



REVIEW PAPER ON ENVIRONMENTALLY SOUND MANAGEMENT AND SUSTAINABLE MINING PRACTICES IN INDIA: GUIDELINES TO MITIGATE THE IMPACT OF MINING ACTIVITIES IN NON-COAL MINING SECTOR UNDER ENVIRONMENT IMPACT ASSESSMENT (EIA) REGIME

Environmental Science

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ABSTRACT

Mining and industrial activity adversely affect rate of proliferation of wild life population by associated deforestation, air and water pollution. Over industrialization in some parts of the world has become matter of great concern and environment conscious governments have begun to assess what the societies are losing as a result of industrialization. Local population undergoes both quantitative and qualitative changes due to industrial activities which have brought changes in socio-economic and socio-cultural value systems and even damage to civil structures. The Ministry of Environment, Forest and Climate Change and Ministry of Mines and other concerned Departments are working towards environmentally sustainable mining in the Country.

KEYWORDS

Sustainable mining practices, major and minor minerals. impact due to mining, mines rules, Environment impact study, mitigation measures.

INTRODUCTION

Environment is a complex aggregate of external conditions which affect the life, development and survival of organisms. Environment is composed of biophysical and socio-economic elements which have a reciprocal relationship with people. The human has been exploiting natural resources for making life more comfortable. The natural resources are part of eco-system wherein a mutually balanced relationship exists between living creatures and natural forces. Any exploitation of natural resources means changes within the eco-system and which spreads its influence to all organism. Mining and related activities have a philosophical and wide influence on the earth's natural environment.

The mining industries enhance comfort of human life on one hand while on other hand; it pollutes the air and water. Air and water are essential for survival of life. Therefore, clean air and potable water should be the primary concern in the society. Broadly the Environment can be divided into six components viz. Land, water, air, biota, human settlement and human body. Mining and other activities related to natural resources may have impact on any of these components either directly or indirectly. Both the agricultural and forest land has faced hazardous effect of mining activities [4]. In case of open cast mining, land surface is completely disturbed whereas underground mining has limited losses. Land use pattern is also disturbed due to cut of forests and shifting of agricultural activities in mine areas.

MINES AND MINERALS (DEVELOPMENT AND REGULATION) ACT

Mining is the third largest industry in the world. India is the world's biggest producer of mica, the third of coal, lignite and barytes, fourth of iron ore, sixth of bauxite and manganese and eleventh of crude oil in the World. With globalisation, the mining sector faces new challenges. The main metals produced are iron-ore, copper-ore, chromite or zinc concentrates, gold, manganese, bauxite and lead concentrates. More than 90 percent of the value of non-metallic minerals comes from limestone, magnesite, dolomite, barytes, kaolin, gypsum, apatite & phosphorite, teatite and fluorite.

The Ministry of Mines, Government of India, is the apex body for formulation and administration of the rules and regulations and laws relating to mines in India. The Ministry of Mines is responsible for survey and exploration of all minerals, (other than natural gas and petroleum) for mining and metallurgy of non-ferrous metals like aluminium, copper, zinc, lead, gold, nickel etc. and for administration of the Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act) in respect of all mines and minerals other than coal and lignite [1 & 5]. The Act was enacted when the Industrial Policy Resolution 1957 was the guiding policy for the sector, and thus was aimed primarily at providing a mineral concession regime in the context of the metal making public sector undertakings. After the

liberalization in 1991, a separate National Mineral Policy was promulgated in 1993 which set out the role of the private sector in exploration and mining and the MMDR Act was amended several times to provide for a reasonable concession regime to attract the private sector investment including FDI, into exploration and mining in accordance with NMP 1993. The MMDR Act enables all the State Governments to exercise their powers within a uniform national framework. The State Governments, as owners of onshore minerals, grant mineral concessions and collect royalty, dead rent and fees as per the provisions of MMDR Act, 1957.

The MMDR Act, 1957 was amended through the MMDR Amendment Act, 2015 [5]. The amendment that came into force on January 12, 2015 has ushered in the regime of transparent and nondiscretionary grant of mineral concessions. The major features of the Amendment Act are:

- (i). Mining Leases will now be granted for a term of 50 years.
- (ii). The mineral concessions will now be granted through auction process and will not be renewed after the expiry of the concession.
- (iii). The Central Government will prescribe the terms and conditions for grant of mineral concessions through competitive bidding.
- (iv). Reconnaissance Permits will henceforth be granted on non-exclusive basis.
- (v). The Central Government has the authority to reserve mines for specific end uses at its discretion.
- (vi). District Mineral Foundation is to be set up in each mineral bearing district for local area development.
- (vii). National Mineral Exploration Trust is to be set up for regional and detailed exploration in the country

Mines Act, 1952: The Mines Act, 1952 prescribes the laws relating to the regulation of labor safety in mines, regulations for carrying out mining operations and management of mines. It lays down the basic provisions for health and safety of people employed in mines and regulates their working conditions. It also has provisions relating to inspection of mines and procedure of reporting to be followed.

