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Clean Coal Initiatives in India

Sribas Goswami

Department of Sociology, Serampore College, West Bengal, India
PhD, Assistant Professor
E-mail: sribasgoswami@gmail.com

Abstract

Availability of, and access to, coal is a crucial element of modern economies and it helps pave the way for human development. Accordingly, the thermal power sector and steel industries have been given a high priority in the national planning processes in India and a concerted focus on enhancing these sectors have resulted in significant gain in generation and availability of electricity and steel in the years since independence. To meet the need of huge demand of power coal is excavated. The process of excavation to the use of coal is potential enough to degrade the environment. Coal Mining is a development activity, which is bound to damage the natural ecosystem by all its activities directly and ancillary, starting from land acquisition to coal beneficiation and use of the products. Huge areas in the Raniganj and Jharia coal field in India have become derelict due to abandoned and active opencast and underground mines. The study is pursued to illustrate the facts which show the urgent need to clean coal mining in India.

Keywords: clean coal; environmental degradation; health hazards; mine fire; pollution.

Introduction

Burning coal produces about 12 billion tons of carbon dioxide each year which is released to the atmosphere, about 70% of this being from power generation. Coal is the most abundant source of energy in the world and will be continued to be used as the major feedstock for electricity production for at least the next 30-40 years. Currently, the power sector consumes about 80% of the coal produced in India (Eleventh plan report-2007-12). As the demand for electricity is expected to rise dramatically over the next decades, coal will persist to be the dominant energy source. Clean coal initiatives are those which facilitate the exploitation and utilization of coal economically and eco-friendly manner, keeping emission of greenhouse gases within sustainable limit of the earth. A basic approach to the clean coal initiative is to mine coal with minimum quality dilution, prepare the coal to segregate waste rock and stow it back below the earth crust; transport the coal with minimum vehicular exhaust, noise and use it for industrial purposes with high fuel efficiency, minimum generation of waste matters and greenhouse gases. The inefficiency of mining and coal preparation in India are manifested during combustion not only in form of inefficient power plants but also heavy emission of pollutants damaging even the ozone layers. Increasing demand for environmental quality, protection of greenery, clear air and water, minimization of noise congestion and open space for active outdoor recreation have all taken with key importance. An impact of coal mines can be defined as any change in physical, chemical, biological, cultural, socio-economic and environmental system that can be attributed to human activities.

Raniganj and Jharia coal mining region plays an important role in India's economic development. This region has well developed transport and communication and rich mineral resources. This famous coal bearing region has got very well scope for large industrial development along with other kinds of developments such as agriculture, livestock, forest, water and other minerals. Therefore an integrated approach is very necessary for sustainable development in this region. It is thus clear that coal mining leads to environmental damage, while economic development and self-reliance call for the increase in mining activities of the available mineral resources. Though there is no alternative to the site of mining operations, options as implementation of clean coal technology, adaptation of eco-friendly coal mining process and aforestation around the mining site etc. can really minimize the damage to the environment.

Sources of data & method of study

The present study is an empirical research conducted in two major coalfields namely Raniganj Coalfields and Jharia Coalfields in India. Raniganj coalfield has one subsidiary company of coal India, ECL (Eastern Coalfields Ltd) and Jharia coalfield has two subsidiaries, BCCL (Bharat Coking Coalfield Ltd) and CCL (Central coalfields Ltd). The methodology of the present study includes collection of research material over the field study and direct observation methods. The present research is based on both primary as well as secondary data. Primary data have been collected from a structured interview schedule with the officers and workers of Coal India Ltd. and secondary data have been collected from CMPDI (Coal Mining Planning And Design Institute) records, monthly journals of IICM (Indian Institute of Coal Management) , books and research paper related to coal mining. The field study was conducted from the Coal India Headquarters in the year of 2013.

Several aspects of environmental degradation in coalmining areas in India

The environment of underground mines have been a subject of serious concern in the mine operators because of the liberation of methane with coal cutting, heat, humidity and generation of fumes with the blasting of coal (Wathern, 1988). The opening of the coal 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 dust or suspended participate matter is suppressed 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.

