Effective Land utilization for Rehabilitation of a Fragile Limestone Mining Zone at Darlaghat, District Solan, Himachal Pradesh

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Abstract. Rehabilitation of mined landscape has been a challenge both for foresters as well as mining managers over the period of time. Proper rehabilitation requires holistic planning with regard to containing soil erosion, preserving the traditional water sources, conserving the local flora and fauna besides providing alternate sources of employment to the local people. This paper highlights the concerted efforts made by the mining managers in consonance with the Forest department to attain these objectives achieving fruitful results within a short span of time.

Keywords: Rehabilitation, Conservation, holistic planning.

Land utilization process comprises of aesthetic development & ecological balance between soil, micro-flora, fauna and surrounding atmosphere besides socio-economic considerations for the local community and the habitat creation for fauna. There is an imminent need of land-utilization of the sites which have been taken up for developmental activities like mining etc.

A sustainable Land utilization scheme for a limestone mining area at Darlaghat owned by M/s Ambuja Cements has been formulated with two prime goals i.e. –

I) Short term goals
II) Long term goals

I) Short term goals – Short term goals of this restoration scheme as per seriatim are –
   i) To control soil erosion by planting fast growing grasses.
   ii) To provide planting blocks of selected plants species.
   iii) Waste material utilization for aesthetic look of landscape.

II) Long term goals – The long term goals envisages sustainable development of the region as enlisted below –
   i) Establishment of multipurpose plants species of socio-economic importance for the benefit of stakeholders.
   ii) Self sustaining habitat for the surrounding fauna.
   iii) To inculcate a feeling of environment belongingness amongst the locals.

- The landscape may be broadly categorized under the following sub heads:-
  a) Mined out area
  b) Built up /construction areas i) Colony landscape ii) Plant landscape
  c) Barren landscapes in surrounding areas

- The Plan of Action of Rehabilitation/Reclamation/Afforestation may be studied under the following sub heads:-
  1. Location
  2. Study of climate & soil character / substratum.
3. Knowledge of existing surrounding plants in the area.
4. Selection of plants species.
5. Physico-Biological measures adopted for Rehabilitation/Reclamation/Afforestation.

1. Location

Darlaghat is located in Solan district of Himachal Pradesh at 31.08º N Latitude and 77º E Longitude. The mean altitude of the area is around 1350m above msl. The Limestone mines are at a distance of about 20 kms from Darlaghat town adjoining the Chandi Kashlog area.

2. Climatic & Edaphic features –

Climate & soil characters are the prime attributes for landscape restoration. Climatic data for the years 2004 – 2006 suggest a minimum temperature of 4.7° c (January) which peaked in July to 21.1° C and gradually tapered down to7.9°c during December. This feature widens the scope of plants grown here from mild temperate to subtropical without encountering many problems. The total rain fall for a year amounts to between 780 - 917mm of which 65% is received during July, August & September.

Soil depth is quite less at the mining site. Soil sampling done for the mined & construction sites suggests that the substratum was shale for the former and sandy loam for the latter.

3. Existing plants species in Darlaghat area –

The natural vegetation surrounding the Cement plant colony & the mines is essentially xerophytic in nature with predominance of cacti, succulents, wild pomegranates, hardy shrubs & trees. The important economic flora of this area is - Acacia catechu, Achyranthes aspera, Adhatoda vasica, Aegele marmelos, Albizia chinensis, Albizia procera, Bambusa sp., Bauhinia variegata, Berberis sp., Bombax ceiba, Bougainvillea glabra, Butea monosperma, Callistemon lanceolatus, Calotropis procera, Carisa carandas/spinarum, Cedrela toona, Celtis australis, Chrysopogon fulvus, Citrus aurantifolia, Colebrookea oppositifolia, Cynodon dactylon, Desmostachya bipinnata, Dodonaea viscosa, Duranta sp., Emilia officinalis, Erianthus munja, Festuca sp., Ficus auriculata, Ficus bengalensis, Ficus carica, Ficus elastica, Ficus glomerata, Ficus religiosa, Girardiana heterophylla, Grevillea robusta, Grewia optiva, Hibiscus sp., Indigofera pulchella, Ipomea sp., Jacaranda mimosifolia, Jasminum humile, Juglans regia, Leucaena sp., Murraya koenigii, Nepier sp., Nerium odorum, Ocimum sanctum, Olea sp., Phoenix sylvestris, Pinus roxburghii, Pistacia integerrima, Plectranthus rugosus, Populus sp., Prinsepia utilis, Prosopis cineraria, Prunus pumila, Pterocanthus sp., Panica granatum (wild), Pyrus pashia, Reinwardia sp., Ricinus communis, Robinia pseudoacacia, Rosa moschata, Rumex hastatus, Rubus ellipticus, Salix sp., Terminalia chebula, Tecoma grandiflora, Urtica dioica, Vitex negundo, Woodfordia fruticosa, Ziziphus mauritiana etc.