Mines Rules, 1955: The Mines Rules, 1955 defines the framework for medical examination of persons employed or to be employed in mines, basic health and sanitation provisions and welfare amenities for the miners and their families

Mineral Concession Rules (MCR), 1960: The Mineral Concession Rules, 1960 defines the process of grant of mineral concessions as per the provisions of Section 13 of the MMDR Act, 1957. The rules lay down the process and timelines for grant of concessions, disposal and refusal of applications and the basic conduct of accounts, registers and information reports.

State Mineral Concession Rules: Various State Governments have prescribed rules for the grant of mineral concessions in respect of

minerals classified as minor minerals under the MMDR Act, 1957.

Mineral Conservation & Development Rules (MCDR), 1988: The Mineral Conservation & Development Rules (MCDR), 1988 prescribes guidelines for the conservation and development of minerals as per the provisions of Section 18 of the MMDR Act, 1957. The rules prescribe procedures for carrying out prospecting and mining operations and the general requirements relating to preparation of mining and prospecting plans and filing of notices and returns. The rules also cover guidelines for protection of the environment.

ENVIRONMENT IMPACT ASSESSMENT (EIA) NOTIFICATIONS

The Environment Impact Assessment in India was made mandatory through a notification issued by the MoEF&CC on 27.01.1994 under the Environment (Protection) Act, 1986, for various activities listed therein. During the course of implementation of the said EIA Notification 1994, various development on the field environment were observed and these were attempted to be overcome by way of making amendments from time to time. The Ministry of Environment and Forests conducted a comprehensive review of the environmental clearance process under the Environment Management Capacity Building Project in 2001.

Based on the comprehensive review carried out, the Ministry of Environment, Forests and Climate Change (MoEF&CC) is the nodal agency in India for planning, promoting, co-ordinating and overseeing environmental, ecological, forestry and wildlife policies and programmes. The EIA is used as a management tool to minimize adverse impacts of developmental projects on the environment and to achieve sustainable development through timely, adequate, corrective and protective mitigation measures. The MoEF&CC has notified Environment Impact Assessment (EIA) Notification, 2006 on September 14, 2006 under the provisions of the Environment (Protection) Act, 1986 which deals with the process to grant Environment Clearances [2]. This Rule is amended from time to time. The Rules *inter-alia* regulates rapid industrial development of the country for minimizing the adverse impact on environment and reversing any trends which may lead to climate change in long run. As per the EIA Notification, 2006, amended from time to time, Environmental clearance is required for the all the non-coal mining projects irrespective of the size of the mine lease area and type of minerals (major & minor minerals).

There are two category projects which are divided in to Category 'A' and Category 'B'. Category 'A' Projects are being handled in the MoEF&CC and Category 'B' projects are being handled in the respective State Environment Impact Assessment Authorities (SEIAAs) notified by MoEF&CC and following the procedure prescribed under the EIA Notification, 2006. As per the present position, Non-Coal Mining Projects, having mining lease area of more than 250 hectare are Category 'A' projects. Category 'B' projects are the proposals in respect of major and minor minerals, having mining lease area from less than 250 hectare. As regards the Coal Mining Projects, Category 'A' Projects are the proposals having mining lease area greater than 500 hectare and Category 'B' projects are the proposals having mining lease area less than 500 hectare. The details are as below:

Mining	Category 'A' projects	Category 'B' projects
Non-coal mining projects	≥250 ha of mining lease area	<250 ha of mining lease area
Coal mining projects	>500 ha of mining lease area	≤500ha of mining lease area

Further, as per "General Condition" under the EIA notification, 2006, "Any project or activity specified in Category 'B' will be treated as Category 'A', if located in whole or in part within 5 km from the boundary of: (i) Protected Areas notified under the Wild Life (Protection) Act, 1972, (ii) Critically Polluted areas as notified by the Central Pollution Control Board from time to time, (iii) Notified Eco-sensitive areas, (iv) Inter-State boundaries and international boundaries".