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 the process causes spontaneous heating and fire in underground under favorable conditions. The heating process generates SO_2, CO, CO_2 and higher hydrocarbons (Boliga, 2010). These gases reach to the atmosphere through cracks and fissures make the underground environment 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. The atmosphere of underground and surface is affected by number of mining activities like cutting, blasting, coal loading, transport and preparation to beneficiation on the surface. The factors responsible for generating and adding different pollutants and greenhouse gases in the atmosphere are shown in the following figure. The most damaging constituent among them are the suspended particulate matter, transport and preparation of coal, the methane releases from the coal seams and burning of coal produces greenhouse gases.

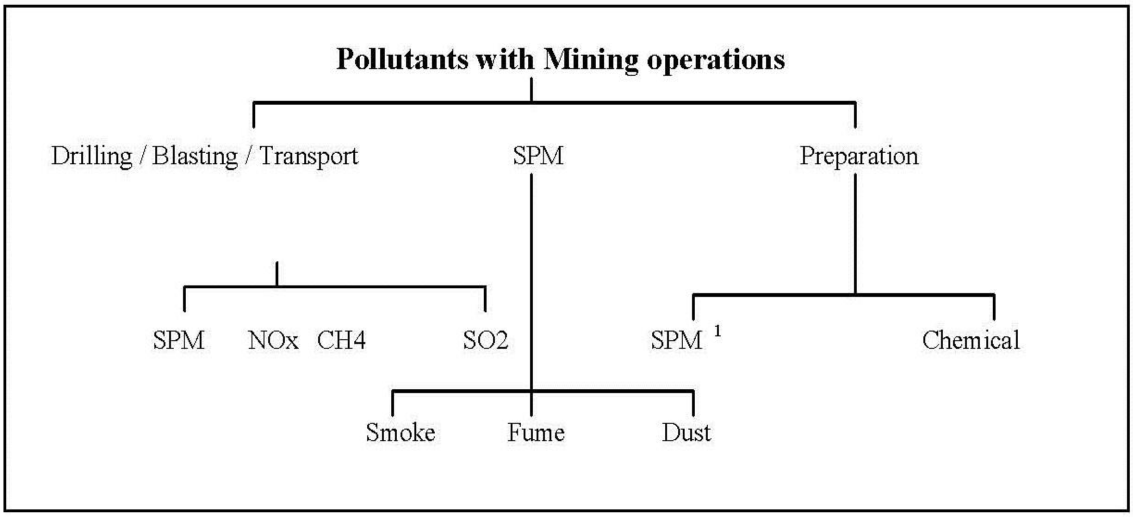

Fig. 1: Atmospheric pollutants with different mining operations in Raniganj and Jharia coalfields

Some of the pollutants are the natural product of the coal formation while a number of them are produced during the mining operations, preparation and handling of coal mines. The underground mining technology has been developed in different parts in the country to improve the surrounding environment and to minimize hazards associated with different mining activities.

Raniganj and Jharia coalfields most of the time is covered by smoky air containing several invisible poisonous gases and micro particles. So clean coal initiative should be taken effectively to protect the environment. Constantly developing series of technology solutions may improve the efficiency and environmental impact of using coal as an energy supply (Singh, 2012). They are following.

1. Beneficiating coal (pre-combustion) – coal de-watering, coal washing and briquetting
2. Efficient unconventional uses of coal reserves – UCG, coal seam methane
3. Effectiveness improvements of power plants (post combustion)– Plant upgrades
4. Supercritical and ultra-supercritical plants.
5. Sophisticated technologies – IGCC, PFBC and IGFC
6. Super-Advanced Technologies – Carbon sequestration or elimination

Dust hazard in coalmining areas

The environment is under severe constraint because of the limited geometry of opening, number of simultaneous mining activities, liberation of gases from the coal seams and reaction of air with freshly exposed coal surface and pyrites. Typical result of dust concentration in the environment of mining regions is shown in the following table.

Table 1: Dust concentrations in the environment in mining regions in Raniganj and Jharia Coalfields

Production per day (ton)	**Dust load dg[*] / day**	**Dust gm[†]/ton**	**Dust Concentration / mg[‡]**	**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, 2013

Table 1 shows that maximum production creates maximum dust concentration in the air which is 2.7 mg per 300 ton coal production per day. Increasing demand for coal also increase the environmental vulnerability. The dust particles causing harmful effect are divided into inert and proliferate groups. The inert particles link 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 gives 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. In either case, the change in function is associated with bronchitis or emphysema.

