HELIX
The Scientific Explorer

https://doi.org/10.29042/2020-10-4-39-42

Helix (2020) 10 (4): 39-42

Matrix Approach to Select Post Mining Land Use

[1] Sanniv Shome, ✉ [2] M S Tiwari, [3] G G Manekar
[1] Environmental Researcher, Nagpur, India
sanniv1492@gmail.com
[2] Shri Ramdeobaba College of Engineering and Management, Nagpur, India
tiwarims@rknec.edu
[3] MOIL Limited, Nagpur, India
ggmanekar@gmail.com

Received: 04th June 2020, Accepted: 19th June 2020, Published: 31st August 2020

Abstract
India occupies 2.5 percent of the total land area of the world, but supports 16.7 percent of the world population. The per capita availability of agricultural land has shrunk to 0.3 hectare per farmer compared to over 11 hectares in the developed world. Land is the most important natural resource which embodies total ecosystem. Mining is a site specific industry and it cannot be shifted anywhere else from the location where mineral occur. Hence there is urgent need to reclaim and restore mined out land for its productive reuse. India is among the top ten mineral producing nations and contributes significantly in the production of coal, iron ore, bauxite, limestone and manganese ore in the world.
To produce every million tons of coal, 4.0 hectare of land is degraded directly and another 4.0 hectares indirectly. The legal aspects of reclamation presently consider only bringing the mined out land to its original contour or to its original revenue earning capacity in India. There is no system of undertaking likes redeemable bonds as in European or American countries. Only the economic parameter is given highest weight age and filling up to the mined out land is still considered as best outcome of reclaimed land. Other uses which may be more socially and environmentally acceptable are overlooked. An attempt is made in this paper to develop a generalized matrix, covering environmental, social and economical parameters, which may help in selecting the best post mining land uses which are as per the requirements of local community. Presented case study will help understand the matrix solution.

Keywords
Land, Natural Resource, Post Mining Land Use, Reclamation

Introduction

India produces as many as 95 minerals, which includes 4 fuel, 10 metallic, 23 non-metallic, 3 atomic and 55 minor minerals [1]. The mining sector in India employs a smaller percentage of India's population, just about 0.3% as compared to 3.8% in South Africa, 1.4% in Chile and 0.7% in China. The McKinsey Global Institute report suggests that development of mining sector will be important if India has to achieve 7% plus GDP growth. The report further says that mining sector alone has the potential to create 6 million additional jobs by 2025. The sector can contribute an additional USD 125 billion to India's output and USD 47 billion to India's GDP by 2025. According to a report by FICCI, if India is looking to increase the share of mining sector to 5% of the GDP in the next 20 years, this sector would be required to grow at the rate of 10-12 percent annually [2].
Land is the most important natural resource which embodies total ecosystem. Mining is a site specific industry and it cannot be shifted anywhere else from the location where mineral occur. India occupies 2.5 percent of the total land area of the world, but supports 16.7 percent of the world population [3]. The per capita availability of agricultural land has shrunk to 0.3 hectare per farmer compared to over 11 hectares in the developed world [4]. Mining is a site specific industry and it cannot be shifted anywhere else from the location where mineral occur. Hence there is urgent need to reclaim and restore mined out land for its productive reuse [5]. India is among the top ten mineral producing nations and contributes significantly in the production of coal, iron ore, bauxite, limestone and manganese ore in the world [6]. The legal aspects of reclamation presently consider only bringing the mined out land to its original contour or to its original revenue earning capacity in India. There is no system of undertaking likes redeemable bonds as in European or American countries [7]. To produce every million tons of coal, 4.0hectare of land is degraded directly and another 4.0 hectares indirectly [8].
As the per capita availability of agricultural and forest land is very low, the problem of land management becomes more conspicuous when judged against the alarming growth rate of population. Mine designers must therefore consider the effects of a mine on its surroundings, integrate the process of mining, land use planning and reclamation, adopting an appropriate social and environmental care policy. A generalized matrix, covering environmental, social

and economical parameters, which may likely affect the selection of post mining land use, is presented for selecting a particular post mining land use [9]. A case study of opencast coal mine located near Nagpur is presented wherein weight ages to various parameters have been allotted as positive or negative depending upon their impact.

