EnvironmentAsia
The international journal published by the Thai Society of Higher Education Institutes on Environment

Available online at www.tshe.org/EA
EnvironmentAsia 8(1) (2015) 24-33

Coal Mining vis-à-vis Agriculture in India: A Question of Sustainability

Sribas Goswami [a] and Ramananda Goswami [b]

[a] *Department of Sociology, Serampore College, West Bengal, India*
[b] *Royal Global School, Guwahati, Assam, India*

Abstract

Coal 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 agriculture. In the subsequent discussions an attempt has been made to clarify the coal mining activities and its residual impact on environment and agricultural activities.The leaseholds for the underground mines are procured from the land lords who grantmining authority the right for underground coal mining. The land for houses, dwellings and the associated activities are purchased piecemeal from different sources while large portion of the surface right remained under the control of farmers and landlords. Underground mining in these areas is conducted with full responsibility of the surface protection by the operators who normally maintain pillars as the natural support to the surface features. Increasing demand for open caste mining process requires huge land. These lands sometime are acquired at the cost of cultivable land. Coal mining has direct impact over agriculture in the study region and residual impacts of mining bring far reaching consequences. The present study is explanatory in nature based on empirical facts collected from various formal sources from Coal India office. The task is to bring out the issues related to coal mining activities and their impact on vegetation and agriculture in adjoining areas in Raniganj and Jharia coalfields in India through this study.

Keywords: coal mining; environmental degradation; agriculture; subsidence; sustainable development

1. Introduction

Mining is an extractive industry, which, by withdrawing the raw materials, creates anthropogenic land forms such as mine pits, soil tips and subsided lands leads to land degradation. The most significant environmental changes in Raniganj and Jhariacoalfields have been the removal of the tropical deciduous forest cover and changes in the surface run off and ground water levels. However, the greatest environmental impact of mining has been on the land itself. Mining has degraded the land not only by denuding it of its forest cover, and choking up the natural drainage lines, but has also destroyed the agricultural potential of this region. The human dimensions of these physical impacts have been marginalization of the poor tribal and scheduled caste groups from the mainstream, formal economy, displacement of peasantry, the growth of small scale, informal industries, and illegal coal mining under local initiative. A degraded environment has fore closed alternative employment opportunities especially in the forestry and agricultural sector, leading the poor people to unlawful activities (Bose, 1989). This is so because environmental degradation has affected especially the common property resources such as land and water on which depend the subsistence and well-being of the marginal groups.

The study region being the foremost coal producing region of the country also ranked high in the list of environmentally degraded areas. Vast areas in the Raniganj and Jharia coal belt have become derelict due to abandoned and active surface and underground mines. In the opencast mines, waste materials are usually stacked as huge dumps in the immediate surroundings. These, coupled with coal dumps, cause significant adverse impact on land. Large areas of forest, agricultural land, and pasture land have been converted into colliery colonies or into fallow land due to rapid expansion of the coal mines. As a result, the land use pattern has changed considerably over the last three decades. The net cultivable land in the *Jamuria* block, for example, has decreased from 6,407.7 hectares in 1990-2000 to 5,785.00 hectares in 2010 and in *Asansol* the change has been from 1,490 hectares to 1,230 hectares (Goswami, 2014).

The non-sustainable nature of development in the coalfield areas of Raniganj and Jharia need to be reversed. The way coal is being extracted is not up to the international stranded which demands the introduction of clean coal strategy. Availability of, and access to, electricity is a crucial element of modern economies and it helps pave the way for human development. Therefore coal is needed to meet the present requirement for our survival and also needs to

preserve coal for future generation for the sustenance of civilization.

The objectives of thisempirical and explanatory study are to find out the impact of coal mining on environment in Raniganj and Jharia coalfield, and also to find out the various components of the environment related with the coal mining projects. It is intended to elucidate the coal mining practice in Raniganj and Jharia coalfield and to analyze the various proximate factors influencing the coal mining projects. Another important objectives are to find out the relation between the environmental condition and coal mining projects and lastly to discuss the causes and consequences of environmental degradation in the Raniganj and Jharia coalfield.

2. Research methodology

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 for a period of six months. Fifty coal India officers were asked questions through interview schedule. 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 2013.

