

# MITIGATING ENVIRONMENTAL AND SOCIAL IMPACTS OF COAL MINING IN INDIA

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## *Abstract*

*Coal is the only natural resource and fossil fuel available in abundance in India. The major environmental challenges encountering the coal industry are impacts of mine fires, dust suppression and control particularly haul road dust consolidation, treatment of mine waters containing heavy metals/acid mine drainage, restoration of water table and quality of ground and surface water, augmentation of pumped out mine water for drinking purpose, reclamation of mined out areas with pre-determined land use patterns conducive to the local populations etc. The biggest environmental challenge facing the coal industry is the issue of greenhouse gases and acid rain. Overall environmental management improvement has been taking place with the implementation of state of art environmental management schemes particularly under Environmental and Social Mitigation Project (ESMP) of CIL.*

*A great ongoing social challenge for the coal industry is sustainable development and community acceptance of its role in society. The problem of mining-induced displacement and resettlement (MIDR) poses major risks to societal sustainability. MIDR is accompanied by the resettlement effect, defined as the loss of physical and non-physical assets, including homes, communities, productive land, income-earning assets and sources, subsistence, resources, cultural sites, social structures, networks and ties, cultural identity and mutual help mechanisms.*

*Even with its major hurdles, coal will remain a future mainstay, a foundation and a fundament of our economy. Coal has a crucial role in meeting current needs and is a resource bridge to meet future goals through the enhancement of knowledge and technology. The challenge is to apply the right technology in the most efficient and environmentally friendly way.*

## **Introduction**

World's population is expected to reach over 8 billion by 2030, from its current level of 6.4 billion and consequently global energy demand will grow by almost 60 percent by 2030 and rise to 16.5 billion tones of oil equivalent per year. Fossil fuels and in particular coal will meet up this challenge in future. Nuclear energy though provides a significant proportion of energy in some countries, but in general it faces serious public opposition. Renewable energies are growing fast, but make up only a small part of global energy production- the International Energy Agency (IEA) predicts that by 2030 only 14 percent of total energy demand will be met from renewable sources. In fact it is not wise to depend on a single source of energy.

Coal can play a unique role in meeting the demand for a secure energy supply. Coal is globally most abundant and economical as well of all fossil fuels, which can be used for both power generation and industrial applications. The production and utilization of coal is based on well-proven and widely used technologies. Coal reserves are significantly more abundant and much more widely and evenly dispersed than other fossil fuels. The world currently consumes over 5500 million tones of coal for use in power generation, steel production, cement manufacture, as a chemical feedstock and as a liquid fuel.

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This paper was presented in 1st International Conference on "Managing the Social & Environmental Consequences of Coal Mining in India" during November 19-21, 2007 at New Delhi.

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Coal is the most abundant fuel resource in India. It is the prime source of energy and perhaps the largest contributor to the industrial growth of the country. Coal industry has come a long way since independence. Coal mining, which was operated in small scale and mainly confined to Jharia and Raniganj Coalfields of Bihar and Bengal, today spreads over to several States. After nationalization of coal mines, enhanced investment, increased share from opencast mining, increased emoluments and welfare amenities for coal workers, etc. resulted in large increase in production. As a consequence of increased demand for coal, more and more coal is being mined and processed. It has resulted in an unprecedented expansion of coal mines in India. The coal production in India has risen from 73 Mt in 1972 to about 407.02 Mt in 2005-06.

### **‘Coal Vision 2025’**

Standing Committee on Coal and Steel observed that in the absence of a Vision Document, Department of Coal was not in a position to plan and act in order to meet the future coal demand. The Committee, therefore, expressed grave concern for want of a vision document for the coal for the next 20-25 years, a long-term perspective plan because of which not only the performance of coal companies was being crippled but also there would be a yawning gap of more than 95 million tonnes in the next five to ten years in the demand and supply of coal that was required for core sectors like power generation steel, aluminium and infrastructure. The Committee, therefore, strongly recommended that the Department of Coal should come forward with a vision document, i.e. “*Coal – 2025*” without any further delay and constitute a task force for holding consultation/discussions with experts and industry at large, in this direction, so that the Department could have a long term view of the industry. The outcome was ‘Coal Vision 2025’ brought out by the Ministry of Coal, Government of India.

- ◆ The Coal Vision 2025 indicates that the overall annual growth in coal demand till 2025 is expected to be 5.62% with 8% GDP growth scenario, and 5.04% with 7% GDP growth.

This means that the demand for coal would increase to 1147 MT (7% GDP growth) and 1267 MT (8% GDP growth) in 2025. The total domestic coal production is projected to increase to 1086 MT in 2025, of which the opencast production will be 902 MT (83%).

- ◆ The Coal Vision 2025 asserts that CIL (Coal India Ltd ) would be able to reach a production level of 500 MT by 20011/12 and continue to produce at the same level till 2036/37 if, in addition to its existing mines and projects, it is allowed to use the identified 289 virgin coal blocks for future projectization (meaning to bring under production). This leaves behind 136 virgin coal blocks being offered for captive mining and 74 coal blocks known as non-CIL blocks , totalling to 210 blocks with only 13 BT of proved reserves and 28 BT of indicated and inferred resources.
- ◆ The Coal Vision 2025 further asserts that the production from CIL alone would be able to reach 893 MT by 2025 to partially meet the total domestic coal demand of 1086 MT. The remaining 222 MT has to be contributed by SCCL (Singareni Collieries Company Ltd) and/or private sector, and 25 MT is expected through CBM (coal bed methane) equivalent.
- ◆ Coal Vision 2025 has estimated that 1,70, 000 families or 8,50, 000 displaced persons would have to be rehabilitated by 2025 when the requirement for land would double from current 147, 000 ha (hectares) to 292 500 ha.
- ◆ The requirement of forest land for mining would also increase more than three-fold from the current 22, 000 ha (15% of the current total land requirement) to 73, 000 ha (25% of the projected total land requirement) since much of the coal resources to be exploited in future are located in forests.

