Remediation of mined out areas and abandoned Mines

A CASE STUDY ON SESA’S APPROACH

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- Minerals are site specific and mostly overlap with forest area.
- Utilizing mineral wealth for development is very essential at the same time preserving wildlife and bio-diversity.
Eco Sensitive Zones and Mining Belt in Goa
Mineral exploitation (Mining) is second only to agriculture as the World’s oldest and most prominent industry.

Mineral and mineral based products are integral parts of the economic and social development of the society.

Mining is an unique industry – Site Specific. (Mining has to be planned around where the mineral deposit exists.) – Unpalatable Fact

Mining causes damage to land, soil, water, flora, fauna as earth/crust/mining land gets disturbed.

Mining does not mean permanent loss of land for other use.

On the other hand it holds potential for altered and improved use apart from restoring for agriculture, forestry and irrigation.

Sporadic Estimation for Mineral Reserves in early 20th Century.

1940’s onwards, concessions were being granted to entrepreneurs.

Maximum Lease Areas limited to 100 Ha.

Post World War II, during 1950 first Shipment of Iron Ore exported to Japan – commencing the new era of business.
Leading Iron ore Producer
- +60 years of existence
- Sesa is well placed to capitalise the global seaborne demand due to favourable logistics
- Iron ore Mining Operations in Goa and Karnataka and upcoming project in Liberia, Africa (next iron ore hub)
- Over 3,000 employees, +800 professionals
- R and R of 337million tonnes

Overview

Goa
- Proximity to Port
- Low cost River transportation
- Road Transport (Mine to Jetty ~16 kms)

Karnataka
- Proximity to domestic steel market
- Logistics infrastructure in place

Liberia
- Large Resource base of around 3.8 billion tonnes
- All three deposits within 70-140 kms from Sea
VALUE ADDED BUSINESS

- Diversified into Manufacture of Pig Iron (0.72 mtpa) & Metallurgical Coke (0.6 mtpa), WHRB Power Plant (60 MW), Sinter Plant (1.0 mtpa)
Iron Ore Business - Goa Operation Flowchart

- **Mine**
  - Prospecting
  - Blasting/Drilling
  - Dozing
  - Loading/Hauling

- **Processing Plant**
  - Dry Screening
  - Wet Processing/Tailing disposal

- **Bunder**
  - Drying of ore
  - Hauling>Loading

- **Sea Port**
  - Loading at port by MOHP

- **Mid-stream loading**

- **Transhipper**

- **Mother vessel**
Why reclaim & rehabilitate mined out areas?

- Open cast mining - land is excavated to win ores/minerals.

- Considerable overlap of forest cover and mineral reserves, indicates requirement of abundant caution while mining the minerals.

- While these mines are worked, over burden and waste produced is dumped in & around the lease.

- Land is key element in all-mining operations, thus systematic and scientific reclamation and rehabilitation of mined out areas and dumps is the key issue of ‘Sustainable Development’ in mining industry.

- Mining is a process of segregation thus there is rejection of wastes that have impact on environment.

- The strategy for rehabilitation has to be guided by the end use, namely, restoring sink potential by raising plantation, development of recreation and water sport facilities, development of settlements or agricultural farms.
Reclamation & Rehabilitation: Statutory Provisions, as per MCDR, 1988

As per Section 23 - Abandonment of mines:

1. The owner, agent, mining engineer, or manager of every mine shall not abandon a mine or a part of mine during the subsistence of the lease except with prior permission in writing of the Controller general or the authorized officer.

2. The owner, agent mining engineer, or manager, of every mine shall send to the Controller General, Controller of Mines, and the Regional Controller under registered cover, a notice in the Form –D of his intention to abandon a mine or a part of a mine so as to reach them at least ninety days before the intended date of such abandonment.

3. Such a notice shall be accompanied by plans and sections on a scale not less than, 1 cm – 10 meters setting forth accurately the work done in the mine up to the time of submission of the notice including the measures envisaged for the protection of the abandoned mine or part thereof, the approaches thereto and the environment:

   Provided that, the Controller General may require the plans and sections to be prepared on any other suitable scale.

4. The Controller General or the authorized officer may by an order in writing made before the proposed date of abandonment, prohibit abandonment or allow it to be done with such conditions as he may specify in the order.