As per the EIA Notification, 2006, the environmental clearance is a process involving the four stages viz. Stage (1) – Screening; Stage (2) – Scoping i.e. prescribing Terms of Reference (TOR) for undertaking detailed Environment Impact assessment studies; Stage (3) – Public

Consultation which to be conducted by the respective State Pollution Control Board/Union Territory Control Committee; and Stage (4) Appraisal by Expert Appraisal Committee (EAC)/State Expert Appraisal Committee (SEAC). The EIA/EMP Report is to be prepared by the Project Proponent based on the Terms of Reference prescribed in accordance with the provisions prescribed as per the EIA Notification 2006.

ENVIRONMENTAL CLEARANCE FOR MINING OF MINOR MINERALS

The requirement for environmental clearance (EC) for minor mineral mining projects of area less than 5 hectare arose pursuant to order dated 27.2.2012 of the Hon'ble Supreme Court, in SLP (C) No.19628-19629 of 2009 titled Deepak Kumar etc. versus State of Haryana & Ors. Pursuant to the aforesaid order dated 27.02.2012, this Ministry issued an Office Memorandum dated 18.05.2012 stating *inter-alia* that all mining projects of minor minerals including their renewal, irrespective of the size of the lease would require prior EC. Further, the Ministry, vide Notification dated 15.01.2016, has further decentralize the process of EC and concept of District Survey Report [2].

DISTRICT SURVEY REPORT (DSR):

The Ministry of Environment, Forest and Climate Change, Government of India, vide Notification dated 15.01.2016, for the first time, has made the provisions for preparation of District Survey Report for the projects related to mining of minor minerals. The main objective of the preparation of District Survey Report is to ensure the identification of areas of aggradations or deposition where mining can be allowed; and identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited and calculation of annual rate of replenishment and allowing time for replenishment after mining in that area. The report shall have the following structure: (i) Introduction; (ii) Overview of Mining Activity in the District; (iii) The List of Mining Leases in the District with location, area and period of validity; (iv) Details of Royalty or Revenue received in last three years; (v) Detail of Production of Sand or Bajari or minor mineral in last three years; (vi) Process of Deposition of Sediments in the rivers of the District; (vii) General Profile of the District; (viii) Land Utilization Pattern in the district: Forest, Agriculture, Horticulture, Mining etc. (ix) Physiography of the District; (x) Rainfall: month-wise; (xi) Geology and Mineral Wealth; (xii) District wise detail of river or stream and other sand source; (xiii) District wise availability of sand or gravel or aggregate resources; & (xiv) District wise detail of existing mining leases of sand and aggregates.

A survey shall be carried out by the DEIAA with the assistance of Geology Department or Irrigation Department or Forest Department or Public Works Department or Ground Water Boards or Remote Sensing Department or Mining Department etc. in the district. The District Survey Report shall be prepared for each minor mineral in the district separately and its draft shall be placed in the public domain by keeping its copy in Collectorate and posting it on district's website for twenty one days. The comments received shall be considered and if found fit, shall be incorporated in the final Report to be finalised within six months by the DEIAA. The District Survey Report shall form the basis for application for environmental clearance, preparation of reports and appraisal of projects. The Report shall be updated once every five years.

PROCEDURE FOR ENVIRONMENTAL CLEARANCE FOR MINING OF MINOR MINERALS INCLUDING CLUSTER:

The Ministry of Environment, Forest and Climate Change, Government of India, vide Notification dated 15.01.2016, has made the policy for environmental clearance of mining of minor minerals including cluster situation. The procedure, *inter-alia*, includes the following: (i) The data provided by the States (Sustainable Sand Mining Management Guidelines, 2016) [3] shows that most of the mining leases for minor minerals are of lease area less than 5 hectare. It is also reported that in hill states getting a stretch in river with area more than 5 hectare is very uncommon. So the size of lease for minor minerals including river sand mining will be determined by the States as per their circumstances; (ii) The mining of minor minerals is mostly in clusters. The Environment Impact Assessment or Environment Management Plan are required to be prepared for the entire cluster in order to capture all the possible externalities. These reports shall capture carrying capacity of the cluster, transportation and related issues, replenishment and recharge issues, geo-hydrological study of