### **Environmental and social challenges facing the Coal Industry**

Coal plays a fundamental role in global development, but it must meet a number of social and environmental challenges to demonstrate its role in sustainable development. Coal is the world’s most abundant and widely distributed fossil fuel resource, emphasised by the role coal has

played in underpinning world's economic and social progress. The coal industry recognises the need to address issues that challenge the role of coal in the transition to a more sustainable society.

#### **(A) Environmental Issues**

It is important to understand the environmental impacts of mining, processing, and utilization of coal. The choice of mining method is largely determined by the geology of the coal deposit. Underground mining currently accounts for about 60 percent of world coal production, although surface mining is more common in several important coal producing countries. In India also surface mining is given importance. Surface mining or opencast mining is only economic when coal seam is near the surface.

Opencast mines damage a large land surface area, displace people from their ancestral homesteads and cause agricultural losses. But the method is cost effective, recovery is high, comparatively better in safety aspects and is considered to be a modern method. Surface mining requires large areas of land to be temporarily disturbed. This raises a number of environmental challenges, including soil erosion, dust, noise and water pollution, and impacts on local biodiversity. Mine subsidence can be a problem with underground coal mining, whereby the ground level lowers as a result of coal having been mined beneath. Steps are taken in modern mining operations to minimise these impacts. Good planning and environmental management minimises the impact of mining on the environment and helps to preserve biodiversity.

Whether coal is to be extracted by Opencast or by Underground methods of mining the selected method is to acknowledge the need to reduce environmental impact and to provide security of supply, deliver environmental and social goals and promote competitive energy markets.

#### **I. Impact of Mining on Air Quality**

Air pollution in coal mines is mainly due to the fugitive emissions of particulate matter and gases including methane, sulphur dioxide, oxides of nitrogen and carbon monoxide. The major operations producing dust are drilling, blasting, hauling, loading, transporting and crushing. Basically, dust sources in mines can be categorized as primary sources that generate the dust and secondary sources, which disperse the dust and carry it from place to place called as fugitive dust.

Opencast coal mining is more severe an air pollution problem in comparison to underground coal mining. In underground coal mining men suffer from coal dust inside underground mine workings. But opencast mining create much more air quality deterioration in respect of dust and gaseous pollutants. It creates air pollution problem not only within the mining premises but also in surrounding residential area affecting abundant air quality. High levels of suspended particulate matter increase respiratory diseases such as chronic bronchitis and asthma cases while gaseous emissions contribute towards global warming besides causing health hazards to the exposed population. The vehicular traffic on haul roads has been identified as the most important cause of fugitive dust emissions and can contribute as much as 85% of the dust emitted from an opencast coal mine.

**Mitigation:** The following measures can be adopted for minimizing the generation of dust in the mining and associated activities.

- Use dust extractors with drills.
- The blast design should be optimized for obtaining proper fragmentation and then minimizing the dust generation.
- Use suitably designed water sprays at the transfer points to suppress the dust.
- Control and manage the generation of dust on the haul roads, either by suitable spraying or by using appropriate chemicals.
- Use air pollution control systems in the washeries and enclosed coal handling plants.

- Plan for the development of green belts around the areas having mining and associated activities.
- Plan for the formation of soil stacks and overburden dumps in such a manner that the contribution of these activities towards the concentration of SPM in the ambient air is minimum.

### ***Problem with greenhouse gases, acid rain and ground level ozone***

The key environmental challenges facing the coal industry are related to both coal mining and the use of coal – greenhouse gases, acid rain and ground level ozone, issues which can be local, regional and global in their impacts.

The greenhouse effect is a natural phenomenon which refers to the increase in the earth's surface temperature due to the presence of certain gases in the atmosphere. There is concern that this natural phenomenon is being altered by a greater build up of gases caused by human activity. This is known as the enhanced greenhouse effect. The combustion of coal, like that of other fossil fuels, produces CO<sub>2</sub>, a gas that is linked to global warming through the greenhouse effect.

The combustion of coal produces gaseous emissions of sulphur dioxide (SO<sub>2</sub>) and nitrous oxides (NO<sub>x</sub>) that are responsible for the production of 'acid rain' and 'ground level ozone'. Acid rain occurs when SO<sub>2</sub> and NO<sub>x</sub> gases react in the atmosphere with water, oxygen and other chemicals to form acidic compounds. Ground level ozone (O<sub>3</sub>) is mainly responsible for smog that forms a brown haze over cities. Ground level ozone is formed when NO<sub>x</sub> gases react with other chemicals in the atmosphere and is enhanced by strong sunlight. Emissions of SO<sub>2</sub> and NO<sub>x</sub> are termed trans-boundary air pollution because the environmental impacts from the production of these gases are not restricted by geographical boundaries.

