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Environment Management in Mining Areas (A Study of Raniganj and Jharia Coal Field in India)

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Abstract- Coal mining practices in India have a long history. On a commercial scale mainly British companies started it in India. From its very first day exploitation of coal reserve started and it resulted into the environmental degradation through various ways. It is a topic of research importance because now a day the environmental problem is a burning global issue. Now a day if one observes any coal-mining project in India the truth aforesaid will automatically reveal. There is destruction of vegetation, soil resource, water resource; underground resource and great intensity of various pollutions have been observed. In short an inhuman treatment is meted out to the environment by modern civilization. The Raniganj Coal Field of Eastern Coal Field Ltd. and Jharia coalfield of BCCL are not an exception in this regard. Eminent Research scholars have done many research works in India regarding coalfield. But here the author wants to emphasize the environmental impact of the Raniganj and Jharia coal mining projects through this research work. Though coal is an essential resource but protection of environment is not less important. The author wants to disclose all the environmental impact of coal mining projects with its possible preventive measures. So the environmental impacts of coal mining projects are immense which will also help understand the development of Raniganj and Jharia coalmines.

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I. History of Coal Mining in India

Coal mining on a commercial scale was started in India mainly by British Companies. Mining practices adopted were based naturally on the experience of mining engineers. As large capacity excavation equipment was not developed, even shallow thick seam deposits were mined by underground bored and pillar method. This has lead to huge loss of coal and problems of fire. A large part of good quality of coal reserve in standing on pillars and its liquidation does not appear in sight.

Today the obvious choice for most of such areas would have been opencast mining, had it not been developed by underground methods. With the availability of large sized excavation equipment,moving during the construction of dams. Many of the experts of opencast mining in India had worked on such dam construction projects. A large part of the HEMM (Heavy earth moving machinery) had come from U.S.A., which even now leads in the manufacture of HEMM. A responsible manufacturing base of HEMM has been established in India. The mining practices followed today have been influenced by this historical fact to a considerable extent. NCDC (National Coal Development Corporation), a public sector company, formed in 1956, sought collaborations with Polish and Russian mining institutes. This led to the development of a few underground shaft mines with mining methods practices in the aforesaid countries. With the rapidly increasing demand of power grade coal, high capacity fully mechanized opencast mining commenced large inferior grade thick shallow coal deposits had been ignored altogether in the past, as earlier the demand was mainly for the superior grade of coal.

II. Eco-Friendly Coal Mining in Raniganj and Jharia

Towards the beginning of the earth's history the four spheres on the globe, i.e. the lithosphere (the land), hydrosphere (the water regime), atmosphere and biosphere (the plants and animals) had been set by the nature in a balanced state to live irresponsible harmony with each other. The system had thus been in the state of a simple balance in which any action in one part would result into an equal and opposite reaction in the system itself. Three among these four spheres, namely lithosphere, hydrosphere and biosphere together from the "ecosystem", the result of juxtaposition of land, water, forest, men and animal (biosphere). Any damage to any component of this result in damage to ecosystem, the counter-effect of which to the same system may not always be very acceptable or comfortable to men, as men is a part of this same system. Because of this fact all industrial activities should be planned and executed in such manner that the natural ecosystem is damaged to a minimum extent.

Coal Mining is a development activity, which is bound to damage the natural ecosystem by all its activities direct and ancillary, starting from land acquisition to coal beneficiation and use of the products; but it cannot be avoided be avoided because it required development. Hence it is the time of "Eco-friendly Coal Mining".

