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## Coal Mining, Environment and Contemporary Indian Society

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# Coal Mining, Environment and Contemporary Indian Society

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## I. INTRODUCTION

On the unstable earth, the un-resting man constantly uses the different resources for his daily life. Coal is recognized to be the main source for energy for many decades and contributes to nearly 27% of the world commercial energy requirement. Coal is mined by two main methods - Surface or opencast and underground mining method. Geological condition determines the method of mining. Coal mining is usually associated with degradation of natural resources and destruction of habitat. This causes invasive species to occupy the area, thus posing a threat to biodiversity. Huge quantities of waste material are produced by several mining activities in the coal mining region. If proper care is not taken for waste disposal, mining degrades the environment. The method of waste disposal affects land, water and air and in turns the quality of life of the people in the adjacent areas.

Mining activities are below the earth crust in hostile environment including darkness, hot and humid condition and slow moving air losing its oxygen content with the oxidation of coal. Release of inflammable

methane; a natural product of the coal has tendency of layering along the roof due to its low density. Its concentration within 5 -15% form explosive atmosphere.

The explosion due to methane gas underground has been responsible for nearly 38% the total fatalities since 1901 in Indian coal mines. The inrush of water from the surface of subsurface water sources to the mine was responsible for nearly 24.9% of the total fatalities during the same period these environmental hazards often caused disaster, killing hundreds of miners in single occurrence and shaking their confidence for years.

The pneumoconiosis and dye to air borne coal and silica dust were identified as the main occupational hazards due to inhalation of contaminated air underground. The miners also suffered from a number of other skin, intestinal aid bronchial problems due to prolong exposure to the polluted water and air. They are grouped under occupational health hazards.

The movement of the strata including aquifuge or aquiclude disturbs the hydraulic regime. The disturbance of water level particularly that of the subsurface results in slow death of the plants, green carpet and biodiversity. The pollution of water due to leaching of salts from otherwise impervious strata and biological pollution due to rotting of biological mall underground causes scarcity of potable water though millions of gallon of water is pumped every day. The extensive caving causes surface subsidence and damage to surface features and land. The subsidence disturbs land from agricultural farms to forest, meadows to dwellings and thereby the total environment and ecology around the mining zone.

The domain of environmental damage due to the underground coal mining as such could be classed as follows:

### a) *Environmental Impact - Underground*

Safety hazards

- Explosion of gas and coal dust
- Inundation with roof and side falls

Health hazards

### b) *Environmental Impact –Surface Domain*

- Land disturbance
- Water regime disturbance
- Air pollution
- Biological disturbance
- Societal disturbance

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The impact of underground mining as such has been realized in the form of safety and health hazards for the miners because of the polluted environment, hostile ground behaviour and unhygienic working environment. Being away from the ray of sun with limited air availability, rising temperature due to thermal gradient of the strata and humidity due to the water charged formation around and every moment fear of accident of hazards have made the underground environment no better than death hole from the very late stage and realized much later by the common mass.

## II. OBJECTIVES OF THE STUDY

1. To find out the impact of coal mining on environment in Raniganj and Jharia coalfield.
2. To find out the various components of the environment related with the coal mining projects.
3. To elucidate the coal mining practice in Raniganj and Jharia coalfield.
4. To discuss the various socio-economic infrastructure and environmental factors influencing the coal mining projects.
5. To discuss the causes and consequences of environmental degradation in the Raniganj and Jharia coalfield.

## III. SOURCES OF DATA & METHODOLOGY

The methodology of the study includes collection of research materials by field study and observation methods. The present study is based on both Primary and Secondary data.

### a) Study Area

One of the important coalfield in India as well as of West Bengal, namely Raniganj coalfield has been selected for research purpose. The Raniganj coal field is bounded by latitudes  $23^{\circ} 35^{\circ}$  N to  $23^{\circ} 55^{\circ}$  N and longitudes  $86^{\circ} 45^{\circ}$  E to  $87^{\circ} 20^{\circ}$  E is the most important coalfield of West Bengal (Burdwan District) lies in the Damodar valley region is surrounded by Durgapur – Asansol Industrial belt. For empirical study, another study area of Jharkhand namely, Jharia coalfield has been selected for research purpose. The Jharia coalfield is located in the Dhanbad district of Jharkhand state at a distance of 260 km from Kolkata towards Delhi. It is bounded by latitudes  $23^{\circ} 38^{\circ}$  N to  $23^{\circ} 52^{\circ}$  N and longitudes  $86^{\circ} 08^{\circ}$  E to  $86^{\circ} 29^{\circ}$  E.