the cluster area. The Environment Impact Assessment or Environment Management Plan shall be prepared by the State or State nominated Agency or group of project proponents in the Cluster or the project proponent in the cluster; (iii) There shall be one public consultation for entire cluster after which the final Environment Impact Assessment or Environment Management Plan report for the cluster shall be prepared; (iv) Environmental clearance shall be applied for and issued to the individual project proponent. The individual lease holders in cluster can use the same Environment Impact Assessment or Environment Management Plan for application for environmental clearance. The cluster Environment Impact Assessment or Environment Management Plan shall be updated as per need keeping in view any significant change; (v) The details of cluster Environment Impact Assessment or Environment Management Plan shall be reflected in each environmental clearance in that cluster and SEAC, and EAC shall ensure that the mitigative measures emanating from the Environment Impact Assessment or Environment Management Plan study are fully reflected as environmental clearance conditions in the environmental clearance's of individual project proponents in that cluster; (vi) A cluster shall be formed when the distance between the peripheries of one lease is less than 500 meters from the periphery of other lease in a homogeneous mineral area; and (vii) The Environment Impact Assessment or Environment Management Plan for Category 'A' and Category 'B1' projects shall be prepared by the accredited consultants of Quality Council of India, National Accreditation Board for Education and Training.

PROCEDURE FOR MONITORING OF SAND /RIVER BED MINING

The Ministry of Environment, Forest and Climate Change, Government of India, vide Notification dated 15.01.2016, *inter-alia*, emphasises the procedure for monitoring of sand /river bed mining w.r.t. the monitoring of the mined out material which is key to the successful implementation of sustainable Environment Management Plan. So use of IT and IT enabled services for effective monitoring along with process reengineering has been made a part of the notification. The gist of monitoring mechanism, *inter-alia*, are (i) The movement of sand is controlled through Transit Permit. The security feature of Transit Permit should be as Printed on IBA approved MICR paper; Unique Barcode; Unique QR code; Fugitive Ink Background; Invisible Ink Mark; Void Pantograph and Watermark; (ii) Use of IT and IT enabled services for effective monitoring of the quantity of mined out material and transportation along with process reengineering has been made a part of the Notification; (iii) Stringent Monitoring of movement of mined out material from source to destination using Information Technology tools: bar coding, SMS etc. Till date there is no authentic data on how much sand is being mined, this system will generate real time data on mined out sand; and (iv) The route of vehicle from source to destination shall be tracked through the system using check points, Radio-frequency identification (RFID) Tags, and Global Positioning System (GPS) tracking. The status of compliance of stipulated conditions of the environmental clearances of different projects, including sand mining projects, is monitored by Regional Offices of this Ministry in the Country [2].

APPRAISAL OF PROJECTS BY EAC/ SEAC FOR GRANT OF TERMS OF REFERENCE (TOR)

The MoEF&CC has constituted the Expert Appraisal Committee (EAC)/ State Expert Appraisal Committee (SEAC) in pursuance to the EIA Notification 2006. EAC/SEAC is a multi-disciplinary body for appraisal of project proposals for environmental clearances. The EAC/SEAC follows due procedure contained in the EIA Notification 2006 while appraising a developmental project requiring prior environmental clearance and making appropriate recommendations. During appraisal of a project proposal by the EAC/SEAC, the Environment Impact Assessment Report, declaration made in Form-I, Pre-Feasibility Report and presentation made before the EAC/SEAC etc. form the basis for appraisal and making appropriate recommendations. The time lines have been prescribed under the EIA Notification, 2006. Accordingly Terms of Reference (TOR) shall be conveyed by the EAC/SEAC within thirty days of the receipt of Form-I to the Project Proponent. The EAC/SEAC recommends the proposals for grant of TOR; accordingly, the Ministry/SEIAA issues the TOR with certain terms and conditions.

APPRAISAL OF PROJECTS BY EAC/ SEAC FOR GRANT OF EC

Project Proponents are required to comply with the conditions

mentioned in the TOR which *inter-alia* includes (i) collection of base-line data for one season (three months), (ii) approved mine plan, (iii) conducting the public consultations, and (iv) submission of final EIA/EMP Reports to the Ministry/SEIAA along with all the relevant documents. That on receipt of final EIA/EMP report after the public consultation, the project is appraised by the EAC/SEAC within sixty days in a transparent manner in a proceeding to which the Proponent is invited for furnishing necessary clarification in person or through an authorized representative. Thereafter, the EAC/SEAC recommends/rejects the proposals and the MoEF&CC/SEIAA takes the final decision with regard to Environmental Clearance as per the EIA Notification, 2006. This decision is conveyed to the Proponent within forty five days of the receipt of the recommendations of EAC/SEAC. In other words, the decision shall be conveyed within one hundred five days from the receipt of the final EIA/EMP report/requisite documents [2].