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III. Damage to Ecosystem by Coal Mining

Damage to ecosystem by coal mining starts immediately after land acquisition, when pre-mining land-uses start shifting. This may require shifting of habitations to new sites, which may require damage to greenery at the new site. Further, to replace a cultivation or horticultural land may require cutting greeneries which were existing at the new site. Regarding forest-lands to be disturbed by mining, "compensatory a forestation" is an essential activity but to view from the stand-point of ecology, "no forest can be compensated in a year or two", as forests the sum total of ecological, and biological parameters. What can be done is, only "compensatory plantation". Saplings of selected forest species planted in the name of "compensatory a forestation" can only form, at best, a dense population of plants which will take a considerable number of years to from a real forest. Over and above such direct damage to ecosystem after land acquisition, greeneries and surface water bodies may gate damaged by direct excavation (at the quarry sites) the OB dumping (at the OB dumping sites) causing a direct damage to ecosystem.

Any excavation, be it at the mining site or at the site for rehabilitation of the population to be shifted, opens a source of severe erosion and hence damage to land and surface water bodies by situation. Further, to facilitate excavation below water table it needs pumping out of ground water which damages ground water resource of the region. This results in chances of damage to greenery.

After excavation the coal needs haulage, storage, transportation and beneficiation before it is used. Throughout the total process coal-dust spreads over the surrounding land and greeneries. This damages greenery growth and specially sprouting of fresh leaves.

Damage to greenery results in more barren land, more erosion, and loss of surface water bodies by siltation, hence decrease in irrigation potential of the region which triggers the cycle of land degradation. This total process, once started, works through number of "do-loops" in accelerated speed resulting into more damage as detailed in figure given below. The ultimate effect is damage to ecosystem which is exhibited in the regions land-cover and land-use pattern. Studies from Jharia and Raniganj coalfield corroborate this fact.

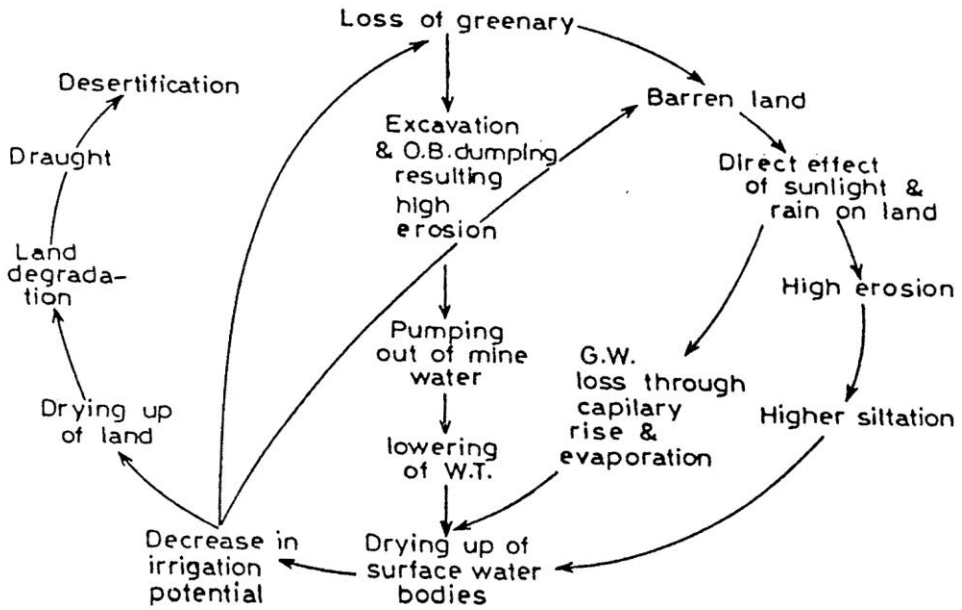

Fig. 1: Land degration cycle due to mining and related activities

Figure1 : Main Issues for Eco-friendly coal mining

The parties to the Climate Convention have already committed to promote and cooperate in the development, application, and diffusion including transfer of technology to reduce and control greenhouse gas emission. As per the President of the World Resources Institute, Washington, "if countries who sign the treaty put in place the requisite policies and action, the world will be set on a new course, one which is less