The dust concentration in the surrounding environment varies with the operation and location and 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-2013). All the measurements are taken with MRE 113a, Gravimetric Dust Sampler. The dust concentration is high in case of dry, soft coal with high ash content. The dust particles size under suspension varies from 1.5 micron to below 10 microns being most crucial and responsible for pneumoconiosis amongst miners.

Table 2: Underground dust concentration during different mining operations in Raniganj and Jharia Coalfields

Operations	**Dust concentration mg/m³ 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, 2012-13

[*] DG-Dust generator
[†] Gm- Gram
[‡] Mg- Magnesium
[§] CMRS- Coal Mining Research Standard
[**] SDL- Side Discharge Loaders

For every ton of coal in underground mine, 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. Blasting produces the highest dust concentration in the air which is 10.00-20.00 mg/m. It also produces other kinds of poisonous gases.

Table 3: Irrespirable dust composition produced from underground mines in RCF* and JCF†

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 (2.09-2.27)
Loading	0.52 (0.31-0.70)	18.50 (14.81-27.71)	4.37 (1.52-6.89)

Sources: CMRS Annual Report, 2012-13

In the report, nearly 0.56% sulfur, 15.70% ash and 4.05% silica of irrespirable dust is produced per meter of 43mm diameter hole drill in coal seams during 2012-13. Mechanized cutting of coal, concentrated heavy production, movement of heavy machine and low velocity of the air are responsible for high 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 improve air quality.

Dust concentration in coalmining areas in Raniganj and Jharia Coalfields.

The dust concentration in the coal mining area is one of the worst menace affecting the local 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 both coalfields is self revealing in this regard. 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 contributes nearly 47% of total SPM load while the direct contribution of the underground mining is estimated to be 6% only (CMPDI report-2013).

Table 4: Suspended particulate matter (SPM) in coal mining areas in JCF

Location	SPM	Level –Microgram/m³
Mining cum residential area	801	(664-910)
Do (in rainy season)	480	(288-802)
Town residential area	786	(585-1010)

* Raniganj Coalfields
† Jharia Coalfields

Do (in rainy season)	491	(147-713)
Average	618	-

Sources: CMPDI Survey Report, 2013

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 requires remedial steps. The vehicular discharge engages for the transport and handling of the coal within the coalfield is responsible to a large extent in adding suspended particulate pollutants to the atmosphere. The concentration of suspended particulate matter in ambient air of the coalfield on an average is high and the extreme reaches up to 1464 mg/1 in mining areas. The trace elements are also reported as pollutant in ambient air of Jharia coalfield, including Lead, Manganese, Arsenic Chromium and Cadmium (CMPDI report-2013). Table 4 shows that the residential area surrounded by coal mines are badly affected by the high concentration of SMP (801) which is 664-910 microgram/m3. The average concentration of SPM is also reaches the danger level of pollution which is 618.

Dust concentration in mine fire area

Depillaring or partial extraction of thick coal seams under shallow depth cover has caused cracks traversing the overburden. This has been facilitated breathing of air to the seat of coal resulting in spontaneous heating and fire. The underground coal mine fires are the common picture 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 from coal to surface grass is burnt with smoke all around resulting rise in temperature of the surrounding area. Jharia coalfield alone has over 70 active fires 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 bellow in the following table.

Table 5: Presence of gaseous pollutants in air of Jharia coalfield

Site Area / Collieries	**Sulfur dioxide (µg/m³)**			**Nitrogen oxide (µg/m³)**		
	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, 2013.

The carbon mono-oxide concentration in ambient atmosphere of Jharia coalfield varies within 787-893 µg/m³ in winter season. The concentration of CO is attributed to active fire in this coalfield. If we look at the table 5 the presence of SO_2 & NO_2 in the air during January is high in all collieries.

Table 6: Annual rate of increase of greenhouse gases in RCF & JCF

Radioactive gases	Approx. Average Annual increase (%)
Carbon dioxide	0.4
Methane	1.3
Nitrous oxide	0.3
Frepm – 11	5.0
Methyl	10.0

Sources: CMPDI Survey Report, 2013.

Table 6 shows how the rate of emission of greenhouse is increasing day by day to the dangerous level. Raniganj and Jharia coalfields both are potentially harmful for producing the obnoxious gases. The annual rate of CO_2 emission is increasing 0.4% every year in these coalfields. So far emission of Methane is concern it is also increasing heavily with a rate of 1.3% per year. Methyl is contributing highest to the atmospheric pollution with an increase of 10% per annum.