5. The leaseholder shall not abandon a mine or part thereof unless a final mine closure plan duly approved by the Regional Controller of Mines or the officer authorized by the State Government in this behalf, as the case may be is implemented. For this purpose, the lessee shall be required to obtain a certificate from the Regional Controller of Mines, or the officer authorized by the State Govt. in this behalf to the effect that protective, reclamation and rehabilitation work in accordance with the final mine closure plan or with such modifications as approved by the competent authority, have been carried out before abandonment of mine.
As per Section 34 - reclamation and rehabilitation of lands:

Every holder of prospecting license or mining lease shall undertake the phased restoration, reclamation and rehabilitation of lands affected by prospecting or mining operations and shall complete this work before the conclusion of such operations and the abandonment of prospector mine.
Reclamation & Rehabilitation challenges?

- Erosion control.
- Stabilization of dump slopes.
- Developing alternative use of abandoned mine pits.
- Ecological restoration.
- Developing alternative livelihood opportunities for surrounding community.
- Top soil conservation.
Waste/OB materials can be used to fill up the abandoned pits.

The filled area then can be leveled and covered with soil/mud.

Finally, it is covered with freshly removed soil mixed with organic manure and fertilizers.

The land then can be biologically reclaimed.

Shallow pits, where material is not available for back filling can be reclaimed by plantation, provided slopes are suitably graded.
Traditional approach for Mine land reclamation

- Waste dump stabilization using laterite cover, garland drain, etc.

- Planting hardy plants species like Eucalyptus, acacia with the sole aim to green the area and create a biomass without consideration to Biodiversity or community use.

- No consideration for post mine closure land use.
Reclamation & Rehabilitation Ways and Means

Systematic and Scientific Approaches

- Waste dump Reclamation –
  - Geo-textile Approach
  - Afforestation –
    - Biotechnological approach,
    - Agri – Horticultural approach etc.

- Exhausted Mine Pits -
  - Backfilling Approach
  - Pisciculture
  - Rain Water Harvesting
  - Water sports
Sesa has taken special care to rehabilitate mined out areas without abandoning them in “as is where” condition.
Geotextiles - a new approach for waste dump management

• CONTROL SOIL EROSION
• DUMP STABILIZATION
• CONTROL WATER POLLUTION
PLANTATION GROWN ON A GEOTEXTILES LADEN DUMP

- Ensures green ground cover for erosion control as well as for soil enrichment
- Higher survival rate for tree species
Native species grown in Root Trainers

- Inhouse Root Trainer Nursery growing and catering 2 lakhs sapling/annum

- Root trainers for growing healthy saplings with developed root system.

R & D Efforts:

- Biotechnological Approach for improving the survival rate of native species on mine rejects – Research project with NEERI & In house replication of same

- Research project with Goa University for mass culture growth of Ectomycorrhizae- for improving the survival of native species
Company sponsored project with Goa university namely “Ectomycorrhizal fungi & mass cultivation of this fungi for reclamation of mine dumps with native species.

Ectomycorrhizae forms mutual interaction with roots of plants & take up the function of feeder roots.
Codli and Sonshi mines are the biggest operating mines of Sesa Goa, producing 10 MTPA.

At these mines a different Biotechnological approach for mine land reclamation was adopted, through a Collaborative project with NEERI & Lund University, Sweden.

- Soil analysis & pot culture studies for selection of plant species.
- Plants inoculated with Nitrogen fixers like Azaetobacter & rhizobia.
- Suitable soil amendments like Mushroom compost, Farm yard manure & top soil.
- Size of the pit: 0.65*0.65*0.65m
- Fencing, watering & after care provided for three years.
- Growth studies conducted at interval of 4 months
- Mycorrhizae added in the root zone.
Biotechnologically reclaimed mine site

CODLI and SONSHI MINE RECLAMATION

Biotechnologically Reclaimed site – fresh plantation- Original Dump Site

Biotechnologically reclaimed site – same dump after 10 years
Orosso Dongor mine - North Goa – Extent 100 Ha.

Mining carried out in the 60’s and exhausted in 1974.

Overburden dumps initially stabilized with fast growing trees, Followed by cashew plantation which provides economic returns to local villagers.

Presently, entire dump area is under cashew plantation – A cashew orchard.