The Expert Appraisal Committee, during appraisal, has *inter-alia* also considering mitigation measures with respect to Protection of Wildlife & Endangered species; Protection of Forests Land; Protection of Flora & Fauna; Issues related to Ground water intersection; Mitigation on impact of habitation during mining activities; Advanced technologies for environmental protection; Effective safeguard measures to protect Environmental Pollution etc. The Expert Appraisal Committee *inter-alia* recommending the EC project with certain mitigation measures for its sustainable mining.

ENVIRONMENTAL MONITORING AND COMPLIANCE MECHANISM

Environmental clearances are accorded stipulating a large number of specific and general conditions to mitigate and contain the adverse environmental impact of mining in and around the mining lease areas. MoEF&CC monitors the conditions stipulated in the environmental clearances of various projects in different sectors, including mining projects, through its Regional and Sub-Regional Offices. A monitoring mechanism regarding compliance of the stipulated conditions has also been prescribed for effective steps to ensure timely action against the defaulter project proponent. Under the EIA Notification 2006, it is mandatory for the project proponent to submit half-yearly compliance reports in respect of the stipulated conditions of environmental clearance and all such compliance reports shall be public documents and such compliance report shall also be displayed on the web site of the concerned regulatory authority.

MINE WATER EFFLUENTS: TREATMENT AND CONTROL

The major sources of liquid effluents include Mine water pumped out during drainage operations; Spent water from handling plants, dust extraction and dust suppression; Effluents from preparation and beneficiation plants, and Leachates/wash offs from waste/tailings dumps [6].

Efforts should be made to preclude or reduce the discharge of toxic and objectionable effluents into surface water bodies, ground water aquifers or usable lands to a minimum. Wherever possible, Recycling of Mine/Mill waste water should be practiced. Effluents should be treated to conform to the standard laid down by the Central Govt. & State Pollution Control Boards/Committees for Prevention and Control of Water Pollution before discharge. While laying down environmental quality standards of liquid effluents, due consideration to local conditions should be given with a view to possible reuse. Effluent treatment system should be selected on the basis of problems specific to the particular mining characteristics of effluents, ambient soil and water quality and other relevant factors. The mine water should be utilised for irrigation of the plantations raised to stabilize the mine waste dumps.

SURFACE WATER MONITORING

Followings are the parameters may include the surface water monitoring programs:-

- Streams traversing the proposed mining area may often need to be diverted. Measures for diversion of such streams will have to take note of the conditions in the catchment and downstream areas, so as not to affect the regime and downstream users.
- Apart from providing adequate channel capacity of the diversion section with due regard to maximum flood intensity, area of command catchment etc., it would also be necessary to consider the bed slope and coefficient of rugosity of the water course and other hydraulic parameters.

- (c) The exact course of diversion should be determined not only on the basis of surface topography but also the hydrological aspects, calling for hydrological model studies, if necessary.
- (d) Diversion of water course would also have an effect on flora and fauna resulting in ecological imbalance to some extent. The measures proposed for changing the water course should ensure the rehabilitation of flora and fauna.
- (e) Mining operations, apart from changing the water course, may also cause drastic changes in the drainage pattern, which must be studied and avoided to the extent possible.
- (f) Influx of fines and wastes (solid) from mining operations may lead to excessive aggradation of stream courses, leading to several adverse effects including over spilling and creating artificial barriers in the channel-such situations need to be avoided.
- (g) Withdrawal of surface water for mining/colony requirements upstream may reduce the flow and adversely affect the pollution absorption/dilution capacity of the stream. Efforts should be made to obtain water supplies from a separate source.

GROUND WATER MONITORING

Artificial lowering of the ground water table and depletion of aquifers that are tapped by underground mining operations may lead to the following problems:-

- (a) Adverse effects on wells, tanks and even effluent reaches of streams/rivers.
- (b) Enhancing drawdowns in pump wells in alluvial/sedimentary areas (coal/sand mining operations).
- (c) Changes in the hydrodynamic conditions of river/underground recharge basins.
- (d) Reduction in volume of subsurface discharge to rivers, depending on the hydro geological conditions.
- (e) In many cases, where there are permeable strata near the surface, introduction of fines through leaching and percolation may reduce the effective transmissibility of the aquifers and their water yielding properties.
- (f) Adverse hydro chemical alterations will be caused by chemical pollution from mining wastes.

