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Challenges of Environmental Management in Indian Coal Mining Sector

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Abstract:

Mining adversely affects the eco-system as a whole. It is important to conduct suitable assessment studies to learn the potential adverse impact of mining on flora and fauna. To overcome from the problems one should have knowledge about the various activities of environmental concern. A degraded environment has foreclosed alternative employment opportunities especially in the forestry and agricultural sector, leading the poor people to criminal activities. This is because environmental degradation has affected especially the common property resources such as land and water on which depend the subsistence and well-being of the poor groups. The study region being the foremost coal producing region of the country also ranked high in the list of environmentally degraded areas. Vast areas in the Raniganj and Jharia coal belt in India have become derelict due to abandoned and active surface and underground mines. In the open cast mines, waste materials are usually stacked as huge dumps in the immediate surroundings. These, coupled with coal dumps, cause significant visual impact. Large areas of forest, agricultural land, and pasture land have been converted into colliery colonies or into fallow land due to rapid expansion of the coal mines. As a result, the land use pattern has been changed considerably over the last three decades. This paper aims to study the impact of coal mining on its surrounding environment.

Keywords: **environmental degradation, health hazards, mine fire, pollution, productivity.**

1.0 Introduction

1.1 Underground environmental hazards due to coal mining in India

Mining of coal underground in India starts in the form of narrow gallery development with pillars around and depillaring by way of drilling and blasting or mechanized cutting of coal by continues miners or shearing. In case of long wall mining, the drilling, cutting shearing, loading and transport of the coal adds dust and fumes to the atmosphere. Coal dust and Methane in the presence of a source of ignition creates the worst environmental hazard in form of explosion in underground. The opening of the seams or fragmentation of the coal follows operation of the drills, movement of the machines and blasting of the explosive causes noise menace to the working environment.

The working philosophy in the form of inter connected narrow gallery in underground and stable size pillars are developed for the safety against the roof fall, collapse of the burden cover, inflammable gas and coal dust explosion, water inrush and inundation and unhealthy working atmosphere due to heat, humidity and reparable dust. The long wall mining or depillaring operations are aggravated the situation in restrict of surface subsidence, occurrence of roof and side fall, spontaneous heating and fire within the goaf, and danger to the surface dwelling, biodiversity and forest cover (Biswas, 2007). With the surface subsidence or occurrence of fire, the impact of underground mining reaches to the surface and affects environment and ecology. The following chart presents a view about underground mining hazards. The subsidence of land due to underground mining has many adverse impacts as has been pointed out earlier. Most of the subsidence in Raniganj and Jharia coalfield (and practically in every Indian coalfield) has been triggered of by mining at shallow depth. The subsidence of land initiated by mining at shallow depth is invariably associated with large scale fissure and crack formation which allows air to pass through to extracted areas (Boliga, 2010).

In board and pillar mining which is the dominant underground method in all the coalfields of India, the percentage extraction is generally poor and lot of coal is abandoned in the extracted area (goaf). Air passing through cracks and fissures in subsided land causes spontaneous combustion of coal left in the goaf and ultimately fire breaks out.

2.0 Sources of data & method of study

The methodology of the study includes collection of research material over the field study and observation methods. The present study is based on both Primary and Secondary data. Primary data are collected from a structured interview schedule with the officers and workers of Coal India Ltd. and secondary data are collected from CMPDI records, journals of IICM (Indian Institute of Coal Management) and books and research paper related to coal mines. The field study is conducted from the Coal India Headquarters in the year of 2012.

3.0 Atmospheric pollution

Environment of underground mine working in India has been extremely dangerous because of the constricted geometry, darkness around, suffocating mine atmosphere, heat and humidity. Working under poor light in past caused miners mustangs practically is unknown now because of the improved lighting. Heat humidity and thermal stress often extreme under deep mines have been responsible for poor efficiency of the miners (Banerjee, 2007). Air conditioning of the atmosphere in some of the deep underground mines has been realized in the interest of efficiency. For the safety risks, ill health and likely injuries and accidents can be minimized. In this exercise, optimization of the man, machines, and environment system- physical environment in terms of heat, humidity, air movement, illumination noise, vibration, toxic agent, dust and fumes are to be looked into. The environment of underground mines have been a subject of serious concern to the mine operators because of the liberation of methane with coal cutting, heat and humidity and generation of fumes with the blasting of coal (Wathern, 1988). The opening of the seams with interconnecting galleries, coursing for intake and return air, creation of air draught and deployment of auxiliary or forcing fans are some of the conventional means adopted to improve the environment of underground. The suppression of dust or suspended participate matter is trued by water spraying from the loading or transfer points. In the subsequent years water infusion in the seams and water jet mounting on the cutting edges is tried to minimize dust menace during cutting of the coal (Bisare, 1992).