## ***II. Impact of Coal Mine Fires***

A number of coal mines in the country are affected by fires leading to steady destruction of precious energy resource. The reason for mine fires presumably involves the phenomenon of spontaneous heating through two interrelated processes viz., the oxygen coal interaction or oxidative process and the thermal process. If remains uncontrolled, the fire could spread further through interconnected pathways and fissures in the strata. It is estimated that about 10% of total national coal resources are in the fire-affected areas.

Mine fires give rise to several environmental problems besides safety hazards and economic losses. The major adverse impacts of mine fires are observed on all the four basic components of the environment viz. air, water, land and population. Mine fires to a great extent are responsible for polluting the atmosphere. The effects of fires on air are severe once the fires become surface fires. The pollutants released from mine fires mainly comprise of gases like carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), saturated and unsaturated hydrocarbons, hydrogen sulphides (H<sub>2</sub>S) and other photosensitive oxidants apart from particulate matter. Unburnt hydrocarbons in presence of NO<sub>x</sub> and other photosensitive oxidants cause eye irritation due to formation of smog like conditions.

### **Mitigation:**

- ◆ Do not leave loose coal on the floor and sides of the openings and in the goaves in underground workings and on the coal benches in opencast mines.
- ◆ Do not leave the surface cracks due to subsidence without filling. Do not fill the cracks by sand.
- ◆ Do not burn dried grasses, etc. on the surface close to the opencast mines, outcrops, subsided areas, abandoned quarries, etc.
- ◆ Do not make dumps of carbonaceous shales and pyrite containing rock mass mixed with other rocks.
- ◆ Plan for proper and adequate ventilation of the mine workings.

- ◆ Plan for minimum possible exposure of coal seams in opencast mines.
- ◆ Wherever possible, stop access of air to the active fires as a first step towards mitigation.

### **III. Impact of Mining on Water regime**

Mining and its associated activities not only uses a lot of water but also affects the hydrological regime of the district and often affects the water quality. The major hydrological impact of a large and deep opencast mine, however, is on the ground water regime of the region. The water seeping into the mine and collected in the mine sump is partly used up in the mine and the excess amount is discharged into the surface drainage system. The water used up in the mine for spraying on haul roads, conveyors, at loading and unloading points, bunkers etc. are lost by evaporation. A deep mine is likely to have longer haul roads requiring more spraying water. Many areas of the country are faced with the problem of over exploitation of ground water resources resulting in alarming lowering of water table. Therefore a lot of care has to be taken in estimating the water need and the mines of future are likely to be subjected to a lot of constraints on water use and discharge.

**Mitigation:** The following measures can be adopted for optimizing the impacts of mining on the water regime.

- Plan the surface layout of the opencast and underground mines in such a manner that the impacts on the surface water bodies as well as the surface drainage system are the minimum.
- Plan the opencast and underground mines with provisions for the development of underground and surface water bodies so that in the post mining period water in sufficient quantity is available for various uses.
- In both the underground and opencast mines water is pumped out of the mines. This water should be planned for treatment so that the requirement for domestic and industrial uses can be met.

### **Augmentation of pumped out mine water**

The mining industry has to discharge millions of litres of water everyday to the adjacent watercourses and thereby may cause water pollution in and around the mining areas. This water, otherwise a valuable water resource because of acceptable quality, becomes contaminated with various domestic and industrial trade effluents and subsequently is just wasted while putting on an extra cost burden on the underground mines. Further costs are incurred on abstraction of water from adjoining surface water bodies containing this water and additional costs are required for the treatment to meet the water quality objective criteria. It is emphasized here to augment and protect this precious ground water availability of nearly acceptable quality to meet various water demands particularly drinking water of already affected mining population. Augmentation of pumped out mine water from coal mines for various water supplies particularly for potable purpose should be the prime goal of the concerned mining authority in the already drought prone thickly populated mining areas.

#### **◆ Acid Mine Drainage**

Acidic water results in severe water pollution problems. Acid Mine Drainage (AMD) refers to distinctive types of waste bodies that originate from the weathering and leaching of sulphide minerals present in coal and associated strata. Environmental effects of AMD include contamination of drinking water and disrupted growth and reproduction of aquatic plants and animals. Effects of AMD related to water pollution include the killing of fish and loss of aquatic life and corrosion of mining equipments and structures such as barges, bridges and concrete materials.

AMD is the most persistent pollution problems in mines of North Eastern Coalfield. Generally, water quality characteristics of acidic mine water reflect high acidity and high hardness

along with high iron and sulphate contents. Various toxic trace/ heavy metals become soluble in acidic water and may be presenting significant to concentration levels depending upon their availability in the source material. Fortunately the considerable majority of coal mining areas are safe and only in a few localized areas problem of AMD exists. AMD cripples the economy of mines due to compliance of stringent environmental standards and involves huge cost burden in its management.

**Mitigation:** Some of the mitigative measures that can be used in the dealing with the Acid Mine Drainage are outlined here:

- ◆ *Bacterial Inhibition*
- ◆ *Active Treatment Methods:* Limestone, Hydrated Lime, Soda Ash, Caustic Soda, Ammonia
- ◆ *Passive Treatment Methods:* Constructed Wetlands, Pyrolusite Process, Microbial Reactor System, Bio-sorption System, Limestone Ponds, Open Limestone Channels, Limestone Sand Treatment, Diversion Wells, Anoxic Limestone Drains, Vertical Flow Reactor
- ◆ *Mine Sealing*

#### **IV. Impact of Mining on Land**

Irrespective of the type of mining used for extracting coal, mining invariably results in enormous land disturbance- e.g. large scale excavation, removal of top soil, dumping of solid wastes, cutting of roads, creation of derelict land etc.

