Scholars Academic Journal of Biosciences (SAJB) **ISSN 2321-6883 (Online)**
Sch. Acad. J. Biosci., 2016; 4(7):560-564 **ISSN 2347-9515 (Print)**
©Scholars Academic and Scientific Publisher
(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI : 10.36347/sajb.2016.v04i07.002

Review Article

Socio-economic and environmental impacts of mining in Odisha, India

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Abstract: Mining plays a significant contribution towards the economic development of Odisha as well as of India. While mining is beneficial to economy but it almost always have adverse environmental impacts and eventually health impacts. This paper briefly explains about the mining in Odisha, its contribution towards wider economy, the impact of mining on environment and its remediation. Mining is beneficial to the economy in terms of its own economic impact and earning from other industries, the environmental impact of mining is presented for both underground and open cut mines. The environmental impact of mining includes erosion, formation of sinkholes, and loss of biodiversity and contamination of soil, ground water and surface water by mobility of chemicals from mining processes. Hence, all of these concerns are challenging and required urgent attention and its remediation.

Keywords: mining, economic development, environmental impact

INTRODUCTION

A major environmental problem relating to mining in many parts of the world is uncontrolled discharge of contaminated water from abandoned mines [1].Mining is the extraction of minerals or other geological materials from the earth from its ore body. Ores recovered by mining include metals, coal, oil shale, gemstones, limestone, rock salt, potash, gravel and clay. Mining is required to obtain any material that cannot be grown through agricultural processes, or created artificially in a laboratory or factory. Mining exist in many countries.

Mining is an extraction of solid minerals occurs in six consecutive stages: exploration, development, extraction, beneficiation, further processing and final decommissioning stage. London is known as the capital of global "mining houses" such as Rio Tinto Group, BHP Billiton and Anglo American PLC. The US mining industry is also large, but it is dominated by the coal and other non-metal minerals.

In mining sector, Minerals and Sustainable Development (MMSD) project highlighted the need to be treated, when administering aid and delivering support, as a community activity emphasizing integrated rural development [2]. To prevent explosion, a wet rag should be applied to the outlet and not placed directly into the water [3].

Different types of mining

Mining technique can be divided into two types: surface mining and underground mining. Today, surface mining is much more common and produces more metallic ores and minerals excluding petroleum and natural gas.

Surface mining is done by removing surface vegetation, dirt and if necessary layers of bedrock in order to reach buried ore deposits. Surface mining technique includes open pit mining (recovery of materials from an open pit in the ground), quarrying (identical to open pit mining except sand, stone and clay), strip mining (stripping surface layers off to reveal ore underneath), mountain top removal (taking the top of a mountain off to rich ore deposit at depth) and landfill mining (landfills are excavated and processed).

Underground mining consists of digging tunnels or shafts into the earth to reach buried ore deposits. There are different types of underground mining: Drift mining (utilizes horizontal access tunnels), slope mining (uses diagonally sloping access shafts) and shaft mining (utilizes vertical access shafts). Mining in hard and soft rock formation require different techniques.

Some mining like in situ leaching is done by less common methods of digging neither at the surface nor underground. The extraction of target mineral by this technique requires that they will be soluble, e.g., potash, potassium chloride, sodium chloride, sodium sulphate, which dissolve in water. Some minerals, such as copper minerals and uranium oxide, require acid or carbonate solutions to dissolve.

Other methods include shrinkage slope mining (mining upward, creating a sloping underground room), long wall mining (grinding a long ore surface underground) and room and pillar mining (removing ore from rooms while leaving pillars in place to support the roof of the room), hard rock mining (mining of hard rock), bore hole mining, drift and fill mining, long hole slope mining, sub level caving and block caving.

