Occupational Health Hazards in and around Sonepur Bazari Open Cast Project, West Bengal, India

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Abstract:

Each and every countries of the globe are attempting to secure more energy, food and infrastructure. These attempts leave a trail of environmental contamination as well as human health hazards. Mining has always been among the most hazardous of occupations, and with the increasing demand for coal safety in mines assumes even greater importance. This article describes the present situation with regard to conditions in mines, the diseases and disabilities resulting from them. Coal is a fossil fuel and non-renewable energy which is used to generate energy as well as electricity along with other varieties of infrastructural commodity. So, countries with coal reserve are exploring the coal by means of underground as well as opencast mining. They are using different types of heavy machineries along-with man power to extract the coal from the mine. A coal-fired power plant is a prodigious generator of environmental pollution, releasing large quantities of particles as aerosols in the atmosphere. Without their knowledge, people are inhaling the micro-particles, nanoparticles of coal constitute an invisible risk to human health. Continuous inhalation of these hazardous substances triggers many diseases such respiratory and cardiovascular disease, systemic inflammation and neurodegeneration. The impact of coal particles inhalation effects on the lungs, immune system, heart, reproductive system, brain, DNA, and, in general, the human health. Coal as an energy source must be utilized with appropriate measures of environmental protection and to safeguard human health. During exploration of coal, different types of machines, drilling, blasting are taking place causing further hazards for human health in the form of noise, vibration, heat etc. The hazards covered are accidents, dust, high temperature and humidity, noise and vibration, toxic gases and miscellaneous other hazards. So due to coal mining, miners suffer directly while performing their duty or occupation.

Keywords: Coal Mining, Displacement, Environmental Pollution, Occupational Health Hazard, Coal Caused Diseases, Village Health Amenity.

Introduction:

Extraction of different minerals are going on from prehistoric time around the world. In today's world, in most of the countries, mining involves and include minerals exploration, minerals extraction, preparations including crushing, grinding and washing of the extracted material. And the lifecycle of mine area consists of exploration, mine development, mine operation, decommissioning and land rehabilitation. As mining is multi-disciplinary industry, so drawing on several professions and trades. So, it is very important to enquire about the details of mining tasks as miner is relatively non-specific term to ensure precision in clinical and epidemiological work.

Mining is a prerequisite for much industrial production – the products of mining are necessary for the production in manufacturing, construction and many other sectors.

Social well-being and economic development of any modern society depends on the mineral resources of that society or nation (Mancinia and Sala 2018). Annual consumption of primary energy has been increased tremendously during the last few decades. Importance of mining has been advanced greatly due to the rapidly increasing demand for metal and minerals of all kinds. As a results, global mining industries are booming since early 20s and these industries not only creating employment opportunities at national, state and local levels but also increased the earning of tax revenues and foreign money for the nation (Mishra 2009). On the other hand, mining has negative impacts on both environmental and social spheres. Most of the negative effects of mining activities greatly affect the local communities living in and around the mining sites (Hota and Behera 2016; Kitula 2006; Mishra 2009; Sincovich et al. 2018). Mining has been practiced across the world but not confined within a single country (McCullough and Lund 2006; Gisore and Matina 2015; Dold 2008). Mining has also been formulated the best practice to mitigate associated issues.

Coal, being one of the most important natural resources, is being cultivated worldwide (Petkova et al. 2009; Morrice & Colagiuri 2013; Frantal 2016). For the past few decades, demand for the energy has been increased with increasing population. As a result, huge amount of foreign investment took place in the mining industry which supports unprecedented growth in mineral production (Hota and Behera 2016). India, like other developing countries, generates over 70% of its required electric energy from coal (Hota and Behera 2016). India started its first coal mining in the Raniganj coalfield area and with time, it spread over different parts of the country. Coal mining in India first started in the Raniganj coalfield area, and later it spread to different parts of the country. Nationwide 33 million tons of coal was extracted during 2012 – 13. Presently there are 98 active coal mines under the leadership of Coal India Limited (Annual Reports and Accounts of CIL 2016-2017). Though the opencast and underground mines are there in India, but the share of opencasts are the maximum (Annual Reports and Accounts of CIL 2016-2017; Gautam et al., 2012). Naturally the cause for loss of livelihood is greater because of these opencast mines. As per Siddiqui and Lahiri-Dutt (2015), 42% mining households are highly vulnerable in India for the reason of unsecure job. On the contrary, Mishra (2009) shown that there is a strong interrelationship between mineral extraction and local livelihood generation.

