

Reclamation after Mine Closure Procedure Considering Biodiversity Offset and Ecological Restoration: A need of the hour.

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Abstract- Mining Industry being a fundamental industry in shaping of the modern world also has its backlogs and uncertainties associated with the mining operations due to working against natural creations. In a society where nature is getting exploited day by day, we the mining industry have to consider reclamation as a compulsory part after all the operations in and around the mining site. With the exploration of minerals and their respective extraction we also exploit the natural habitats of flora and fauna of the site and that leads to ecological imbalance and ultimately harms nature. The forest helps regulate temperature and other factors which are essential for the ecosystem. This paper will mainly give a detailed overview of why the reclamation should be done and how it should be planned so as to restore and reclaim what we have lost during the mining operations. It also highlights the importance of Ecological Restoration, Biodiversity Offset and Environmental Impact Assessment.

Keywords – Biodiversity Offset, Ecological Restoration, Environment, Mine Closure, Reclamation.

I. INTRODUCTION

Sustainable development should be a part of every industry of which Mining Industry should not be an exception. The resources extracted are used for shaping a new world. With passing time, we need to develop our mindset to not only financial gains but also environmental sustainability and the reclamation after the mining operations in a particular site. The aspects to consider will mainly be many out of which some has to be reclaimed completely while some needs to be compensated.

The rest of the paper is organized as follows. Domestic and Global Scenario are explained in section II. Reclamation and Restoration is presented in section III. Environmental Impact Assessment is given in section IV. Effects on Crucial Aspects are presented in section V. Detailed Case Study done in section VI. Conclusions done in section VII and Acknowledgement in section VIII. References has been noted in section IX.

II. DOMESTIC AND GLOBAL SCENARIO

A. *Canadian Scenario –*

Oil sands development is subject to environmental standards that are among the most stringent in the world. The Government of Alberta requires that companies remediate and reclaim 100 percent of the land after the oil sands have been extracted. Reclamation means that land is returned to a self-sustaining ecosystem with local vegetation and wildlife. Steps are then taken during the life of a project to minimize any negative effects. Oil sands companies must file a Conservation and Reclamation Plan as part of their initial project application, keep it current, and post financial security bonds for reclamation. The provincial government ensures that all oil sands companies fulfill their legal obligation to reclaim the land.

In the oil sands area, the Government of Alberta has committed to conserving and protecting more than 2 million hectares (ha) (20,000 square kilometers [km²] or 7,722 square miles [sq. mi.]) of habitat for native species as part of the 2012–2022 Lower Athabasca Regional Plan. In addition, there are almost 4.5 million ha (44,800 km², 17,300 sq. mi.) of federally protected land – Wood Buffalo National Park of Canada – just north of the oil sands.

B. *Indian Scenario –*

A report from Indian Bureau of Mines says that 285 Final Mine Closure Plans has been approved (FMCP) since its inception. Only 2966 mines has reclaimed an area of about 17019 hectares by following simultaneous restoration and reclamation. Due to afforestation, 113 million saplings has been planted in 46873 ha of land. This gives a survival rate of 68% which on comparison to foreign countries like Canada, Australia, China, etc is much less.

This comparison thus highlights the need for improving the mine closure plans and also the increased need to reclaim the land we use for mining and restore its ecology making the process sustainable.

III. RECLAMATION AND RESTORATION

- Exponential growth in mineral production since 1980.
- Mining activities causes physical, chemical, biological and socioeconomic changes in the area.
- Surface mining activities disturb the original land profile.
- In India mineral production comes mostly from opencast mines & hence Land degradation problem is of serious concern.
- An intricate, in-depth and site specific techniques involving integrated approach is necessary.

3Rs Of MINING INDUSTRY

- *Reclamation*
Reclamation means return the mined out land with useful life.
- *Rehabilitation*
Rehabilitation is to bring back the degraded land to a normal stage by a special treatment.
- *Restoration*
Restoration is the process of returning the mined out land being fit to an acceptable environmental condition.

Ecological Restoration

- It is the scientific study, which is the practice of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats in the environment by active human intervention and action.
- It can be achieved in various ways which shall be described later on.

Biodiversity Offset

- Biodiversity offsetting is a system used predominantly by planning authorities and developers to fully compensate for biodiversity impacts associated with economic development, through the planning process.
- In some circumstances, biodiversity offsets are designed to result in an overall biodiversity gain.

IV. ENVIRONMENTAL IMPACT ASSESSMENT

- Environmental Impact Assessment (EIA) is the process by which the anticipated effects on the environment of a proposed development or project are measured.
- If the likely effects are unacceptable, design measures or other relevant mitigation measures can be taken to reduce or avoid those effects.