## IV. VARIOUS ASPECTS OF COAL MINES ON ENVIRONMENT

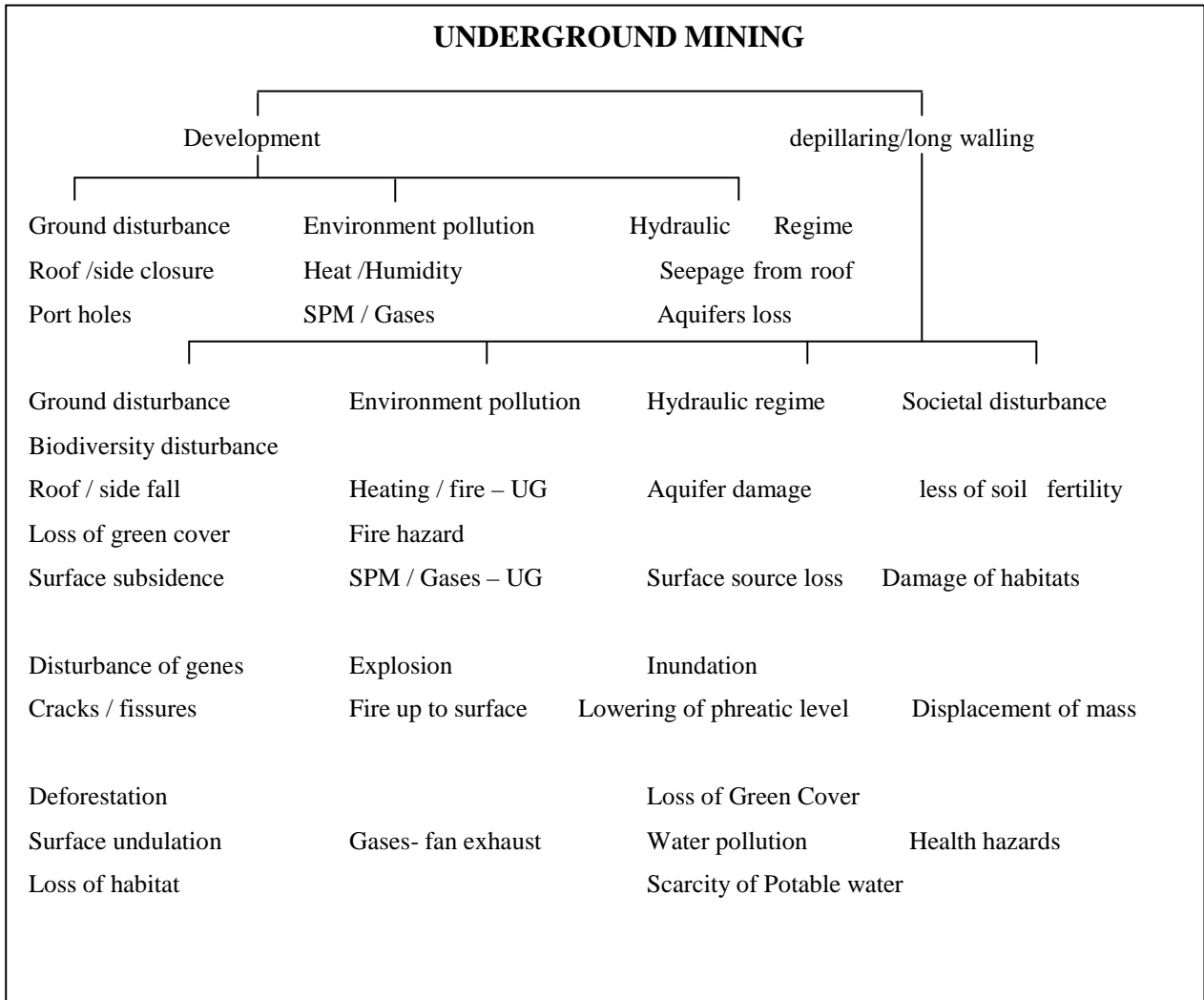
### a) Underground Environmental Hazards

Mining of coal underground 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 underground in form of explosion. 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 and stable size pillars was developed for the safety against a) the roof fall, b)collapse of the burden cover, c) inflammable gas and coal dust explosion, d) water inrush and inundation and e) unhealthy working atmosphere due to heat, humidity and reparable dust. The long wall mining or depillaring operation aggravated the situation in restrict of a) surface subsidence, b) occurrence of roof and side fall, d) spontaneous heating and fire, and e) danger to the surface dwelling, biodiversity and forest cover. 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.