At present, the contribution of carbon dioxide to global warming is roughly 50%. The other 50% is due to the other gases, such as methane, nitrous oxide and chlorofluorocarbons. The pollutants from coal combustion are mainly CO_2 and NO_2 become increasingly oxidized in the atmosphere. This causes increase in the acidity of rain water. Dry deposition of collected SPM over trees is clearly visible in mining areas. In the day time these particles increases the temperature of leaves. The soft part of the leaf cannot sustain the increased temperature and ultimately it loses the fertility and growth. This phenomenon is very common near the opencast mines and the power generation plants. Greenhouse effect is caused by excess CO_2 in the atmosphere which is the result of extensive burning of coal and accelerated deforestation during the past decade in these regions. These facts show the need for clean coal mining in India.

Surface atmospheric pollution in coalmining region in Raniganj and Jharia

Mining below the surface destabilizes the ground, while the process of mining particularly blasting under shallow cover causes surface structure vibration and noise menace. The transfer of the raw coal, its beneficiation and handling generates coal dust and open burning of coal for steam or other usage releases gaseous pollutants 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 dump of the waste rocks, discharge of effluents from the machines and pumping out of the hard polluted water to the surface water sources make surface water unfit for mass consumption. The incidence of surface subsidence due to caving or fire damages the surface structures and endangers the surface dwellers around Raniganj and Jharia coalfields. The underground mines are ventilated by large size fans discharges polluted underground air up to 12,000 m^3 /min of 3m to 5m diameter at over 200mm pressure (CMPDI Report, 2013). The air absorbs moisture from the underground mines often reduces the suspended particulate matter but the fumes of explosives, Methane, SO_2, and Oxides of Carbon are added to the atmospheric air. The concentration of these hostile gases often creates a little impact over the surface and the population nearby mine area. With the latest study about the impact of these green house gases over the Ozone layer has drawn the attention of the global community and efforts are to made on to drain methane and put it to use as a fuel here. The biodiversity and the local populace are also disturbed by the mining activities though they are mostly underground (Dhar, 2000).

Impact of underground mining on surface domain

Most of the lands acquired for the mining purpose are interior barren land, agricultural farms, or government controlled fallow and forest cover in Raniganj and Jharia. The development of the underground as well as opencast mining establishments, residential complex and civic amenities requires nearly 10% of the total surface area which has been developed at the cost of forest, farms, or fallow land (Dhar, 2000). These lands are used for the common facility development with the marginal disturbance to the soil cover and green carpet. However the natural biological diversity of the mining area either are driven out or disturbed with the human settlement, noise nuisance in mining area which has been created by heavy vehicles and construction of jungle of concrete. With the cutting of the exotic plants the natural plant succession of the area is hindered and the loss of the green cover followed soil erosion.

The concentrated underground mining of coal in and around Jharia and Raniganj town has transferred the underground pollutants to surface atmosphere. The mine exhaust through main ventilators and the return airways has added the gaseous and particulate pollutants to the surface atmosphere. Weathering of the coal and rock mass, leachets from the dumps and noise menace from blast wave and movement of surface handling plants pollute the surface environment to variable degrees.

Change in land use pattern due to mining activity

The coal mining has created land degradation because of surface subsidence, solid waste and coal dumping, underground fire and silting of the surface. The disturbance of the aquifers and subsurface water table follows loss of green cover and vegetable mass. The subsidence and disturbance of hydraulic regime has been dealt separately because of their importance. The bunker in these coalfields have been very poor and the excavated coal is stocked openly along the railway siding. In the off seasons the pit head stock varies up to the production level of 15 days in 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 are picked and scattered around creates severe eye shore. The surface condition of Jharia coalfield is self revealing.

As the size, shape and magnitude of the dumps varies with demand, the land degradation under its influence is variable. Nevertheless, an area once under coal heap remains permanent eye shore unless is reclaimed by systematic plantation.

The other factors are responsible for the degradation of land in the coalfields of Raniganj and Jharia. The subsidence in normal cases has caused undulation of the surface, damage to the structures and drainage pattern. In case the slope exceeds 15 degrees, erosion of the soil occurs; usually 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 an estimate, over 5.5 million hectares of land are already converted to waste land in Damodar valley alone (Goswami, 2013).