Sections Of The Society Getting Affected:

- ✓ Plants (Flora)
- ✓ Wildlife (Fauna)
- ✓ Air
- ✓ Water
- ✓ Public

Different Methods Of Eia:

- Ad-hoc
- Checklist
- Sectoral guidelines
- Systematic sequential approach
- Simulation modelling workshop
- Spatial analysis method
- Rapid assessment techniques

The above methods have their own criteria and are used at different conditions depending upon the factors such as time, cost, impact and many more parameters essential for the mining company as well as the environment.

V. EFFECTS ON CRUCIAL ASPECTS

Effects On Overburden

Disturbance of the overburden due to surface mining causes significant changes in the physical and chemical nature of the system. The consolidated nature of the bedrock materials is destroyed during the mining process resulting in a

significantly different system. Precipitation and surface runoff from adjacent sites can easily infiltrate through the surface and percolate into the system.

Effects On Wildlife

- Physical injury/Mortality
- Habitat loss/fragmentation
- Loss of wetlands
- Loss of crucial habitat types
- Toxicities
- Increased human activity
- Induced harvest changes
- Migration barriers

Effects On Topography

- Destruction of geomorphic features
- Rill erosion
- Mass wasting,
- Differential settling of fills
- Degraded mine areas, fills resulting from waste rock and tailings, and subsidence due to underground mining.
- Landscape diversity is often lost.

Light Density Due To Canopy

In most forests, the battle for sunlight shapes the forest structure. The researchers found that the rainforest structure stems from what happens after a tall tree falls and creates a gap in the canopy. The gap enables sunlight to reach the forest floor and fuel the rapid growth of small trees. Over time, the trees' crowns grow to fill the gap until the point where not all of the trees can fit in the sunlit patch. Some will be left behind in the shade of their competitors.

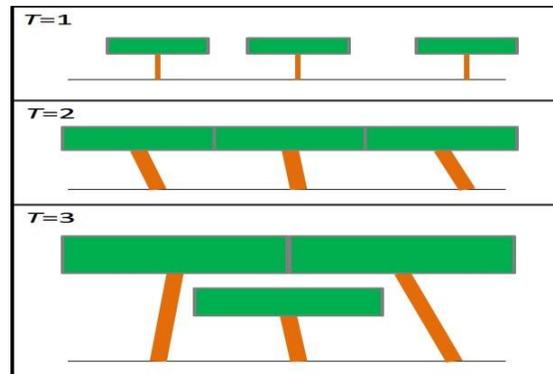


Figure 1: Tree Canopy and Micro Environment

So, the micro environment developing under this canopy and its contribution to the ecological balance is very crucial and should be taken care of as all of it gets disturbed by all the mining operations. Reclamation is the only way we can achieve the micro environment back.

Deforestation leads to the destruction of the micro-environment and its associated elements. The actual species of plants should be reclaimed and planted so as to give back a sustainable forest area which would contribute to the nature.

VI. DETAILED CASE STUDY

Saranda Forest (Jamshedpur)

- ✓ Mining What? Iron Ore
- ✓ Who? Jindal Group of Companies, SAIL etc.
- ✓ How? Surface Mining/ Open cast mines
- ✓ Ho people inhabit the area, which is dotted with iron ore mining towns including Gua, Chiria, Kiriburu and Noamundi.

- ✓ Sal (*Shorea robusta*) is the most important tree in the area.
- ✓ Other important trees are Mahua, Kusum, Tilai, Harinhara (*Armossarohitulea*), Gular (*Ficus glomerata*), Asan.
- ✓ Wild elephants are common in Saranda and Porahat forests.

Facts And Figures For Saranda

Considering the rich flora and fauna biodiversity of Saranda forest area, a detail study of the biodiversity along with EIA and EMP has been re-assessed by the User agency through the Indian Council of Forestry Research and Education (ICFRE), Dehradun. The detail study report has been quite exhaustive in assessing the biodiversity of the surrounding area.

Fact Sheet
(as per MoEF file No.8-46/2010(FC))

3.	b) Forest area involved	Total area proposed is 1018.50 of which mining is proposed for 999.90 ha. 8 ha. for widening of the road and 10.60 ha. for conveyer belt.

5.	i) Vegetation	The forest area is mixed deciduous forest comprising of 50-55 % of quality Sal, the middle and lower canopy is of
	ii) No. of trees which will be affected.	miscellaneous species. The proposed area is virgin and has vast floral and faunal diversity (P 56/c) Besides 20.43 ha. of Safety zone, the number of trees of rest 979.47 ha. forest land is 2,91,010 (P 556/c)
	iii) Density	0.7-0.8
6.	Whether area is significant from wildlife point of view.	The entire forest of Saranda Forest Division including the proposed mining lease area has been notified as Core Area of Singhbhum Elephant Reserve. The Saranda Forest is considered to be one of the finest habitat for elephants. The presence of elephants in and around the proposed area is evident through many of the indirect evidences seen at the time of field inspection. The user agency however, undertakes to implement a planned scheme for protection of wildlife & forest to mitigate the effects due to mining (P 57/c).
7.	Whether any rare/endangered/unique species of flora and fauna found in the area – if so details thereof.	Indian elephant, giant squirrel, reptiles, sloth bear, wild boar, barking deer, etc. have been reported in the area.