dependent on fossil fuels, less polluting and less a threat to human health." The industrialized countries have to play a major role in this endeavor in the light of the fact that 20% of the world population in these countries is responsible for 90% of the global carbon emission that has been carbon emission that has been released into the atmosphere since the industrial revolution. They should help the developing countries introducing cost effective emission control measures and efficient technology for clean power generation. This will help reduce the threat of global warming which is likely to cause 1 to 3.5 degree centigrade rise in earth temperature within next century. It may be of interest to note that this may cause more rapid change in the climate than has occurred for the last 10,000 years. The life cycle of coal starting from exploration to mining, beneficiations and combustion has damaging impact over environment and ecology. The issue is mainly to take account of the global efforts and add its humble contribution in the following areas:

IV. Mining

The mining of already developed, caved or partially worked coal seams in many coalfields has advanced mixing and hence clean coal is the casualty with the underground and surface mining. Reduction of ash content will minimize the load over the transport system which is to be carried to remote areas. Eco-friendly mining with subsidence control and protection of fields, farms and forest need in-depth R&D effort. Waste management may be integrated for surface protection and support for selective thick seam mining. Following dimensions of mining technology are needed in the interest of eco-friendly coal mining:

- Horizon control during mining underground to avoid dilution of roof floor.
- Selective mining technology of desired quality coal by leaving the bands underground
- Ways and means to control the dilution of coal quality at the loading point, railway siding and dump site.
- Backfilling of waste material sorted, picked or segregated in the voids created during mining
- Methane drainage and utilization to minimize release to the environment.
- Control of mine fire and oxidation of coal to minimize carbon dioxide release to the atmosphere.

V. Transport

- Scope of encapsulated transport of coal to pit top bankers of nearly build consumers.
- Scope of inland water channel transport of coal-rivers like Brahmputra, Ganga, Godavari, etc.
- Transport of coal from mine site to the loading points by artificial canals or water channels.
- Scope of coastal shipment of coal to enter remotely located coastal consumers.
- Railway transfer pits-handling plants at main dump sites to minimize pollution level.
- The road transport restricted to sealed containers, on well maintained roads of heavy duty and dedicated lining.
- Location of power units close to the pit top with water channel transport.

VI. Combustion

- Evaluation of residual life and modernization of the inefficient power plants.
- Adopting state of art technology for upcoming power plants for energy efficiency.
- State of art technology for greenhouse gas emission control.
- Scope of locating power plants close to the mine site or nearest locale to the production.
- Efficient management of fly ash and bottom ash including underground packing.
- Development of efficient national power grid for power traction rather than coal transport.

VII. Environment

- Protection of land, water, atmosphere and bio-diversity during mining
- Reduction in vehicular emission, pollution and particulate load
- Adoption of the state of art technology for pollution control in mining, transport & combustion
- Reclamation of mine site for landscaping, green cover and aforestation
- Rehabilitation and resettlement of flora, fauna & displaced population

Environment and ecology of the earth has been disturbed with the increasing use of fuel; particularly coal produced over the last centuries by the developed world. This has taken the global up to the verge of ozone hole formation and global warming. The developing world has joined the race and if adequate precaution is not taken, the globe will suffer irreparable loss and every creature of the earth will have to bear the brunt of it. The global fraternity has to open to ensure better environment and ecology of the mother earth to keep it safe for our posterity and maintaining sustainable uniform growth of the present populace.

This needs sharing of knowledge, technology and resources by the developed world so as to maintain the rate of progress in the under developed nations. Energy is being the prime mover; especially coal playing important role requires special attention in terms of clean coal initiatives as this is going to be the main source of commercial energy of tomorrow in some of the developing nations. The developing the sate of art

technology in mining, transportation, beneficiation and combustion to save our common heritage.

