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TEMPORAL VARIATION IN GEO-ENVIRONMENTAL CONDITIONS AROUND THE DONGRI-BUZURG MANGANESE ORE MINES, BHANDARA DISTRICT IN MAHARASHTRA, INDIA

SANNIV SHOME[1], K. PATHAK[2], SUSHIL MHASKE[3] AND G.G. MANEKAR[4]*

[1,2,3] IIT, Kharagpur, India
[4]MOIL Limited, 1-A, MOIL Bhavan, Katol Road, Nagpur 440 013, India

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ABSTRACT

Mining is ecologically devastating, but economically very useful. These diverging needs force the corporation to follow mining both Public and private, damaging the environment or causing an irreparable loss to the ecology. Therefore, there is a need to comprehensively study the mining region to analyse the changes that take place over the years in terms of geo-environmental changes and their impacts on the environment. In the light of the above facts, Dongri-Buzurg manganese ore mines in the Bhandara district of Maharashtra has been selected for accounting the detailed changes during the entire 50-years journey of its existence. The Changes that are focused more here are geo-environmental changes over the five decades. From an environmental point of view, parameters like change in land use land cover, drainage pattern and base flow changes in the adjoining streams, air quality index, as well as noise pollution levels during the non-working hours are selected. This study showed that the drop of Forest cover from 42% to 8.1%, an increase in waterbody area by 2.5% and overall increase in the agricultural land by 42% as part in over five decades. This drastic change in pattern creates an unsustainable amount of pressure on the local ecological environment. In contrast, plantation over the mine dump and creation of buffer zone has led to some preservation of the ecology in its original form. Interestingly the village area over the decades is only increased by 0.1 %, which indicates that damage is manageable with proper planning as the population rise is geometrical in nature. Water quality analysis over the years are also demarcates certain trends in the area, with high mineralogical contents, which are found manageable with mild treatment. The investigation revealed that the depth of drainage base flow changes from 50 cm to 12 cm in the adjoining stream. The Air quality index was monitored with PM2.5 and PM10 as major parameter of the Study. The Above two parameters were found moderate within the study Area. The Ambient Noise pollution with a set criterion of 75db was analysed over the years, which indicated the noise pollution levels to be way lower than 75db during the entire period of Mining in the Study area. Whereas, a change of 30% in activity characteristics is observed in over four decades of Industrialization. The paper is an overview of man-made changes and its impact on nature.

KEY WORDS : Environmental monitoring, Geological monitoring, Air quality indexing, Sustainable mining

INTRODUCTION

Dongri Buzurg is one of the largest manganese open cast mine of Manganese Ore India Limited , which produces around more than 3 Lakh tonnes of run of mines (ROM) from the pit with more than 5 Mm3 of excavation of overburden rock per annum. Rocks representing the lower part of the Sausar Group sequence viz. Tirodi gneisses, Sitasaongi and Munsar formation that occur in and around Dongri-Buzurg Mine. Lohangi formation is absent in this area. The Manganese horizon occurs at the

([1] PhD Scholar, [2] Prof., [3]SPO, [4]General Manager (Mines)

stratigraphic contact of the Sitasaongi and Munsar Formations. Manganese ore is associated with Gondite, a regionally metamorphosed manganiferous and non-calcareous rock, characterized by spessartite (a manganese almandine garnet) and quarts with or without manganese silicates showing essentially bedded characteristics of enclosed politic meta-sedimentary rocks. Method of mining is with shovel-dumper combination and transportation of ROM to crushing and screening plant. The combination of various rock type (Granitic Gneiss, Tirodi Biotite Schist/ Muscovite Quartzite Schist) is present in the overburden dumps. The Mining Activities in the Area are operational from the year 1960s under the aegis of Central provinces Mining Company which post Nationalization become a part of Ministry of Steel and finally of MOIL. The rich legacy and heritage are present and preserved in its true form. While Surveying the study area, we found the details of CPMO till 1962 and then post 1977 when it Became a 100% state owned Corporation. A detailed study through its Past To its present was done in order to access the Changes Due to mining.

DESCRIPTION OF THE STUDY AREA

The Area referred comprises of Core zone and Buffer zone of the Dongri Buzurg mines. The mine is located in Bhandara District of Maharashtra (India), about 120kms from the Nagpur and 25 kms from Tumsar Township. The area is approached by Metal Road which is motor able in all seasons. The mine is connected by a 7 KM long all weathered road to Goberwahi which in turn is connected through a system of state and National Highways to all parts of thecountry. The mine also has a broad-gauge railway siding from the DongriBuzurg station, which is connected to Tumsar Road Junction.