The auto oxidation of the coal; a slow process is aggravated when large surface area of the fine coal particles come in come in contact of air. The oxidation of pyrite adds a new dimension to the problem and being an exothermic process causes spontaneous heating and fire underground under favorable conditions. The heating process generates SO2, CO, CO2 and higher hydrocarbons (Boliga, 2010). These gases reaching to the atmosphere through cracks and fissures make the underground atmosphere unsuitable for the miners and also pollute the surface atmosphere around the up cast channels. Similarly the blasting underground generates NO_x and other gases in addition to fine particulate matter (Bryson, 1986). The atmosphere underground is affected by a number of mining activities like cutting, blasting, loading and transport and preparation to beneficiation on the surface. The factors responsible for generating and adding different pollutants in the atmosphere underground are shown in the following chart. The most damaging constituent among them are the suspended particulate, impurity attributed to be due to handling, transport and preparation of coal and the methane released from the coal seams (Paramita, 2011).

Some of the pollutants are the natural product of the coal formation while a number of them are produced during the mining operation, preparation and handling (Nish, 2012). The underground mining technology has been developed in different parts of the world to improve the mine environment and to minimize hazards associated with different activities (McDowell, 1996). Main activates of the underground mining, their impact over the face workers, overlying formation and the surface and common remedial measures are summarized in the following table.

Table 1: Environmental problems of underground coal mining in India

Operation	Impact	Remedial Measures
Excavation	Methane Explosion Drainage	Effective ventilation
Drilling/ Cutting Blasting	Coal explosion Noise pollution Earmuffs Fumes and vibration and detonator	Dust extractor / Water infusion Improvement in explosive
 Loading Transport	Dust pollution Noise pollution Noise pollution Maintenance Water spry	Water infusion, Séquence control Earmuffs, improved
Ground Movement	Dust pollution Roof and side fall Opening of join/fissures Remote operation of m/c	 Effective support system Reinforcement
Subsidence	Land degradation Damage of surface Features Lowering or water table	Mining with harmless geometry/ Stowing, and Reclamation.

Sources: CMPDI, Survey Report, 2012

4.0 Underground dust hazard

The atmosphere of underground is under severe constraint because of the limited geometry of opening, a number of simultaneous mining activities, liberation of gases from the coal seams and reaction of air with freshly exposed coal surface and pyrites (Chattopadhyay, 1986). Rise in temperature by 1^0 C/ 22m depth cover made the atmosphere hot while the seepage of water from the roof and walls increases the humidity when the dust particles get segregated. Typical result of dust concentration in return air ways of a mine is shown in the following table.

The dust particles causing harmful effect are divided into inert and proliferate groups. The inert particles-line stone, and smoke soot do not impair lung function unless excessive deposition over years. Proliferate group of dust includes free or crystalline silica and coal dust. The silicosis giving rise to difficulty in breathing, reduction of chest expansion and susceptibility to tuberculosis is because of the silica dust. Coal dust causes focal emphysema and results in marked disability in advance stage. The disturbance in the lung function in the early stage of fibrosis results in reduction in breathing or ventilator capacity and impairment of the process of gas exchange (Chari, 1989). In either case, the change in function is associated with bronchitis or emphysema. The dust concentration underground varies with the operation and location, quality of coal and natural moisture content of the mine environment. Typical findings for an Indian mine is summarized in the following table covering different operational sites (CMRS Annual Report-2012). All the measurements are taken with MRE 113, a Gravimetric Dust Sampler. The dust concentration is high in case of dry, soft coal with high ash content. The dust particles size under suspension varied from 1.5 micron to below 10 microns being most crucial and responsible for pneumoconiosis amongst miners.