Mining in India

The Indian mineral industry produces more than 80 mineral commodities including mineral fuels. Approximately 4,000 to 5,000 mines operate throughout the country, the majority of which are small surface mines using manual mining methods and having relatively low annual production outputs. Of the total number of mines, approximately 500 are underground mining operations, most of which are small, having non-mechanized operations. The major non-coal mining sectors are: Bauxite (aluminium), Chromite (Chromium), Copper, Hematite/ magnetite (Iron), Lead/zinc, Manganese, Limestone, etc. In the mineral map of India, Orissa occupied an important position both in terms of deposit and production. The mineral deposit of the state is not only vast but also equally diverse. It is one of the largest minerals bearing states in India, having 16.92% of the total reserves of the country.

India produces about 90 minerals, which include four fuels, 10 metallic, and 50 non-metallic, three atomic and 23 minor minerals. It is the second largest producer of chromites, barites and talc in the world and ranks third in production of coal and ignite and fourth in production of iron ore, kyanite, andalusite and silimanite.

Mining in Odisha

Odisha is a state of India lies between the latitudes 17.780N and 22.730N and between longitudes 81.37E and 87.53E. The state has an area of 155,707 km^2, which is 4.87% of total area of India. In the mineral map of India. Orissa occupied an important position both in terms of deposit and production. The mineral deposit is not only vast but also equally diverse. It is one of the largest mineral bearing states in India, having 16.92% of the total reserves of the country. While mining is beneficial to the economy, both in terms of its economic impact and the value to other industries of its product, it almost always has adverse environmental impacts and eventually health impacts [4].

Odisha occupies an important position in mineral map of India with having mineral resources like iron ore, chromite, manganese, nickel ore, bauxite, thermal grade coal, rare earth minerals etc. The state has 16.92 percent of the total mineral reserves of the country. The mineral reserves in Odisha with respect to chromite, nickel ore, graphite, bauxite, iron ore, manganese and coal are 97.37 percent, 95.10 percent, 76.67 percent, 49.74 percent, 33.91 percent, 28.56 percent and 27.59 percent respectively of the total deposit of such minerals in India but the mineral production in Odisha is only 10.21 percent of the total value of minerals produced in India. The total reserve of iron ore in the state is 4177 million tonnes, which comes to 33.91 percent of the total iron ore reserve in the country. It is mined in four districts of the state i.e. Keonjhar (79.88 percent), Sundargarh (16.95 percent), Jajpur (2.39 percent) and Mayurbhanj (0.78 percent). Similarly, the total reserve of chromite ore and manganese in Odisha are 97.37 percent and 28.56 percent of total reserve in the country respectively. Chromite is abundantly available in Jajpur, Dhenkanal and Keonjhar district, manganese deposits are available in Sundargarh and Keonjhar district. Only one district Jajpur has 97.43 percent of the total chromite stock in Odisha while the other two district is only 2.57 percent. Dolomite is available in large quantities in Sundargarh district. Koraput is the major bauxite producing district in Odisha, which produces 98.82 percent of the state's total bauxite production. Only 1.22 percent of the total bauxite is mined in Sundargarh district. Coal is mined to the tune of 66.69 percent in Angul district followed by 33.13 percent in Jharsuguda, Sundargarh and Sambalpur districts taken together. Manganese is found in two districts as 83.96 percent in Keonjhar district and 16.04 percent in Sundergarh district. Although a huge amount of mineral resources are present in Odisha but the rate of exploitation to its total reserve is less than one percent in case of all minerals except iron ore and chromite [5].

In Odisha more than hundred billion tonnes of iron ore has been produced from Keonjhar district but 62% of Keonjhar's population still found to be below poverty line. While poverty and economic development are key concerns, the issues of health and environmental degradation from mining is also matters to the people of Keonjhar [4].

Socio-economic development

Mining is important because minerals are major sources of energy as well as materials such as fertilizers and steel. Mining is necessary for nations to have adequate and dependable supplies of minerals to meet their economic and defence needed at acceptable environmental, energy and economic costs. Some of the nonfuel minerals mined, such as stone, which is a non-metallic or industrial minerals, can be used directly from the earth. Metallic minerals, which are also nonfuel minerals, are usually found in combination with other materials as ores.