AIR POLLUTION DUE TO MINING AND MINERAL BENEFICIATION ACTIVITIES

Air pollution caused by mining and associated activities can be classified into two categories viz. (i) Gaseous pollutants (Sulphur dioxide, Nitrogen oxides, Carbon monoxide and Hydrocarbons etc.); and (ii) Suspended Particulate Matter (Silica, Fluorides, Asbestos and Metallic Mineral Fumes etc.). [7] Followings are the measures to be adopted for prevention and control of Suspended Particulate Matter:

- (a) Transportation of minerals from mines to plant and ports is the main source of dust. To prevent dust from being air borne, transport equipment (trucks and railway wagons etc.) should be leak proof and properly covered. Alternatively, suitable chemicals may be sprayed on the top to prevent such effects.
- (b) Adequate dust suppression and extraction facilities must be provided at the coal/ore handling plants, crushing and screening units.
- (c) The haul roads in the open cast mines/quarries need to be adequately water sprayed.
- (d) Roadside plantation of dense belts of trees serves as dust arresters (one hectare of trees can arrest 30-50 tonnes of dust).
- (e) To minimise dust pollution, measures such as adoption of hoods at transfer points, proper design of chutes, vulcanising of conveyor belt joints, under belt cleaning devices, apart from installation of dust suppression and/or dust extraction systems for conveyors should be introduced.
- (f) In the case of surface mines and allied operational units, dust concentration standards should be specified.
- (g) Residential and sensitive points should be as far away as possible so as to maintain air quality parameters in these areas within the limit prescribed.

NOISE AND VIBRATION PROBLEMS

Several mining and mineral processing activities generate obnoxious levels of noise and vibration. In underground mines these constitute occupational health problems. Above ground operations may also cause noise pollution in neighbouring communities and damage to structures in the vicinity. Blasting, drilling, underground mining equipment and ventilation fans are sources of noise and vibration underground. Heavy earth moving machinery, drills, dumpers, material handling, crushing and cleaning equipment are prominent sources above ground. In beneficiation plants noise and vibration are

primarily occupational health problems.

A. Noise Abatement and Control

Noise is best abated at source by choosing machinery and equipment suitably, by proper mounting of equipment and ventilation systems and by providing noise insulating enclosures or padding where practicable. Residential colonies and township should be located reasonably away from the mining premises. Boundary walls (baffle walls), waste banks and dense belt of trees should be erected at act as acoustic barriers. Adequate wide belt of trees of different heights is specially useful to act as a noise attenuator in the mining areas. In existing mines, it is suggested that a noise survey should be conducted by an expert to identify sources of excessive noise and to design and implement appropriate control measures. In new mines anticipatory measures for noise reduction should be incorporated at the planning stage in consultation with an Expert.

B. Vibration Abatement and Control

Ground vibrations are caused by blasting operations, subsidence due to mining operations, deployment of mobile equipment, rock bursts and rock bumps. Blasting also generates air vibration waves (air blasts). Vibration may cause structural damages, which depend upon the periodical acceleration due to vibration. Air blasts can damage structurally unsound buildings and cause window glass failure. Vibration can also be a cause of annoyance to human beings. Control of ground movement due to vibration can be achieved by avoiding over-charging, use of delays and improved blasting technology. Due regard must be paid to vibration transmission properties of geological formations and terrain stability (tectonism, seismicity etc.). Buildings likely to be affected due to vibrations should be identified and protected by trenching or other appropriate measures to minimise vibration effects. Vibrations due to mobile plants and equipment can be minimised by modernisation and proper maintenance. Norms for permissible limits of vibration for various zones should be prescribed.

C. Subsidence Problems and its Control

Surface subsidence causes extensive degradation of the natural environment and damages to manmade structures. It affects the ground water regime, surface drainage pattern and usable land. Highways, buildings, bridges, water and gas mains may also be sheared, twisted or broken by strains and slope changes. The environmental significance of subsidence is related to three main factors i.e. Surface area affected; nature of the land use in the affected areas; and the type and magnitude of ground movement. The alleviation of subsidence damage can be undertaken either by precautionary measures on surface to protect installations, or by appropriate modification of the mining methods so as to minimise deformation of the surface. The following structural precautions should be taken into consideration while designing new structures in mining areas:-

- (a) The site should be away from areas of natural geological discontinuities/weaknesses (faults, thrusts, fractures etc.).
- (b) The structures should be designed (factor of rigidity, flexibility, etc.) with due consideration for the subsidence possibilities and geotechnical setting.
- (c) The required precautions and scientific methodology should be adopted for the mining operations to minimise and control subsidence. The mining operations should be planned to permit controlled subsidence, with the entire overlying ground subsiding uniformly e.g. by adopting Harmonic Mining. Adequate support should be provided in the underground workings to avoid subsidence, where necessary. The worked-out areas, particularly for steeply dipping metaliferous ore bodies, should be filled with sand or other suitable packing materials.