Table 2: Dust concentrations in return airways of selected mines in India

Production tins/day	Dust load dg/day	Dust gm/ton	Dust Concentration mg/m3	Operation
300	9.5	32	2.7	Depillaring
180	2.9	17	0.5	Development
180	00.0	61.5	1.68	Road header
150	7.7	51.5	185	Scraper conveyor
120	4.1	34.5	1.2	Depillaring
90	0.54	6.0	0.16	Watery mine

Sources: CMPDI, Survey Report, 2012

Table 3: Dust concentration during different mining operations in India

Operations	Dust concentration mg/m^3 of air
Tub loading	1.93-2.85
Drilling	3.00-10.27
S D Loading	5.00-6.25
Under cutting	8.00
Transfer points	2.73-2.86
Blasting	10.00-20.00

Sources: CMRS Annual Report, 2011-12

For every ton of coal mined underground, about 100 gm irrespirable dust is produced, out of which about 1-10% is air borne including 5 and 1 micron particles in the ratio of 1:40. The irrespirable dust generation in high rank coal seams or seams with higher ash content is proportionately more. The dust generation with the blunt cutting bits is also higher when the cutting is more under compression.

Table 4: Irrespirable dust composition from underground mines in India

Operations	Sulfur %	Ash %	Free Silica %
Under cutting	0.49 (0.15-1.05)	20.94 (1.95-57.05)	5.46 (1.56-13.32)
Drilling	0.56 (0.27-1.12	15.70 (11.64-20.63	4.05 (2.67-7.71)
Blasting	0.41 (0.31-0.70)	19.0 (13.42-32.67)	4.66 (2.09-12.27)
Loading	0.52 (0.31-0.70	18.50 (14.81-27.71)	4.37 (1.52-6.89)

Sources: CMRS Annual Report, 2011-12

In are port, nearly 28 gm of irrespirable dust is produced per meter of 43 mm diameter hole drilled in coal seams during 2011-12. The irrespirable dust generated during cutting by different machines is summarized in Table 4. Mechanized cutting of coal, concentrated heavy production, movement of heavy machine and slow velocity of the air are responsible for heavy concentration of air borne coal and silica dust. The problem in case of long wall and continuous mining is being tackled by the use of sharp bits, use of dust extractor and directional clearance of dust by improved air velocity.

5.0 Measures to control dust

The concentration of dust in the presence of moisture underground has shown decreasing trend because of agglomeration of the suspended particulate matter. The use of scrubber at different critical points as such could suppress the dust generation and dispersal. Even in the case of conventional loading of the blasted coal. Water spraying has been practiced to control the dust in Indian mines (Goswami, 2013). The system is quite popular in case of continuous miners and transfer points of the conveyors. The water infusion in the coal seam and spraying of water during cutting has been practiced for dust suppression. The likely variation of irrespirable dust during different operations and the mining environment at Katras mine is shown bellow. Plain water or water mixed with surfactants and polymers has been injected into dry low volatile coal seams to reduce the dust generation in the India. The surfactant in very low dilution improved the dust suppression by 15 to 20% compared to plain water (Briggs, 2009). The best arrangement appeared to have one spray behind each cutting bit that provided 4 liters/minute of water at 1-2 Mpa. Hydro jet cutting in shearer has been a common practice to reduce the dust generation during fast cutting of coal at high productive faces.

Table 5: Irrespirable dust concentration during different mining operations in India

Operation	Dust concentration Average (Range)	Remarks
Development workings Undercutting	2.75 (1.50-4.00)	Face naturally wet
Drilling	2.20 (2.15-2.25)	Face naturally wet
After blasting	7.13 (7.00-7.25)	Face naturally wet
Manual loading	1.50 (1.25-2.35)	Coal naturally wet
Depillaring operation	2.00 (1.30-2.20)	Air velocity 5.7m/min
Drilling	1.10 (1.05-1.15)	Face naturally wet
Manual loading	5.75 (3.07-8.85)	Face naturally wet
Drilling	5.00 (4.36-5.64)	Coal dry
Chute discharge LHD loading	1.05 (1.02-1.05)	Wet Dry

Sources: CMRS Annual Report, 2011-12.