There is 4 leaseholds of MOIL and total area is 173.8ha. Method of mining is mechanized. Shovel and dumpers are deployed for overburden removal and ore excavation. Currently opencast mining is carried out in 46.25 ha lease area in central portion of ore Body. Shovel Dumper combination and deep-hole blasting are used for bench formation and overburden removal. The leasehold area presents rolling topography with low lying hillock that extends from east to west. Rocks of Saucer series (Igneous rocks) have traversed a large Area of Balaghat and Chindwara districts in Madhya Pradesh and Bhandara and Nagpur districts in Maharashtra. The Saucer Series extends from Balaghat district in the east to Chinndwara district in the west between longitudes 78° 49" and 80°20"; Latitudes 21° 22" and 22°05" having a length of 210 Km and a width of 25- 30 Km. The ore deposit is underlain by rocks belonging mostly to the lower part of the Meta sedimentary sequences of Saucer Series. The manganese ore is associated with gondites, a regionally metamorphosed manganiferous and non-calcareous rock, characterized by spessartite (a manganese almandine garnet) and quartz with or without manganese silicates, showing essentially bedded character and enclosed in peletic and psammitic metasedimentary rocks. The mine area is representing an overturned southern limb of a syncline with older formation like Tirodi, Gnesisses and Sitasaongi formation forming the hanging wall of the Manganese Ore. Mica Horizon and Mica Schist is forming the footwall as well as the core of the syncline. The strike length of the ore body is about 2150 m with the strike direction E-W. The thickness of the ore body ranges from 2m to 30m. It is the thickest in the central part and gradually taper down up to 2m at both the ends. The average dip of the ore body is 60° due South. The Manganese ore horizon occurs as a continuous bed at the stratigraphic contact of overlying Sitasongi formation and the underlying Mansar formation, on the reversed limb of a regional anticline.

The area is characterized by an undulating topography with average height of the ground level varying between 233m and 339m. Several micro catchments areas exist, in the area, as a result of the undulating topography in the area. These micro catchments area present a composite picture of the drainage pattern of the area. The land quality in the area can be enhanced by establishing an irrigation network in the area by using Bawanthari river water. A land use Map of 1975 has been prepared using the Survey of India Topo sheet No. 55O/10 and 55O/11. Traditional agricultural practices are also in vogue in the fertile lands of the area. During 1975, most of the surrounding area was covered by dense forest but is has been extensively destroyedas revealed from 2011 dataA land use Map of 1975 has been prepared using the Survey of India Topo sheet No. 55O/10 and 55O/11. Traditional agricultural practices are also in vogue in the fertile lands of the area. During 1975, most of the surrounding area was covered by dense forest but is has been extensively destroyed as revealed from 2011 data.

CHANGE IN LAND USE AND LAND COVER

Since mining involve change in the Natural ecosystem, therefore the change in land use changes is bound to happen. Going through all the Data Available at our Disposal we pointed out the drastic land pattern changes in the land utility in the 50 years or 5 decades of mining. The Table and the Chart below is providing an insight into the land utility changes over the years (the area is given in Hectares).

Observations

1. Over all change in Land use and land cover pattern over the study area is found to be 67%.
2. The human Settlement did not increase much but the mining activities increased.
3. The Change in the pattern is linear in Nature and associated with particulars activities and hence it can be predicted through the proper AI programming.
4. Various Activities contribute in a particular way, weightage of each activity if taken into account can provide the ultimate futuristic prediction which will occur after a particular lapse of time, keeping other parameters as non-variant or same.

Location wise Temporal Changes in Noise Pollution Levels

The noise pollution is an acute problem, which if persists can cause deafness in the human beings. Due to changes in the blasting methodology, noise has reduced quite significantly. Many steps are taken Accordingly in the recent years that has reduced its impact significantly over the years. Data has been continuously gathered around the area of major operations in the vicinity, which in the recent years has shown some signs of steady activity. The location wise noise level variation is presented in the table below:

Observations

1. Over all noise pollution from 2014 to 2019 has increased by 3%.
2. Still, we can say the noise pollution levels are under controllable limits and are kept in such a way so as to cause minimum harm.
3. To reduce the noise and ground vibrations, non-electric detonating system with NONEL shock tubes. Delays and micro-mili second detonators have been used.
4. Connecting tubes/detonating wires has been covered with muck of loose drilling material to avoid noise.
5. To use the suitable strength explosives now using site mix slurry / site mix emulsion explosives with non-electric shock tubes
6. Large leaf plants have been planted around the lease boundary to arrest and reduce the dust propagation and reduce noise.
7. These activities have reduced the noise level well within the prescribed dB scale
8. From the graph and equation the factors are

Table 1. Decadal changes of land use /land cover of DongriBuzurg Mines

Sr. No.	Land use/land cover	1975	1985	1995	2011
1	Agricultural land	29.9	35.8	38.7	42.84
2	Dense Forest	42.4	40.5	32	8.1
3	Mines	0.5	2.5	8	19.85
4	Rivers	2.2	2.2	2	1.9
5	Villages	1.7	1.7	1.75	1.8
6	Water body	1.7	1.8	1.9	2.4

Table 2. Temporal Changes in Noise levels with accordance to various locations

Sr. No.	Location	Noise ambient levels	2014	2016	2017	2018	2019
1	Near Machine drills	115	79.4	73.2	73.8	82.7	73.1
2	Near Haul Road	85	68	61.6	68.1	78.3	81.4
3	Near Crushing and Screening Machine	90	74.1	65.2	64.2	76.1	82.7
4	Near Operator Cabin	85	70.5	69.8	71.6	76.1	68.3
5	Near Guest House	65	43.6	44	43.5	43.8	44

inter-related but shows less correlation. This may be due to the strong measures adopted by the mine management in the area of environment.