Opencast mining has more potential impact on land than underground mining. With improved technology, opencast coal mining is being used extensively because of its cost effectiveness and productivity though it results in large-scale land disturbance. Although underground mining has considerably less impact than opencast mining on land, it causes enough damage through subsidence as observed in Jharia and Raniganj Coalfields. The surface subsidence inflicts severe damages to engineering structures such as highways, buildings, bridges and drainage besides interfering with ground water regime.

**Mitigation:** Given below are the measures that can be adopted for the optimization of the impacts on land.

- Design the mining and associated activities for the minimum possible land requirement.
- Predict the subsidence movements due to underground mining and their impacts on the land and its uses.
- Design the mining activities in such a manner that the changes in the surface drainage pattern are minimum.
- In case of opencast mines plan the mine with decommissioning, closure, reclamation and rehabilitation so that the land after mining can be brought in economic uses.
- Provisions should be made in opencast mining for separate removal and handling of top and sub-soils so that these can be re-laid at the time of reclamation for developing the land uses of the reclaimed surface.

#### **V. Impact of Noise and Vibrations from Mining**

A cumulative effect of all mining activities produces enormous noise and vibrations in the mining area, which constitutes a source of disturbance. The availability of large diameter, high capacity pneumatic drills, blasting of hundreds of tonnes of explosive etc. are identified as noise prone activities. Inpit crushing system with mobile crusher and large capacity materials handling plants are being installed to facilitate speedy handling of large quantities. All these activities are major sources of noise & vibrations in and around the mining complexes.

The obvious implication of noise is, of course, the potential for noise-induced hearing loss. In addition, noise produces other health effects, influences work performance and makes communications more difficult. Besides, the fauna in the forests and other areas surrounding the mines/industrial complexes is also effected by noise and it has generally been believed that wildlife is more sensitive to noise and vibrations than the human beings.

**Mitigation:** The management and mitigation techniques should incorporate the following:

- All potentially noisy construction equipment should be selected taking into consideration the sound power level of the equipment.
- All conveyor systems should be inspected on at least a weekly basis.
- Operators of noisy machinery should be instructed and trained in noise minimisation techniques.
- Fixed items of equipment, such as pumps should, where practicable, be located in positions where noise effects to residents in the vicinity are minimized.
- If any noisy operations have the potential to exceed the specified noise limits, specific barriers, enclosures or other effective means should be utilized for that operation to ensure that the specified limits are not exceeded.
- Use of additional equipment, such as enhanced vehicle mufflers.
- Reduction in operating hours for noisy activities.
- Addition of secondary exhaust mufflers on hydraulic excavators.
- Change in location of noisy equipment.

**(B) Social Issues**

Coal mining, despite the very substantial benefits they bestow on society, stir strong emotions. A great ongoing social challenge for the mining industry is sustainable development and community acceptance of its role in society. The problem of mining-induced displacement and resettlement (MIDR) poses major risks to societal sustainability.

*(i) Landlessness:* MIDR raises the significant risk of landlessness by removing the foundations upon which productive systems, commercial activities, and livelihoods are articulated.

*(ii) Joblessness:* The ethnic people living in the designated areas depend generally for their livelihood on the land. Since, in mining areas the land is taken for mining and associated activities these people lose their livelihood. Post-displacement unemployment or underemployment is often chronic following the dismantling of the local income-generating resource base.

*(iii) Homelessness:* Defined as the “loss of house-plots, dwellings and shelter.” For many people homelessness may be only temporary, but in poorly executed displacements, it remains chronic.

*(iv) Risk of Marginalization:* The risk of marginalization threatens displaced individuals and entire communities as they slip into lower socio-economic status relative to their local areas.

*(v) Changes in population dynamics:* All the manpower required for mining and associated activities comes from outside as such trained manpower is usually not available in ethnic population. Thus, the population dynamics of the area undergoes a major change over the years resulting in dilution of the ethnic population

(vi) *Cost of living*: Increased industrial and economic activities generate more money and increase the buying power of the people directly and indirectly associated with these activities. This leads to an increase in the cost of living, which adversely affects the other people, including ethnic people, who are not associated with these activities.

(vii) *Health Risks*: The already marginal health status of displacees is worsened by the stress and trauma of moving. Recurring problems are reported with resettled populations gaining access to safe potable water and safe sanitation; increased diarrhoea, dysentery and epidemic infections often result.

(viii) *Disruption of Formal Educational Activities*: Risk occurs in the disruption of education and routine socialization. Displacement and relocation often cause a significant interruption in the functioning of schools and in child access to education during the year of transfer or for longer periods of time.

(ix) *Addictions*: Increased economic activities and affluence brings in more addictions in the society. In the tribal areas the ethnic people may also get affected by additional addictions.

**Mitigation**: Often mining-induced removal and resettlement of populations threatens rights to a livelihood which meets basic needs. Therefore, projects must be designed so that resettlement is minimized or avoided wherever possible. Treating resettlement issues as an integral component of the overall mining project and dedicating proper planning, implementation and financial resources is necessary for the success of a project's ability to restore or even improve social and economic well being to the displaced population.

Mining companies must accept the right of land-owners to negotiate access to their land, to determine whether or not exploration or mining takes place there. If access is given, they must be able to negotiate conditions, such as the preservation of sacred sites, access to traditional hunting grounds, proper resettlement and rehabilitation of those who have to be moved and the determination of compensation packages. In conjunction with community representatives, companies should develop protocols for conducting negotiations over land. These should include procedures for identifying land-owners, conducting meetings, providing technical advice, handling differences between land-owners and determining when negotiations should cease.