6.0 Nose pollution in underground mines

The noise is now being recognized as a major health hazard; resulting in annoyance. Cases of Partial hearing loss and even permanent damage to the inner ear after prolonged exposure are noticed. The problems of underground are of special importance because of the acoustics of the confined space. The ambient noise level of the underground mining area is affected by the operation of the cutting machines, tub/conveyor movement and blasting of the coal. The movement of coaling machines and transport units-conveyor, tubs and transfer points caused audible noise which becomes disturbing underground because of the poor absorption by the walls (Singh. 2012).

6.1 Noise pollution due to mining activities

The most mote generating equipment underground are the haulage, ventilators-main, auxiliary and forcing fans, conveyor transfer points, cutting and drilling machines. The ambient noise level due to different operations in underground mines varies within 80-1040 dB (A).In a mine of Raniganj and Jharia coal field, the noise level near fan house, conveyor system shearer and road headers is reported to be within 92-93 dB (A). The values increased in many Indian mines because of poor maintenance of the machines and exceeded the permissible limit of 90 dB (A) for 8 hours per day exposure. The transfer points of the coal underground are the main point of the noise menace. The result of a noise survey for a coal mine conducted by DGMS is summarized in the following table, which indicates noise over 90 dB by the drills, breaking and crushing units and transport system underground (Banerjee,2007).

Table 6: Noise level in underground coal mines in India

Location of survey	Average Noise level dB (A)
Near shearer	96
Transfer point	99
Tail end belt conveyor	89
Power pack pump	91
Drive head of AFC	96

Sources: CMRS Annual Report, 2011-12

The mechanized mines have lower noise problem in comparison to the old conventional mines operational mines operating with haulage and coal cutting machines. The results covering wholly manual, partly mechanized with coal cutting machines and partly mechanized with SDL loading Showed reduction in the noise level underground.

7.0 Impact of underground mining on surface domain

Most of the leases acquired for the mining purpose are interior barren land, agricultural farms, or government controlled fallow and forest cover. The development of the underground mining establishments, residential complex and civic amenities required nearly 10% of the total lease area which has to be restored at the cost of forest, farms, or fallow land. This land is used for the common facility development with the marginal disturbance to the soil cover and green carpet. However the naturalized biological genes of the mining area are driven out or disturbed with the human settlement, noise nuisance created by heavy vehicles and construction of jungle of concrete. With the clearing of the exotic plants, the natural plant succession of the area is hindered and the loss of the green cover followed by soil erosion (Mathur, 2008).

The concentrated mining of coal underground in and around Jharia, Raniganj and Katras towns has transferred the underground pollutants to surface atmosphere. The mine exhaust through main ventilators and the return airways added the gaseous and particulate pollutants to the surface atmosphere. The waste rock-shale or sandstone intrusion sorted out of the coal mass for quality improvement is stocked near the pits or the railway siding. Weathering of the coal and rock mass, leachets from the dumps and noise menace from blast wave and movement of surface handling plants polluted the surface environment to variable degrees (Chadwick, 2007).

The non-mining activities like burning of coal in open stock, active fires and road transport of the coal have added a new dimension to the atmospheric pollution of the region. The sources of pollution associated with underground mining are summarized as follows:

1) Change in land use pattern and land depredation.
2) Ground Vibration with blasting.
3) Suspended particulate in the atmosphere.
4) Noise and vibration menace due to mining and vehicular movement.
5) Societal problems due to cultural, economic invasion and displacement.

Table 7: Noise survey in selected coal mines in India

Type of mine	Machine points	Noise Level	Duration of Operation
Wholly manual Mechanized	Drill Tugger haulage	87dB(A) 105Db(A)	1-2 hrs 4 hrs
With CCM cutting	CCM Drill Auxiliary fan	94Db(A) 94Db(A) 93dB(A)	1 hr 1-2 hrs 8hrs
Mechanized loading	Drill LHD Chain conveyor	88Db(A) 98Db(A) 84Db(A)	2 hrs 4-5hrs 4-5hrs