Mine has led to the economic benefit, both in terms of its own economic impact and the value to other industries of its product. Socio-economic benefits such as the development of social and economic infrastructure, manufacturing and construction industries, commercial and public sector activities have improved. The level of employment is an important measure of economic development of a nation. The mineral sector in Odisha provides employment to a large number of skilled and unskilled people.

Impact of mining on Environment

Mining is a hazardous occupation in which workers are exposed to adverse conditions. There is high morbidity amongst miners, indicating the need for regular health checkups, health education, use of personal protective devices and engineering measures for control of the workplace environment. Research studies in the iron ore mines of Goa highlighted that mining operations vastly and disproportionately increase the hardship borne by women in their role as caretaker of food, water and health of their family as well as their livelihood. In urban areas mining may produce noise pollution, dust pollution and visual pollution. The life cycle with wide environmental impact of metals production associated with 62 metals in year 2008 [4].

Mining and smelting activities affect the biophysical environment and human health of residents close to a nickel-copper mine and smelter plant. There are some healths effects such as fibrosis, sequelae, bronchiogenic cancer and malignant mesothelioma are caused due to asbestos mining in India. The physical, chemical, biological and health hazards of mining and associated metallurgical processes. Mining remains an important industrial sector in many parts of the world and although substantial progress has been made in the control of occupational health hazards, there remains room for further risk reduction. This applies particularly to traumatic injury hazards, ergonomic hazards and noise.

Mercury contamination of the environment from historical and ongoing mining practices that rely on mercury amalgamation for gold extraction is wide spread. Contamination was particularly severe in the immediate in the vicinity of gold extraction and refining operations; however, mercury, especially in the form of water soluble methylmercury, may be transported to pristine areas by rain water, water currents, deforestation, volatilization and other vectors.

Impact of mining on Atmosphere

The increasing trend of opencast mining along with adaptation of large scale mechanisation lead to release of huge amount of dust and gaseous pollutants, which will affect the ambient air quality more severely. Open cast mining creates much more air pollution than underground mining. In opening of open cast mine, massive overburden will have to be removed to reach the mineral deposits. These may require excavator, loader, dumper, conveyor belt etc. which will result in massive discharge of fine particulates from overburden. Similarly normal operation will require excavation, size reduction, waste removal, transportation, loading, stock-pilling etc. All the above activities lead to air pollution due to emission of particulate matters [6]. Vehicular emission on haul road of mechanized mine can contribute as much as 80% of dust emitted. About 50% of total dust released during journey time on an unpaved haul road while 25% during loading and unloading of mineral ores [7]. Drilling is another source of fugitive dust [8]. Another major source of fugitive dust is wind erosion from coal stockpiles. The average size of fines produced from open cast mines depends on different working sites. The specific gravity of fines produced in coal washery vary from 1.23 to 1.7, average loss on ignition was 8-10% and free carbons were 15-20% [9]. In coal washery particulates are respirable in nature and hazardous to human health [10]. There should be proper balance maintained between sustainable development and environmental management. So environmental impact assessment plays a crucial role in resolving the conflicts. Thus it is necessary to assess the impacts on air environment due to mining so that proper mitigation measures.

Impact of mining on Hydrosphere

Mining can have bad effects on surrounding surface and ground water due to mobility of water soluble metals by surface runoff and also through leaching. There is potential for massive contamination of the area surrounding mines due to various chemicals used in mining processes as well as potentially damaging compounds and metals removed from the ground with ore. Large amounts of water produced from mine drainage, mine cooling, aqueous extraction and other mining processes increase the potential for these chemicals to contaminate ground and surface water.

Acid mine drainage is characterized by low pH, high salinity levels, elevated concentrations of sulphate, iron, aluminium and manganese, raised levels of toxic heavy metals such as cadmium, cobalt, copper, molybdenum and zinc and possibly even radionuclide. The acidic water dissolves salt and mobilizes metals from mine workings and residue deposits. Dark, reddish- brown water and pH values as low as 2.5 persist at the site [11]. Acid mine drainage is not only associated with surface and ground water pollution, but is also responsible for the degradation of soil quality, aquatic habitats and for allowing heavy metals to seep into the environment [12]. In 1989, it was estimated that about 19300 km of stream and rivers, and about 72000 ha of lakes and reservoirs worldwide had been seriously impacted by mine effluents, although the true scale of the environmental pollution caused is difficult to assess and quantify accurately [13]. The effect of the contaminated water from the mines can persist for more than 10 km beyond the source [14]. Evidence of radionuclide pollution was found in the catchment [15].