Account should be taken of alternative plans proposed by the affected people, who must be allowed to identify suitable resettlement sites. Where those being displaced have agriculture as their primary source of income and livelihood, every effort must be made to replace land with land. If suitable land is not available, other strategies built around opportunities for employment or self-employment should be used. Relocated people must receive legal land titles for their resettlement plots, whether these are house plots or agricultural land.

### ***(C) Examples of Best Management Practices***

#### **• National Policy on Rehabilitation and Resettlement, 2007**

The Union Cabinet gave its approval for the National Policy on Rehabilitation and Resettlement, 2007 on October 11, 2007 to replace the National Policy on Resettlement and Rehabilitation for Project Affected Families, 2003.

- ◆ The new Policy and the associated legislative measures aim at striking a balance between the need for land for developmental activities and, at the same time, protecting the interests of the land owners.
- ◆ The benefits under the new Policy shall be available to all affected persons and families whose land, property or livelihood is adversely affected by land acquisition.
- ◆ The benefits to be offered under the new Policy to the affected families include; land-for-land, to the extent Government land would be available in the resettlement areas; preference for employment in the project to at least one person from each nuclear family within the definition of the 'affected family', subject to the availability of vacancies and suitability of the affected person; training and capacity building for taking up suitable jobs and for self-employment; scholarships for education of the eligible persons from the



affected families; preference to groups of cooperatives of the affected persons in the allotment of contracts and other economic opportunities in or around the project site; wage employment to the willing affected persons in the construction work in the project; housing benefits including houses to the landless affected families in both rural and urban areas; and other benefits.

- ◆ Adequate provisions have also been made for financial support to the affected families for construction of cattle sheds, shops, and working sheds; transportation costs, temporary and transitional accommodation, and comprehensive infrastructural facilities and amenities in the resettlement area including education, health care, drinking water, roads, electricity, sanitation, religious activities, cattle grazing, and other community resources, etc.
  - ◆ A special provision has been made for providing life-time monthly pension to the vulnerable persons, such as the disabled, destitute, orphans, widows, unmarried girls, abandoned women, or persons above 50 years of age (who are not provided or cannot immediately be provided with alternative livelihood).
  - ◆ Special provision for the STs and SCs include preference in land-for-land for STs followed by SCs.
  - ◆ A strong grievance redressal mechanism has been prescribed, which includes standing R&R Committees at the district level, R&R Committees at the project level, and an Ombudsman duly empowered in this regard.
  - ◆ For ensuring transparency, provision has been made for mandatory dissemination of information on displacement, rehabilitation and resettlement, with names of the affected persons and details of the rehabilitation packages.
  - ◆ Under the new Policy, no project involving displacement of families beyond defined thresholds can be undertaken without a detailed Social Impact Assessment
  - ◆ The affected communities shall be duly informed and consulted at each stage, including public hearings in the affected areas for social impact assessment.
  - ◆ The Policy also provides that land acquired for a public purpose cannot be transferred to any other purpose but a public purpose, and that too, only with prior approval of the Government.
  - ◆ The entitled persons shall have the option to take up to twenty per cent of their rehabilitation grant and compensation amount in the form of shares.
  - ◆ One of the objectives of the Policy is to minimize displacement of people and to promote non-displacing or least-displacing alternatives.
- **Resettlement and Rehabilitation (R&R) Policy of Coal India Limited (CIL)**

Mining-induced displacement and resettlement (MIDR) increased substantially since the 1970s as the country's coal production shifted from underground to opencast mining. The issue has gone beyond economics and environment; local NGOs, such as Operations Research Group (ORG), a consultant of Coal India Limited (CIL), reported that MIDR is creating a pattern of "gross violation of human rights," and "enormous trauma in the country." By the mid-90s, Resettlement and Rehabilitation (R&R) Policy of CIL has been designed to ensure that affected people improve or at least regain their former standard of living and earning capacity after a reasonable transition period. Coal India Limited implemented the Environmental and Social Mitigation Project (ESMP) in 25 selected opencast mines with World Bank funding during 1996 to 2002. Environmental and Social Mitigation Project (ESMP) aimed to mitigate adverse effect of coal mining on environment and people affected by such activities. ESMP consisted of two components:

- **Environmental component** - implemented through Environmental Action Plan (EAP).

**Environmental Action Plan (EAP)** includes Domestic Effluent Treatment Plant, Workshop Effluent Treatment Plant, Mine Water Discharge Sedimentation Plant, Dust Suppression Majors, Tree Plantation, OB Dump Reclamation, Top Soil Storage and Spreading for Bio Reclamation, Environmental Monitoring.

- **Social component** - implemented through Rehabilitation Action Plan (RAP) and Indigenous Peoples' Development Plan (IPDP).

**Rehabilitation Action Plan (RAP)** includes Shifting of villagers affected by mining, Resettlement and rehabilitation of project affected families (PAFs) by giving a plot of land in well developed resettlement sites or a lumpsum package to settle at a place at their choice. The PAFs are also trained in different trades for their economic rehabilitation.

