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USE OF TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT – A CASE STUDY

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ABSTRACT

Minerals are the backbone of any industrial activity. They are also main source of energy and employment. Mining and its various operations presents an apocalyptic nightmare of environmental degradation and ecosystem instability. The activities like deforestation, waste dumping, soil erosion, polluted air and contaminated water along with physical and socio-economical changes are some of the negative impacts of mining. Minerals can be mined only at their place of occurrence. Unfortunately many mineral deposits occur in forest region. To sustain mineral supply with minimum environment degradation is the big challenge. We are witnessing the impact of global warming on climatic changes, flora and fauna which is only due to human generated emissions. Hence protection of environment has become necessary for the survival of human species.

Degradation of environment due to mining cannot be eliminated but its impact can be certainly reduced by scientific methods of mining along with adoption of eco friendly technologies. This paper presents a case study of Dongri Buzurg manganese ore mine of MOIL Limited, where scientific studies and implementation of new technologies has helped mine management to reduce environmental impact, development of new forest cover and in reducing carbon emission

Key words: environmental degradation, eco system, scientific studies, new technology

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1. INTRODUCTION

Nature has bestowed India with many natural resources. India has good deposits of coal, iron ore, bauxite, manganese ore, chromite, rare earths and limestone (1). A major part of the country enjoys more than 300 sunny days in a year thus creating potential for generating solar energy (2). It has more than 7517 km long coastal line making way for wind energy (3). It's a developing nation having population of 1.38 billion (4). Due to low per capita land availability, land is a scare resource. Thus mined out land is required to be reclaimed. Presently Indian economy is one of the fastest growing economies of the world. Sixty percent of energy requirements are met through coal fired power plants. Large consumption of coal increases carbon di oxide percentage in the atmosphere, which is responsible for global warming. Major production of minerals is from opencast mines. Opencast mines degrade land, water and environment the most. To sustain the growth, there is a need of reducing negative impacts of opencast mining. This is possible by using new scientific techniques in the area of mining methodology, reclamation, developing forest cover over dumps and using renewable energy.

MOIL Limited is the largest producers of manganese ore & its value added products in India. It produces around 1.1 million tons of manganese ore per year from 10 mines, which are located in the state of Maharashtra & Madhya Pradesh. Out of this 7 mines are underground & 3 mines are opencast. The underground mines are accessed by inclines/shafts. Opencast are worked with shovel dumper combination. There are two integrated mineral beneficiation plants, located at Balaghat & Dongri Buzurg mine & two processing plant for value addition i.e. Electrolytic Manganese Dioxide plant at Dongri Buzurg & Ferro Manganese Plant at Balaghat mine.

Blasting is required to be done to break the rocks into small lumps so that they can be transported easily. Blasting produces vibrations and dust. The minerals are found below earth surface. To mine mineralized portion top cover has to be removed. The top soil is stored separately. Some of the overlaying rocks are dumped into mined out areas and some at non mineralized zone. The height of such dumps varies from 60m to 125m. Stability, erosion and aesthetics of man made dumps is a concern area. Lot of trees is cut for mining of minerals. Forestation over the reclaimed land and dumps is another challenge. Forest as such is natural absorbents of carbon di oxide which is a major source of global warming.

MOIL Limited as an responsible corporate citizen has engaged Central Institute of Mining & Fuel Research (CIMFR) for controlled blasting parameters, National Institute of Rock Mechanics (NIRM) for slope stability analysis & National Environmental Engineering Research Institute (NEERI) for Rejuvenation of mine spoil dumps at Dongri Buzurg opencast mine.

Dongri Buzurg mine is located 120 km from Nagpur in Bhandara district of Maharashtra state. Total lease hold area of the mine is 174.860 ha, out of which at present mining area are about 92 ha. It produces around 3 Lakh tonnes of manganese ore per year that includes around 10000 -15000 tonnes of dioxide ore which is being used for making dry battery and chemicals. Electrolytic Manganese Dioxide (EMD) plant of 1000 TPA capacities and Integrated Mineral Beneficiation plant of 400000 TPA capacity is operated at mine head.

The scientific studies done by various organizations and there implementation at Dongri Buzurg mine has helped MOIL Limited to adopt eco friendly mining. Implementation of some of the scientific measures which have resulted in reducing impact on environment are discussed below-

Blasting : Chemical energy is used to break the rocks. A part of this energy escapes in the atmosphere creating ground vibrations, fly rocks and dust. Ground vibrations damages stability of structures and fly rocks & dust is injurious to health. The scientific study carried out by CIMFR has helped in designing the blast so as to reduce not only vibrations and dust but also improving size of rock fragmentation. Reduced size of fragmentation increases transportation and crushing efficiency thus reducing energy requirement. Controlled blasting technique is used at Dongri Buzurg mine with deck charging using non electric detonators with calculated charge per delay(5).

