the Air. However in none of the months the $PM_{2.5}$ concentration exceeded the permissible limit of 60µg/m^3 as prescribed by Central Pollution Control Board Standard.

3. In different months the SO_{25} concentration at different locations were found to be different. The maximum concentration of $SO_{2.5}$ was 7.6 µg/m3 in the month October 2014, the SO_2 Concentration was 9.7 µg/m3 in the month December 2014, the SO_2 concentration was 9.2 µg/m3 in the month February 2015, the SO_{25} Concentration was 9.2 µg/m in the month of April 2015, and for the month of June 2015 the maximum concentration was 10.2 µg/m3. Thus the data reveal that the maximum concentration of SO_2 was observed in the month of June, followed by December, February, April and October. The average concentration of SO_2 in different locations varied from a minimum of 4.8 µg/m3 to a maximum of 7.0 µg/m^3 in the month of October 2014, of 5.6 µg/m^3 to a maximum of 8.1 µg/m3 in the month of December 2014, of 5.3 µg/m3 to a maximum of 6.6 µg/m3 in the month of February 2015, of 5.3 µg/m^3 to a maximum of 7.5 µg/m3 in the month of April 2015, of 6.4 µg/m^3 to a maximum of 6.9 µg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of SO_2 Concentration in the Air. However in none of the months the SO_2 concentration exceeded the permissible limit of 80 µg/m3 as specified by Central Pollution Control Board Standard.

4. In different months the NO_X concentration at different locations were found to be different. The maximum concentration of NO_X was 15.6 µg/m3 in the month October 2014, the NO_X Concentration was 15.1 µg/m3 in the month December 2014, the NO_X concentration was 14.4 µg/m^3 in the month February 2015, the NO_X Concentration was 12.8 µg/m in the month of April 2015, and for the month of June 2015 the maximum concentration was 11.9 µg/m^3. Thus the data reveal that the maximum concentration of NO_X was observed in the month of October, followed by December, February, April and June. The average concentration of NO_X in different locations varied from a minimum of 10.4 µg/m3 to a maximum of 13.5 µg/m^3 in the month of October 2014, of 10.6 µg/m^3 to a maximum of 12.9 µg/m^3 in the month of December 2014, of 11.3 µg/m^3 to a maximum of 12.3 µg/m^3 in the month of February 2015, of 10.7 µg/m^3 to a maximum of 13 µg/m^3 in the month of April 2015, of 9.5 µg/m^3 to a maximum of 11.5 µg/m^3 in the month of June 2015. The data reveal that during different seasons there is variation of NO_X Concentration in the Air. However in none of the months the NO_X concentration exceeded the permissible limit of 80 µg/m3 as specified by Central Pollution Control Board Standard.

5. In different months the CO concentration at different locations were found to be different. The maximum concentration of CO was 0.6 µg/m^3 in the month October 2014, and CO Concentration was 0.4 µg/m^3 in the month December 2014. The average concentration of CO in different locations varied from a minimum of 0.2 µg/m^3 to a maximum of 0.3 µg/m^3 in the

month of October 2014, and December 2014 respectively. The data reveal that during different seasons there is variation of CO Concentration in the Air. However in none of the months the CO concentration exceeded the permissible limit of 80 µg/m3 as specified by Central Pollution Control Board Standard.

6. It was found from the data of six locations that the minimum noise of 37.6 db recorded during day time from 6 a.m. to 10 p.m (from 9-14th Dec 2014) was in the residential areas located near Daitari Guest House and the maximum was 57.8 db in the commercial areas located near OMC office. The maximum average noise was 49.5 db in the industrial area and the minimum average was 34.3 db in residential areas located near water reservoir pump house. In the night period from 10 p.m. to 6 p.m (from 9th to 14th December) the highest noise of 43.3 db was recorded in the residential area located at Baliparbat Township and the minimum was 33.7 db recorded inthe residential areas near water reservoir pump house. The average maximum of 37.6 db was recorded in silence zone located near Daitari Hospital.

7. It was found that noise is produced in the mines mainly due to crushing, excavation process and drilling process. Maximum noise is produced because of crushing followed by excavation of ores and drilling operations. However as recoded, the level of noise pollution was above 75 db in the crushing site with a variation from 68 to 77db during the day time. Whereas in the excavation site and drilling point site, the noise level was within the permissible limit of 75 db.