A natural spring existing at the mine is protected by constructing a channel - Now a source of drinking water to surrounding villages.
Scientific approach for reclamation: Association with various Organizations like FRI, NIO, State Agriculture Department, State Forest Department, Goa University to name a few.

Management plan prepared and got approved by State Forest Dept.– for conversion of Exhausted mine to Eco-tourist Spot

Regular scientific studies to assess the reclamation status

Horti – Silvi culture approach

Spice plantation, Bamboo Arboretum, Medicinal garden, Nakshatra Vruksh Devta Udyan, Charak Vatika, Aromatic garden, Butterfly garden, Pisciculture pond

Bamboo Pavilion – Centre for excellence

Sesa technical school and Sesa Football academy
Environmentally, technically and scientific reclamation of mined out areas enabling sustainable post closure of land uses.

In our business, it is an accepted fact that the impact we leave on the environment has a long-term, negative impact. Which is why our efforts to preserve and protect, while we simultaneously grow, are of immense importance and integral to the way we do the business.

With the same objective, Sesa has reclaimed the worked mine and converted it to a garden and productive asset. Sesa has also constructed a technical School and Football academy at the reclaimed site. Pit has been converted to a Pisciculture pond. A nakshatra garden, fruit bearing trees, and a butterfly park is set up in the garden.

The need for a convention centre for visits by school children, delegates, nature lovers etc. at the Sanquelim mine, led to the concept of a Bamboo pavilion as no other solution suited the requirement better than bamboo as the medium for building the pavilion.
CSR Initiatives SFA on Sanquelim reclaimed mine

SESA FOOTBALL ACADEMY
CSR Initiatives STS on Sanquelim reclaimed mine
In our opinion, one of the greatest challenges facing the world today is integrating economic activity with environmental integrity, social concerns and effective governance systems.

The goal of that integration can be seen as ‘Sustainable Development’.

In the context of the minerals sector, the goal should be to maximize the contribution to the well being of the current generation in a way that ensures an adequate distribution of its costs and benefits, without reducing the potential for future generations to meet their own needs.

The approach taken to achieve this has to be both comprehensive – including the whole minerals chain – and forward looking, setting out long term as well as short term objectives.
60 YEARS OF SESA”S JOURNEY CONTINUES

THANK YOU
Reclaimed mine site
Silvi Horticultural Plantation on Sanquelim Mine Dump

One of the worked out pits (Lisboa) was terraced with loose soil to facilitate afforestation, and the pit is used for Pisciculture.

The pit is 150m x 30m with an average 6m depth of water.

Water was treated so as to make it favourable and improve nutrient status and pH

The fingerlings of Rahu, Mrugal and Carp were released.

The temperature was monitored daily at 1m depth and accordingly the feed was adjusted.

The results were very encouraging, and now the pond is full of fish.
Mine reclamation
Land Reclamation done thro Bio-technological approach at Sanquelim mines.

“Medicinal Garden/Nakshatra Van”

“Charak Vatika”

“Bamboo Pavilion”

Model Reclamation at Sanquelim Mine – Astral Garden, Medicinal Garden, Butterfly Garden, Bamboo Pavilion
"Charak Vruksha Devata Udyan"
It is mainly based on Ayurveda...

Based on Dravaguna Science, plants are classified into 9 different classes and again according to functions into 81 sub classes.

Plants Acting on the ailments related to:

"S" MEDHYADI  Nervous system
"E" CHAKSHUSHYADI  Eye, Nose, Ear, Tongue & skin
"S" HRIDAYADI  Circulatory system
"S" CHEDANADI  Respiratory System
"A & G" DEEPANADI  Digestive System
"O" ARSHOGRHNADI  Liver, Spleen
"O" VRISHYADI  Reproductive system
"A" MUTRALADI  Kidney
"A" JWARAGHNADI  Fever & other blood related
Medicinal garden/ Nakshatra van
• Initially grow leguminous tree
• Selective thinning after four years
• Introduce horticultural plants – irrigation from exhausted mine pits.
Horticulture plantation on mine road sides
Sesa football academy
A case study of Sesa’s reclaimed mines
Thank you

Journey continues...
Mine Closure Plan

- Adequate time and financial resources to plan for a mine closure.
- Annual Review
- Public health and safety aspects need to be fully integrated with design;
- Adverse social and environmental impacts are minimized and benefits where feasible, maximised; and
- Post closure land use to be productive and brings value to the local community as well as to conservation/biodiversity interests.
- Stakeholder engagement is required on the post closure land use of the site to arrive at an acceptable option or multiple options also keeping in mind the extant and future ownership of the land.