While the initial focus was on externalities generated by production activities, it has also been pointed out that those engaged in various capacities within the industry can also be affected. Such occupational hazards are common in industries like mining, limestone, gem cutting, etc. One of the most hazardous industries is-coal mining, The unhygienic working conditions in underground mines create health hazards for the mine workers and have a major effect on their health. The problem is especially serious in view of the economic importance of coal mining in India- as a source of energy, in terms of its contribution to GDP, and as a major provider of employment.

Study Area, Sonepur Bazari OCP:

Sonepur-Bazari Open Cast Project ($23^{0}40'45''$ to $23^{0}42'28''$ N & $87^{0}13'11''$ to $87^{0}15'37''$ E) falls in the Haripur panchayat of Pandabeswar block of Paschim Bardhaman district of West Bengal (Fig. 1). It is located in the Eastern part of Raniganj Coalfield. The Project area is about 30 km from Asansol, 15 km from Raniganj and 19 km from Durgapur town. The Raniganj-Suri Road passes through this area. Nearest railway station, Ukhra, is at a distance of 8 km from the Sonepur Bazari OCP.

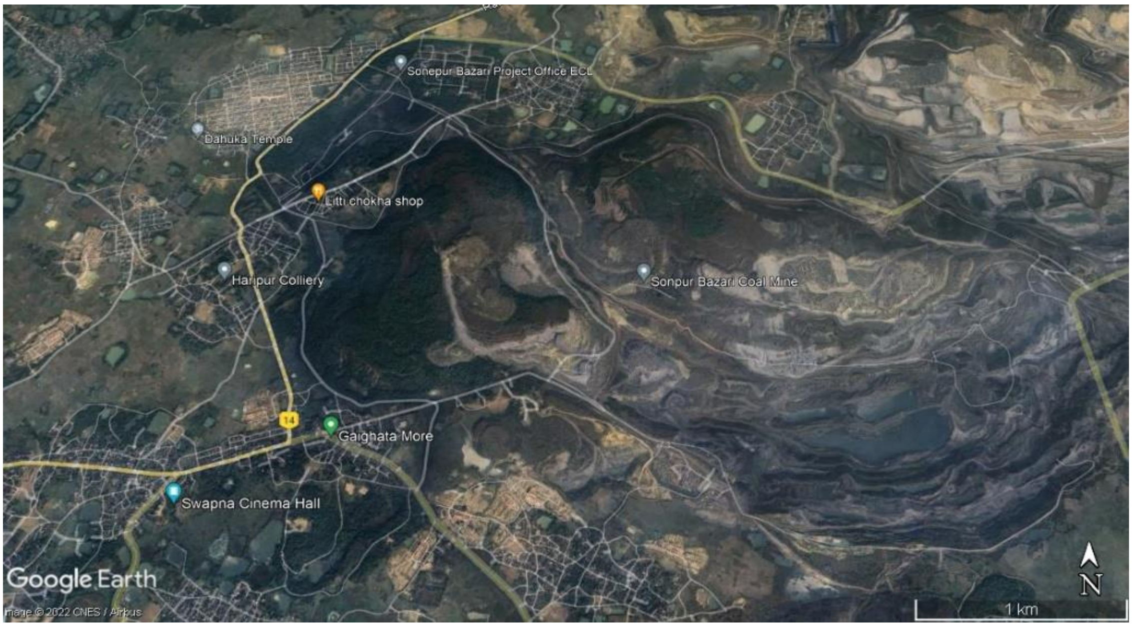

***Fig. 1:** Location Map of Sonepur Bazari Open Cast Project, West Bengal*

It is one of the largest OCP (Open Cast Project) of Raniganj Coal belt. It was first started in 1979 as Kumarkhala OCP. Later on, renamed as Sonepur-Bazari OCP in the year 1991 under Eastern Coalfield Limited (ECL). Total 2404.85 hectare of the land has been acquired for this project (CMPDI Report of Sonepur Bazari OCP, Aug 2014) (Fig. 2). The project has already rehabilitated 12 affected villages and 5 are in the way of rehabilitation in its near future. Where, a total of 3665 Project Affected Families (PAFs) to be shifted of which 41% (1486) has been shifted. The rehabilitation of the project affected people (PAP) has been done in Dahuka and Chinchuria Mouza of Jamuria block and Bahula mouza of Pandabeswar block.