3. Results and discussions

3.1. Land disturbance due to mining activities

The underground mines have been using huge amount of timber as roof support, leading to large scale deforestation. Nearly 95% of the supports in underground are timber chocks and props in the year 2012 and on an average the timber consumption is around 10 m^3/1000 tons of coal produced during development and 50-100 m^3/1000 tons of coal produced from the depillaring operations (Goswami, 2014). The impact though indirect causes colossal loss of the forest wealth. The colonization of the area also requires a large amount of timber for building work which has resulted gradual denudation of the forest cover around coal mines. It has also adverse impacts on cultivable land in surface.

The environmental awareness brought life to most of the areas and concerted effort for reclamation of the subsided land or land under fire has 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 20 years. As a result, the apparent mining lease has dropped from 17.7% in 2000 to 12.5% in 2010. As the table projects green cover has been considerably decreased near about 16% during last 20 years. Barren land has been used for either coal mining or ancillary industries not for agriculture (Biswas *et al*., 2007). The land usage pattern of Jharia and Raniganj coalfield is showed in Table 1.

The other factors responsible for the degradation of land in coalfields of Raniganj and Jharia primarily are the subsidence and fire. The subsidence in normal cases causes undulation of the surface, damage to the structures and drainage pattern. In case the slope exceeds by 15 degrees, erosion of the soil occurs, when the top soil is removed with torrential rains. This converts the farms to wasteland of low fertility and causes siltation of the dams, streams and ponds and has directs adverse impact on agriculture. According to estimate, over 5.5 million hectares of land is already been converted to waste land in Damodar valley alone (Banerjee, 2007). The degraded land of Damodar valley along with the cause is summarized in Table 2.

The above table shows that due to subsidence 96% land has been degraded with low fertility. 25% land is fire affected, vulnerable for the agriculture activities. 17.49 sq. km. land is abandoned can't be used for cultivation. The population in the study region mostly depends on the agriculture. With the increasing mining activities the cultivable land is becoming inadequate which creates an alarming situation for the survival of local people. On the contrary the forest covers are diminishing gradually due to heavy demand of land.

Table 1. Land usage pattern of Jharia and Raniganj coalfield

Usage	Percentage under different use (year wise)		
	1990	2000	2010
Settlement	8.6	16.0	32.3
Coal Mines	4.7	17.7	12.5
Ponds and streams	7.3	6.7	3.1
Forest	4.9	0.7	0.7
Green cover	65.4	56.8	49.4
Barren land	9.1	2.4	2.0

Sources: CMPDI Report, 2013

Table 2. 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

Source: CMPDI Survey Report, 2013.

The way the development activities are going on has tremendous negative impact on mass as well as on environment. So this suggests us to follow the path of sustainable development.

3.2. Land degradation and its effects on agriculture

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 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 (SPM). The extension of urbanization associated with mining also contributes to land loss in many ways in these coalfields (Boliga, 2010).

3.3. Biological disturbance due to mining

The depillaring or long wall mining over critical area causes surface subsidence, cracks, fissure and lowering of water table. Soil cover, the most valuable constituent of the earth crust sustaining biological domain is 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 are 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* (*Shorea robusta*), *Mahua* (*Madhuca indica*), *Palas* (*Butea monosperma*), *Bija* (*Pterocarpus marsupium*), *Kendu* (*Diospyros melanoxylon*) and *Bhelwa* (*Semecarpus anacardium*) 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 (*Origanum vulgare*) 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.

With the depletion of the forest cover, increase in population and mining activities, the region rich in biodiversity slowly became barren. There is an urgent need to restore the balance of the nature. We have to contemplate on the sustainable development strategy for the survival of coal mining as well as surface environment for a long time.

3.4. Land degradation due to opencast mining

In the Indian coal industry the dependence on opencast mining has been increased rapidly during the last two decades due to mechanization and modernization of mining operation. 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 2005-06 was around 168 mt. But in the year 2011-2012 the opencast production contributed to 70 percent of total production of 403 mt (Table 3). The total requirement of land for opencast projects up to the year 2012 as per the master plan of Raniganj coalfield was 80 km^2 (8000 hectares) and 20 km2 (2000 hectares) land has already been damaged

Table 3. 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

Source: CMPDI Survey Report, 2013.

by opencast mining, which means that the opencast mining have damaged damage 100 km^2 (10,000 hectares) of land up to 2012 (Goswami, 2013). With the increasing demand of opencast mining, huge barren as well as agricultural land has been acquired. If the rate of land acquisition goes on escalating the agriculture would go vanish gradually. And with the extinction of agriculture the question on employment, food security and environmental degradation will be a great concern for sustainable development.