VIII. Impact of Coal mining on Human Health

Coal mining operations have resulted in environmental degradation, ecological changes and are associated with health and safety of mine workers. The environmental hazards are dangerous for the mining community as they aggravate the problem of ill-health. Majority of the children suffer from moderate malnutrition and are found to have vitamin and iron deficiencies in particular. Mining communities, who have inferior access to balanced diet, easily falls pray to the chain of malnutrition, poor health and weakness which are prone to diseases. Polluted environment further aggravates the situation. Clean coal technologies are definition an answer to the above mentioned problems. However, it is very doubtful that such mining condition because of their high cost, high level of pollution etc. As scholar stated "falling into the trap of opting for technologies which are not sustainable within our means."

IX. Health Technology

A new technology to combat environment stresses on the working personnel associated with coal mining can be betterment of their health by gainfully using the knowledge of proper nutrition and balanced diet. A large section of the population in and around the coal mining area in Damodar Basin suffers from chronic water borne diseases. Miners develop intestinal parasitic infection, anemia, skin diseases, tuberculosis; they also succumb to diarrhea, weight loss and are subjected to respiratory infection. The transition of the natural environment which has resulted in worsening of the situation can be tackled effectively with the help of health technology.

Health is the key to all progress, whether for the individual or for the society. Overall social and economic development of a country depends on the health of its workers. To achieve good health better identification and improvement in nutritional status is necessary. The quality of nutrition affects the well-being and immune capabilities of a person.

A personal survey was conducted in two different coal-belt areas of Damodar River Basin. From hospital records and general survey it was found that people suffering from gastrointestinal diseases were high in both the areas due to water pollution and unhygienic conditions. People suffered from respiratory diseases as a result of air pollution in both areas. Besides the above mentioned two types of diseases, it was observed that due to nutritional deficiencies anemia, skin diseases were commonly found among the mining population. But what is noteworthy is that, people living in unhygienic conditions and suffering form nutritional deficiencies and its effects is higher in one area in comparison to the other as observed in Table 5.4.. Consciousness regarding proper nutrition, health and hygiene helped the people of one region to reduce nutritional deficiencies.

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

Health education about simple sanitary practices and checking of unhealthy dirty habits such as spitting, buying and selling of food exposed to flies and dust etc. must be checked. Diarrhea, weight loss, anemia, dermatitis can be checked by ensuring proper nutrition sanitation. Consumption of clean water will check diseases such as typhoid, cholera, dysentery. It is also necessary to see that a habitat is also necessary to see that a habitat is not over congested. Primary health care is the prerequisite of health technology and so periodical health check up must be done. Mind free form tension but constantly engaged provides food for happy and healthy life. Yoga, hygiene has a key role to play in maintaining proper health.

Table 1 : Morbidity Pattern of Worker's Community in Coal Mines (2008-2010) Raniganj Coalfild and Jharia Coalfield

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

Source : Personal survey-2010

Table 2 : Calorie Consumption of Coal Miners' Community

Type of work	Calorie Require-ment	Coal Mine No.1 Calorie consu-		Coal Mine No. 2 calorie defici-		deficiency %	Excess %	Calori Consu-	Average Defici-ency %
	Consu- ency	mption	%		mption			mption	
MAN									
Heavy work	3900	3540	9.23	-	3860	1.03	-	3700	5.13
Mod. Work	2800	2650	5.36	-	2890	-	3.21	2770	1.07
Sed. Work	2400	2210	7.92	-	2410	-	0.42	2310	3.75
WOMAN									
Heavy work	3000	2630	12.33	-	2890	3.67	-	2760	8.00
Mod. Work	2200	1990	9.55	-	2170	1.36	-	2080	5.45
Sed. Work	1900	1770	6.84	-	1930	-	1.58	1850	2.63
ADOLESCENT									
10-12 Years	2100	1550	26.19	-	1690	19.52	-	1620	22.86
7-9 years	1800	1330	26.11	-	1450	19.44	-	1390	22.78
4-6 years	1500	1080	28.00	-	1220	18.66	-	1150	23.33
1-3 years	1200	830	30.83	-	960	20.00	-	895	25.42

Source : Personal survey-2010

Special attention has to be paid to women and children. Health technology emphasizes on health status and education. Today man is armed with sufficient knowledge of balanced diet to achieve all around progress.