Geology:

The coalfield represents a synclinal basin with the Gondwana sediments lying unconformably over the basement; and the southern boundary is marked by major faults. The basin is affected by numerous faults of different magnitude. The total deposits of Raniganj formation occur on 10 horizons designated as Seams R-I to R-X in an ascending order with thickness ranging from 1 m to 11 m. The general attitude of beds is East-West southerly dipping. The amount of dip varies from 3^0 to 11^0. The seams tend to thicken towards East. In the Barakar formation there are seven standard coal horizons designated as Seams B-I to B-VII in an ascending order with thickness ranging from 1 m to 24 m. A larger part of the coalfield is occupied by Barakar and Raniganj coal measures. The stratigraphic succession is given in Table – 1.

Mining and Displacement of Local Community in Sonepur Bazari OCP:

‘Displacement’ is not merely physical removal from someone’s land; it destroys people’s lives economically, socially and culturally. Such displacement is often caused by land-based development projects that wrecks communities’ social structure and leaves those displaced more vulnerable to impoverishment (Maldonado, 2009).

Waste, both overburden and remaining of displaced community, is one of the major concerns in opencast mining. For this purpose of waste disposal, a massive area of land has to be acquired. Later, for OCP mining excavation and for vegetation clearance, more land may have to acquire. Local communities are displaced to another place from their ancestral land, causing loss of home, assets and traditional livelihood system before as well as during the process of excavation for opencast coal mines (Patrova and Marinova 2013; Lahiri-Dutt 2005). As per World Bank (1994), nearly one million people are displaced from their homes and land each year due to numerous development projects in developing countries.

Due to this type of displacement in Sonepur Bazari OCP, many people became landless, homeless, jobless, marginalized, food insecure. Because, before starting of Sonepur OCP, people used the area as cultivate land, especially for growing paddy. But soon after the Authority acquire the land, the local community lost their property rights. Due to the change in demography, for the displacement, local people disarticulated socially.

Table – 1: Geological Formations of the Raniganj Coalfield (after Singh et. al., 2010)

Geological age	***Formation***	***Major lithology***
Recent	River alluvium	Sand, clay and limestone
	Unconformity	
Jurassic to Cretaceous	Rajmahal Trap/Intratrappeans	Dolerite, mica peridotite dykes and sills
Upper Triassic	Supra Panchet	Sandstone and shales
	Unconformity	
Lower Triassic	Panchet Series	Medium- to coarse-grained feldspathic sandstone and red clays
Upper Permian	Raniganj measures	Fine- to medium-grained sandstone, sandy or micaceous shale, coal seams, siltstone and carbonaceous shale
Middle Permian	Iron Stone Shale	Carbonaceous shales containing nodules of clays
Lower Permian	Barakar measures	Massive sandstones and grits with shale beds and coal seams
Upper Carboniferous	Talchir series	Tillites to boulder conglomerate, yellowish green sandstone, etc.
	Unconformity	
Archaean	Metamorphic rocks with igneous intrusive	Granites, granitic gneiss, hornblend schist traversed by bands and patches of amphibolite, pegmatite, and veins of quartz

Occupational Hazards in the Study Area:

The hazards of working in mines vary greatly depending on the type of mineral being mined, related geological formations, the mining techniques employed and the general health of the workers.

Injuries due to accidents constitute the greatest health hazard among mine workers and pneumoconiosis, caused by the inhalation of dust, is the major occupational disease. In addition, adverse environmental conditions such as high temperature and humidity, changes in atmospheric pressure, poor lighting, excessive noise and vibration, poor air quality, ionizing radiation and the accumulation of dust and poisonous gases make mining one of the most dangerous of occupations (Table – 2).

Fig. 2: *Sonepur Bazari Open Cast Project Area*

Under the Constitution, safety, welfare and health of workers employed in mines are the concern of the central government. Mines are regulated by the Mines Act, 1952 and the rules and regulations framed there under.

Table – 2: The Major Health Hazards in Mines (Cho K.S. & Lee, S.H.,1978)