4. Selection of plant species for vegetation –

The plants species were selected keeping in view the needs of local surrounding communities. Looking into all the aspects of rehabilitation/reclamation/afforestation /, the plants species were selected for an effective land utilization schemes respectively.

5. Physico-Biological measures adopted for Rehabilitation/Reclamation/Afforestation –

Environment preservation coupled with meeting the socio-economic needs of the people have been the focus areas of the programme. Afforestation & reclamation schemes have been supported by the expertise of the Forest Deptt, Dr Y.S.Parmar University of Forestry, Solan and the Himalayan Forest Research Institute, Shimla etc. The various activities carried out for meeting these objectives may be enlisted as under:
5.1. Mined out area & around -

5.1.1. Afforestation activities -
1,97,000 nos saplings (most of which have been supplied by Forest department) have been planted under afforestation scheme over a span of five years. This scheme involves the planting efforts of right mix of various native floral species and maintenance of planted saplings for better upkeep / survival of the saplings. The major species which we have planted are – Toona ciliata, Leucaena spp, Vitex negundo, Carrisa spp, Prinsipia utilis, Prunus puddum, Pyrus pashia, Grewia optiva, Bauhinia varigata, Bombax ceiba, Bamboo, Tecoma, Agave etc.

Afforestation works under taken at Magazine adjoining Section of Kashlog limestone mines.

Afforestation works in progress at the Village of mining area.

5.1.2. Reclamation process was designed to adopt the mined out area for better utility by involving local people of this area. The whole development process is based on the principle of biological succession. The substratum at mined out area is shale where pits of size 45cm x 45cm x 45cm were dug in an area of 1 Hectare with planting distance of 2 meters. Plantation of trees has been done in patches for an effective establishment. Grasses followed by shrubs & trees conducive to the site were essential components of restoration in the area. Few hectares has since been restored @2500 saplings per ha. The soil for plantation works has been made available from construction areas to the mining site. The major plants species selected for rehabilitation workings are Grevillea robusta, Punica granatum (wild), Salix sp, Emilica officinalis Populus sp, Acacia catechu, Adhatoda vasica, Withania sominifera, Robinia pseduacacia, Leucaena sp., Prunus puddum, Bauhinia variegate, Dodonaea viscoso etc.

Initial status of mined out area

Existing status of mined out area

5.1.3. Nursery – A Plants propagation centre (seedling bank) for the successful plantation need has further been established close to the crusher site in the mining area. The plant raising capacity of 10000 saplings / year of the nursery supplements the efforts of the Forest department for providing plants needed for rehabilitation.
5.1.5. Soil conservation measures – Complete soil conservation measures have been undertaken to reduce the soil erosion.

- Mycorrhizal soil inoculation (VAM) has been affected for regulation of pH and good growth of plants roots. Regulation of soil temperature, conservation of moisture and organic matter mulching has also been done for better health of vegetation.
- Soil conservation works – coir jute matting applications, stone barriers, check dams / check filters etc. have further been provided at suitable locations to control surface soil erosion.

5.1.6. Water harvesting / drainage system -

There is garland drainage system in the mining area to minimize surface area of soil erosion impacts and to have proper water channelization besides ground water recharging. Ditches have also been provided near the planting pits for water conservation and better growth of the plants.

5.2. Measures for Built up / Construction sites –

5.2.1. Cement plant, Residential & other construction sites – In contrast to the species planted on the mined area, which are of forest in origin, the plants for manufacturing and residential areas are of multipurpose value. The restored area of residential landscape is 6 Hectares whereas it is 35 hectares for cement manufacturing site. Since the terrain is hilly, suitable check walls have further been provided. There is also a proper drainage system along the roads and buildings. The rain water which flows through these water channels is collected in the reservoir for ground water recharging as well as for raising saplings for plantation during the rainy season. The total nos. of saplings planted in the respective areas with the help of Forest department from the years 2001-2005 are:

i) Cement manufacturing site - Approx 59000 nos.
ii) Residential site - Approx 24000 nos.
iii) Other construction sites - Approx 7000 nos. **GRAND TOTAL: - 90000 nos.**


5.3. Barren landscapes in surrounding areas –

5.3.1. Development of Navgrah Vatika (Temple of nine trees)

Navgrah worship has a special significance in any religious ceremony of the Hindu religion. According to ancient scriptures; each of the nine planets in the astrological chart of an individual can be propitiated with a specific tree.