Figure 1 : Dimension of disturbed domain due to underground mining



V. ATMOSPHERIC POLLUTION

Environment of underground mine working has been extremely dangerous because of the constricted geometry, darkness around, suffocating mine atmosphere, heat and humidity. Working under poor light in the past caused miners mustangs, is practically 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.

Air conditioning of the atmosphere in some of the deep underground mines has been realized in the interest of efficiency. In the safety risks, ill health and likely injuries and accidents could 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 has 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. 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 were some of the conventional means adopted to improve the environment of underground. The suppression of dust or suspended particulate matter was tried 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 was 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 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 SO<sub>2</sub>, CO, CO<sub>2</sub> and higher hydrocarbons. 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<sub>x</sub> and other gases in addition to fine particulate matter. The atmosphere underground was 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 were the suspended particulate, impurity attributed to be due to handling, transport and preparation of coal and the methane released from the coal seams.

Some of the pollutant were the natural product of the coal formation while a number of them were produced during the mining operation, preparation and handling. 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.

## VI. 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 was 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 were 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.

## VII. IMPACT OF UNDERGROUND MINING ON SURFACE DOMAIN

Most of the leases acquired for the mining purpose were 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 was 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 were 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 was hindered and the loss of the green cover followed soil erosion.

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 was stocked near the pits or the railway siding. Weathering of the coal and rock mass leaches from the dumps and noise menace from blast wave and movement of surface handling plants polluted the surface environment to variable degrees.

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:

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

## VIII. 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 was lost and the dust polluted the area under the influence of underground mining and fire, affecting even the local non mining population. The waste rocks picked and scattered around created severe eye shore. The surface condition of Jharia coalfield is self revealing.

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

The other factors responsible for the degradation of land in coalfields of Raniganj and Jharia, primarily worked underground were 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 exceeded 15 degrees, erosion of the soil occurred, when the top soil was removed with torrential rains. This converted the farms to wasteland of low fertility and caused 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.

## IX. LAND DISTURBANCE

Leaseholds for the underground mines were procured from the land lords who granted them the right for underground coal. The land for houses, dwellings and the associated activities were 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 was 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 was very damaging under the condition of Jharia coalfield where thick seams were 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 were formed through which valuable fertile soil drained underground and many a time surface structures were 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 was not singular in Jharia coalfield because of the unscientific mining of thick coal seams under shallow cover. Over 40 pot holes were reported at Mahabir colliery since 1922 while a dozen such pot holes occurred at Handidua colliery during last 3 decades. 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 6294ha. of land was 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:

- Surface subsidence 3487 He.
- Underground fire 1732 He.
- 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 was 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 was estimated to be nearly 1000 He in Jamuria, Asansol and Kulti blocks of Raniganj coalfield by now.

## X. 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, pumping out of the hard and 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 and endangers the surface dwellers. The underground mines were ventilated by large size fans discharging up to 12,000 m<sup>3</sup> /min. through fan evasive of 3m to 5m diameter at over 200 mm pressure. The air absorbing moisture from the underground workings often reduces the suspended particulate matter but the fumes of explosives, methane, SO<sub>2</sub>, and Oxides of Carbon were added to the general body of air. 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 were 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 were mostly underground.

## XI. 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 was estimated to be 6% only.

The ambient air quality of the mining area often polluted by the associated activities was 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 was 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 was high and the extreme was up to 1464 mg/1 at Nirsas. The trace elements were also reported as pollutant in ambient air of Jharia coalfield, including lead, manganese, arsenic chromium and cadmium.

### XII. 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 were 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.

### XIII. 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.

- Acid mine drainage due to sulfur content
- Deoxygenating and Eutrophication of coal
- Hardness of water due to leaches
- 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.