8 a. The water in the four sites was found to be colourless with a turbidly varying from 12 NTU to 19 NTU which was above the CPCB prescribed limit of 5-10 NTU

b. The pH value was supposed to be in the limit of 5-10. The samples tasted from four locations have a pH value ranging from 6.74 to 7.43. Thus the water samples were found to be acidic or tend to be acidic.

c. The total hardness as $CaCO_3$ (Calcium Carbonate) was found to be within the range 39-63 mg/l, the CPCB prescribed limit being 200 mg/l.

d. The Iron content was found to be within the range 0.24-0.38 mg/l, the CPCB prescribed limit being 0.3- 0.5mg/l.

e. The chloride content was found to be within the range 14-19 mg/l, the CPCB prescribed limit being 250-1000mg/l.

f. The Fluoride content was found to be within the range 0.08 to 0.17 mg/l, the CPCB prescribed limit being 1.5 mg/l.

g. The Total dissolved solids was found to be within the range 88 to 108 mg/l, the CPCB prescribed limit being 500-2100 mg/l.

h. The Calcium content was found to be within the range 13.9 to 19.2 mg/l, the CPCB prescribed limit being 75-200 mg/l.

i. The Magnesium content was found to be within the range 7.1 to 9.7 mg/l, the CPCB prescribed limit being 200 mg/l.

j.. The Nitrate content was found to be within the range 0.39 to 0.48 mg/l, the CPCB prescribed limit being 1.5 mg/l.

k. The Sulphide content was found to be less than 1.0 mg/l, the CPCB prescribed limit being 10 mg/l.

l. The Mercury content was found to be less than 0.00001 mg/l, the CPCB prescribed limit being 0.001 mg/l.

m. The Alkalinity content was found to be within the range of 39-57 mg/l, the CPCB prescribed limit being 200-600 mg/l.

Suggestions:

There are potential pollution problems with iron mining in Jajpur and keonjhar districts of Odisha. This includes the loss of wetlands and streams and groundwater and threats from acid mine drainage. It has affected the ponds and the streams in the area. The presence of pyrite and other sulfides in the region could be a source of acid mine drainage. When sulfide materials are exposed to air and waste, they can produce sulfuric acid in the water. Mercury pollution may be produced in future which may pollute the air and can convert to toxic form in water. The sulphates in the rocks can pollute the surface water to a larger extent. An open pit mine "functions as a hydrologic sink drawing groundwater and storm water through cracks in the bedrock. There may be also change in the drainage pattern in the mining zone. The mine could lower groundwater around the pit, affecting local wetlands, streams and lakes. Surface water pollution with excessive silt and soluble Iron occurs from mine run-off. Noise pollution is because of drilling and blasting operations.

1. Using latest software to develop the mining plan, there is a need for greater scientific and systematic mining. The plan should be based on dumping area availability, distance of nearby villages, optimum use of forest land, necessity of land reclamation, water harvesting for beneficiation and pollution control. In case of OMC sequential mining can be considered as a good approach.

2. Surface and groundwater will have to be monitored continuously.

3. The tissue of fish and other aquatic life, bird eggs and sediments will have to be examined for any potential effects from the mine.

4. The mining operations should be restricted to above ground water table and the operations to be such that it should not intersect groundwater table.

5. The mining activities should ensure that no natural watercourse or water resources should be obstructed due to any mining operations. In this regard Guard wall should be provided at the Bank of Nalla maintaining the safety zone and site specific surface run off management measures like; de-silting pits, and linear recharge structures, etc. are provided.

6. Over burden should be stacked at earmarked dump sites only and should not be kept active for long period. The maximum height of the dump should not exceed 30m having three terraces of 10 m each. The overall slope of the dump shall not exceed 27 degree. The OB dump should be scientifically vegetated with suitable local species to prevent erosion and surface run off. Monitoring and management of rehabilitated areas should continue until vegetation becomes self-sustaining. Proper care and survival of sapling should be carried out during upcoming season. Back-filled area should be reclaimed by plantation. Monitoring and management of rehabilitated areas should continue until vegetation becomes self-sustaining.

7. Catch drains and siltation ponds of appropriate size should be constructed to arrest silt and sediment flows from mine working, soil, OB and mineral dumps. The water so collected should be utilized for watering the mine area, roads, and green belt development etc. The drain should be regularly desilted particularly after monsoon and maintained properly. Garland drain of appropriate size, gradient and length should be constructed for mine pit, soil, OB and mineral dumps and sump capacity should be designed keeping 50% safety margin over and above peak sudden rainfall and maximum discharge in the area adjoining the mine site. Sump capacity should also provide adequate retention period to allow proper settling of silt material.

Sedimentation pits should be constructed at the corners of the garland drains and de-silted at regular intervals.