Post Mining Land Uses

To put back the post mining land in the use is called reclamation. Land reclamation can be broadly classified as below [9]-[12]:-

- Development of forestry and wild life.
- Agricultural: for gazing fields, crops, orchards, timber land etc.
- Recreational: for hunting, fishing, water sports, vacation resorts etc.
- Township : for suburban and urban housing
- Industrial: for development of small and heavy industries.
- Water Reservoir: rain water storage, for drinking, industrial purpose or for fisheries.
- Garbage dumping: waste discharge of the township.

Of all the post mining land uses listed above the most commonly adopted in Indian scenario is development of forestry and wild life. Post-mining regions include various landscape and geophysical changes, and often differ significantly from surrounding (rural) landscapes. Mining leaves behind various land disturbances, such as open pits, waste rock dumps, tailings, and roads. Further, post-mining sites can also include standing buildings, above ground and underground structures and machinery. There are no universal reclamation planning schemes for former mining areas, and thus, detailed objectives of closure plans and post-mining measures are largely site-specific [10]. A large area of reclaimed land can be redeveloped to many different land uses when the heterogeneous environmental conditions within a mining site are considered. For example, some parts of a mining site close to roads and city centers may be better to be redeveloped into industrial and commercial site or residential area, while some parts with unfavorable topographic condition can only be restored to forest [11]. Land suitability analysis can help to identify possible suitable land uses for each location in a mining site. However, some locations may be appropriate for multiple land uses with the same suitability level. Land uses are exclusionary, and only one type can be allocated to each location. The optimal land use cannot be determined solely based on the land suitability analysis in this circumstance. Other methods need to be applied to further refine the reclamation planning process. Governments and decision makers increasingly recognize the importance of integrating ecosystem services into ecological restoration and landscape planning [12].

Procedure Adopted in Developing the Matrix

A list of parameters that might affect the post-mining land use is tabled along the vertical column. These parameters are grouped under three logical sets, as environmental, social, and economical. Under each of these sets, sub sets are made, showing the specific topics involved under each set like environmental degradation can be due to land, water, air or noise pollution. After listing these topics numerical values showing the relative weights of these subsets are given. These weights are attached by distributing 1000 parameter importance points among these topics bases on their priorities and effects. Since quantitative assessment of environmental and economical parameters is feasible for each of the post mining land uses, equal weights of 400 points each, are given to these two parameters. Social impact of any of the land reclamation method is difficult to quantify. The benefits which each of the possible post mining use can accrue for the society are given a total weight of 200 points.

The different post mining land uses are tabled under the horizontal axis. Thus the number of total land uses listed horizontally in table 1 is 7 and 25 parameters which can affect above land uses are listed vertically, which gives a total f 175 possible interactions. By judgment these places of interactions are marked on the matrix. Place a number from 1 to 5 on this matrix to indicate their relative magnitude of impact, '5' represents the severest magnitude of impact, and '1' the minimum. Here, for these numbers enter a positive sign for beneficial impacts and negative sign for negative impact.

Once the weight points for each of the parameters is fixed and corresponding values of impact are assigned under different post mining land uses, the product of the weight point and the arithmetical value of magnitude of impact will give the individual score for each of the parameters that are mentioned under the vertical column. Further the arithmetical sum of these individual scores will give the total score of each post mining land use.

Table 1: Matrix for Post Mining Land Use Selection, Case Study of a Coal Mine near Nagpur

