

SUSTAINABLE DEVELOPMENT STRATEGIES FOR MINING BY THE GOVERNMENT OF INDIA AND THE IMPACTS OF MINING ON THE ENVIRONMENT

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Abstract: Mining is the source of metals that are required for the human-built environment. The mining industry is an important entity for the development of a country. Though a country's economic value rises due to mining, the mining industry is destructive by nature. Air pollution, water pollution, soil pollution, land pollution, deforestation, wildlife habitat loss, etc. are caused due to mining activity. Therefore the process of mining requires careful analysis of the subsequent effects it might cause on the environment.

No mining activity can be environment-friendly but the damage caused due to mining activity can be reduced through sustainable mining process. The Government of India [GoI] has several sustainable development strategies for mining activity to reduce the impact of mining on the environment. The mining industry should also have social responsibility and ensure to follow the sustainable development guidelines formed by the GoI. The GoI also has stringent mine closure rules to rehabilitate the mining environment close to its original form.

Key Words: Mining, Environment, Sustainable Development, Pollution, Minerals, Ores, Government Of India [GoI], Central Pollution Control Board [CPCB], State Pollution Control Board [SPCB], Environmental Impact Assessment [EIA], Environmental Clearance.

I. MINERAL RESOURCES

A mineral is a naturally occurring substance which has a definite chemical composition. Its physical properties are identifiable but vary accordingly. Minerals are formed over millions of years. A combination of minerals forms ore. Metals are obtained from ores through appropriate methods. Metals form the most important part of the manufacturing of products useful for human development.

Minerals such as copper, iron, magnesium, aluminum and zinc are formed on the earth's crust. These minerals are extremely essential for industrial development. Limestone, granite and marble are also minerals used in the construction of buildings. Non-metallic resources include coal, salt, clay, cement and silica. Minerals with aesthetic properties such as diamonds, emeralds, and rubies are of high human value and are used in ornaments. Metals such as gold, silver and platinum are also of high value and used in ornamentation. Minerals such as oil, gas, and coal are formed from the fossils of plants and animals. Minerals and their ores are formed in the earth's interior and are extracted for human use by a process called mining. Surface mining [open cast or quarrying strip mines] and deep shaft mining are the two types of mining.

The four stages of mining are:

Prospecting – searching for the mineral

Exploration – assessment of the size, shape, location and economic value of the raw material i.e. mineral deposits.

Preparation – the process to access the deposits for extraction.

Exploitation – the process of extracting the minerals from the mines.

In yesteryears, mining was performed in places where the surface area showed some significant deposits of minerals. With the improvement in technology like Geographic Information System [GIS],

determining the place of mining has become almost accurate. This has paved the way for increased mining activity, especially in the past few decades.

II. MINING IN INDIA

Mining and mineral based industries play a major role in the economic growth of a country especially in a developing Nation like India. Mining provides raw materials for most of the development in the human-built environment. The mining sector has huge foreign investors which add to the economy of the country. In the mining sector, India exports 16% and imports 20% thus making foreign trade an important constituent in the country's economy. In 1851 the Geological Survey of India formed the Scientific Mineral Survey in India. 98% of mapping of the mineral resources in the map able area of the country was done by Society of Geoscientists and Allied Technologists [SGAT] in 2009. India produces 89 minerals in which are 4 fuel minerals, 11 metallic minerals, 22 minor minerals and 52 non-metallic minerals. India is the largest producer of mica blocks, it ranks second in chromites. India is the third largest producer of coal and lignite and the fifth largest producer of iron. India ranks 6th in bauxite and manganese production, eleventh in aluminum and 12th in crude steel.

