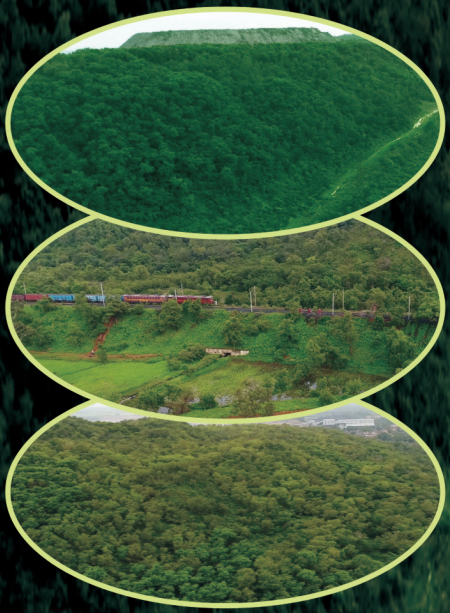
TURNING MINE DUMPS INTO GREEN MOUNTAINS

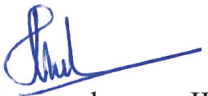
Animesh Goverdhan



Foreword

Shri. Animesh Goverdhan, State Forest Service (SFS) Officer Trainee of 2020-22 batch from Chattisgarh state has written a Field guide on greening and afforestation in mining dumps based on his previous experience and stint in Coal India Limited. It is a useful guide to the practicing foresters and also mine managers. I compliment Shri. Animesh Goverdhan State Forest Service (SFS) Officer Trainee of 2020-22 batch for bringing a useful guide. It will also serve as a bench mark guide to mine managers as they have further scope of developing as per their requirements. I also wish him to keep the enthusiasm in documenting useful management practices for the benefit of forest managers.

Best Wishes.



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Preface

Mining for minerals like coal is indispensable to sustain economic growth and industrialization for a rapidly developing country like India. Though the government is giving great thrust on renewable energy but the conventional mining based on non-renewable fuels like coal is here to stay till the fruits of tapping renewable energy sources can be realized. Moreover, mining in our country is largely based on open cast method that leaves behind large trails of overburden dumps apart from causing denudation of forest land. The technical as well as biological reclamation of these mine dumps is of paramount importance from both environment as well as human perspective. This book has been written to highlight some of the best practices for reclamation of these mine dumps along with some success stories especially from Chhattisgarh region where coal mining is largely prevalent through South Eastern Coalfields Ltd. I have also tried to incorporate my observations and the experiences on mine dump reclamation I gained from working as Assistant Manager, Environment in Coal India Ltd before joining forest department. I hope this book will be of use to forest staff, readers and environment enthusiasts alike.

CONTENTS

Introduction

The wheels of economic growth of a country are driven by industrial development which in turn is inherently dependent on mining for natural resources. Large tracts of land that may include forest land, Government non-forest land and tenancy or private land are required for its developmental as well as operational activities. While using land for the project activities, land degradation is imminent due to change in land use pattern. Mining is one of the most destructive activities to the existing structure of land as top soil containing micro-organisms and minerals essential for plant growth and survival is completely lost if its conservation is not scientifically undertaken. In the process of mining activities especially in open cast projects due to excavation of land & removal of earth to extract minerals like coal, an external dump is created and it is continued till the internal dumping or back filling is started. These dumps are the unconsolidated remains of the overburden left behind after excavation of minerals. Mine dumps comprise rocks, debris, boulders and soil. These are largely devoid of nutrients for any vegetation, in fact they contain toxic metals. Mine dumps if managed unscientifically tend to have precipitous slopes that increase chances of erosion and mud slides. These can pose a danger not only to the mining personnel

in the event of dump failure but also to people in the surrounding villages by way of leaching of harmful contaminants like arsenic and lead to the ground water during heavy rains. Hence their ecological restoration becomes necessary.

Legal aspects related to mine dumps

- As per Ministry of Environment, Forest and Climate Change (MoEF & CC) guidelines in open cast mining project user agency has to undertake both technical and biological reclamation of dumps (discussed in subsequent pages).
- The project proponent also has to prepare a mine closure plan where it is mandated to undertake eco-restoration of mine dumps. By eco-restoration it is meant that project proponent shall make all endeavors to ensure that the mining site is reclaimed back to original situation as far as possible.
- In case of coal open cast mine the maximum height of overburden can be 90m as per MoEF & CC guidelines.
- The slope of the dump cannot exceed 28 degrees.
- As per Director General of Mine Safety norms the safety factor for mines should atleast be 1.5. This factor of safety is determined considering all concerned parameters like geo-mechanical properties of rock mass, ground water condition, hydro-geological studies, seismic effect, method of mining, etc.