Besides good food several other factors also help to lead a healthy life. It is observed that in coal mining area where pollution level is high people with simple fares, frugal habits and having contented mind have better longevity.

Health technologies which are relatively an inexpensive technology and are well within our means serve as a simple guide to healthy living. Health care program combining and coordinating the needs of both curative and preventive medicine, knowledge of balanced diet are the prerequisites of the people residing in coal mining region for sustaining healthy and vigorous life. To draw utmost benefit from health technology information must be transferred by proper motivation through training education and feedback.

X. Process of Environmental Rehabilitation in Opencast Mines

Coal is the major primary source of energy and has a share of about 60% in the National energy scenario. Besides, the coal is also used by the steel and other base manufacturing industries. It is rather ironical that the power grade coal, the prime source of energy is deposited in the forest areas. This immediately brings

direct confrontation of coal exploitation with environment.

The perspective plan of the production programme drawn for the VIII & IX Plan and 2007-08 period is given below:

Table 3 : Technology-Wise Coal Production Programme From Indian Mines

	1992-93	1993-94	1994-95	1995-96	VIII plan 1996-97	IX Plan 2001-02	2007-08
Opencast	168.33	177.33	190.60	199.84	210.82	274.45	403.74
Underground	68.76	71.78	74.98	79.79	82.39	95.58	43.96
Total	237.09	249.51	265.58	279.63	293.21	370.03	447.00

Sources : CMPDI Survey Report, 2010.

Though the above figures are rather indicative, the growth of opencast production in absolute terms will need opening of big new mines. This will in turn, have confrontation with the environment and will need effective rehabilitation measures for their environmental restoration.

The opencast mines generally affect most of the environmental attributes. However the major concerned descriptors of the environment being affected are land, water, air, flora and fauna.

The environment in an opencast mine in post-mining phase is as important as or rather more important than the operational phase. The importance of post-mining environment can be comprehended since the post-mining scenario become everlasting unless properly rehabilitated. The rehabilitation of the mined out areas and the OB or reject dumps assume special significance in the rehabilitation efforts in the post-operational period.

XI. Environment Impacts of Opencast Mines (Operational Stage)

Before going to the post mining stage, the environmental impacts of the operational stage can briefly be discussed.

a) Air

The air in the opencast mine including its surrounding zone is affected due to various mining operations. If effective dust suppression measures are not taken the air quality deterioration in the operational stage of an opencast mine may become appreciable. However, for environment, health and operational efficacy the dust suppression is taken care by the mine management.

b) Water

The natural water system in the project area as well as its surrounding zone is affected due to various reasons like mine water discharge, erosion from dump etc.

c) Land

The impact on land in the operational phase is direct and visible. The mined-out area, the overburden or reject dumps, the infrastructural built-up area all affect the land during the operational stage. Unless proper reclamation is possible by backfilling, the land impacts during the operational stage remain visible and glaring. Most of the land management can be done only in the post-mining stage. However, at present thrust is for concurrent or early backfilling and physical reclamation of the mined areas or OB dumps during the operational phase itself.

d) Flora and Fauna

The flora and fauna in the forest areas face the direct impact of the mining operation. The diversion of forest land for the mines and OB dumps clearly affect the floral system in the area. The fauna in the area normally migrate because most of the coal mines in the forest area are surrounded by contiguous forests.