8. Dimension of the retaining wall at the toe of the temporary over burden dumps and OB benches within the mine to check run-off and siltation should be based on the rain fall data.

9. Plantation should be raised including a green belt of adequate width by planting the native species around the ML area, OB dumps, roads etc. in consultation with the local Forest Department and Agriculture Department. The density of the trees should be around 2500 plants per hectare.

10. Regular water sprinkling should be carried out in critical areas prone to air pollution and having high levels of SPM and RPM such as haul road, loading and unloading point and transfer points. It should be ensured that the Ambient Air Quality parameters conform to the norms prescribed by the Central pollution Control Board.

11. Regular water sprinkling should be carried out by engaging no. of water tankers on the haulage roads for dust suppressions. Fixed - auto water sprinkling arrangement for provided at mineral dispatch haulage can also be taken up. .

12. Monitoring of AAQ sample should be continued in the core as well as buffer zone and results should be always within the norms.

13. The OMC should implement suitable conservation measures to augment ground resources in the area. Retaining wall should be constructed at downstream of dump site to arrest sliding of wastes.

14. Regular monitoring of ground water level and quality should be carried out in around the mine lease by establishing a network existing wells and constructing new piezometers during the mining operation. The monitoring should be carried out four times in a year Pre –monsoon (April-May), Monsoon (August), Post monsoon (November) and Winter (January).

15. Regular monitoring of ground water level and quality should be carried-out by utilizing the Piezometers periodically. The data so obtained should be submitted to authorities regularly.

16. Appropriate mitigate measures should be taken to prevent pollution of the rivers in consultation with the State Pollution Control Board. Site specific mitigation measures to prevent silt carried into nearby natural water bodies should be implemented like; surface run off management structures, and guard wall across the bank of the Nalla.

17. Suitable rainwater harvesting measures on long term basis should be planned and implemented in consultation with specific agencies like Central Ground Water Board.

18. Vehicular emissions should be kept under control and regularly monitored. Measures Should be taken for maintenance of vehicles used in mining operations and in transportation of mineral. The vehicles should be covered with a tarpaulin and should not be overloaded. Preventive Measures should be taken for maintenance of vehicles used in mining operations and transportation of mineral.

19. Blasting operation should be carried out only during daytime. Controlled blasting shall be practiced. The mitigate measures for control of ground vibrations and to arrest fly rocks and boulders should be implemented using appropriate technology like Nonel technology. The ground vibrations should be within the norms. Minimate should be used to record the vibrations. The blasting zone should be provided with siren before blasting operation.

20. Drills should be operated with dust extractors or equipped with water injection system. Latest technology drilling machine with inbuilt dust extraction system is should be utilized.

21. OMC should take all precautionary measures during mining operation for conservation and protection of endangered fauna namely elephant and sloth bear spotted in the study area. Action plan for conservation of flora and fauna should be prepared and implemented in consultation with the State Forest and Wildlife Department. It should include the cost of implementation of the plan and Regional Wild life Management Plan for Conservation.

Conclusion:

Iron ores in India are found in Odisha, West Bengal, Chhattisgarh, Karnataka, Goa, Andhra Pradesh, Kerala, Maharahtra and Jhrakhand. There are nearly 257 iron ore mines in India. The maximum amount of iron ore extracted is from Chhattisgarh, followed by Goa and Jharkahand. The production of iron ore during 2017 in India was to the extent of 190 million metric tons and it is expected to rise in the coming years. It is well known that iron ore mines contribute substantially for the economy of our country. But it creates adverse effects on the environment. For every ton of iron ore extracted nearly about two and half tons of wastes are generated. These wastes when allowed to flow in to the rivers or nallas affect the water quality and also the aquatic lives. Further the ecology of the total area gets disturbed because of cutting of the forests, loss of vegetation and the top layer of the soil. This affects the agriculture adversely. Though every effort is made to maintain the ambient air quality in the work zone and also in the vicinity of the mining areas, but it is not possible in large scale mining operations inspite of the best of efforts. The measures taken to control the flow of mine wastes are not sufficient. In the absence of proper pollution control measures, the run-offs from the mines create pollution in the nearby streams as observed through its colour and turbidity. This water thus becomes unfit for human and animal consumption. Through tailing dams efforts are being made to settle the iron ore slimes and clear water discharges to down streams. But major effort is required for recycling of the solid wastes. Reclamation of waste is a way out. There is further a need for massive afforestation programme to create lush greenery areas which is a prerequisite sustainable mining operation.

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