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Biodiversity plantations

“Medicinal Garden/Nakshatra Van”

“Charak Vatika”

“Butterfly Garden”

“Bamboo Pavilion”

Model Reclamation at Sanquelim Mine – Astral Garden, Medicinal Garden, Butterfly Garden, Bamboo Pavilion
Faunal Study of Sanquelim Mine

The objectives and outcomes of studies carried out by CANOPY;

• A three season data for Sanquelim mine was collected.
• Non samples survey technique was used to conduct the survey
• To infer the success of the restoration efforts based on the findings the site was divided in four zones:
  • Zone I: The water body (pit) and its surrounding areas
  • Zone II: The area with plantation of fruit crops including the butterfly garden
  • Zone III: The Nakshatra Van
  • Zone IV: The area leading to and around the pump-house
• **Results:** The following diversity of various faunal components was observed
  • 3 species of mammals
  • 70 species of birds
  • 42 species of butterflies
  • 14 species of odonates
  • 12 reptiles
  • 10 amphibians
Need based Community Development Programme

- Established Dept. of mining engineering at GCE, Goa
- 10 Community Medical Centers and 2 MHU’s are operating across operations in Goa, Karnataka & Orissa.
- Alternative livelihood methods for community around mining area.
- Establishment of self help groups.
- Paediatric Neuro Rehab Centre – Bambolim Hospital

Leading industry wide community development activities through Mineral Foundation of Goa

Infrastructure projects for community
Preferences given to the local villagers in the value chain creation
More than half a million lives touched...

<table>
<thead>
<tr>
<th>Health</th>
<th>Beneficiaries</th>
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<tbody>
<tr>
<td>1. CMC- 10 centers</td>
<td>149,318</td>
</tr>
<tr>
<td>2. MHU- 2 Units</td>
<td>13,704</td>
</tr>
<tr>
<td>3. Health &amp; Awareness Camps</td>
<td>153,234</td>
</tr>
<tr>
<td>4. Neuro rehab center</td>
<td>1,114</td>
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<tr>
<th>Education</th>
<th>Beneficiaries</th>
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<tbody>
<tr>
<td>1. VCEP- 395 schools in Goa and 2,000 schools in Karnataka</td>
<td>360,000</td>
</tr>
<tr>
<td>2. SFA</td>
<td>141</td>
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<tr>
<td>3. STS</td>
<td>750</td>
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<td>4. Educational Aid to schools like Uniform, Notebooks etc.</td>
<td>49,867</td>
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<tr>
<td>5. Balwadi and Children festival</td>
<td>2,700</td>
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<tr>
<td>6. Vocational Tuition classes and evening study centres</td>
<td>10,000</td>
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<td>7. Manthan</td>
<td>4,489</td>
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<tr>
<td>8. Sesa Dnyan Jyoti Shishyavriti</td>
<td>57 schools, 670 Students</td>
</tr>
<tr>
<td>9. Aanganwadi and Balwadi projects</td>
<td>3,964</td>
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<th>Special Projects</th>
<th>Beneficiaries</th>
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<tbody>
<tr>
<td>1. Gram Nirman</td>
<td>13,856</td>
</tr>
<tr>
<td>2. ALOP (1,100 households)</td>
<td>6,000</td>
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<th>Women Empowerment</th>
<th>Beneficiaries</th>
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<tbody>
<tr>
<td>1. Training course for SHGs</td>
<td>500</td>
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<th>Back To Farming</th>
<th>Beneficiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reviving paddy fields</td>
<td>500</td>
</tr>
<tr>
<td>2. Distribution of seeds and fertilisers</td>
<td>500 families</td>
</tr>
<tr>
<td>3. Drinking Water Scheme at Kirlapal Dabal</td>
<td>5700</td>
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<tr>
<td>4. Around 2,100 acres brought under watershed development in Karnataka</td>
<td>4 villages</td>
</tr>
<tr>
<td>5. Distribution of smokeless biomass stoves in Karnataka</td>
<td>849</td>
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