XII. Environmental Impacts of Open cast Mines (Post-Mining Stage)

The following are the impacts on the environmental descriptors in the post-mining stage as can be envisaged at present.

a) Air

After closure of the mining operation the activities causing air pollution are minimized. The activities of reclamation and rehabilitation of the areas may generate just a meager quantity of dust. This is not likely to have any impact on the ambient air quality.

b) Water

The impact on water quality after the closure of the mining operation will also get reduced appreciably. The pumping of the mine water is likely to the mine water is likely to stop due to reduced activities. The quality of mine water, even if pumping is continued for some reason will be always within the acceptable limits. The pollution due to waste dumps will also slowly reduce with improved vegetative cover on these waste dumps. The problem of acidity or alkalinity will also appreciable reduces with no exposure of fresh rock surfaces in the mined area. It is therefore stated that rehabilitation of the dumps is a must for controlling the water pollution.

c) Land

Land is a major problem even in the post-mining stage. The following land uses will result upon completion of the mineral extraction.

i. Mined-out area (voids)
ii. Internal dump areas
iii. External dump areas
iv. Infrastructural areas
v. Residential areas.

Out of the above, the residential areas may be suitable developed so that aesthetically and also environmentally they remain acceptable. However, other four post-mining land uses need proper rehabilitation so that they match with the ambient scenario and are acceptable to the society as a whole.

d) Flora and Fauna

The impact on flora and fauna after completion of the mining operation would remain insignificant. However, a possible impact can always be envisaged with proper planning of the land use and proper harvesting of the water and soil resources within or near the project area. The proper rehabilitation of the mining areas and rational utilization of water and soil resources will help to enrich the growth of flora and thereby advent of the migration fauna. This could be useful post-mining scenario.

XIII. Rehabilitation Measures

a) Land

Land is a limited resource under the prevailing circumstance. It can be called a depleting resource. There is continued denudation of the top soil rendering the useful land as waste land. The waste land can be regenerated but the geological process of the top soil rendering the useful land as waste land. The waste land can be regeneration by us may not be effective. Therefore land can be treated as a depleting resource.

The population density of our country is galloping in each decade. The rate of increase has already caused concern and therefore there is pressure on the conservation of good land and regeneration of the waste land. This establishes that rehabilitation of the mining areas is a national priority and has to be taken up in concerted way with required steps.

The following are the different post-mining land use scenario. These are:

i. Mined out and internal dump areas
ii. Internal and External OB dumps.
iii. Infrastructural areas and residential areas.

The rehabilitation measure for each of the above scenario is discussed below:

b) Mined-Out Areas

The different in the post-mining stage can be envisaged as follows.

- Complete void
- Partial void
- Completely backfilled

In situations where the underlying seams are yet to be worked or the waste generated by the mine has been used for some very useful purposes, this situation of the complete void is envisaged. This is normally a rare situation. Normally partial void situation in the mined-out areas are a common feature. This situation arises as voids left over the last years of the mine life cannot be backfilled without re-handling, or bringing waste from the other operational mines. The partial void situation presents a suitable scenario for effective rehabilitation. The situation of the completely backfilled area is again quite rare but this may arise due to some safety reasons of not allowing the water bodies in the abandoned mine.

XIV. Rehabilitation of Complete Voids

In the coalfield situation where water is a scarce resource the complete void scenario presents an opportunity for water harvesting and conservation. If the mine is isolated from the workings in the neighborhoods, the void can be ideally suited for being developed into ponds. The different uses of the water can be for supporting the life in the vicinity, as a water resource the inhabitants, development of fisheries, development of picnic sites and it will also act as moderator of heat and temperature in the ambient area. For developing fisheries and scenic sites a scheme need be drawn and suitable modifications in and around the mine voids will be affected.

XV. Partial Voids

This is a common situation arising in the opencast mining. Normal practice for a useful post-mining land use is to develop the haul road in the mine on one of the flanks. The backfilling is systematically carried out from the other end of the quarry. The backfilled areas are so fro filed that the dump level at the quarry edge matches the height of it he external dumps if disposed near the quarry edge in the blasting zone. This situation normally creates small water body at the dip side and along the haul road maintained at one of the flanks.