Under **Indigenous People Development Plan (IPDP)** villages falling within one kilometer area from the leasehold of the mines are considered. Activities under IPDP include 1. Development of Community infrastructure like School Building, Community Hall, Dispensary Building, Village Roads, School Furniture, Wells, Tube wells etc. 2. Community Activities like Mahila Mandal, Youth Club, Self Help Groups, Sports, Cultural Programmes etc. 3. Training & Capacity Building, Training for self-employment, Non-formal Education etc.

Overall environmental management improvement has been taking place with the implementation of state-of-art environmental management schemes particularly under Environmental and Social Mitigation Project (ESMP) of CIL.

- **Neyveli Lignite Corporation (NLC)**

#### ***Environmental Management***

Neyveli Lignite Corporation has accorded the high priority to Environmental management. Continuous monitoring in respect of liquid/ gaseous effluents control is carried out at units and treated effluents meet all MINAS and the statutory requirements. To improve the environment the Corporation has a planned afforestation programmes, and reclamation of wasteland development to control pollution free air in Neyveli as a regular activity of the Corporation. Neyveli Lignite Corporation is well aware of the effects of open cast mining to the environment. It therefore gives a lot of importance to pollution control, reclaiming land and maintaining ecological balance.

The dumped soil is improved in stages through modern techniques to bring back its original fertility and the agricultural operations are carried out by adding nutrients, like organic, inorganic and bio-fertilizers. Now crops and vegetables of various varieties are being continuously raised. Further it is also proposed to increase this backfilled area into cultivable land.

#### ***a. Afforestation in and around Mines***

The dreary and parched atmosphere of Neyveli, where mining began has now given way to lush greenery. The plantation helps control air pollution, acts as a windbreaker and prevents soil erosion. Massive afforestation were carried out in Mine spoil area, Industrial Units and Township.

- ◆ ***Reclamation in Mine Spoil*** : Research work was carried out in the Mine Spoil area by Organic farming, biological reclamation using biofertilizers and Humic Acid. Utilization of Fly Ash in agriculture also carried out in Mine Spoil
- ◆ ***Ash Pond Reclamation*** : R&D Works were undertaken to re-vegetate in the Ash ponds. Field trials were carried out in these areas and successfully establish re-vegetation with Orchard/Forest Species. The suspended dust particles, emitted from Mines, Thermal Power Stations and other industrial units, are being arrested by the dense tree coverage.
- ◆ ***Formation of artificial lakes, ponds and picnic spots*** : Lakes and ponds were formed in the afforested areas and a picnic spot was also created with boating facilities, along with a mini zoo with rabbit, peacock, dove, spotted deer, duck etc. Fishes are bred in the lake. Different varieties are being grown. Water bodies, green shady trees and good climate attract birds from far and near. Neyveli has become a bird sanctuary and hundreds of species visit during different seasons.

### ***b. Water Conservation***

Many water conservation measures have been taken up by NLC like

- Optimization of ground water pumping in Mines,
- Introduction of dry ash disposal system.
- Artificial recharging of ground water etc., and
- Stoppage of ground water pumping for Township and using mine storm water after treatment for Township.

Neyveli is now rich with crops, trees, lakes making it clean and green.

### ***c. Air Pollution Control***

- Dilution of gases emission through wind sweeping and vertical mixing.
- Green belt development to act as a barrier.
- Water spraying at excavator face, along the conveyors and on haul roads.
- Dust extractors and wet drilling.
- Black topping of service roads.

### ***Social Measures***

In acceptance of its social responsibility , NLC has been offering jobs to the Project Affected Persons(PAPs) to the extent possible, apart from resettling them in the well-developed Resettlement Centres(RCs). Further, a Corporate Resettlement and Rehabilitation Policy(RAP) has also been framed and being implemented for the benefit of the various section of the PAPs who have given lands.The displaced persons are being resettled smoothly as per the provisions of the RAP.

### ***Peripheral Development :***

- Drinking water to surrounding villages
- Irrigation water to 20,000 acres in nearby villages
- Facilities for mentally handicapped children, destitute women and aged people 'Sneha'.
- A Centre for making Jaipur type artificial limb for handicapped
- Free Medical Camps for surrounding villages; Sterilizations.

A school for the speech and hearing impaired "Shravanee".

- **Gujarat Mineral Development Corporation Limited (GMDC)**

### ***Environmental Management***

Mining of minerals and associated activities adversely affect the environment resulting in degradation of land, air, water and noise pollution. Considering the serious consequences of the situation, GMDC took a leading step towards massive afforestation at the mines with reclamation of the mined out areas. The Corporation has planted almost over 7 lakh saplings over 812 hectares of land at its different projects.

As a policy to be proactively engaged in managing environmental matters an effective Environment Management Systems is being followed, for that an environment cell reporting to Chief Executive is working to plan execute, monitor and control environment protection measures from Corporate level to unit level.

The reclamation of the mined out area is also going on systematically. The near original contour is achieved and large number of fruit trees are grown over it. Steps are taken for suppression of dust by large water sprinklers on mines haul roads. Some chemicals are also tried to consolidate roads to minimize dust generation by movement of heavy vehicles.

Effluent treatment plant has been working to control the pollution of water, the output of this plant is partly recycled and partly used for plantation, a policy of zero discharge is being

followed. Sewage treatment plant is working for control of pollution of water in residential colony for last twenty year.

Monitoring of the environment has also a regular habit. An in-house team is on the job, which visits all the working projects once every month to conduct surveys for air and water. In addition, an external GPCB approved agency is also deployed for monitoring the environmental conditions.

Environment Audit is one of very important aspects to assess the efficacy of Environment Management Systems and it is being regularly under taken by external agency.