Sources: CMRS Annual Report, 2011-12

8.0 Change in land use pattern

The underground mining has caused land degradation because of surface subsidence, solid waste and coal dumping, fire underground and silting of the surface. The disturbance of the aquifers and subsurface water table followed loss of green cover and vegetable mass. The subsidence and disturbance of hydraulic regime has been dealt separately because of their importance. The bunker age in Indian coalfields have been very poor when the coal produce has to be stocked open along the railway siding. In the off seasons the pit head stock varied up to the production level of 15 days to a month covering a large area. The green cover over the patch is lost and the dust pollutes the area under the influence of underground mining and fire, affecting even the local non-mining population. The waste rocks picked and scattered around has created severe eye shore. The surface condition of Jharia coalfield is self-revealing (Madwbwe, 2011).

As the size, shape and magnitude of the dumps varied with demand, the land degradation under its influence is variable. Nevertheless, an area once under coal heap remained permanent eye shore unless reclaimed by systematic plantation. The other factors are responsible for the degradation of land in coalfields of Raniganj and Jharia, primarily worked underground are the subsidence and fire. The subsidence in normal cases caused undulation of the surface, damage to the structures and drainage pattern. In case the slope exceeds 15 degrees, erosion of the soil occurs, when the top soil is removed with torrential rains. This converts the farms to wasteland of low fertility and causes siltation of the dams, streams and ponds. According to one estimate, over 5.5 million hectares of land is already converted to waste land in *Damodar* valley alone (Goswami, 2013).

Table 8: Degraded area in *Damodar* valley in India due to different factors

Type of degradation	Area in sq.km in coal mining subsidiaries			
Subsidence	29.4 (43.6%)	34.97 (51.8%)	3.08 (4.6%)	67.45
Fire	5.88 (23.4%)	17.32 (68.8%)	1.96 (7.8%)	25.16
Abandoned mines/dumps	4.42 (25.3%)	10.67 (61.0%)	2.40 (13.7%)	17.49

Sources: CMPDI Survey Report, 2012

8.1 Land Disturbance

Leaseholds for the underground mines are procured from the land lords who granted them the right for underground coal. The land for houses, dwellings and the associated activities are purchased piecemeal from different sources while large portion of the surface right remained under the control of farmers and landlords. Underground mining in these areas is conducted with full responsibility of the surface protection by the operators who normally maintained pillars as the natural support to the surface features. The condition is very damaging under the condition of Jharia coalfield where thick seams are worked under shallow cover. There are some pockets in the coalfield which have subsided by over 10m due to repeat depillaring activities (Singh, 2012). In geologically disturbed areas, deep pot holes are formed through which valuable fertile soil drained underground and many a time surface structures are damaged distorted or spoiled.

The exposure of the roof rock mass during development followed stabilization and attainment of equilibrium by way of sagging and progressive fall. Surface deformation in the form of pot hole occurred due to roof fall at shallow depth cover when the formation up to the surface and the features within the influence zone subsided without warning. Sinking of a family sleeping on the bed near *Kenduadih* colliery in September 1995 is a typical example of the same. The type of phenomena is not singular in Jharia coalfield because of the unscientific mining of thick coal seams under shallow cover. Over 40 pot holes are reported at *Mahabir* colliery since 1922 while a dozen such pot holes occurred at *Handidua* colliery during last 3 decades (Goswami. 2013). These pots have been responsible for the destruction of the houses, damage to the railway line, roads, paddy fields and surface water sources.

The degradation of land in Jharia coalfield with the underground mining started in early 20th century with the thick seam mining under shallow cover. Nearly 6294 ha of land is estimated to be damaged before the nationalized of the mines of this field. The cause wise land damage of Jharia coalfield is summarized as follows: (Coal India Annual report-2012)

1) Surface subsidence 3487 He.
2) Underground fire 1732 He.
3) Abandoned pits 434 He.

The land of Jharia coalfield is under regular threat because of mining operation; failure of pillars and stocks, pillar crushing and advancing fire in adjacent pockets. The story of Raniganj coalfield is in no way different where nearly 4000 He of land subsided up to the year 1988 and the average will be disturbed by subsidence alone by the year 2000AD. The impact of underground coal mining in terms of loss of agricultural land is estimated to be nearly 1000 He in *Jamuria, Asansol and Kulti* blocks of Raniganj coalfield by now.