This situation can be used again for water harvesting and developing a scenic spot and also fisheries in the water bodies. The backfilled area of the mine can be developed for afforestaion or as pasture land. The physical rehabilitation of the backfilled area will not be complicated in the instance case. With water availability within the area being reclaimed, the aforestation over the backfilled area will be a good land use. It can be developed into a suitable picnic spot.

XVI. Completely Filled Areas

This situation allows the mining authority to productive uses of the reclaimed area. After proper physical reclamation by dozers and graders a layer of soil will be spread over. The soil will be treated with suitable modification agents for generation of micro biota. As the soil conservation can be feasible in this situation, the land can be generated to support even agriculture. The afforestation and the pasture land development will always be possible in these circumstances. The filled-in areas will be reclaimed physically so as to match with the ambient landscape. After the bio reclamation, the re habited area will be in complete harmony with the local scenario.

XVII. OB Dumps

Reclamation of OB dumps is one of the most challenging areas in the Environment Management of opencast mines. The physical reclamation of the dumps need making the slope area mild enough (30 degree gradient) for supporting the attempt of water and soil conservation. In difficult conditions small benches at intervals of 3 m or so may be developed.

The development of the OB dumps can be programmed in 2 different ways:

- Building the peripheral area for immediate bio restoration.
- Building the dumps in complete totality before bio-reclamations done.

The first choice is more scientific and if implemented will give good results. In systematic mining conditions, this choice must be adhered to. The development of the peripheral first bench is required to be done. The peripheral development of subsequent bench is not bringing out the same advantage. Once the peripheral area of the first bench is physically and biologically reclaimed, the dumping in the first bench can be continued without any adverse impact of situation and soil or water conservation. The second bench can be developed with complete filling from one end with the beam width between the benches needing to be kept only up to 30 m on the top of the first bench onwards. The silt load from the second and third benches will be caught by the bio-reclaimed area of the first bench and will not be allowed to enter the natural water benches also. The physical reclamation of the OB benches by toe walls, proper beam widths, mild slopes (30 degrees) and adequate bunds at the top of the OB dumps will be completed with.

XVIII. Bio-Restoration of The Dump Area (Both Internal and External)

The broad objectives of bio-restoration of the dumps are

a) Ecological restoration
b) Soil and water conservation
c) Preventing air and water from entering the layers of coal seams
d) Providing effective coverage to the mine area so that the pumping needs of the mine area is reduced
e) Bring improvement in the aesthetics of the area and moderate the ambient temperature
f) Providing fodder and fuel for the local population
g) To support economic activities of the area by providing timber, fruits and other raw materials.

XIX. Principles of Mine Restoration

a) Physical Reclamation

i. The hydrology after reclamation should be as close to the original as possible.
ii. The dump slope should be stable (nearly 30 degrees), the flat portion of the dump top should slope inward.
iii. The dumps should be developed with due considerations of spontaneous heating.
iv. The sediment control measures should be developed to ensure soil conservation on the dumps.
v. The precipitation drainage and internal seepage should be properly taken care of.

b) Biological Reclamation

i. Protection and reuse of top soil is an important activity
ii. Dust in the ambient air to be reduced.
iii. Choice of succession of plantation-grass, legumes and trees to be decided.
iv. Choice of species of grass, legumes and trees to be finalized based on the ambient air, water and soil quality.
v. Nursery development for sapling to be ensured
vi. Study and application of micro organisms to be ensured.
vii. Suitability of fertilizers and manures to be decided.
viii. Lab facilities for evaluation of air, water and soil to be developed
ix. After care of pants to be ensured.

XX. Role of Micro-Organism in Reclamation Process

Mine spoil and mined land lack microbial activity as it is devoid of organic matter. Microbial processes such as humification, soil aggregation and nitrogen & carbon cycling are essential in establishing productivity in mine spoil. The restoration of spoil and mined land should be evaluated not only on above ground biomass, but also on the degree of development of functional microbial population resembling those in undisturbed soil, namely, Bacteria, fungi, Actinomycetes, Rhizobium, Azatobacter etc. which play

an important role in biological reclamation. Microbial processes are so important to ecosystem recovery that the activity of micro-organisms can be used as an index of the progress of spoil restoration in mine land reclamation.