Water reservoir at mines.
The plants species which have been planted in Navgrah Vatika are: aak (*Calotropis*) for Sun, Plash (*Buteamonosperma*) for Moon, Puthkanda (*Achyranthes aspera*) for Mercury, Gular (*Ficus glomerata*) for Venus, Shammi (*Prosopis cineraria*) for Saturn, Doob grass (*Cynodon dactylon*) for Rahu, Kusha (*Demostachya bipinnata*) for Ketu, Peepal (*Ficus religiosa*) for Jupiter, Khair (*Acacia catechu*) for Mars.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Planet</th>
<th>Local Name of Plant</th>
<th>Botanical Name of Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ketu</td>
<td>Kush/Daab</td>
<td><em>Desmostachya bipinnata</em></td>
</tr>
<tr>
<td>2</td>
<td>Guru</td>
<td>Peepal</td>
<td><em>Ficus religiosa</em></td>
</tr>
<tr>
<td>3</td>
<td>Budh</td>
<td>Apamarg</td>
<td><em>Achyranthes aspera</em></td>
</tr>
<tr>
<td>4</td>
<td>Shani</td>
<td>Shami, Khejri</td>
<td><em>Prosopis cineraria</em></td>
</tr>
<tr>
<td>5</td>
<td>Ravi</td>
<td>Shweth Aak</td>
<td><em>Calotropis procer</em></td>
</tr>
<tr>
<td>6</td>
<td>Shukra</td>
<td>Gular</td>
<td><em>Ficus glomerata</em></td>
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<tr>
<td>7</td>
<td>Rahu</td>
<td>Doob Grass</td>
<td><em>Cynodon dactylon</em></td>
</tr>
<tr>
<td>8</td>
<td>Mangal</td>
<td>Khair</td>
<td><em>Acacia catechu</em></td>
</tr>
<tr>
<td>9</td>
<td>Chandra</td>
<td>Phalash/Dhaak</td>
<td><em>Butea monosperma</em></td>
</tr>
</tbody>
</table>

These plants when planted in a design, as depicted below, constitute a Navgrah Vatika (a Temple of nine trees)

Such ideas evolved from ancient scriptures may go a long way to provide a place for people to worship plants countering planetary effects and also to help conservation besides offsetting carbon emissions. One such Navgrah Vatika has since been established close to Chamarkri Bridge along NH-88 a few kilometers away from the mined area. This Vatika has become a focus of tourist attraction besides helping in the conservation

Navgrah Vatika established at Chamakri along NH-88 road side near Darlaghat town.

5.3.2. An eco-park has also been developed on the barren land along NH-88 at Kararaghat overlooking the mined out hill. This steep hillock has been restored by planting grasses, shrubs and trees of perennial nature. The students of Kararaghat School were also involved in the rehabilitation process thus inculcating a sense of greenliness in the young minds.

Eco- Park developed on barren landscape along NH-88 at Kararaghat

5.3.3. *Aloe vera conservation park*—This medicinal park, where dense planting of aloe vera has been undertaken is on the dump site along NH-88 near Chhamla. Biofencing work has also been affected for proper protection. Such an endeavor has helped check soil erosion besides motivating the people for developing alternate means of livelihood.
Aloe Vera conservation site developed near Chhamla along NH-88 road side.

The plants species selected & planted in barren landscapes & reclamation, afforestation works in mining locations are - Bauhinia variegate, Cedrela toona, Robinia pseudoacacia, Salix sp., Carisa carandas/spinarum, Prunus puddum, Bambusa sp., Ziziphus mauritiana, Emilia officinalis, Vitex negundo, Murraya koenigii, Acacia catechu, Punica granatum (wild), Populus sp., optiva, Woodfordia fruticosa, Prinsepia utilis, Berberis sp., Rumex hastatus, Reinwardtia sp., Pieracanthus sp., Rubus ellipticus, Cynodon dactylon, Erianthus munja, Colebrookea oppositifolia, Adhatoda vasica, Dodonaea viscos, Indigofera pulchella, Pyrus pashia, etc.

6. SUCCESS INDICATORS-

- The surface run off water and soil erosion problem has been reduced extensively and the slopes have started getting stabilized.
- Proper selections of plant species have proved their worth in the restoration process. Survival rates of 76% in mining area & of 85% in the built up/construction areas could be affected only by proper planning implementation.
- Reclamation works in the mined out area are proving to be an educative guide of landscape rehabilitation both for mining managers and environmentalists. Students and environmentalists are visiting mines, plant and colony areas to learn about rehabilitation of mined landscapes.
- The local farming community is showing keen interest in the cultivation of medicinal and other economic plants developed at the site nursery for raising their livelihood status.
- The herb, shrub and tree species selected for planting may prove to be a core guide for rehabilitating similar landscapes elsewhere.
- Involving people and children in landscaping works shall go a long way in addressing our environmental concerns of carbon foot prints, carbon sequestration etc in the long run.

7. References