## XIV. COAL MINING AND DAMAGE OF FLORA AND FAUNA

The underground mines have been using huge amount of timber as a support, leading to large scale deforestation. Nearly 95% of the supports underground were timber chocks and props in the year 2002 and on an average the timber consumption was around 10 m<sup>3</sup> / 1000 tons of coal produced during development and 50 -100 m<sup>3</sup> /1000 tons of coal produced from the depillaring operations. The impact though indirect caused colossal loss to the forest wealth. The colonization of the area also required a large amount of timber for building work which resulted gradual denudation of the forest cover.

The environmental awareness brought life to most of the areas and concerted effort for reclamation of the subsided land or land under fire changed a number of barren patches under green cover. Over 1 million trees of different species have been planted in Jharia coalfield alone during last 15 years. As a result, the apparent mining lease has dropped from 17.7% in 1984 to 12.5% in 1999. The progress in Raniganj coalfield has not been to satisfaction because of the poor land holdings under government control.

## XV. BIOLOGICAL DISTURBANCE

The depillaring or long wall mining over critical area caused surface subsidence, cracks and fissure and lowering of water table. Soil cover the most valuable constituent of the earth crust sustaining biological domain was marginally disturbed along the fracture planes. Soil erosion is prominent in case of thick seam working under shallow cover due to steep slope. The balance of soil is however least disturbed and is possible to be reclaimed for the useful purpose. The biotic survival of a region is influenced by three gifts of the nature-water, soil and air. All the three were affected for a limited period and to some extent with the underground mining and so the biological system of the area.

The lowering of water table and loss of surface water sources starved the trees -Sal, Mahua, Palas, Bija, Kendu and Bhelwa a portion of which was cut for common use. The surface cover slowly reduced to shrubs and bushes growing profusely in the rainy seasons and drying in winters. Bantulsi became the most common bush of the coalfields capable to sustain the particulate pollution because of the nature of the leaf. Forest as a result slowly disappeared from Jharia and Raniganj coalfields even though very little under the influence of direct mining.

These belts; rich in flora and fauna before the advent of mining suffered heavy loss even though the mining activities were mainly underground. The loss and the damage to the biodiversity may be attributed to the following reasons.

- Hunting by the mine officers
- Killing by the explorer and miners for their own safety
- Disturbance in living environment of the beasts and the birds
- Depletion of forest cover
- Noise menace due to movement of machines and blasting waves
- Urbanization on forests and inaccessible lands.
- With the depletion of the forest cover, increase in population and mining activities, the region rich in biodiversity slowly became barren.

The rare species - leopards, wild dogs, hyena, jackals, bears, bison, sambar, spotted deer and bores were butchered by the early miners as a fun or trophy and or for their safety. The frequent visit of bears in Katras mine area, leopard in west Bokaro and Satgram mining area were the past records. Chirping of the rare species of the birds is uncommon in most of the coalfields and their place taken by cawing of crows.

## XVI. LAND DEGRADATION AND ITS EFFECT ON AGRICULTURE

“Oh my earth, we have belonged to each other for decades. I have been totally identified with your land and soil and thus have become a party in your continuous movement around the solar system amidst the endless sky.”

The above four lines from the Nobel Laureate poet Rab indranath Tagore describes vividly and beautifully, the inseparable bond between man the land. But the meaning of the four lines may be conveyed as follows:

The fundamental link between man and land described by the poet is however rudely disturbed in an area when mining is started. The history of land loss and land degradation in coalfield areas of Raniganj and its adjoining areas are an eloquent testimony of disturbing this fundamental link between man and land.

The land is non-renewable asset and its degradation therefore has far reaching implications affecting the life of thousands of inhabitants living in the degraded land. Land loss and land degradation due to mining may be due to underground or opencast mining. In underground mining subsidence causes the major loss of land and in Raniganj and Jharia coalfield, extensive area may be considered to be degraded due to instability created by wrong mining procedure. In the surface mining, the excavation and spoil heaps is the major cause of land degradation. There are other causes of land degradation which are associated with mining. Land may become less productive and therefore degraded due to deposits of coal dust and other suspended particulate matter. The extension of urbanization associated with mining also contributes to land loss in many ways.