Metal contamination in sediment could modify their bio availability, and thus their toxicity for aquatic organisms [16]. Changes in pH or temperature can affect metal solubility, and thereby the bio-availability directly impacts on organism. Algal communities are less diverse in acidic water [17].Diatoms communities are also greatly modified by any chemical changes. High metal concentration diminishes the abundance of planktonic species [18]. Water insects and crustacean communities are modified around a mine, resulting in a low trophic competeness and community being dominated by predators [19]. Fishes are also affected by pH, temperature variations and chemical concentrations [20].

Impacts on lithosphere

Mining creates drastic changes on soil and rocks of nearby mining area. Soil texture can be greatly modified in disturbed sites which lead to soil pollution. The mining industries can impacts on soil quality through different ways. Structure of lithosphere becomes disturbed by which natural habitat of some organisms also disturbed. Established plants cannot move away from perturbations, and will eventually die if their habitat is contaminated by heavy metal or metalloids at concentration too elevated for their physiology. Soil acidification through pH diminution by chemical contamination can also lead to a diminished species number. Heavy metal deposition is the major environmental problem at mining sites.

Impact of mining on biosphere

After reclamation of mining areas, there is drastic modification of the original site and anthropogenic substances release can have major impact on biodiversity of that area. Destruction of the habitat is the main component of biodiversity losses. Endemic species are especially sensitive, since they need really specific environmental conditions. Destruction or slight modification of their habitat puts them at risk of extinction. Habitats can be damaged when there is not enough terrestrial as well by non chemicals products from the mines that are discarded in surrounding landscape [21]. Bioaccumulation of toxic metals play an important role in polluted habitats at mining site which impacts on biodiversity.

Animals can be contaminated directly by mining pollutants. Some toxic metals like copper and lead are bio-accumulated by plants or smallest organisms which come to other organisms and also human body through food chain [22]. Habitat destruction is also another issue of mining activity. Huge areas of natural habitat are destroyed during mine construction and exploitation, forcing animals to leave the site.

Plant cultivation is also a problem near mines. Plant also accumulates heavy metals in their aerial organs, possibly leading to human intake through fruits and vegetables. Regular consumption might lead to health problems caused by long term metal exposure [23].

Microorganisms are extremely sensitive to environmental modification, such as modified pH, temperature changes or chemical concentration [24].In water, a small change in soil pH can provoke the remobilization of contaminants [25], in addition of direct impact of pH on pH sensitive organisms. Twenty years after disturbance, even in rehabilitation area, microbial biomass is still greatly reduced compared to undisturbed habitat [26].

CONCLUSION

The major findings of the study show that the presence of the mine has led to the economic benefit such as the development of social and economic infrastructure, manufacturing and construction industries, commercial and public sector activities have improved. It almost always has adverse environmental impacts and eventually adverse impacts on soil, water and vegetation of that area leads to impact on human health. Another effect is the scarcity of land which cannot be developed for human settlement due to pollution on that area. The mine is faced with financial difficulties, which have limited its ability to meet environmental quality standards and also to extend assistance to the community within which it operates. The mining land should be properly reclaimed and also renewed vegetation and wildlife in previous mining lands and can even be used for farming. Metal recycling levels are generally low, so some landfills contain higher concentration of metal than mine themselves. Hence proper soil and water treatment must be needed for that area by which pollution rate becomes reduced.

ACKNOWLEDGMENT

We are thankful University Grants Commission, New Delhi for providing financial support and Head, Post Graduate Department of Botany, Utkal University for providing Laboratory facilities during the investigation.

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