Table 7: Degraded area in *Damodar* valley in Raniganj and Jharia Coalfields due to coal mining

Type of degradation	**Area in sq.km in coal mining subsidiaries**			
	ECL	**BCCL**	**CCL**	**Total**
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, 2013.

Land Disturbance due to mining activity

Leaseholds for the underground mines are procured from the land lords who have granted coal mining authority 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 remains under the control of farmers and landlords. Underground mining in these areas are conducted with full responsibility of the surface protection by the operators who normally maintains pillars as the natural support to the surface features. Now the condition is very damaging under the Raniganj coalfield where thick coal seams are worked under shallow cover. There are some pockets in the coalfield which have subsided by over 10m due to repeat depillaring activities. In geologically disturbed areas, deep pot holes are formed through which valuable fertile soil is drained to underground and several times surface structures are damaged, distorted or spoiled.

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 hector of land have been subsided up to the year 2011. The impact of underground coal mining in terms of loss of agricultural land is estimated to be nearly 1000 hector in *Jamuria, Asansol* and *Kulti* blocks of Raniganj coalfield until today. Thus the way coal mining is going on in this region has tremendous negative impact over socio-economic structure locally and damage to the environment has far reaching consequences.

Water pollution due to mining activity

As we are discussing serially the impact of coal mining on environment, the pollution of water due to mining needs to be discussed extensively. The hydraulic cycle starting from ocean to sky and ultimately precipitation to the earth is no exception for these coalfields 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 varies extensively over *Damodar* valley to *Pench Kanhan* coalfields. The coal seams are known to be impervious, restrict the cross infiltration when different layers charge along the exposure serve as the confined aquifers. The extraction of the coal has followed disturbance of the aquifers and lowering of the water table. In this process mineral leaching occurs, affecting the water quality of underground. The water pollution problems in mining may be broadly classified into the following four major heads (Chadwik, 2007).

- Acid mine drainage due to sulfur content
- Deoxygenating and Eutrophication of coal
- Hardness of water due to leached
- 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 8: Average characteristic of mine water in Jharia coalfield

Parameters	**Winter**	**Summer**	**Rainy season**
Temperature (C)	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
Chemical Oxygen Demand mg/1	14.8	21.5	37.7
Iron mg/1	2.1	2.2	2.6

Sources: CMPDI Report, 2013.

Noise pollution due to mining activities

The noise is now being recognized as a major health hazard resulting annoyance. Cases of partial hearing loss and even permanent damage to the inner ear after prolong 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 mining area is affected by the operation of the cutting machines, tub/conveyor movement and blasting of the coal. The movement of heavy machines and transport units-conveyor, tubs to transfer points creates heavy noise pollution and disturbing the entire population specially in opencast mining regions (Singh. 2012).

Table 9: Noise level in Raniganj coalfields

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

Sources: Director General of Mine Safety Report, 2012-2013

Table 10: Noise survey in selected coal mines in Raniganj coalfields

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

Sources: Director General of Mine Safety Report, 2012-2013

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 show that covering wholly manual, partly mechanized with coal cutting machines and partly mechanized with

* Db- The decibel
† CCM- Carousel Cutting Machine
‡ LHD- Large Height Deviation

SDL[*] loading has been showed reduction in the noise level . As we know that if noise level exceeds 85 dB it becomes harmful for human health. The average noise level in Raniganj is higher than the permissible limit in and around coal mines.

The most noise generating equipments in coal mining in Raniganj are the haulage, ventilators-main, auxiliary and forcing fans, conveyor transfer points, cutting and drilling machines. Blasting also creates heavy noise in this region. The ambient noise level due to different operations in mines varies within 80-1040 dB (A) (Banerjee, 2007). In 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 degree of noise pollution is increased in many mines due to poor maintenance of the machines, which sometimes exceed the permissible limit of 85 dB (A) for 8 hours per day exposure. The transfer points of the coal in underground mining are the main points of the noise menace. The result of a noise survey for a coal mine conducted by DGMS[†] is summarized in the above table, which indicates noise reaches over 90 dB by the drills, breaking and crushing units and transport system in underground. The typical results show that the operation with Tagger haulage brings noise level 105 dB for 4 hour operation.

From the above discussion pollution of air, water and noise reaches to the danger level in these coalfields which have direct adverse impact on human health. The situation also demands the immediate initiative for clean coal mining in these regions.