9.0 Surface atmospheric pollution

Mining below the surface destabilizes the ground, while the process of mining particularly blasting under shallow cover causes vibration of the surface structures and noise menace. The transfer of the raw coal, its beneficiation and handling generates coal dust while open burning of coal for steam or other usage releases gaseous discharge to the surface atmosphere. The movement of coal from the pit head to the loading or consumption points in open leaky trucks or open wagons also adds coal dust to the environment all along the route. The leaches from the waste rocks, discharge of effluents from the machines and pumping out of the hard polluted water to the surface water sources make the water source unfit for mass consumption. The surface subsidence due to caving or fire damages, the surface structures endangers the surface dwellers. The underground mines are ventilated by large size fans discharging up to 12,000 m^3 /min. through fan evasive of 3m to 5m diameter at over 200 mm pressure(Madwbwe,2011). The air absorbing moisture from the underground workings often reduces the suspended particulate matter but the fumes of explosives, methane, SO_2, and Oxides of Carbon are added to the general body of air (Dhar, 2000). The concentration of these hostile gases often creates a little impact over the surface and the population nearby. With the latest realization about the impact of these green house gases over the Ozone layer has drawn the attention of the global community and efforts are on to drain methane and put it to use as a fuel. The biodiversity and the local populace are also disturbed by the mining activities though they are mostly underground (CMPDI Survey Report, 2012).

10.0 Dust concentration in mining areas

The dust concentration in the coal mining area is one of the worst menace affecting the common residents and miners alike. The miners from the organized sector get health support and other medical facilities while the common citizens suffer without any such insurance. Major portion of the menace is indirect; associated with open stock burning of coal, dumping, of the waste rock and road transport of coal and sand. The suspended particulate matter in mining atmosphere of Katras coalfield is revealing in this respect. The predominant air emission source in most of the coalfields is road generated dust and vehicular exhaust. In some of the areas road transport is the only mode of coal movement where open, leaky, inefficient trucks and dumpers carry coal on ill maintained roads and pollute the region. In Jharia coalfield, the vehicular movement contributed nearly 47% of total SPM load while the direct contribution of the underground mining is estimated to be 6% only (Dhar, 2000).

The ambient air quality of the mining area often polluted by the associated activities is of the non mining origin but of public concern and required remedial steps. The vehicular discharge engaged for the transport and handling of the coal within the coalfield is responsible to a large extent in adding suspended particulate pollutants in the general atmosphere. The concentration of suspended particulate matter in ambient air of the coalfield on an average is high and the extreme is up to 1464 mg/1 at Nirsa. The trace elements are also reported as pollutant in ambient air of Jharia coalfield, including lead, manganese, arsenic chromium and cadmium.

Table 9: Suspended particulate matter in Katras mining area in India

Location	SPM	Level –Microgram/m^3
Mining cum residential area	801	(664-910)
Do (in rainy season)	480	(288-802)
Town residential area	786	(585-1010)
Do (in rainy season)	491	(147-713)
Average	618	-

Sources: CMPDI Survey Report, 2012

10.1 Dust concentration in mine fire area

Depillaring or partial extraction of thick seams under shallow depth cover caused cracks traversing the overburden. This facilitated breathing of air to the seat of coal resulting in spontaneous heating and fire. The underground coal mine fires are the common scene in Jharia and Raniganj coalfields. The record of coal mine fires are available for Raniganj even before 1869 and Jharia coalfield since 1916. In the process of burning, everything from coal to surface grass is burnt with smoke all around resulting rise in temperature of the whole area. Jharia coalfield alone had over 70 active fires in 1970's extended over 17.5 sq km emanating huge amount of noxious gases including poisonous CO to the atmosphere.

The occurrence of fire in underground mines in Jharia coal field has devastating impact over the atmosphere due to release of Hydrocarbons, SO_2 and other gases from the coal mass with the rise in temperature. The ambient air pollution near mine fire area of Jharia coalfield is given in the following table.