### ***Social Measures***

GMDC strikes a perfect balance between developmental aspirations, environmental concern, conservation of other natural resources and safe mining practices. Social equilibrium of the people inhabiting the mining region is an over-riding concern. In all mining regions, GMDC undertakes a series of measures for ideal rehabilitation, enhancement of community, infrastructure and development of existential support systems. GMDC has corporate culture of carrying social commitments viz., multifaceted measures for ideal rehabilitation of population, enhancement of community infrastructure, development of infrastructure and support systems. GMDC has water empowerment by (1) constructing check dams, bore wells and water storage tanks, (2) building drinking water sources for humans and animals, (3) enabling irrigation in drought prone areas, (4) reducing salinity ingress through water resource empowerment and (5) helping community to conserve water by rain and dew water harvesting.

GMDC generating rural employment opportunities through making arid lands irrigable and cultivable. For education purpose, GMDC renovating schools, building and helping educational institutes for rural infrastructure development. GMDC constructing pucca roads, bus stops, walls and structures, Panchayat house, community halls, Anganwadis, community bathing houses, sports centres, hostels for weaker sections. For health care, GMDC organizing diagnostic camps for the poor, helping TB and leprosy patients, assess higher health care, arranging low cost treatment in cardiology, nephrology and cancer care, operating ambulance vans and mobile clinics in rural interiors.

- **Tata Steel Limited**

Tata Steel Limited has two collieries in West Bokaro and Jharia, in the state of Jharkhand. While West Bokaro unit is an open cast mine, the Jharia unit is underground. The coal mines are about 150 kms from the steel plant at Jamshedpur and produce superior grades of clean coal. Tata Steel's collieries use 'Surpac', a state-of-the-art mine planning software that estimates the volume of coal in every seam. This software is coupled with qualitative detailing that focuses on output consistency. To maximise productivity and utilisation, a voice and data equipped Global Positioning System is used, which helps to supervise mining activity for machine movement and engine status. The collieries division is equipped with in-house washeries, which use the beneficiation process to separate coal from impurities. The Dense Media Cyclone process utilised over here refines coal particles smaller than 13mm while Froth Flootation Cells processes coal below 0.5 mm.

### ***Eco-friendly Mining***

Tata Steel Limited is fully committed to preserve nature's balance for posterity and is awakened to the dangers of reckless mining, which may lead to ecological devastation. The entire mining operation of the Company is safe guarded against accident occurrence. Proactive measures are undertaken to ensure the employee's health and productivity through ergonomically designed work stations and by protecting them from occupational hazards. All its mines are ISO-14001 - Environmental Management System Certified. In addition to conducting massive tree plantation campaigns, locations specific, environmental management initiatives have been taken.

## *Collieries & Mine*

Close circuit effluent management, Auto dust suppression, Centrifuges to check the ore fines in waters, Recycling washery rejects in power plants, Electro static precipitators, transformation of subsided area into natural landscapes, utilisation of fly ash to land field, Afforestation and waste land development. First slime dam in the country, Check dams to arrest rain run off, Environment laboratory, Botanical park, Back filling etc.

## *Environmental Management*

### **a. Water discharges, runoff and the receiving ecosystems**

West Bokaro and Jharia Collieries have all achieved zero discharge. The domestic effluent is discharged through the septic tank - soaking pit route at the Mines & Collieries.

#### ◆ **Work area environment**

Tata Steel has implemented a variety of mitigative measures to improve the working environment at the shop floor and work area environment quality at different places.

#### ◆ **Total water use**

Tata Steel has taken various actions for optimum use of water. The increased emphasis on water recirculation in all process units has contributed to considerable reduction in specific water consumption. The Company does not use any ground water source for industrial or domestic use. The potable water supplied by the Company to the city matches all national and international parameters.

### **b. Biodiversity**

#### ◆ **Reclamation and Afforestation of Land**

Massive plantation in all the units of Tata Steel initiated in 1998 as the "Green Millennium" countdown. It led to 1000 trees being planted per day for 1000 days to greet the new millennium with one million trees. More than 240 hectares of mined out areas in its outlocations have been reclaimed with plantations so far.

Survival rates have improved from 30% to 85% by providing protection to the saplings planted and watering them during dry periods in the past 10 years.

#### ◆ **Impact on bio-diversity**

The Environmental Impact Assessment has been undertaken for all the units of Tata Steel. The reports indicate that there is no major impact on bio-diversity associated with the Company's activities and/or products and services in territorial, fresh water environments. No reportable changes to the natural habitats have occurred from the Company's products, services and activities as indicated by the Environmental Impact Assessment Studies conducted for all the units, including Mines & Collieries.

## *Social Measures*

#### ◆ **At the vanguard of social commitment**

Tata Steel has for decades used its skills and resources, to the extent it can reasonably afford, to give back to the community a fair share of the product of its efforts. It was the first to establish labour welfare practices, even before these were made statutory laws across the world.

#### ◆ **Health and Hygiene**

The tribal population is dispersed across a wide geographical area of Jharkhand and Orissa, where most of Tata Steel's operating units are located. To promote better health among them, Tata Steel operates 46 mobile clinics in areas within Jamshedpur, surrounding rural areas and the mines and collieries in Noamundi, West Bokaro, Sukinda, Bamnival and Jamadoba, among others. Tata Steel also organizes eye camps, which provide free treatment to cataract patients, 75 per cent of

whom are tribals. The Company also ensures safe drinking water for the tribals by not only installing new tube wells but also repairing and maintaining existing ones.