Process of environmental rehabilitation in opencast and underground mines:

Coal is the major primary source of energy and has a share of about 60% in the national energy requirement. Besides, the coal is also used by the steel and other base manufacturing industries. It is rather ironical that the power grade coal, the prime source of energy is deposited in the forest areas. This immediately brings direct confrontation of coal exploitation with environment. Underground mining has its own damaging capacities which are responsible for emission of poisonous gases to the environment. But opencast mining degrades surface land has direct impact of socio-economic life of surrounding population. We have seen in the recent past the reaction regarding land acquisition for coal mining.

The perspective plan of the production progammes drawn for the 2005-2012 periods are given below:

Table 11: Coal Production Programme (mining type wise) in Indian Mines

Mine type	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Opencast (Million Tons)	168.33	177.33	190.60	199.84	210.82	274.45	403.74
Underground (Million Tons)	68.76	71.78	74.98	79.79	82.39	95.58	43.96
Total (Million Tons)	237.09	249.51	265.58	279.63	293.21	370.03	447.00

Sources: CMPDI Survey Report, 2013.

Though the above figures are rather indicative, the growth of opencast production in absolute terms will need opening of big new mines. This will in turn, have confrontation with the environment and will need effective rehabilitation measures for their environmental restoration.
The opencast mines generally affect most of the environmental attributes. However the major concerned descriptors of the environment being affected are land, water, air, flora and fauna.
The environment in an opencast mine in post- mining phase is as important as or rather more important than the operational phase. The importance of post-mining environment can be

[*] SLD- Side Discharge Loaders
[†] DGMS- Director General of Mine Safety

comprehended since the post-mining scenario has become everlasting unless properly rehabilitated. The rehabilitation of the mined out areas and the OB or reject dumps assume special significance in the rehabilitation efforts in the post-operational period.

Table 12: Coking and non coking coal production in India

Coal Production in Coal India Ltd										
Grades	**Fiscal year**									
	2010		**2011**		**2012**		**2013**		**2014 JAN**	
	Raw coal production Million	% of Raw coal production	Raw coal production Million	% of Raw coal production	Raw coal production Million	% of Raw coal production	Raw coal production Million	% of Raw coal production	Raw coal production Million	% of Raw coal production
Non Coking Coal 1	395.13	91.6	389.97	90.4	392.48	90.1	408.555	90.3	328.774	89.7
Coking Coal 2	36.13	8.4	41.35	9.6	43.36	9.9	43.656	9.7	37.796	10.3
Total	431.26	100.0	431.32	100.0	435.84	100.0	452.211	100.0	366.570	100.0

Source: https://www.coalindia.in/en-us/performance/physical.aspx

The above table shows the growth of production of coking and non- coking in India. The production of non-coking coal has been increased significantly over the years keeping the parity with demand for electricity. Some 23% of primary energy needs are met by coal and 39% of electricity is generated from coal. About 70% of world steel production depends on coal feedstock (Coal India web report, 2014). Coal is the world's most abundant and widely distributed fossil fuel source. Other estimates put carbon dioxide emissions from power generation at one third of the world total of over 28 billion tones of CO_2 emissions (Hill, 2003).

Impact of coal mining on human health in Raniganj and Jharia Coalfields:

Coal mining operations have resulted environmental degradation, ecological changes and are associated with health and safety of mine workers and surrounding population. The environmental hazards are dangerous for the mining community as they aggravate the problem of ill-health. Majority of the children suffer from moderate malnutrition and are found to have vitamin and iron deficiencies in particular. Mining communities, who have inferior access to balanced diet, easily falls prey to the chain of malnutrition, poor health and weakness which are prone to diseases. Polluted environment further aggravates the situation. Clean coal technologies are definition an answer to the above mentioned problems.

A new technology for clean coal mining is needed to combat environmental degradation and stresses on the working personnel associated with coal mining. A large section of the population in and around the coal mining area in *Damodar* Basin suffers from chronic water borne diseases. The population is mainly sufferer of intestinal parasitic infection, anemia, skin diseases, tuberculosis; succumb to diarrhea, weight loss and respiratory infection. The transition of the natural environment which has resulted in worsening of the situation can be tackled effectively with the help of sustainable development.