- As per MoEF & CC guidelines the project proponent for mining has to conserve the top soil and a soil conservation plan has to be prepared. This top soil can be used during biological reclamation of mine dumps.

Challenges faced in reclamation of dumps

- The first challenge is poor soil fertility. It is mostly calcareous, sandy or rocky with poor soil structure. In absence of an adequate nutrient base the growth of plants is stunted.
- The second challenge is high slope gradient. This makes transportation of trees for plantation to the top a formidable task.
- Another problem associated with this is the heavy erosion that is caused during rains that results in formation of ravines. Even if grass beds are laid, it still is usually not enough to arrest the rapid flow of water.
- The next challenge is to ensure availability of irrigation. The mine water present nearby is usually unfit for watering the plants as it is laden with chemicals. In absence of a dedicated irrigation arrangement especially in the formative years of plants, it becomes difficult to ensure their good survival rate.

However, these issues come at a later stage during reclamation. The main problem is at the inception itself. **The biggest constraint is availability of land**. Keeping mine overburden to lower slope and height for increased stability would mean requirement of

more land which project proponent is unwilling to part with since land is the costliest resource. The result is that mine overburden has great heights and precipitous slopes that even flouts MoEF & CC norms. This in many cases results in overburden dump failure.

Case studies on overburden dump failures

To truly understand the importance of slope stabilization and the necessity of following MoEF & CC protocols on mine dumps we will consider an overburden dump failure case study that cause irreparable damage to environment as well as to human life.

(1) **Overburden dump failure** at Lalmatia OCM under Eastern Coalfields Ltd (under Coal India Ltd) in 2017 claimed the lives of 18 miners apart from unevaluated economic losses.

Cause of failure- Director General of Mines Safety identified that it was a clear case of negligence by Eastern Coalfields Ltd. It was observed that the incidence was sudden since large heaps of around 500m length was stacked on all three sides of

working face to a height ranging from 100-150 m(a case of clear and blatant violation of MoEF & CC guidelines on overburden dump).

(2) **Overburden dump failure at Sasti OCM**

Sasti OCM was under Western Coalfields Ltd, it happened in 2009, resulted in death of one senior overman and one PC operator who were buried under the overburden.

Cause of failure- Steep slope of 37 degrees and overburden height of more than150m as per DGMS investigation.

(3) **Overburden dump failure at Kulda OCM**

Kulda OCM is under Mahanadi Coalfields Ltd, it happened in 2013. It resulted in death of 13 persons from nearby villages who had trespassed in to the overburden area.

Cause of failure- High slope of 32 degrees, height of more than 100m compounded with problem of heavy rain during the period which caused seepage of water and eventual failure of dump.

(4) **Overburden dump failure at Rajmahal OCM**

Rajmahal OCM is under Eastern Coalfields Ltd. The overburden dump failure resulted in the death of 7 workers in 2016.

Cause of failure

DGMS investigation revealed that cause of failure was high length of the dump greater than 300m, height of more than 110m and high slope.

So, from above case studies we see that it becomes imperative that we maintain proper slope and height of dumps as per MoEF & CC protocols. This becomes even more important in cases of heavy rainfall that further increase the risk of failure due to seepage. This causes additional damage and harm to property and life if guidelines of DGMS and MoEF & CC are flouted.

Turning Mine dumps into green mountains

Basically the reclamation of dumps involves the following:

- Top soil management
- Technical Reclamation of External OB dump (basically the overburden dump)
- Biological reclamation on technically reclaimed dumps
- Technical Reclamation of Internal dump / backfilled area (basically the active mining area)
- Management of void left after completion of extraction
- Monitoring of reclamation

Top Soil Management

Top soil is the upper and outer most layer of soil, usually the top 5.0 cm to 20.0 cm. For forming just an inch of top soil, it takes 500 years at least, but for its loss it takes a matter of minutes whether it be due to erosion or mining. Moreover top soil is the one that has the highest concentration of organic matter and is a safe haven for several micro-organisms that play a pivotal role in growth of plants

as well as in biogeochemical recycling of nutrients. Hence appropriate management of top soil is of paramount importance.

MoEF & CC has stipulated that topsoil should be stacked at earmarked specific sites with adequate measures to preserve and should be used as top layer for reclamation of mined out areas. Moreover, topsoil is a source of nutrients and trace elements essential to plant growth that are not normally found in required measure or absent in the excavated soil deeper in the soil profile. The mine spoil dumps are not having required basic nutrients like Carbon, Nitrogen, potassium etc. which is essential to sustain any vegetation to grow and more so the microorganism which give back the carbon from the litters. Further the top soil may contain native seeds that are concentrated in the top 50 mm of the soil profile. In order to ensure re-establishment of native species, the thin layer of surface / top soil should be removed prior to the removal / stripping of overburden. This preserved top soil can be used later for future vegetation when biological reclamation of the mine dump is taken up. However, the duration of stockpiling should be minimized, since excessive time of storage may cause structural degradation and death of seeds and microorganisms, especially when soil moisture

content is high. One of the most important aspect is to maintain record of top soil where it has been stored along with date that should be available in the project.