## XVII. LAND DEGRADATION DUE TO OPENCAST MINING

In the Indian Coal industry the dependence on opencast mining has increased rapidly during the last two decades due to mechanization and modernization. The large opencast mines have advantage of low gestation period and higher recovery of coal and are more amenable to heavy mechanization and modern technologies than underground mines, thus ensuring speed and economy in implementation.

The total production of coal in the whole country from opencast in the year 1972 - 73 just prior to nationalization was around 18 mt. which amounted to approximately 20 percent of total production but in the year 2003 -2004 the opencast production contributed to 70 percent of total production of 238 mt.

The total requirement of land for opencast projects up to the year 2008 AD as per the master plan of Raniganj coalfield would be 80 km<sup>2</sup> (8000 ha) to



which must be added the land of 20 km<sup>2</sup> (2000 ha) already damaged by opencast mining, which means that the opencast mining would damage 100 km<sup>2</sup> (10,000 ha) of land up to 2008 AD.

### XVIII. LAND DEGRADATION DUE TO UNDERGROUND MINING

Traditionally, coal production in Raniganj and Jharia coalfield was mostly from underground mines though the scenario has changed significantly in favour of opencast mining after nationalization as has been stated earlier. A number of prestigious underground projects have been undertaken in Raniganj coalfield after nationalization, including one at Jhanjra which is already under implementation with Russian collaboration. Jhanjra underground project has been planned to be one of the biggest underground mining project in India. The work on an Indo - French project at Khottadih has been started recently.

The land loss and land degradation due to underground mining is of lower magnitude compared to opencast mining. But due to sustained underground mining activities carried over so long large area of coal bearing area has been degraded and lost due to subsidence. An estimate indicates that about 4600 hectare of land has undergone subsidence up to the year 1988 and the average surface lowering is about 0.6 m. It may be anticipated that another 1000 hectare of land would be affected by subsidence up to the year 2008 AD. The above estimate however do not take into consideration 47 areas where subsidence may be triggered anytime due to inadequacy of supporting coal pillars left underground.

It will, however be profitable to make an effort to portray a comprehensive and total picture of land degradation without going into project specific details.

### XIX. EFFECT ON AGRICULTURAL ACTIVITIES

The estimate presented in the fore - going paragraphs indicates that approximately 15 to 17 percent of the total land in the coalfields in Raniganj and Jharia would be degraded due to mining and related causes. It is very difficult to assess the quantum of agricultural land involved in the total land degradation. The sample survey presented earlier shows that agricultural land has generally been 18 -55 percent of land degraded in a project. The quantum of agricultural land involved increases with mining entering into a relatively new area, whereas when the project is on an area where mining activities are already in full swing, the quantum of agricultural land involved may be smaller. A reasonable estimate may be that 35 -40 percent of the total land involved may be agricultural land, which means around 10,000 ha. of

agricultural land might be involved in the Raniganj coalfield during the process of mining up to 2008 AD. The total land use pattern in the coalfield has never been verified in Raniganj coalfield though some aerial survey data is available for Jharia coalfield. The following table would, however, give an impression of the problem of dwindling agricultural land in the coalfields of West Bengal and Jharkhand.

### XX. MIGRATION OF WORKERS FROM AGRICULTURE

It is a difficult task to estimate the number of farmers and agricultural workers displaced or affected due to land loss and land degradation. From the relevant data it is revealed that in Satgram area alone the number of cultivators decreased from 4103 in The year 1971 to 1753 in 2004, which means a decrease in cultivators of 2350 in a span of 33 years. It may be noted that whereas in Asansol, Salanpur and Katras development blocks (all located in coalmining area) there has been a decrease in number of persons employed in agriculture by approximately 3300, 3500 and 2600 respectively over a period of ten years (1994-2004) there has been increase in agricultural employment in non mining areas.

In actual terms, it is not that a particular group of agricultural labors become completely redundant, but the partial loss of occupation pervades in the agricultural labour class. The effect of such partial loss of occupation becomes more intense because in the Raniganj and Jharia coal belt the people subsisting on agriculture have no means of augmenting their income by keeping cattle or by fish culture as these occupation have now become rare in the coal belt.

The tendency of indigenous population to shift from agricultural activities is being accentuated due to the presence of migrant labors employed in coal mines and having steady income. The unemployed men flock of these families tends to take up the job of "share cropping" replacing the traditional share cropper or agricultural worker in the process. If this trend continues and become dominant the profile of agricultural community in the coalfield will undergo a sea change.