#### ◆ Northern Coalfields Limited (NCL)

##### *Environmental Management*

Northern Coalfields Limited (NCL) is committed to the Environmental Conservation and Pollution Control. The company has framed its own Environmental Policy and developed Effective Management Programme to minimize the impact on environment due to mining operations. Programme has also been adopted to train all employees with respect to Environmental Awareness and Mitigation Measures.

##### **Air Pollution**

Air pollution control measures adopted by NCL are:

- Drills are provided with dust extractors to control dust at source.
- Approach roads to mines and service roads are provided with black topping to reduce dust generation.
- Water sprinklers of fixed type and mobile type are deployed for dust suppression on haul roads.
- Dust cyclones are provided at bottom of receiving pits of crusher house.
- Coal Handling Plants (CHP) have been fully enclosed to reduce coal dust emission out side it.
- Coal is loaded to Merry Go Round (MGR) System through Rapid Loading System in moist form.
- To despatch by truck, coal is wetted after loading and then covered with tarpaulin.
- Thick green belt curtain, in the form of tall plants with broader leaves, have been provided at mine boundaries to arrest air borne dusts.
- Under Over Burden (OB) dump reclamation plan, non-active OB dumps are provided with vegetative covers to prevent dust emission.
- Provision made for dust proof cabins in HEMM and dust masks to employees exposed to dust.
- Fire hydrant system installed at CHPs, Coal Dumps, etc.

##### **Water Pollution**

Water pollution control measures adopted by NCL :

- **Sewage Treatment Plant (STP)**

Domestic STPs have been constructed in the township with activated sludge process. Plant contains aeration units for oxidation, clarifiers for removal of suspended solids, sludge drying beds, grit removal facilities, sewer lines, manholes, pump houses, control room, etc. Treated water is taken for reuse in tree plantation, horticulture, construction activities. Dried sludge is valuable manure for tree plantation and horticulture works.

- **Effluent Treatment Plant (ETP)**

Integrated Industrial ETPs are designed for average discharge from mines, workshops and CHPs. The plant contains traps for recovery of oil & grease, clarifiers for removal of suspended solids, flush mixers for chemical dosing, sludge drying beds and pumping arrangements. Treated water is reused for tanker filling, sprinklers, etc. Dried sludge are buried in lined pits.

- **Silt Arrestors**

Substantial amount of silts are carried along with run off water. Catch drains with silt arrestors are provided in mines area. Those are cleaned at regular intervals. Check dams and siltation ponds are provided to arrest silt flowing into the watercourse. Gabions (loose boulders packed in wire crates) are provided at toe of the active dumps and across the water course with filter pad to stop silt escape into water body.

### **Noise & Ground Vibration Control Measures**

- Blasting operations are carried out between 1200 to 1500 hrs being lean period for project work.
- Muff and/ plugs for ears are provided to employees under effect of noise.
- Curtain plantations are provided at mine boundaries.
- Routine maintenance of all equipment is done to control noise and vibration.

### **Reclamation of OB Dumps**

Vegetative covers over bare OB dumps have been provided in major projects. It ensures stability to dump slopes. The dumps have been reclaimed by constructing proper benching and providing reinforced grass-mat covers, gabions and drains. The slope surface has been covered with mixture of grass-seeds, agricultural soil and manure laid in coir/ hay/ straw / geo-textile-mat. The plantation of trees, shrubs and grass has been done profusely on crowns of dumps, ring bunds, dykes, recess, slopes, etc to ensure thick biological growth. For maintaining vegetative cover, water sprinklers have also been deployed at specific points.

### ***Social Management***

NCL is conscious of its responsibility towards its Corporate Social Responsibility. Under the community development programme, tribal sub-plan and special component plans encompass various measures to provide different facilities to the local people living in the nearby area.

- Employment provided to the land oustee as per existing norms.
- Displaced families rehabilitated at alternative sites.
- A no of rehabilitated village provided with facilities like schools, Tube wells/ hand pumps, Wells, Link Roads, Community Halls, Health Centres, Street Lighting, Shopping Centres, Panchayat Bhawan, Children Parks/ play ground and Tree Plantation.
- Steps taken to generate self-employment potentials for PAPs, tribals and economically weaker society.
- Keeping in view the corporate social objective, NCL has taken due care of the effective rehabilitation and resettlement of project affected persons (PAPs). Besides payment of compensation for the land acquired by the company, five rehabilitation complexes have been developed for resettlement.

### **Conclusions**

Coal would continue to serve as the primary energy source, as India is endowed with considerable coal reserves but with limited oil and gas resources. However, the increased demand would result in increased coal mining and consequently the concern over its environmental and social impacts. From the preliminary survey to final consumption stage, coal mining affects environment through land degradation, de-forestation, pollution of both surface and underground water regimes, air pollution, noise, vibration and its effect on plants and wild life. The intensity of mining impact largely depends on the method of mining, stage and size of the operation. Surface mining, in particular, causes severe damage on the environment. Even though subsidence and mine safety are important factors affecting underground mining, it does not have any of the adverse effects on environment. Hence choice of technology becomes crucial for guaranteeing the protection of the environment.

The negative impact of mining on health, land, water, air, plants and animals, and other aspects of society can be reduced by careful planning and implementation of mining. Even though mining brings in its wake several disasters, it is also beneficial to society. It is essential to strike a balance between mineral developments on the one hand and the restoration of the environment on the other.

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