Table 10: Ambient air pollution near mine fire area in India

Year	Mine fire area			Area 1 km away		
	SPM µg/m^3	SO ppm	NO ppm	SPM µg/m^3	SO ppm	NO ppm
1978	582	0.013	0.008	206	0.004	0.002
1979	640	0.014	0.009	217	0.006	0.005
1980	631	0.018	0.011	252	0.007	0.004

Sources: CMPDI Survey Report, 2012.

11.0 Noise pollution in mining area

The mining areas are facing very slight noise pollution in the close vicinity due to direct mining activities like surface winding and handling of coal, loading and transport of coal and sand, main ventilator, workshop activities and in some cases blasting underground. The road transport of coal is known to be the main factor though not directly a part of the underground mining activities. Following table shows the noise level in Jharia and Raniganj.

Table 11: Ambient noise level in Jharia and Raniganj coal field in DB (a) in summer season of 2012

Location	Morning 8-10AM	Noon 12-3PM	Evening 4-8PM	Night 10-12PM
Jharia town	75-80	70-72	80-83	52-55
Jamadoba colony	50-52	48-50	55-60	52-55
TISCO office	60-65	62-68	70-72	65-67
Kunustoria	62-65	60-65	70-75	58-62
Katras Town	70-75	60-65	80-83	65-70
SonepurBazari	55-70	60-65	70-75	52-55

Sources: CMPDI Survey Report, 2012

Some of the sites are far from actual mining activities and hence the noise pollution is mainly because of the non mining reasons. The brunt of the noise problem is faced by the commoner in no way concerned with the mining activities. The gases generated underground from the coal seams, produced after blasting of the explosive and decay of the biological mass are discharged to the surface by the main ventilator. The gaseous pollutants to the surface atmosphere included carbon mono-oxide, carbon dioxide, sulfur dioxide and nitrous oxide a part of which is from the moving vehicles and other sources. The concentration of sulfur dioxide and nitrogen dioxide at some of the sampling sites of the Jharia coalfield are summarized in the following table. The carbon mono-oxide concentration in ambient atmosphere of Jharia coalfield varied within 787-893 $\mu g/m^3$ in winter season. The concentration of CO is attributed to active fire in this coalfield.

Table 12: Gaseous pollutants in air of Jharia coalfield in India

Site Area	Sulfur dioxide			Nitrogen oxide		
	Jan	March	Nov.	Jan	March	Nov.
Dhansar	97 (170)	49 (128)	63 (107)	70 (109)	40 (92)	54 (95)
Sindri/ Tasra	89 (180)	39 (108)	68 (143)	53 (130)	37 (108)	38 (65)
Godhur/ Kusunda	152 (250)	65 (139)	76 (160)	54 (89)	38 (74)	47 (87)
Nirsa/ Kumardhubi	80 (173)	49 (83)	71 (173)	60 (103)	38 (45)	58 (125)

Sources: CMRI Report, 2012

11.1 Trace element pollutants in air

The toxicity of trace elements and complexities of biological and chemical interaction and its impact on the health makes the study of trace element in the environment very relevant to the healthy living of the population. Most of these elements are present in soil or rock mass but their concentration increased in the mining areas because of large scale lithosphere disturbance. The metals released with different mining and associated activities get suspended in atmosphere and get easy access to human body. A survey of the ambient atmosphere of Jharia coalfield shows significant concentration of iron, lead, zinc and copper.

Table 13: Trace element in Jharia coalfield in India (in s.p.m)

SL.No	Element	Area 1	Area 2	Area 3
1	Fe	5.67-13.33	4.38-14.29	5.12-14.92
2	Mn	0.128-.493	0.143-.682	0.148-0.801
3	Pb	0.136-.581	0.148-.623	0.125-.712
4	Cd	0.028-.067	0.018-.073	0.021-.061
5	Cu	0.281-.489	0.362-.521	0.302-.621
6	Zn	1.32-1.52	0.920-1.203	0.822-1.008

Sources: CMRI Report, 2012.