### XXI. LESS PRODUCTIVITY IN AGRICULTURE

The issue of land loss and land degradation shall have to be considered along with the declining productivity in agriculture contributed by the side effects of mining. During the process of research, the paddy plants were collected from different polluted control sites in the mining areas where there have been considerable accumulation of suspended particulate matter and coal dust. There was considerable reduction in the grain size if paddy plants in all polluted sites and there was reduction of number of grains per spike. The weight size

and volume of grain produced at all paddy plants were also reduced. The summary of all the studies pointed out that polluted sites the production were reduced greatly. The water retention capacity of soil in the coalfield is also affected due to mining and this, in turn, addicts the field productivity.

## XXII. LAND DEGRADATION AND SOCIETY'S REACTION

Land degradation and consequent land loss is the unique type of environmental effect associated with mining and is generally not encountered in this scale in any other industrial activity. Opencast mining in scale and in intensity creates most severe form of land degradation and therefore, coalfield communities all over the world hold strong views against open casting as mining operations.

In India the coalfield community's resistance towards land acquisition for an opencast project has delayed the starting of many projects. Such resistance has been most intense in the state of west Bengal. A number of opencast projects in West Bengal including "Sonepur Bazari" opencast project was considerably delayed because of the local citizens' resistance to the land acquisition. The reason of such resistance from coalfield community being most intense in west Bengal may be understood from a perusal of the history of Indian coal mining itself. Coal mining in India was first started in the Raniganj coalfield of the then Bengal more than 200 years back. During the intervening years the coalfield areas have become highly built up with many industries including two steel plants being set up in the area. There has been faced large scale migration from other states.

In future years as other coalfields also became highly built up such resistance from local citizens would be encountered there also. The industry and the government should keep this possibility in mind and should devise schemes to fulfill local aspirations. The reclamation of land should also get adequate priority from the industry.

## XXIII. SUBSIDENCE AND ITS IMPACT ON ENVIRONMENT AND ECOLOGY

The extraction of coal from deep down the earth's crust creates a void and disturbs the initial equilibrium. With the increase in size of the void, the strata overlying the extracted coal seam collapse and tend to fill up the void. The process of settlement continues from roof of the coal seam upwards and ultimately the land surface overlying the extracted area subsides or sinks down.

The settlement process may be divided into two phases - primary settlement and secondary settlement. The primary settlement gets initiated within months of

extraction of coal provided a critical area has been extracted, but the secondary settlement is a long drawn process and may continue for together. The amount of land subsidence depends mainly on the thickness of the seam extracted and also on the method of packing used for filling up the void created by coal extraction. In case sand is stowed in the void, the amount of subsidence would be very less and the damage to the surface would be minimum. With sand-stowing being used an extraction of 4.5 m (15 feet).

The depth at which mining is conducted has also got a bearing on land subsidence and surface damage. At shallow depth, the disturbance is more prominent. At greater depth, the area affected for a particular size of extracted area is more but the nature of damage is relatively gentle compared to that at shallow depth.

The subsidence of land over which some important structures like houses and dwellings are situated may however be prevented by restricting the percentage of extraction of coal and leaving blocks of coal pillars to ensure safety of surface structures. The mining legislation as it stands now has provisions for determining the size of such pillars, but during the first few decades of coal mining in Raniganj coalfield when mining legislations were either non-existent or were very sketchy, extraction of coal was done from many areas of Raniganj coalfield without bothering for surface stability. The pillars left were too small and no plan of such extraction was kept. This has given rise to a problem in many areas of Raniganj and Jharia coalfield where sudden subsidence may occur any time causing damage to life and property.

## XXIV. CONCLUSION

Mining has a significant impact on the economic, social and environmental fabric of adjoining areas. Although mining activities bring about economic development in the area at the same time the land degradation it causes creates ecological and socio-economic problems.

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. The adverse impact should be identified at the planning stage itself so that corrective measures may be taken in advance.

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, 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. In the foregoing discussions an attempt has been made to clarify the coal mining activities and its residual impact on environment and human health. It is also clear that mining is a site specific activity and is done at the sites where mineral exist. Also, mining is considered as an environmentally unfriendly activity.

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