Figure 2: Fact Sheet about details from SARANDA Forest, Jamshedpur (ICFRE)

Land Pollution As An Impact In Saranda:

The severest ecological damage by a mining project is perhaps this factor, as ultimately it affects all the other factors and elements involved. In case of Saranda the facts are as follows:

Sr. No.	Details	Phase – I (in ha.)	Phase – II (in ha.)	Total Area (in ha.)
1	Mining	452.644	220.886	673.53
2	Waste Dump D1	30.65	0.00	30.65
	Waste Dump D2	0.00	69.89	69.89
	Sub grade-Dump	44.11	0.00	44.11
3	Site Office, Manager Office, Time Office, Time Office, Shirt in charge office, Store Facility (Temporary Structure)	5.04	0.00	5.04
4	Magazine	28.93	0.00	28.93
5	ROM Stacking, Crushing & sizing facilities	34.04	0.00	34.04
6	Water reservoir & treatment plant	9.39	0.00	9.39
7	Statutory built-up area (Office Maintenance facilities, Rest shelter, First Aid facilities, Laboratory, Security Barracks, Electrical Sub-stations, Telecommunication, Fire Control, Canteen, etc.)	51.33	0.00	51.33
8	Roads	15.41	0.000	15.41
9	Green Belt / Safety Zone area	10.48	9.95	20.43
10	Access roads to SAIL (including road Safety Zone)	17.15	0.00	17.15
	Total	699.174	300.726	999.90

Figure 3: Land Impact Statistics in Saranda Forest, Jamshedpur

Water Pollution As An Impact

The following factors have to be considered:

- ✓ Algae, Phytoplankton and Chlorophyll.
- ✓ Conductivity, Salinity & Total Dissolved Solids.
- ✓ Dissolved Oxygen.
- ✓ pH and Temperature of Water.
- ✓ Photosynthetically Active Radiation and Solar Radiation.
- ✓ Turbidity, Total Suspended Solids & Water Clarity.

Restoration In Saranda

Now what was done in case of Saranda was that land for compensatory afforestation was found in adjoining areas, of a total area of 1786.14 ha at a cost 35 crores. These receptor sites were developed prior to the mining project start, in November 2012. Furthermore various regions within the surface mine area were restored to previous conditions. Primarily because of the planning biodiversity impacts were avoided and minimized to a very large extent. Now through biodiversity offsetting we try and reverse the damage, renew and restore degraded ecosystems.

Methods Used:

- ✓ The cut root-stock method
- ✓ A field nursery was established to secure rescued saplings from the experimental site and seeds collected from the reference site.
- ✓ Check dams were created to impound surface runoff which helped in improving soil moisture.
- ✓ *Thyshanolena* grass sapling was planted on the overburden slopes to prevent erosion and oxide runoff.
- ✓ Artificial water resources were generated making use of the scarred land surface of the surface mines.

Reports For Saranda

- Within three years the early signs of restored vegetation are apparent, although growth is limited but a mosaic of Woodland and Grassland is now flourishing.
- Dependence of the local community on the restoration plot has now increased, and the patch which was of no use to the community is now a source of Non Timber Forest Products (NTFPs).
- The Sal sapling specifically showed a marked increase at the experimental site.

However, the site is still unstable and requires constant monitoring.

Table 1: Analysis of effects using EIA methods and environmental indices and impact score

Environmental Area	No effect	Positive effect	Negative effect	Direct	Indirect	Short-term	Long-term
Wild life			X			X	
Air pollution			X	X			
Water pollution			X		X		X
Noise			X			X	
Economic value		X		X			X
Public health				X			



Figure 4: Saranda during Mining Operations



Figure 5: Saranda after recent Reclamations

VII. CONCLUSIONS

- ⦿ The comparative analysis should be conducted between reference site, pre and post-restoration conditions of experimental plot indicating changes in abundance, density and cover of native species.
- ⦿ Valuable medicinal species must be recorded and found whether it is regenerative in natural conditions.
- ⦿ Separate elephant corridors and wildlife roadways must be maintained and they should not be hampered.
- ⦿ Some species should be cross bred with the others to at least saving them from extinction.
- ⦿ Flora of the specific place should be reclaimed and exact species should be used for Compensatory Afforestation.
- ⦿ Re-vegetation of the overburden should be performed by screening of local trees species in terms of height and diameter increment as well as biomass accumulation to get the maximum ecological benefits from the trees in terms of fuel, fodder and ultimately timber.

This study shows the importance of reclamation with the existing ways to perform it. The study can be used a base line reference for various large scale reclamation and overburden plantation and other forms of sustainable and eco-friendly mining operations.

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