Though the economy of India is enhanced by mining activity, the process in which mining takes place and the waste produced by it damages the countries precious environment and wildlife. A major part of forest land approximately 1.64 lakh hectares has been cleared in the country for mining activity. Water use and air pollution have been increasing tremendously. Between 2005 and 2006, 77 million tones of water were used for iron ore mining. In 2006 mining of major minerals in India produced about 1.84 billion tons of waste. "Mining sources are considered one of the main sources of environmental degradation" [Bharucha Erach, pg: 32]

III. ENVIRONMENTAL IMPACTS OF MINING

Air Pollution

Mining, in general, affects the quality of air. As the land is blasted and excavated for minerals and ores, unrefined minerals are also released to the surface. These particles of unrefined minerals can also contain toxic materials such as lead, calcium and arsenic. They become air-borne through wind erosion and also while road transportation, causing extensive air pollution in and around the mining sites. Particulate matter carried by wind as a result of excavations, blasting, transportation of materials, wind erosion, fugitive dust from tailing, waste dumps, stockpiles, waste rock piles, mission from transportation automobiles, gas emission from combustion of fuel in the mining process areas and mineral processing etc. are the source of air pollution in the mining industry. Mining impacts the production of CO₂ greatly as excessive CO₂ is released during the mining process and moreover mining is done mostly in forest areas where natural resources are abundant which leads to excessive deforestation and increase of CO₂ in the atmosphere. The hazardous pollutants generated while mining such as heavy metals, carbon monoxide, nitrogen oxides, sulphur dioxide and particulate matter also play a major role in air pollution.

For example: *Environmental impacts of coal*

Coal is the world largest single contributor of greenhouse gases and is one of the most important causes of global warming [Bharucha Erach, pg: 40]. For every ton of coal, there is 3-4 tons of waste produced. Suspended Particulate Matter [SPM] which is a major air polluter is caused by coal-based power generation plants which are not fitted with electrostatic precipitation. When coal is burnt it produces oxides of sulphur and nitrogen. When this combines with water vapor, it leads to acid rain. Acid rain destroys forest vegetations, damages architectural heritage sites, pollutes water, soil and impacts animals and plant life greatly. The major cause of emission and air pollution in the mining operation are by drilling, blasting, hauling, collection and transportation of coal, etc. Mine fires caused by coal mining can last for decades. E.g. the Jharia coalfield in eastern India is a highly polluted area with intense mining and industrial activities. Air quality monitoring by the Central Pollution Control Board of India revealed that the Jaharia falls under the critically polluted area.

Soil And Land Pollution

When vegetation is removed for mining it exposes the land directly to the weather conditions. Mining causes physical damage to the landscape by creating open pits and piles of waste rocks. Mining

contaminates soil over a large area. Direct exposure of cleared land for mining, extracted mineral ores, tailing and waste rock piles can result in substantial sediment loading on the surface land. This affects the land quality and disturbs the water and drainage ways. In addition spills from hazardous materials and depositions of contaminated windblown dust lead to soil contamination. The chemical spills from the mining process also affect the soil greatly.

Water Pollution

Water pollution caused by mining includes metal contamination, increased sediment levels in streams and acid mine drainage. The process of mining has a significant impact on water resources in that area.

For example: the Marcopper Mining Disaster occurred in 1996 in Marinduque, an Island in the Philippines. A fracture in the drainage tunnel of mine caused leakage and discharge of toxic tailing waste into the Makulapnit – Boac river system causing floods in the river beds. An entire village was wiped out in 6 feet muddy slush. Drinking water was contaminated, aquatic organisms were killed and animals which were dependent on the river for water were also killed. Eventually, the river became unfit to sustain life.

Acid Mine Drainage

The mined minerals such as tailing, heaped waste rocks, dump leach materials, underground mines, open pit areas, excavated and exposed to oxygen, water and acid will turn leach or dissolve metals and other contaminants from the mined materials to form a solution that is acidic, high in sulfate and rich in metals like cadmium, copper, lead, zinc, arsenic etc. Heap leaching and blasting in mines cause elevated levels of ammonia, nitrate and nitrites in the water. The important source of water pollutants in mining areas are acid drainage and contaminants in metallic ore mining. These create potential long term hazards. These acid drain pollutants through run-off water cause severe harm to aquatic life in the rivers and streams.

Impacts of Soil Erosion and Mine Waste on Surface Water

A major source of soil erosion and sediment loading at mine sites are open pit areas, heap and dump leaches, waste rock and overburden piles, dams, haul roads, access roads, etc. These processes contribute to sediments with chemical pollutants, especially heavy metals. These sediments deposited in the layers of flood plains or terrestrial ecosystem impacts the surface water and groundwater. The contaminants in the deposited sediments affect the pH of the surface run-off, mobilize heavy metals that infiltrate into the surrounding subsoil or get carried away to the nearby surface water. The contamination in the surface water also affects the groundwater and the soil to an extent where vegetation, animal life and sustainable habitat is lost.