Micro-organisms are prolific producer of vitamins, amino acids and other growth regulation substances. Many soil bacteria and fungi syntheria and fungi synthesize compounds that provoke a growth in plant tissue. Some produces chormone-indol actic acid (IAA) and gibberlicacid which control plant growth, while others produce vitamins. Rhizopheric micro-organisms are differently credited with promoting increased rate of seed germination. Some micro-organism serves as bio-fertilizers and provides stability to plants to respond to stress and to promote growth of pant on mine spoil.

XXI. Some Success Stories of RCF and JCF

GHANSHYAM COLLIERY (ECL, WEST BENGAL): This colliery in Raniganj Coalfields has opencast mined-out area and overburden dumps. Some of the mined-out areas were backfilled and a large operation was left for water storage. The quarries are on both side of GT road. On the north side the water pond has been developed and the backfilled area has been densely planted. On the south side plantation on overburden dumps have survived for more than 6 years and now give a good aesthetic view.

KATRAS O.C.P (BCCL, JHARKHAND): In this project large area of overburden dumps have been reclaimed by plantation on the east side of the mine up to the railway track. The plantation consists of the following species:

a. Dalbergia sisoo
b. Acacia nilotica
c. Acacia auriculiformis

These plantations are surviving for the last five years and some grass is also growing on this over burdens. This gives good picture of biological reclamation of the OB dumps. It may, however, be noted that the initial OB on the eastern side was having some top soil mixed with it. It was not as refractory as the present OB dumps on the quarry.

XXII. Conclusion

In the forgoing discussion we have discussed broad aspects of mined and reclamation along with the ecological restoration. The key to the success is perseverance with the improvement of vegetation cover. The main support to this key is meticulous planning of the OB dumping in proper horizon and strict adherence to the sectional dumping. Preservation of the top soil and its timely reuse are other key areas to achieve fast environmental rehabilitation. The success stories discussed indicate that both in backfilled areas as well as overburden dumps sincere efforts will pay. It is concluded by saying that rehabilitation of the mined-out areas needs care at all the stages and for an encouraging result the awareness at the project and at the area level has to be generated. Once convinced of the good results of the efforts the operational people will involve whole-heartedly and the success of the rehabilitation measures can be ensured.

Opencast mining in the Raniganj and Jharia region has created deep depression and massive flat-topped overburden dumps of sandstone and carbonaceous shales. These rocky materials have very little organic matter and need to undergo special treatment before they can be reclaimed and revegetated. Open cast mines have now become the largest agent for destroying and dereliction of land in Raniganj and Jharia coal belt. According to CMPDIL report (2010) approximately 55.5 Sq. Km. of land has become abandoned due to active surface and underground mining the land excavated in such mines is lost forever to the local community, stagnant waters of exhausted depressions either become a source of malaria or the water quickly dries up in summer and have little resource value. The dumps are regular death traps for local children who haunt the sites in search of leftover coal. The opencast mines have led to alternations in geomorphological, hydrological and biotic processes both at the local and the regional level, leading to the disruption in ecosystem development.

Rarnganj and Jharia coal mining region plays an important role in countries overall development. This region has well developed transport and communication and rich in mineral resources. This famous coal bearing region has got very well scope for large industrial development along with other developments of agriculture, livestock, forest, water and other minerals. An integrated approach is very necessary for a sustainable development in this region.

It is thus clear that coal mining leads to environmental damage, while economic development and self-reliance call for the increased mining activities of the available mineral resources. Though there is no alternative to the site of mining operations, options as to the location and technology of processing, adaptation of eco-friendly coal mining process and a forestation in the mining site etc. can really minimize that damage to the environment.

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