3.5. Land degradation due to underground mining

Traditionally, coal production in Raniganj and Jharia coalfield was mostly from underground mines though the scenario has been changed significantly in favour of opencast mining after nationalization. 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 2000 and the overage surface lowering is about 0.6 meters. It may be anticipated that another 1000 hectare of land would be affected by subsidence up to the year 2015 (Goswami, 2013). Degradation of land makes the soil unfit for agriculture. Natural vegetation is also get affected by degraded land. Development activities due to coal mining bring harmful consequences for the surrounding people. This phenomenon shows the need for sustainable development.

3.6. Impact 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 activities. It is very difficult to assess the quantum of agricultural land involved in the total land degradation. The sample survey presents 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 hectares of agricultural land involves in the Raniganj coalfield during the process of mining up to 2012. 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 in India.

As per the Table 4 more than 1000 hectares of land has been lost over a span of 20 years in only two

Table 4. Downfall of cultivatable land in Raniganj and Jharia coalfields

Block	Decrease (%)	Year	Cultivatable Area (hectare)	Interval
Jamuria No. 1	9.70	1989-90	6405	20 Years
		2010-11	5785	
Asansol Block	3.20	1989-90	1490	20 Years
		2010-11	1230	
Dhanbad-Katras	17.40	1989-90	4481	20 Years
		2010-11	4314	

Source: CMPDI Survey Report, 2013.

blocks in *Asansol* subdivision and *Dhanbad* district. The effect of land loss on agricultural activities may however be more objectively estimated through the statistics of number of persons employed in agriculture and their migration if any. The decrease of cultivable land is clearly visible in Jharia coalfield is estimated 17.40%. The matter has been discussed in subsequent paragraphs.

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 2000 to 1753 in 2010, which means a decrease in cultivators of 2350 in a span of 10 years (Goswami, 2013). It may be noted that in *Asansol, Salanpur* and *Katras* development blocks (all located in coalmining area) there have been a decrease in number of persons employed in agriculture by approximately 3300, 3500 and 2600 respectively over a period of ten years (2000-2010), there has been increase in agricultural employment in non-mining areas (Penz, 2011). In actual terms, it is not that a particular group of agricultural labours 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 are 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 labours 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 havoc change. This alarming situation shows us the need of sustainable development so that the agriculture and coal mining industry would go together.

3.7. Loss of productivity in agriculture society's reaction

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 are collected from different polluted sites in the mining areas where there have been considerable accumulation of suspended particulate matter and coal dust are found. There is considerable reduction in the grain size in paddy plants in all polluted sites and there is reduction of number of grains per spike. The weight size and volume of grain produced at all paddy plants are also reduced. The summary of all the studies points out that in polluted sites the production is 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 (Dhar, 2000).

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 region 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 "*SonepurBazari*" opencast project is considerably delayed because of the local citizens' resistance toward 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. 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 coal mining industry. Loss of productivity may be compensated by the authority and adequate research should be conducted to take care of the local people. These factors are the prerequisite for controlled and sustainable development of any society.

3.8. Subsidence of cultivable land 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 of surface. 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 (goaf) 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 meter (15 feet) in Raniganj coalfield. But in some cases sand has not been stowed in the goaf, the maximum subsidence has taken place due to extraction of a 4.5 m thick coal seam around 3 meter (10 ft.) (Wathern, 1988).

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.

It is generally believed that land subsidence arising from ground water withdrawal is essentially the response of the surface to the compaction of the sediments holding water (aquifers) at depths. Withdrawal of water reduces the water pressure in the pores, which in turn increases effective vertical stress and thus causes compaction of the solid structure of the aquifers. This results in an increase in effective stress in the aquifer system causing large volumes of land subsidence. The following characteristics of water are responsible for the land subsidence phenomenon due to ground water withdrawal.

1) Water cannot be compressed and has different properties of strain under the action of forces. When compressed water moves-up in the layers of the aquifers and it is expanded as it goes down.

2) Water has properties of flowing and transmitting static hydraulic stresses.

Hence, the changes in ground water level are related to the quantum of ground water withdrawal and are a function of stresses in the aquifers. The compaction of the aquifer is reflected on the surface in the form of subsidence movements and depending upon the depth of aquifer and the characteristics of the superincumbent rock mass. The following factors are responsible for land subsidence due to ground water withdrawal.