D. Human Settlement Problems

The mining activities are mostly confined to remote areas which are sparsely populated. Though the population affected by these activities is very small and the problem is not so acute, measures for rehabilitation of the people displaced by the mining operations should be taken. While initiating rehabilitation measures followings care should be taken

- (a) To ensure, to the extent possible, that the traditional life style of the people is not disturbed. The local population should get the maximum benefit accruing due to development of the mineral deposit.
- (b) Adequate facilities for health care, education, recreation, employment etc. should be provided. Since these are located in remote areas the township is essential component of mining activities. These

townships shall be properly planned according to normal town planning practices and should not be allowed to grow indiscriminately. (c) Adequate infrastructure should be developed so as to avoid straining infrastructural facilities of the nearby settlements. The township shall be provided with safe drinking water supply and sanitary system for collection, treatment and disposal of sewage and garbage.

(d) Possibilities of reuse of treated effluent water for sewage farming and pisci culture shall be seriously considered.

(e) Adequate space for recreational activities and parks should be provided.

(f) Tree plantation shall be taken up in a systematic manner in the township.

(g) Adequate arrangements for grazing of cattle should be made. Care should be taken to avoid cattle grazing in areas near streams which may be contaminated by pollution.

(h) To prevent indiscriminate foraging for fuel, fuel depots should be opened.

(I) All care should be taken to avoid growth of slums and temporary settlements.

RECOMMENDATION AND CONCLUSION:

The mining industries enhance comfort of human life on one hand while on other hand; it adversely affect rate of proliferation of wild life population by associated deforestation, air and water pollution. Over industrialization in some parts of the world has become matter of great concern and environment conscious governments have begun to assess what the societies are losing as a result of industrialization. The **mining related environmental problems** are as follows:

(i). The mining projects generate over-burden and underground mine spoil having certain quantities of toxic and un-healthy chemical elements. These pollutants can become air-borne or water-borne and can affect the surroundings and the human population in the vicinity.

(ii). The leachates from mine spoils, mine water and workshop effluents have certain quantities of toxic substances which can adversely impact the local environment.

(iii). The ground water may get polluted because of leaching and percolation of mine water through discharge from tailings and the mining pits.

(iv). The Heavy Earth Moving Machinery (HEMM) equipment's used in the mining projects and the transport vehicles generate high noise level and dust during operation affecting the environment.

(v). In most of the mining projects, monitoring mechanism is poorly developed. This results into helplessness on the side of the Project authorities to tackle any environmental problem because of the inadequacy of data collection and documentation of the environmental happenings.

(vi). Lack of awareness about need for environmental protection and management and scarcity of available trained man-power to tackle with the issues related to environmental pollution and control.

(vii). Non-reclamation of habitats and sites which have been degraded due to mining operations, choosing of unwanted forest species or plants and un-systematic plantation exercises without taking into consideration, quality of soil, gradient of the area and suitability of the species.

(viii). Lack of aftercare and maintenance of the plantations and pollution control devices developed in the project area make the Project authorities also handicapped to accelerate the process of amelioration of the quality of environment and to check further degradation and pollution in the areas where efforts already have been put in.

(ix). Allocation of insufficient budget for implementation of provisions of Environmental Management Plans (EMP).

(x). Forest area in mining region will go on decreasing, with increase in mining activity. Of the total lease area of the mines, the areas occupied by permanent structure like buildings, roads, workshops, office complex, dispensary, residential areas, schools and mining pits cannot be made available for years for afforestation. Thus, a significant proportion of land out of total lease area may reduce the extent of natural growth. Further, the plantation which has been carried out so far, by projects, in these areas by selecting mostly exotic species may have certain ecological impacts in changing the micro ecological settings. Local indigenous species should always be chosen for replenishment which shall generate long term environmental benefit in terms of biodiversity conservation and socio-economic acceptance.

(xi). Use of agricultural land for mining also affects the net crop yield

from the region. Utilisation of agricultural land for industrial use results in shrinkage in crops areas and net crop yield. There has to be a comprehensive mechanism to ensure that total crop yield of the region remains the same from the remaining agricultural lands. New high yielding varieties of crops should be introduced with proper irrigation and fertilizer inputs. The Project areas will witness increase in population flux with greater demand of agriculture produce. Unless the above measures are taken, it is likely that there will be social unrest and rise in conflicts between local inhabitants and Project authorities. The mineral alone cannot meet the local needs especially the food. The mining projects should adopt peripheral villages to introduce the above measures.