	Weightage	Forestry & wild life	Agriculture	Recreational	Township	Industrial	Water reservoir	Garbage Dumping
Environmental implications								
I. LAND								
1 Alteration in relief	20	2 (40)	2 (40)	2 (40)	2(40)	2(40)	3 (60))	2(40)
2 Soil erosion	25	5 (125)	3 (75)	3 (75)	-1 (-25)	-1 (-25)	3 (75)	3 (75)
3 Deforestation	75	5 (375)	2(150)	2(150)	-2 (-150)	-2 (-150)	-2 (-150)	-2 (-150)
4 Aesthetic beauty	20	4(80)	2(40)	4(80)	-1(-20)	-3(-60)	3(60)	-3(-60)
5 Land slide	25	4(100)	3(75)	3(75)	3(75)	3(75)	1(25)	3(75)
II. WATER								
1 Surface water								
(a) Toxic substances	30	nil	-1(-30)	-1(-30)	-1(-30)	-5 (-150)	nil	-2(-60)
(b) Suspended solids	30	-1(30)	-2(-60)	-2(-60)	-2(-60)	-2(-60)	4 (120)	-2(-60)
2. Ground water quality	25	4(100)	3(75)	2(50)	-1(-25)	-2(-50)	5(125)	-2(-50)
3. Water resources								
(a) Surface water	25	4(100)	3(75)	2(50)	-1(-25)	-2(-50)	5(125)	2(50)
(b) Ground water	25	5(125)	3(75)	5(125)	-2(-50)	-2(-50)	5(125)	4(100)
© Effect on aquatic life	20	2(40)	1(20)	5(100)	-2(-40)	-4(-80)	5(100)	-2(-40)
III. AIR								
1. Emission of dust	30	5(150)	3(90)	2(60)	-2(-60)	-4(-120)	5(150)	-2(-60)
2. Generation of noxious gases	30	5(150)	4(120)	4(120)	1(30)	-4(-120)	4(120)	-2(-60)
IV. NOISE								
1. Nuisance to inhabitants	20	5(100)	3(60)	3(60)	-2(-40)	-2(-40)	3(60)	3(60)
Social implications								
1. Recreational	20	4(80)	1(20)	5(100)	1(20)	-2(-40)	3(60)	-4(-80)
2. Medical	20	1(20)	1(20)	1(20)	5(100)	5(100)	1(20)	-2(-40)
3. Education	20	1(20)	1(20)	1(20)	5(100)	5(100)	1(20)	-1(-20)
4. Employment	50	2(100)	5(250)	3(150)	5(250)	5(250)	1(50)	2(100)
5. Income	20	2(40)	3(60)	1(20)	4(80)	5(100)	1(20)	1(20)
6. Pollution	20	5(100)	3(60)	1(20)	-2(-40)	4(-80)	3(60)	-2(-40)
7. Migration	20	-3(-60)	3(60)	1(20)	3(60)	5(100)	-3(-60)	-3(-60)
8. Infrastructure	30	-3(-90)	1(30)	1(30)	5(150)	5(150)	1(30)	1(30)
Economic implications								
1. Capital Investments	300	-3(-900)	-3(-900)	-2(-600)	-3(-900)	-3(-900)	-1(-100)	-nil
2. Operating cost	100	-1(-100)	nil	-1(-100)	-3(-300)	-3(-300)	-1(-100)	-1(-100)
TOTAL	**1000**	**+725**	**+425**	**+575**	**-860**	**-1360**	**+935**	**-330**

Result and Discussion

The decision regarding best post mining land use should be such that it is not only acceptable to all concern but should be an integral part of the local ecosystem. Sustainability of the post mining land use can be arrived it by solving proposed matrix. Matrix solution should be done by at least five independent experts who may be environmentalist, social worker, finance expert, mining expert and local government representative from district planning office. In the given case study four alternatives like forestry & wild life, agriculture, recreational and water reservoir has positive total. All four post mining land uses may be implemented depending upon condition of the terrain, proximity to township and taking into consideration requirements of the region.

Conclusion

Today, reclamation is an integral part of any mining operation as mine plans needs mine closure as essential element. The per capita land availability in India is one of the lowest in the world and procuring land for mining of minerals is not only being difficult but proving capital intensive also. To sustain GDP growth mineral sector in India is required to grow at faster rate, meaning more land requirement. The solution lies in integrated ecosystem approach by involving all stake holders in decision making in selecting best post mining land uses which are as per the requirements of local community.

References

1. Ministry of Mines Annual report, 2018-19
2. FICCI report, "7-8 % contribution of mining sector in GDP can create 25 million jobs in India, November 9, 2017," www.asianage.com
3. S Suresh Kumar, Land use accounting in India, Issues and Concerns, November 06, 2009, www.unstat.un.org.
4. CIL land reclamation report, prepared by CMPDIL, 2016
5. Management and restoration of mining areas in India, www.iucn.org,
6. Mine reclamation, www.wilkipedis.com
7. Alan C. Emery," Environment management in an International Context", Proceedings of First World Mining Environment Congress, India, 1995
8. Chidarwar S" Post mining land use planning," M.Tech. Dissertation, ISM, Dhanbad
9. Sonja kivinen," sustainable post mining land use," International Journal of Sustainability, Vol. 9, 2017.
10. Jiali Wang etc," Mining Site Reclamation Planning Based on Land Suitability Analysis and Ecosystem Services," International Journal of Sustainability, Vol. 9, 2017.
11. Sharma D.K, Subramani K," Environmental Pollution and Reclamation in Opencast Coal mines," Indian Mining and Engineering Journal, June, 1993
12. Rao P B," Environmental Impact Matrix Application to Mining Industry," Indian Mining and Engineering Journal, July, 1996