It has generally been found that the magnitude of surface subsidence is proportional to the drawdown of piezometric level in the aquifers. Different types of rocks respond differently to the changes in the surrounding stress field. The magnitude of compaction of the aquifer beds and hence the land subsidence depends on the compaction characteristics. In addition to the aquifer beds, compaction of the overlying /underlying beds as a response to the changes in the stress field contributes to the subsidence (Hill, 2003).

Land subsidence in general is not influenced by the composition of the superincumbent strata. It is influenced to some extent by the position of the rigid basement below the reservoir. This subsidence has been found to be directly proportional to the rate of ground water withdrawal.

In the Indian context the impacts of the land subsidence due to ground water withdrawal may be outlined hereunder.

3.8.1. Impacts on surrounding cities and agriculture

Land subsidence in the cities, e.g., Raniganj, Dhanbad, etc., can cause the following problems.

1. Changes in surface topography resulting in alterations in the surface drainage pattern.
2. Damages to buildings and structures.
3. Water-logging in the depressions caused by the subsidence.
4. Damages of roads and railway tracks and cracks on land.

The area in Jharia coalfields to Raniganj coalfields in the east has a number of rivers and is one of the most productive agricultural areas. The place is having a large number of tube-wells for meeting the water requirement in the agriculture sector. Land subsidence due to ground water withdrawal has caused the following problems in these areas.

1. Depressions around the tube-wells altering the surface drainage pattern.
2. Water logging in the depressions.
3. Flooding from the nearby water bodies.
4. Flood water may not recede from the depression causing problems in agricultural activities.

These problems have tremendous negative effects on human health. The drinking water gets mixed with contaminated mine water and makes it unfit for

consumption. The development of coal mining is necessary but the side effects of development process need to be taken for consideration for sustainable development.

3.8.2. Land degradation due to surface subsidence

The coalfields of Raniganj and Jharia, being worked since 1990 and 2010 have been developed, depillared caved or stowed in pockets and at places 5-10 seams are worked one after the other. As a result, 35 sq. km. area has been subsided in Jharia field while its toll is 43 sq. km. in Raniganj coalfield. Repeated mining of over or underlying seams has often activated the settled goaf. Mushroom development of habitat, concentration of population and their rising basic needs has squeezed the available leasehold with surface rights to 127 sq. km. in Jharia coalfield. The condition of Raniganj field is even worse with the following pattern of coal distribution under different constraints. The townships and villages covered 252 sq. km. of the coal basin, sterilizing over 5100 million tons of coal (Goswami, 2013).

3.8.3. Damage of soil cover

Tilting of land, development of cracks, formation of undulating trough and change in drainage pattern, followed by erosion of soil cover of the mining area. The effect of these disturbances is manifested in the form of loss of the agricultural land, erosion and drying of the green cover and loss of biodiversity.

Leaving aside the ill effect of spoil heaps, the agricultural land looses fertility because of following.

1. With the increase in slope of the land; fertile soil is eroded and carried down steam.
2. Soil in filled in the cracks and fractures formed due to the subsidence.
3. Spoil mixed coal with iron pyrite increases the acidity of the soil.
4. Acidity of the soil leaches the aluminum component of the soil to physiotoxic level and causes loss of potassium.
5. Low pH values causes phosphate fixation and reduces the nitrogen availability.
6. Cracks and fissures induce secondary porosity to the burden and lower the water table, leading to starvation of the plants.

Damage to growth and difference in yield for the agricultural area of the coalfield is difficult to guesstimate; particularly because of rain dependent farming. Direct impact of subsidence, however, is a temporary phase; easy to restore and bring the soil to the original state. Unless the slope is very steep, more than 10-15 o and the land is subjected to extension, the loss of soil, uprooting of grass and shrubs and plants is likely to be negligible. The topography and drainage pattern of the area, however, are the relevant factors which might alter the degree of erosion.

3.8.4. Damage to forest covers

The damage to the forest has gained importance over the years because of the dwindling ratio of green belt on the earth. The 1982 Central Forestry Commission report showed 22.75% of the total land area under forest in India but a number of patches were in record on the name of forest without any tree. According to land- sat data, the forest area of area of only 16.83% in 1990-92 periods is reduced to 13.94% in 2010-2012. According to the estimate some 43 million hectares of forest land has been encroached to agricultural land industrial plots during 1990-2000. The contribution of mining to this heavy damage was less than 0.9 million hectares. According to a survey in 2000, the land area damaged or considered to be potentially dangerous or likely to subside aggregated to 110 sq. km. (Boliga, 2010). If we take care of the forest covers seriously the volume of air pollutions can be controlled.