Listed below are few **recommendatory measures** which can be implemented at site by the Project authorities for amelioration of the environment and for checking further degradation in the area.

(i). Site selection criteria should be scrupulously followed so that the provisions of all the acts relating to particular project sector are fully adhered to. The sensitive habitats like wet lands, reserve forests, migratory route of animal & birds, archaeological sites, breeding grounds of organism and aquifers are a few parameters among other ecological considerations which are to be kept in mind.

(ii). During various types of construction activities, top soil is removed. This fertile and life supporting entity should not be allowed to lose its vigour and character. Immediate utilisation of this soil for spreading on the infertile and recalcitrant solid wastes like Over Burden dumps and other materials and for taking up plantation should be planned to derive long term ecological benefits.

(iii). The workers engaged in various activities and the local people should be educated and made aware of the importance of nearby natural habitats. The project authorities, contractors and other persons having work force should arrange fuel wood/other fuel facilities for the labourers. The protected surroundings will provide a lot of benefits to the project and the society and will help controlling air, water and noise pollution.

(iv). Continuous efforts for improvement of environmental quality should be made. The Project areas should be surveyed and suitable land scape developed. The indigenous varieties of forest and other trees and herbaceous species should be encouraged to be planted in project area as well as in nearby village/town areas.

(v). The site for schools and hospitals should be so chosen that the air and noise limits as prescribed for sensitive areas can be achieved easily. The project activity should be separated by thick green belt from these areas to avoid noise and air impacts reaching the sensitive areas.

(vi). All types of projects including infrastructure projects generally are required to rehabilitate the population on whose house/land the project operations starts. This is a very sensitive aspect. It is better to take up this issue on priority and comply within a specific time schedule to avoid any resentment, grievance and various other types of social problems. There are instances that project viability comes at stake due to rehabilitation and resettlement issues.

(vii). The drilling machines to be fitted with dust collection, suppression and disposal arrangements; water sprinkling of drilling zones by deep wetting. Blasting should be exercised with optimum quantity of explosives during favourable weather conditions only and with properly wetting the blasting site. Regular maintenance of HEMM and other transport vehicles control of speed limit and smoke emission; roads to be metalled, well maintained and sprinkled with water.

(viii). Mine spoil to be reclaimed by either engineering or biological reclamation methods, leaching of any water from dumps to be routed through garland drain and treated in a settlement tanks before final discharge. Mine discharge water should also be handled with proper treatment before discharging into natural water course.

(ix). Environmental Management Cell (EMC) has to be created with clear-cut responsibility assigned to respective officers of the cell. Collection and updating of data to be done regularly throughout the Project operations. Yearly Action Plan is required to be made for management and control of all the environmental components.

(x). Existing Rules, Regulations and Guidelines relating to mining and environment and compliance must be known to the officers at all levels right from Head of department to the field level officers. Heads of organisations must know about the environmental action plans and their achievements. At least quarterly meetings should be taken by him to review the progress and to direct the concerned accordingly. This helps to execute the project at desired speed and target.

(xi). Adequate fund provision must be made for implementing the programmes relating to environmental management in the project area

and in no case, the funds should become a limiting factor. The sooner the environmental problem is ameliorated, the lesser the investment is needed from the Project and vice-versa.

The Ministry of Environment, Forest and Climate Change and the Ministry of Mines and other concerned Departments are working towards environmentally sustainable mining in the Country. There is a strong need to have an over-all implementation of the various compliances made under the environmental/forest/wildlife clearances for better sustainable mining in the country under various provisions of the Acts and Rules relating to mineral industry. It has become a practice in the mineral industry to open up new area without exhausting the mineral resources available in the already existing mining projects. The investments made in new projects are enormous compared to the annual production targeted in new projects. In fact, the existing mining projects could be strengthened, modernised with new machinery and with an efficient new extraction procedures at a significantly lesser amount to increase the total production compared to heavy investment in new projects. This practice will also yield useful results for the environmental management aspect also because the investment about the environmental management will be at one place and can be achieved satisfactorily. Once the mineral extraction is exhausted at one place, the area becomes available for full reclamation and land can be converted into a better eco-system more like a natural eco-system. It is desirable to have a nation-wide debate on this aspect for the cause of environmentally sound and sustainable development in mineral sector.

Conflict Of Interest:

The authors declare no conflict of interest. Further, these are the views of the author and not Organization.

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