Impacts of Tailing Waste

The impacts of mining are severe contamination of surface and groundwater. Tailing is the byproduct of metallic ore processing. It contains a high volume of waste that can contain harmful toxic substances. Most of the mining companies dispose of tailing waste by mixing them with water and dispose of the slurry behind the tall dam in their mining sites. The slurry contains a large number of toxic materials and water. During heavy rains, the slurry pond overflows along with the toxins and runs off into the land eventually reaching a water body. Thus the land, surface water and water body get poisoned with toxic slurry run-off. This is extremely hazardous to the terrestrial and aquatic environment and wildlife dependent on the particular terrain and water body. Tailing products are also dumped in water sources, marine backwaters and also in naturally existing valleys. For example, a ton of copper generates 99 tons of ore. From a ton of ore 5.3 grams of gold is extracted. The ore or tailing waste product is dumped in natural habitats creating hazards to the environment.

Impacts on Groundwater while Mining

Often when the groundwater source is higher than the mining site, the groundwater is removed to avoid infiltration and obstruction during mining. This is a continuous process, however, when the mining operations end, the mine water is left unattended ending up in accumulation in rock fractures, shafts, tunnels, open pits and uncontrolled release in the wild which also affects the groundwater.

Impacts of Mining on Wildlife

Mining is inherently a destructive industry and has the potential to disturb the ecosystem. Mining is deleterious to wildlife in several ways. Pollution from the mining source affects wildlife extensively. The deforestation caused due to mining activity takes a heavy toll on the environment. Wild animals suffer from habitat loss due to mining. Eventually, this causes the fatal end of the animal species due to loss of habitat and nutrition sources. The patches of areas used for mining in forest areas disrupt the migration routes of wild animals. Due to this animals are forced to inbreed within its range, thus weakening the gene pool of the animal species. In case of wildlife in the aquatic habitat, the waste pollution from the mining industry in the form of run-off pollutants, acid rain and polluted slurry cause severe damage to the aquatic habitat and eventually destroy the aquatic wildlife.

IV. GOVERNMENT OF INDIA- NORMS FOR THE MINING INDUSTRY

The role of mining in sustainable development has been a major issue of concern for Government, Policymakers, Decision makers and Resource Managers for decades. The Legislation of India deals with environmental pollution and degradation. The Parliament enacted 3 comprehensive anti-pollution laws abiding by the Stockholm Conference of the UNO in 1972.

i] The Water Prevention and Control of Pollution Act, 1974

ii] The Air Prevention and Control of Pollution Act, 1981

iii] Environment Protection Act, 1986

The Water Prevention and Control of Pollution Act, 1974 and the Air Prevention and Control of Pollution Act, 1981 formed separate bodies at the Centre and State namely the Central Pollution Control Board [CPCB] and the State Pollution Control Board [SPCB] to work towards environmental protection. The powers and function of CPCB and SPCB is laid down in the Water Prevention and Control of Pollution Act, 1974 and Air Prevention and Control of Pollution Act, 1981, Chapter 3 and 4. Each State should be responsible for its pollution control and thereby the SPCB is the main regulatory agency in a State. The SPCB has the power to obtain information from any industrial sector about the emission of water and air pollutants. It checks whether the industry abides by the standards and rules proposed by SPCB. Samples of effluents or emissions are collected and analyzed to check the levels of pollution in the emissions. In case the pollution levels are higher than stipulated, the SPCB has the power to close the industry and impeach the polluters in the Court of Law.

The EIA and Environmental Clearance Report Requirement for Mining Projects

Based on the Environmental Impact Assessment Stipulations [EIA] notification [2006], the mining projects are categorized as Category A and Category B based on the size of the mining industry.

Category A: The projects under this category will be evaluated by the Central Impact Assessment Committee and then receive environmental clearance from the Central Impact Assessment Authority.