Damage to a forest due to subsidence is envisaged due to the following activities

1. Stretching of the roots of the tree when they happen to be over or in line to fracture plane.
2. Lowering of water table or loss of moisture of soil.
3. Tilting, sinking of trees because of slope, and fracture.

The reclamation of subsided land in BCCL has been a serious problem for which a large scale restoration is taken in hand. Under the program, nearly 450 hectares of land is reclaimed till 2010. The impact of underground mining on agricultural land or forest under the condition of Indian mining is summarized in the following table. The table 5 shows negligible impact of strain up to 20 mm/m on the forest and 10 mm/m on agricultural yield. This fact reveals that to achieve sustainable development the coal mining authority has to work through planned way so that the negative impacts of mining can be minimized.

On the whole, subsidence and even high strain up to 20 mm/m is not likely to cause any severe damage to field or forest. The effect may be further reduced by designing the working for limited fracture planes or zone of surface places or zone of tension. These facts are self explanatory and show the danger in the path of sustainable development.

3.8.5. Disappearance of ground water

The ground water table may be lowered by land subsidence whereas the effect on surface water flow

Table 5. Impact of slope on agricultural land

Land usage	Slope (mm/m)	Strain (mm/m)	Level
Agriculture	-	<5	No impact
		5-10	Marginal impact due to loss of water
		<10	Major impact, sizable reduction in yield
Forest	<10	<5	No impact
	10-20	5-20	Slight tilting of plants/tree
	20-50	10-20	Temporary loss in water retention capacity of the top soil
	>50	>20	Short term impact on trees in zone of fracture places, the crack may get filled in due course some impact on large trees, but those along fracture or tension zone may fall due to tilting high slope zone

Source: CMPDI Survey Report, 2013.

may be much more disastrous. There have been cases of dug wells and water tanks getting dried up as a result of subsidence whereas the effect on surface water flow may be much more disastrous. There have been cases of dug wells and water tanks getting dried up as a result of subsidence. The informed observers cite many specific cases. A few years ago in North Searsole village four dug wells were drained out suddenly. Subsequently an enterprising Director General Mine Safety officer correlated the incident with a major roof fall in a nearby colliery. The roof fall presumably disturbed the aquifers which were supplying the wells. All the four wells were located within 1 km radius of the colliery.

The depth of mining at extensive stretches of Raniganj coalfield is low and this naturally has contributed to disturbance to ground water table. The change of surface drainage pattern and formation of cracks and fissures on land surface may affect the cultivability of the soil. It ultimately may affect the pattern of growth of vegetation and may make the land barren if proper steps are not taken in reclaiming it.

3.8.6 Mine fire and loss of agricultural land

The subsidence of land due to underground mining has many adverse impacts as has been pointed out earlier. Most of the subsidence in Raniganj and Jharia coalfield (and practically in every Indian coalfield) has been triggered of by mining at shallow depth. The subsidence of land initiated by mining at shallow depth is invariably associated with large scale fissure and crack formation which allows air to pass through to extracted areas. In board and pillar mining which is the dominant underground method in all the coalfields of India, the percentage extraction is generally poor and lot of coal is abandoned in the extracted area (goaf). Air passing through cracks and fissures in subsided land causes spontaneous combustion of coal left in the goaf and ultimately fire breaks out. There are many areas in ECL and BCCL where such fire has broken out. This has direct adverse effects on the agricultural productivity and environmental pollution which is also serious constrains for sustainable development.

3.9. Need for sustainable development of coalfields of Raniganj and Jharia

Coal and minerals are wasting asset and every mine has a limited life span. The lifespan may be sufficiently big for an individual but for an area or a province it is not. A number of mines of Eastern Coalfields Ltd. and BCCL have to be closed down in coming years. The closure of some more collieries are imminent. Over the last twenty years the number of people employed in collieries of Raniganj and Jharia has dwindled whereas the production remained stagnant. A number of factories in the coal belt and its fringe have closed or are sick. The agricultural labors are becoming surplus because of land loss and land degradation but they have no alternative occupation to adopt either in mining or in other engineering industry (Chadwik, 2007).