Agents		*Hazards*	*Conditions*
Physical	High temperature and humidity	Heatstroke; heat cramp; heat exhaustion; lassitude; irritability; collapse; anxiety; lowered morale	Deep underground work
	Cold	Frostbite; trenchfoot; aggravated Raynaud's disease	Ground work in winter; high-altitude mines
	Sudden variation in temperature	Respiratory diseases; aggravated, rheumatism	Moving from hot working areas to cold surface conditions
	Change of atmospheric pressure	Bends (joint pain); chokes (chest pain); air embolism; neuralgia; toothache; paranasal sinusitis	Work in deep underground or high-altitude mines
	Poor lighting	Nystagmus (now rare); loss of visual acuity; giddiness	Face work
	Noise	Occupational deafness	Rock drilling; blasting
	Vibration	Raynaud's syndrome	Rock drilling
	Ionizing radiation	Radiation hazards	Working with radioactive ore
	Limited working space	Beat disease (cellulitis and bursitis of joints); dispacement and dislocation of joints	Work in narrow seams and in contorted positions
	Accident	Various	Dangerous work both in and out of the pit
Chemical	Dusts	Pneumoconiosis (silicosis, coal miner's lung, siderosis); induced and aggravated respiratory disease; poisoning by lead, arsenic, mercury, manganese, etc.	Working with mineral dust both in and out of the pit
	Poisonous gases; oxygen deficiency	Gas poisoning (CO, CO_2, NOx, SO_2, methane); anoxia (dyspnoea, dizziness)	Blasting; inadequate ventilation
	Mine water	Occupational dermatoses	Underwater work in the pit
Biological	Parasitic and fungal infections	Ankylostomiasis; sporotrichosis; tinea pedis and / or capitis; leptospirosis (Weil's disease)	Pit work where parasites and fungi grow easily owing to high humidity and poor sanitation

Disorders Caused by High Temperature and Humidity:

Due to the ever increasing demand for energy in developing India, the amount of coal consumption is also increasing. This change in demand is also changing the mining practice in India, which in turn created a new health hazard among the miners of the study area because of high temperature and high humidity. Due to geothermal gradient, machinery and miners, heat is increasing. The increase in terrestrial heat with depth is around 3°C per 100 m. heat produced by diesel locomotives and metabolic heat created during physical work cannot be discounted.

Thermal balance, in the study area, is not possible to maintained when the heat generated duo to workload and environmental heat combine together. As a result, body temperature of the miners increases and they become susceptible to heat collapse.

There are three types of heat disorder:

Heat stroke is characterized by sudden loss of consciousness due to failure of the thermoregulating mechanism as manifested by high fever and cessation of sweating. There may be premonitory headache, dizziness, nausea, convulsions and visual disturbances.

Heat exhaustion is due to the salt depletion and dehydration. The symptoms are weakness, dizziness, stupor and headache, with or without muscle cramps.

Heat cramps denote painful spasm of the involuntary muscles of the abdomen and extremities caused mainly by salt depletion. The skin is moist and cool and muscle twitching may occur.

Dust related Health Hazards:

The poor quality of air is one of the principal causes of health hazards, which generates due to mining in the study area (Fig. 3). One of the most common causes of impurity in mine air is dust, which is released into the air from mining operations such as drilling, blasting, shovelling and tipping. Mining operations also generate significant amount of total particulate matter (PM) that disperses in the surrounding atmosphere (Kurth et al., 2014a; Gautam et al., 2012; Chaulya, 2006; Chaulya, 2004; Chakraborty et al., 2002).

Pneumoconiosis is a lung disease caused by the inhalation of certain types of dust. One of the more severe forms of pneumoconiosis is silicosis caused by minerals containing abundant free silica, a substance widely encountered in the earth's crust. The dust arising during coal mining produces "coalworker's pneumoconiosis" or "anthracosis"; this seldom causes either symptoms or signs, but the resultant condition is all the more severe where the coal dust contains particles of free silica.

Fig. 3: *Dust in the air due to mining in Sonepur Bazari OCP*

Noise Induced Hearing Loss:

Due to mechanized operations such as drilling, crushing, screening, blasting, etc., noise level is much higher than the recommended limit of 90 dB(A) of noise. Moreover, confined space inside the mining area may lead to increasingly high noise. As a result, mine workers exposed to excessive noise undergo occupational hearing loss due to neurosensory deafness. It has been recorded that, during drilling, noise level is as high as 115 – 122 dB or more (Fig. 4). A survey conducted in an underground metal mine has shown that almost 75% of the mine workers had evidence of noise induced hearing loss (DGMS Report, 2004). Exposure to exceedingly high levels of noise and explosive blasts may rupture the tympanic membrane with the result that hearing at all frequencies is impaired and there may be haemorrhage into the middle or inner ear.

Fig. 4: *Uses f Heavy machineries in Sonepur OCP causes noise related health hazards.*

A recent survey (2011) by NIMH of 682 workers in opencast mines showed that 20 – 25% had evidence of noise induced hearing loss.