Slope Stability: After every 2nd bench, a berm bench is provided at Dongri Buzurg mine for making a ramp & transfer of men & machines. Ultimate pit slope is generally 36 to 37 degrees. Place of dumping is located in a plane non mineralized area which is free from geological disturbances and away from water bodies. Terracing is being done at dump at a height of every 10m and no dumping is done within a distance of 50 meters from the edge of the top most benches. The formation of benches and dumps are practised as per the scientific suggestions made by NIRM which has resulted in stable benches and dumps (6).

2. REJUVENATION OF MINED OUT LAND AND DUMPS

Apart from alleviating the pressure on the valuable primary forests, plantations offer continuous production of wood materials through intensive management practices. Besides the direct economic benefits, the ecological dimensions of plantation forestry have attained greater importance in the recent times in view of the invaluable contribution they provide in regulating atmospheric CO_2 emissions and thereby playing a dominant role in mitigating climate change (7).

An approach plan for rejuvenation of land productivity and reclamation of spoil dumps was prepared, based on the physio-chemical-microbiological properties of mine land and mine spoil dumps as per the studies conducted by NEERI. NEERI suggested integrated biotechnological approach (IBA) which envisages the use of industrial wastes like press mud from sugar mill industry as an organic amendment for the spoil & use of nitrogen fixing bacteria like Rhizobium and Azotobacter which can tolerate high manganese concentration and VFM fungi. Laboratory and field studies were also undertaken to select the most suitable plant species for the dumps. On the basis of this study different plant species like teak (Tectona grandis), shishum (Dalbergia sissoo), shiwan (Gmelina arborea), neem (Azadirachta indica), karanj (Pongamia pinnata), cassia (Cassia seamea), awala (Emblica officinalis) and bamboo (Dendrocalamus strictus) were selected for plantation on manganese spoil mine dump.

The various soil parameters affecting growth and survival of plants was tested at Dongri Buzurg mine, the results are tabulated below

Table 1 Descriptive statistics of soil samples

Parameter	No. of Samples	Mean (lbs/ acre)	Standard Deviation
Nitrogen	16	285.97	40.96
Phosphorous	16	18.41	1.64
Potassium	16	39.58	4.03
Organic Carbon	16	1.03	0.25

Based on these studies composite soil quality map was prepared by using GIS software ILWIS 3.3, given below in Table 2 which shows different soil fertility rates

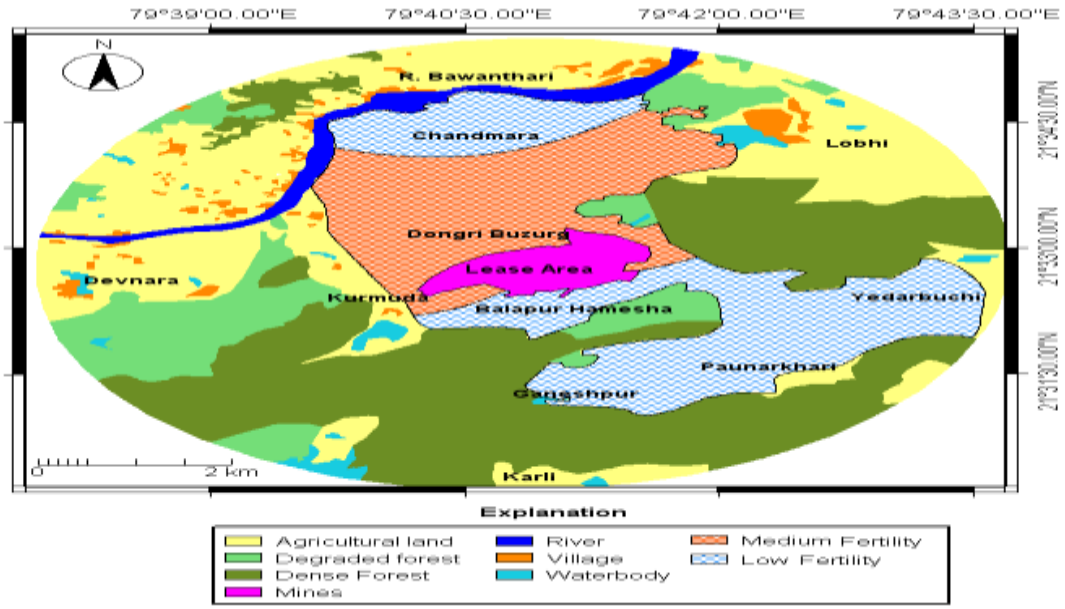

Figure 1 Soil quality map showing fertility status (0-15cm)