Category B: The projects under this category will be evaluated by the State Impact Assessment Committee and then receive environmental clearance from State Impact Assessment Authority. If the State Impact Assessment Committee decides the evaluated project falls within the B1 category, EIA will not be required for the project. Instead, the requirement of EIA can be handed out to the Impact Assessment Agency [IAA] which is under the Ministry of Environment and Forest [MoEF]

Based on the category of the project a detailed check is done by the Expert Appraisal Committee based on questioners and checklist [Form-1], subsequently, the MoEF has a generic structure for the preparation of EIA reports. Before the proposal of the project is sent to the MoEF for Environmental Clearance, the SPCB with the District Administration will conduct public hearing of the proposed project. The documents to be submitted by the project for Environmental Clearance to the MoEF are project report, site clearance, environmental appraisal questioner, EIA report along with Environmental Management Plan [EMP] report, analysis report of the hazardous substance to be used in the proposed project, public hearing report and rehabilitation plans if it involves more than 1000 people to be displaced due to the project.

Role of SPCB in Keeping the Environmental Impact of Mining Projects Minimal

The strategies of SPCB are in accordance with the stages of the mining process to keep the environmental impact of mining projects minimal. The strategies of the SPCB are categorized as:

Pre-establishment phase: The SPCB carries out various functions to evaluate the proposed mining project to ensure it does not create excessive pollution over the permissible limit. The SPCB also checks if the cumulative environmental impact of the project does not cause irreversible damage to the environment based on 'precautionary principals'. The SPCB carries out functions like preparation of comprehensive plans, consent to establish and reclamation and rehabilitation of mines to ensure environmentally safe mining process.

Preparation of comprehensive plans: The SPCB carries out a comprehensive environmental management plan for mining intensive regions, as part of scientific or sustainable mining. This is to check whether mines can be established in that particular region or not. To carry out a mining activity at a place the SPCB requires a Regional Environmental Management Plan, a study on the carrying capacity of that ecosystem, zoning atlas and the Environmental Monitoring Status Report. These reports indicate whether the mining activity would be sustainable or not.

Approval to establish: This process involves a detailed check on the proposed mining site to check the environmental impacts of mining in that particular area. The proposed manufacturing process, pollution control measures to be taken, pollution potential of the project and environmental management practice is evaluated during this process.

Reclamation and rehabilitation of mines: The reclamation and rehabilitation of mines are issued and regulated by the Mineral Conservation and Development Rules [MCDR] 1988, enacted in 2003. It is mandatory that every mine in the country has to have a progressive mine closure plan and final mine closure plan, a year before the closure of the mine or renewal of mining lease. The reclamation process includes rehabilitation inside the mine, management of water body used or affected by the mining process, soil conservation measures, management of roads, planting trees and shrubs in the mining site to keep up the soil quality in the mining area, check and reverse climatic conditions in and around the mining area affected by the mining process, the defining factor of reclamation is the post-mining land use.

The mine closure plans will be reviewed and approved by the Regional Controller of Mines, Indian Bureau of Mines [IBM] or an Office authorized by the State Government. According to the Rule 23F of the MCDR in case a mining industry fails to fulfill the rehabilitation process, the surety amount of the money will be fortified.

V. CONCLUSION:

The GoI takes several measures to ensure environmental sustainability during mining projects. The mining industry should observe the mining laws according to the Mines Act 1952, the Mines and Minerals Development Act, 1957, The Forest Conservation Act, 1980, amended in 1988, The Environmental Protection Act 1986, The National Forest Policy, 1988, etc for sustainable mining and conservation of the environment. The Government should have more stringent rules for mines to follow scientific mine closure methods. Afforestation and Reforestation should be made mandatory in the mine closure strategy. The Environmental Impact Assessment and Environmental Clearance Report of the GoI should be factual and impartial regardless of pressures.

Though the mining industry is inevitable for the development of a country, it should not be a threat to the natural environment of the country. The mining industry should make sure the sustainable use of environmental resources and safe discarding of mining waste. As per the Brundtland Commission, mining cannot be completely eco-friendly as all the minerals and ores extracted through mining are finite and non-renewable. "Even the best-managed mines leave environmental footprints" [Dash M.C, pg: 100]. However, the effects of environmental hazards can be reduced if the mining project abides by the rules of the Government. Every mining industry should stand for Corporate Social Responsibility [CSR]. With the development in technology, the basis of sustainable development like recycling, reuse, waste treatment, reforestation, afforestation and the appropriate use of resources according to the actual need by the mining industry will help a Nation in Sustainable Development.

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