Vibration Hazards:

To save time, heavy earth moving machines has been introduced in the mining operation here in Sonepur Bazari OCP (Fig. 4). As a result, hazards of whole body vibrations among operators have been increased these days. Long term exposure to whole body vibrations causing backache and other degenerative spinal disorders. Pneumatic tools such as drills induce vibration disorders in workers after a few months to several years, the most common being Raynaud's phenomenon, i.e., vasospasm characterized by the spasmodic contraction of blood vessels of the fingers, causing the fingers to become temporarily white and numb.

The surveys conducted in Indian mines have shown that most Heavy Earth Moving Machinery (HEMM) have vibration levels higher than recommended ISO standards and persons employed on HEMM are at risk of developing adverse effects (Mandal & Srivastava, 2010).

Sudden Death at Work:

It has been observed that coal miners of Sonepur Bazari are developing higher risk of cardiovascular diseases and chronic low-level exposure to carbon monoxide. And it is increasing. Irregular episodic physical stress, shift work, etc. may be the reason for such development of risk. DGMS revealed that more than 80% of sudden death cases at work are due to cardiovascular causes.

Gas Poisoning (Intoxication):

The gases encountered in mines do not differ greatly from those found in other industries. In mines, however, their hazards are increased depending on the ventilation of the work places. Toxic gases are more frequently encountered in coal mines than in metal mines.

Oxygen deficiency: Percentage of oxygen in the air in the mining area of Sonepur OCP may fall significantly due to unventilated working area and owing to the oxidation of the coal when a coal seam is exposed. Oxygen content, for the miners, should be 14 to 18% inside the mining area while mining. Below these concentrations, desaturation of the arterial blood takes place, followed by anoxia and possibly unconsciousness.

Carbon dioxide: As because heavy machineries and miners are working together in a very confined area, percentage of carbon di oxide is increasing. Breathing may become laboured when its concentration in the air reaches 5%.

Methane: Methane is the most important non-toxic gas in mines and is present in all undisturbed coal seams. The principal danger of methane lies in its ability to form an explosive mixture with air and should such an explosion occur it could lead to a much more violent coal dust explosion. If the amount of methane is so large as to dilute the oxygen below a respirable level, it may cause asphyxiation.

Carbon monoxide: Carbon monoxide (CO) is a product of incomplete combustion. It commonly occurs in mines after the explosion of either inflammable gas or coal dust. It is also produced by blasting, diesel exhausts and mine fires. As a result, miners sometime inhaling this toxic CO.

Other gases: Hydrogen sulfide may be present naturally in mine air and can rapidly cause death at a concentration of 600 ml/litre. Sulfur dioxide may also be found in coal mines. It is irritant and suffocating.

Miscellaneous Hazards:

Cramped working conditions may lead to repeated pressure on the knees, elbows or hands.

Biological hazards include ankylostomiasis, Weil's disease, sporotrichosis and actinomycosis. But here in Sonepur Bazari area, due to humid climate of the area, interdigital ringworm infection give trouble to the miners.

Summary and Conclusions:

Different types of mines are there in India. They are big and small, manual and mechanized, opencast and underground mines. And the average employment per day in these mines is about one million miners. The annual turnover of India's mining sector is over 40 Billion US dollars and this amount contributing to about 2.5% of GDP.

India is trying to control the traditional health hazards due to mining. Moreover, due to rapidly changing scenario of mining industry, India introduced newer hazards and safety concerns at the mining sites. As a result, India is trying to cope up with the new challenges of newer occupational health hazards.

Mine workers of the study area are suffering from the dust related diseases like "Coal Worker's Pneumoconiosis" and "Silicosis", one of the most important occupational lung diseases. But unfortunately, very few cases are detected and fewer are notified and compensated. Local people as well as the miners are suffering from Noise Induced Hearing Loss (NIHL) due to noise pollution and whole body vibrations due to mining in and around the Sonepur Bazari OCP. Though, both fatal accidents and fatalities have come down over the years in Sonepur Bazari area, but miners and local people are suffering the most due to the accident scenario and due to lack of safety measures in the mine area.

The observations indicate that the existing traditional system of administration of occupational safety and health legislation in mines through inspections, statutory and other investigations have reached its limit of effectiveness. An approach based on a combination of "strategic" and "systems" thinking needs to be devised to prepare the mining industry to achieve better safety and health standards for persons employed in mines. The new thinking must embrace organisational, behavioural and cultural systems in addition to hazard control, analysis to anticipate hazards and engineering solutions to prevent accidents and occupational diseases.

Declaration of Competing Interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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To all those who care about the planet's health. To the mine-affected people of Sonepur Bazari

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