Table 13: Morbidity Pattern of Worker's Community in Coal Mines (2010-2012)
Raniganj Coalfield and Jharia Coalfield

Type of Diseases	ECL		BCCL	
	No. of patient	%	No. of Patient	%
Gastrointestinal disorder	4076	19.32	4289	21.52
Respiratory disease	3224	15.28	3384	16.98
Ear disease	629	2.98	622	3.12
Skin disease	475	2.25	702	3.52
Joint Pain	460	2.18	494	2.48
Fever (Malaria, Filarial etc.)	3051	14.46	3113	15.62
Anemia	4365	20.69	4461	22.38
Injury	1401	6.64	861	4.32
Cardiovascular diseases	722	3.42	630	3.16
Other ailments	2696	12.78	1375	6.90
Total	21099	100.00	19931	100.00

Source: Personal survey from ECL & BCCL main hospitals -2013

Health issue is the key to progress of human development, whether for the individual or for the society. To achieve good health, pure food and improvement in nutritional condition is necessary. The quality of nutrition affects the well-being and immune capabilities of a person.

A personal survey is conducted in two different coalfields of *Damodar* river basin. From hospital records (table-13) and general survey it is found that people suffering from gastrointestinal diseases are high in both the areas due to water pollution and unhygienic conditions. People suffer from respiratory diseases because of air pollution in both areas. Besides the above mentioned types of diseases, it is observed that due to nutritional deficiencies anemia, skin diseases are commonly found among the mining population. But what is noteworthy is that, people living in unhygienic conditions and suffering form nutritional deficiencies and its effects is higher in one area in comparison to the other as observed in the above table.

Salient points of health technology proposed for coal mining community is briefly discussed below. Solid foundation must be laid early to lead a healthy life. Individual responsibility and self help must be of prime importance. Thus the emphasis has shifted from 'Health care for the people' to 'Health care by the people'. Food taken must be simple tasty, nutritious, variable and balanced. An individual's nutrition is linked with his health and development during childhood years. Thus children must be well-fed with suffer from polluted environment linked diseases. Grain-based diet can also have more nutritive value than meat-based diet. Flexibility and opportunism in diet are valuable. Drinking water must be clean. Simple rules of personal cleanliness must be observed and basic elements of health education must be followed.

Concluding remarks:

Clean coal mining initiative has become essential in view of extensive damage to the environment and ecology with the surface mining and even with underground mining. The ash content of the inferior coal with the surface mining is increasing with the size of earth moving machinery when the bands are worked along with the coal. Mining of gassy coal seams and its combustion for power generation are the major sources of methane and carbon dioxide. 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, SO_2, 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 apprehension about the impact of these green house gasses over the ozone layer has drawn the attention of the global community and efforts are made to drain methane and put it use as a fuel.

The bio – diversity and the local people are also disturbed by the mining activities because opencast mining is increasing. Climate change is now given the highest priority in the list of global environmental problems. The gases and pollutants emitted by coal extraction and combustion are factors that interconnect energy security, air pollution and greenhouse effect. In order to understand the implications of the global greenhouse effect we need reliable information on the rate of emission of carbon dioxide and certain other trace gases as a result of coal extraction and burning in these areas. Energy security will figure as the main issue if there is to be concentrated effort to reduce the carbon dioxide emissions.

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. The human dimensions of these physical impacts have been marginalization of the poor tribal from the mainstream, formal economy, displacement of peasantry and the growth of small scale, informal, illegal coal mining under local initiative.

Commercial supercritical combustion technology is the best option for India in the short-to-medium term. While gasification and advanced combustion technologies will be potentially important options for the longer-term future, there are significant issues surrounding the current relevance of these emerging technologies for India, including uncertainties in technical and cost trajectory, suitability for Indian conditions, and timing of India's greenhouse-gas mitigation commitments. There are two benefits of clean coal mining. One is the probable immediate benefits including reductions in CO_2 emissions which result from using upgraded coals in existing power plant boilers. The other is the long-term benefits arising from the use of advanced clean coal technologies which may insist the use of upgraded coal anyway in order to apprehend their potential for increased thermal efficiency.

Enforcement and tighten local environmental pollution controls through better pollution control technologies, greater and meaningful public participation should be ensured to have clean coal mining in India. Solar-power satellites are a serious option for the future. Heat mining, wind energy and biogas can also become alternative sources of energy instead of coal.

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