Location wise air quality parameters since 2011

Air quality is an important parameter in today's world. As we are aware of the current situation, where industrial pollution has led to acid rain, increase in cancer cases, lung diseases etc, the mining is also an industry which changes the ecological delicate balance and creates air pollution i.e., introduction of particulate matter and other gaseous pollutants. Monitoring stations were stationed across the mines in order to monitor the air pollution levels in and around the mines. The location used specifically were the mines office, residential area and open cast mining area. Over the 9 years variations are observed and graphed as below.

Observations

1. The level of PM10 and PM 2.5 has increased with increasing activities, which needs to be Controlled.
2. SOx levels are at control and hence Acid rains are out of the question.
3. Plantation around the Dumps in the mines can help prevent the particulate matter entering into the civilian population.
4. The change in technology has to be changed to suppress the dust formation.
5. Existing technologies has given a linear relation, which co-relate the particulate matter generation and mining practises etc, this is helpful for creating the program for future prediction, of activities based on the past experiences.

Temporal Variation of water Quality in the Mine Waste Discharge

The mine has water discharge which is released into the natural water body. The impact of this water into the natural system is very important and hence the water quality has been assessed for past 9 years now in order to make an objective pattern derivation for the different situations available at the mining site. The data is tabulated with various parameters which are intended to evaluate the suitability of water to be discharged in the natural aquatic systems.

Observations

1. The water quality is satisfactory, but the Dissolved oxygen has to be increased up to a minimum of 9 mg/l.
2. COD treatment would be uneconomical
3. Small treatment plant with in the premises of mine can be established, to remove the suspended particles and BOD.
4. Manganese is within the limit for Disposal.
5. BOD should be near about *Nil* but there is some presence.

Total annual depth of rainfall in mm for the entire area in the past 13 years

It important to predict the probability of occurrence

Table 4. Rainfall variations over the decade

Year	Rainfall in mm
2007	875.2
2008	657.3
2009	392.78
2010	968.79
2011	864.32
2012	963.12
2013	144.15
2014	824.61
2015	785.7
2016	767
2017	581.81
2018	712.07
2019	682.57
2020	797.66

Table 3. Decadal variation of Water quality parameters

Parameters	2011	2012	2014	2016	2017	2018	2019
pH	8.14	7.05	7.64	7.8	6.92	7.16	6.73
Dissolved oxygen	5.54	4.96	6.4	4.5	6.1	6.1	5.6
COD	9	8	24.82	58	3.7	27.3	2.6
BOD	1.8	1.6	8.16	4.8	1.5	1.35	1.2
Suspended solids	7.4	40	9.5	31	8.6	16	7.9
Oil and Grease	1.4	1.4	1.2	1.1	2.3	3.0	2.7
Manganese	0.51	0.40	0.09	0.6	0.05	0.27	0.31

of rainfall from the past records of hydrological data using statistical analysis. Frequency or probability distribution helps to relate the magnitude of the extreme events like floods, droughts and severe storms with their number of occurrences such that their chance of occurrence with time can be predicted easily. By fitting a frequency distribution to the set of hydrological data, the probability of occurrences of random parameter can be calculated. The mine management had taken appropriate steps for the conservation of environment in the mines and surrounding area in technology and resource consumption. It has added to the effect on uniformity of rainfall and other parameters of the environment. The rainfall data from the above depicts, its consistency over the several years though, it has been the change of the land use pattern for the area. It can be further strengthened by more vegetation and plantation in the area and nearby surroundings

Observations

1. The value of R^2 is on the higher side; which represents a model that explains all the variation in the response variable around its mean.
2. The Rainfall mean indicates a use of hard and less water consuming species of plants in order to afforest the area.

RESULTS AND DISCUSSION

The results are a review and comparative analysis of the Data from the past to the present. From the data, we can interpret that the mine has maintained a high standard of surveillance over its activities and has complied with the norms. However, no one could deny the changes that arevisible in the comparative analysis. Increase in Particulate matter has to be controlled. Though increase in noise pollution is not worrisome but the 3% increase could have been avoided by applying proper techniques. Land changes indicate that we need to look in afforestation more seriously and create more of the green buffers.

CONCLUSION

After a brief study of the history and data of the area, huge dumps were found around the area as waste land and thus can be converted into carbon sink. Noise pollution as well as air pollution can be prevented by planting suitable species around the Dump area. For which, species of Vetiver grass especially that of *Chrysophogan zezonoides* can be a solution for maintaining the greenery, and can also aid in providing soil stability, erosion control and pollution control. The use of vetiver grass can increase soil organic content as well as it can also supplement groundwater improvement.

Over the years, forest land has decreased and afforestation is the need of the hour and hence the dump revegetation can be termed as a good option. Overall, the mining is an essential activity but we need to apply the solutions in order to maintain an amicable relationship with the environment.

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