Pitting technique was adapted for plantation on slopes of mine spoil dumps. Pits at slope of dump were 0.6 m x 0.6 m x 0.6 m dimension at ground levels and 1 m x 1 m x 1 m size dimension at elevated levels were formed. Each pit was filled with 4 parts of spoil + 1 part of soil + press mud @ 100 t/ha. The VAM spores (10g) having approximately 30 spores were applied to each pit by mixing with blending material to enhance the nitrogen fixation, development of profuse root system in plants, solubilisation and mobilization of nutrients. IBA significantly improved plant growth 7 to 9 fold, while survival rate for plants like Teak, Neem, Shishum, Shiwan, Bamboo etc., ranged from 84 to 92 percent as depicted below -

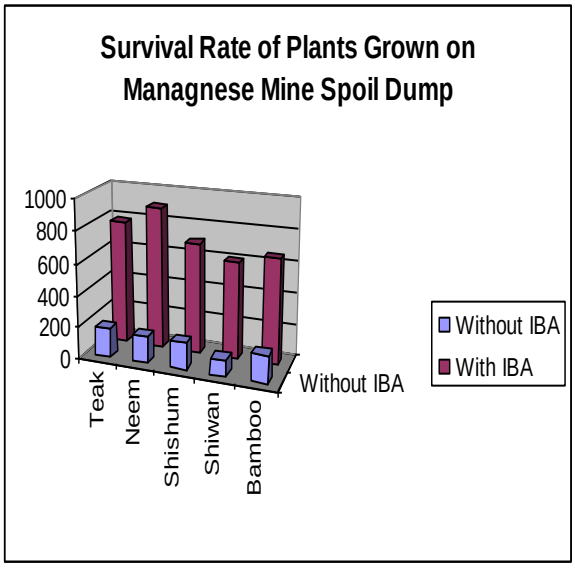

Figure 2

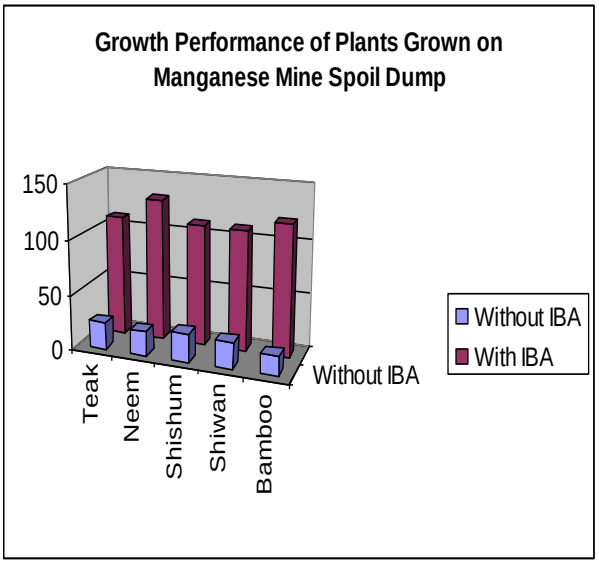

Figure 3

These environmental efforts in forestation resulted in plantation of various species of trees in 33.54 Ha with more than 1,46,807 trees at an survival rate of more than 79 percentage at Dobri Buzurg mine(8).

3. AIR QUALITY ASSESSMENT

Air quality data are collected are collected regularly from the nine village sites falling within the 5 km buffer zone of the mining lease area and also from eight locations in the core zone (leasehold area) for estimation of mining footprint (air) by spatial analysis using GIS.

Table 2 Descriptive statistics of air samples

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
PM_{10}	17	58.576	6.857	47.9	68.3
$PM_{2.5}$	17	18.688	3.491	13.6	23.8

Solar Power Plant: MOIL management has installed a 5 MW solar power plant at Dongri Buzurg mine. One KW coal based energy generates 0.45 Kg of CO_2. Apart from this there are grid losses in transmission (9). Thus installation of renewable energy source like solar plant have saved tremendous amount of carbon di oxide being emitted to the atmosphere.

4. RESULT AND DISCUSSION

As a responsible corporate citizen MOIL Limited has recognized its responsibility towards minimising environmental impacts due to mining. This could be possible due to implementation of outcomes of various scientific studies which were conducted by them. Saving environment is the call of Paris Agreement. India has accepted its role by promising to produce 40% of its power capacity by non-fossil fuel sources. At the same time, India accepted to create an additional 'carbon sink' of 2.5 to 3 billion tons of CO_2 equivalent through additional forest and tree cover by 2030 (10). Sustainable development is only possible by adopting new technologies based on scientific studies replacing age old methods.

5. CONCLUSION

Mining as such is environment degrading activity. It affects land, water, flora - fauna, social and economical aspects of the region. Irrespective of causes it has to be done as minerals are backbone of all industries. With the launch of the National Mineral Policy 2019, India presents a major opportunity for investors. Its impact on environment cannot be eliminated but definitely can be reduced by adopting scientific way of mining, use of renewable sources of energy, practicing reclamation and the most important accepting our responsibility towards protecting environment.

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