The above facts underscore the necessity of developing a conscious and rationale strategy for sustainable development of coalfield areas of Raniganj and Jharia. Before trying to outline such strategy it would be worthwhile to trace the history of past development and to examine how and why it has deviated from a desirable model of sustainable development. The first step towards sustainable development in the coalfield would be to develop agriculture and related activities side by side with mining and other industrial activities. More than 50 percent of the coalfield is essentially rural though rural and mining activities are interwoven in a common fabric. The presence of mining and other activities would provide market for agricultural, poultry and dairy products just at next door. This would provide greatest help in sustaining agricultural

activities (Ghose, 2004).

3.9.1. Use of partially degraded undermined land for sustainable development

There is vast stretch of undermined land under the ownership of Eastern coalfield Ltd and BCCL. Much of this land is partially degraded but with very little additional effort may sustain agricultural activities. The land now remains unutilized as the coal company feels that they may need the land again for mining and it may be difficult for the company to undermine the land once agricultural activities are started on the land though legally the ownership of the land may be retained by them. Similarly there are a large number of unutilized ponds and tanks also under the company ownership. An arrangement may be made whereby the land, ponds and tanks which would not be needed in the coming five years may be given in lease to "*ZillaParishad*" (Local self Government) or to a specially created organization of the State Government. This may be possible through an agreement between the coal company and the concerned *ZillaParishad* with the State and Central Government providing the guarantee for the faithful execution of the terms of the agreement (Singh *et al*., 2012). Partially degraded land can be reused for the agriculture after some scientific treatments to sustain the agriculture productivity.

3.9.2. A forestation programme for sustainable development

As per the recent practice, every mining project is to be cleared by the Department of Environment before its implementation. The project report submitted by the industry gives a blueprint of the proposed environmental protection measures to be taken-up by the company. A forestation is a common part of environmental protection, almost in every project and also necessary for sustainable development. The environmental protection measures including a forestation may create a large number of jobs within a project and for such type of jobs, people with agricultural background is more suitable. It is, therefore, suggested that after the blueprint of a forestation has been drawn-up, the work may be given to the adjoining village Panchayats (Local self Government) on a contract basis. The payment to be made by the coal industry would depend on the number of trees and plants surviving. Moreover, by involving local community in such programme, the chance of its success would be brighter.

4. Conclusion

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. 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. The need for industrialization and its expansion is inevitable but should not be at the cost of agriculture. Agriculture and coal mining should go together so that we can meet the present need sufficiently without compromising the availability of resources for future generation.

References

Banerjee SP. Land reclamation in mined areas. Gondwana. 2010; 63: 73.

Biswas AK, GepingQ. Environmental impact assessment for developing countries. Tycolly International, London, UK. 2007; 232.

Boliga BP. Challenges of environmental management. 4th ed. Indian Institute of Mines, Dhanbad, India. 2010; 25.

Bose AK. Environmental problem in coal mining areas, impact assessment and management strategies- case study in India. Elsevier, Amsterdam,1989; 4: 243.

Chadwik MJ. Environmental impacts of coal mining and utilization. Pergamum Press Oxford, New Delhi, India. 2007; 211.

Dhar BB. Environmental impact and abatement of noise

pollution. ISM press, Varanasi, India. 2000; 168-204.
Ghose MK. Effect of opencast mining on soil fertility. Journal of Scientific and Industrial Research 2004; 63: 1006-09.
Goswami S. Need for clean coal mining in India. Environmental Research, Engineering and Management, 2013; 4(66): 79-84.
Goswami S. Coal mining, environment and contemporary Indian society. Global Journal of Human Social Science. 2013; 13(6): 17-26.
Goswami S. Coal mining, communities and the environment. New Delhi Publishers, New Delhi, India. 2014; 103.
Hill P. Improving efficiencies of coal fired plants in developing countries. 10th ed. Gemini House, London, UK. 2003; 10-18.
Penz P. Displacement by development ethics, rights and responsibilities. Cambridge University Press, Cambridge, UK. 2011; 32.
Singh TN, Gupta ML. Clean coal initiatives. 2nd ed. Scientific Publishers, Jodhpur, 2012; 12.
Wathern P. An introductory guide to EIA in: environmental impacts assessments. 2nd ed. London, UK. 1988; 3-28.

Received 13 June 2014
Accepted 1 August 2014

Correspondence to
Dr. Sribas Goswami
Department of Sociology,
Serampore College,
Hooghly, West Bengal, PIN- 712201,
India
Tel: + 9194 3454 5330
Fax: + 9133 2652 9489
E-mail: sribasgoswami@gmail.com