12.0 Water pollution

The hydraulic cycle starting from ocean to sky and ultimately precipitation to the earth is no exception for the coalfield where the rain, natural moisture and surface to subsurface water sustain biodiversity of the region. The infiltrated water is charged to the coal measure aquifers and is retained by the aquiclude or aquifuge. Depending upon the thickness, porosity, permeability and storage coefficient of the rock mass, the capacity of the aquifers varied extensively over *Damodar* valley to *Pench Kanhan* coalfields. The coal seams known to be impervious, restricted the cross infiltration when different layers charged along the exposure served as the confined aquifers. The extraction of the coal followed disturbance of the aquifers and lowering of the water table. In this process mineral leaching occurs, affecting the water quality underground. The water pollution problems in mining may be broadly classified into the following four major heads (Chadwik, 2007).

1) Acid mine drainage due to sulfur content
2) Deoxygenating and Eutrophication of coal
3) Hardness of water due to leachet
4) Heavy metal pollution oil, tan and grease mixing in water

The mine effluents have high level of dissolved chlorides, nitrates, phosphates or sulfates of sodium, calcium magnesium and iron. At low levels, nitrates, and phosphates act as nutrients, causing rapid growth of algae and subsequent deoxygenating while at higher level, the character of the water is altered with deleterious effect over the fishes. The bicarbonates, sulfates, chlorides and calcium and magnesium cause hardness of the water and make it unsuitable for industrial and human consumption. The characteristic of the mine water of Jharia coalfield in different seasons is summarized in the following table.

Table 14: Average characteristic of Jharia coalfield mine waste water in India

Parameters	Winter	Summer	Rainy season
Temperature	30.5	26.8	29.5
pH value	8.5	7.4	8.0
Alkalinity :	-	-	-
Phenolphthalein mg/1	32.6	21.3	48.6
Methyl orange mg/1	224.3	256.8	283.8
Total Hardness mg/1	483.6	400.9	487.1
Permanent mg/1	314.2	256.2	413.2
Temporary mg/1	169.4	144.7	74.8
Chlorides mg/1	43.6	60.5	35.5
Sulfates mg/1	180.4	73.1	28.2
Phosphate mg/1	141.7	114.6	87.8
Suspended solids mg/1	119.3	111.8	161.4
Dissolved solids mg/1	558.2	497.7	698.1
COD mg/1	14.8	21.5	37.7
DO mg/1	6.6	6.8	6.1
Iron mg/1	2.1	2.2	2.6

Sources: CMPDI Report, 2012.

13.0 Conclusions:

Mining below the surface destabilizes the ground, while the process of mining particularly blasting causes vibration of the surface structures and noise generation. The transfer of the raw coal, its beneficiation and handling generates coal dust, whiles open burning of coal for steam or other usage release gaseous discharge to the surface atmosphere. The movements of coal from the pit head to the loading, or consumption points in open trucks or open wagons also add coal dust to the environment all along the routes. The air absorbing moisture from the underground workings often reduces the suspended particulate matter but the fames of explosives, methane, So2, and Oxides of carbon are added to the general body of air. The concentration of these hostile gases often creates negative impact over the surface and the population nearby. With the latest realization about the impact of these green house gasses over the ozone layer has drawn the attention of the global community and efforts are on to drain methane and put it use as a fuel. The bio - diversity and the local people are also disturbed by the mining activities though they are mostly underground. The adverse effects of subsidence fissures have made most of the subsided areas barren and unstable. The indirect effect of subsidence has contributed to drying up of many tanks and dug wells in the vicinity. Much of these subsided land may however be put back to productive use with joint effort from coal companies and local bodies, but no concerted and coherent effort has however been taken in this direction. Not much study has been done towards reclamation of subsided land in Indian coalfields. In a few areas of Raniganj coalfield including *Ninga* and *Sripur*, plantation on subsided land has been tried. The scientists are of the opinion that before starting reclamation of subsided land, the purpose of reclamation in terms of "land-use" should be decided in consultation with the local people. The most important thing is to plug the cracks and it may not be necessary to bring the subsided land to original profile even for use for agriculture, plantation and housing. Some researchers are, however, badly needed for improving water retaining capacity of subsoil in the subsided land. There is no specific legislation in India concerning subsidence, but as per common law, the coal company is to acquire the surface right of the property in which subsidence may occur due to underground mining. In some countries, there are specific legislation guiding the coal industry in matters of subsidence and perhaps such enactment may be the necessity of the day in our country also.

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