Technical Reclamation of External OB dump

OCM activities start with dumping overburden in the designated external dump area as stipulated in the mining plan and this operation is continued till back filling / internal dumping is started and gradually external dump becomes inactive.

Simply put technical reclamation involves treating the external overburden dump by leveling, grading and terracing the slopes for stabilization with the help of dozers & graders.

The preserved top soil is spread on the surface of the dump top and slope sides for biological reclamation i.e. plantation.

Following techniques are used for slope stabilization of overburden dumps as well as their technical reclamation:

a) Gully plugging – to minimise gully formation

b) Top Surface drainage – to minimize the seepage of water from top

c) Construction of check dams – to arrest silt, clay, sand particles etc.

d) Laying of garland drains – to channelize the silt bearing rain water to the sedimentation tanks or to the desired destination.

e) Use of geo-synthetic mats or bio-degradable jute mats for early stabilization of dump slopes.

f) Construction of gabion retaining wall

Biological reclamation on Technically Reclaimed dumps

After technical reclamation of the site, the next step is biological reclamation. Simply put it is nothing but planting indigenous species of trees as well as grasses to arrest erosion, increase time of concentration and help in binding the soil as well as gradual development of soil health to its earlier condition. This activity can further involve:

a) **Broadcasting of grass seeds** – Normally done on the inaccessible dump slopes. It is also done on accessible dump slopes in combination with planting trees. Seeds can be broadcasted manually or with the help of machine called as hydro-seeder. This truck mounted seeder moves along the terraced road or other convenient

places and sprays the seed on the slope terraced at larger interval before monsoon so that seeds germinate before on set of monsoon and do not get washed by rain. However this inherently assumes that external overburden dump is accessible which may not be always so. In that case labour employed can be used for broadcasting the seeds.

b) **Planting trees** – This is done on the nearly flat surfaces & terraced slopes at short spacing. However, in certain cases it may also be done on steep slopes as an effective slope stabilization measure. However the greatest challenge in such a case arises in transporting the seedlings to top of overburden dump by labour due to its steep slop (further discussed in upcoming case studies). This plantation work is usually taken up by the State Forest Corporations. For this MoU may be done with user agency. In Chhattisgarh for example Chhattisgarh Rajya Van Vikas Nigam Ltd takes up plantation works on coal mined overburden dumps of South Eastern Coalfields Ltd. Besides use of plantation for biological reclamation of overburden dumps, it is also done

i) On Back filled / internal dump areas including terraced slope.

ii) On plane land or vacant land as mitigative measure.

iii) Avenue Plantation or Green Belt generation as mitigative measures as it is one of the cost effective remedial measures to mitigate air and noise pollution.

For better growth Bio-fertilizers are applied. Recent study shows that the fly ash has got good fertilizer property and the fly ash can be used as manure and save expenditure on fertilizer to a certain extent. Moreover MoEF guidelines too allow use of flyash from thermal power plants to be used as source of nutrients for plants in coal mine overburden dumps.

c) **Use of Multi Species Plantation**

Instead of mono culture, there is a need to develop heterogeneous mix of forest with local species so that the survival rate is high, there is less competition and better establishment. The benefits of plantation will be used by the future generations, it may be insisted to plant value laden tree saplings. For example timber yielding tree species can be mixed with fruit bearing ones or with medicinal and aromatic plants or even with grasses. A variety of combinations can be used.

Some of the trees that can be readily planted for example in Chhattisgarh mining regions are given below:

S.No	Botanical name	Common Name	Family
1	*Tamarindus indica*	Imli / Tamarind Tree	Caesalpinaceae
2	*Acacia catechu*	Khair	Mimosaceae
3	*Azadirachta indica*	Neem	Meliaceae
4	*Phyllanthus emblica*	Aonla / Indian goose berry	Euphorniaceae
5	*Ailanthus excelsa*	Maharukh	Rubiaceae
6	*Mangifera indica*	Aam/ Mango	Anacardiaceae
7	*Anogiessus latifolia*	Dhawda	Combretaceae
8	*Cassia fistula*	Amaltas	Fabaceae
9	*Annona squamosa*	Sitaphal	Annonaceae
10	*Zyzyphus jujube*	Red date	Rhamnaceae
11	*Semecarpus anacardium*	marking nut tree	Anacardiaceae
12	*Tectona grandis*	Sagwan	Verbenaceae
13	*Sterculia urens*	Bhutya in marathi or ghost tree	Malvaceae
14	*Grewia tilifolia*	Dhaman	Tiliaceae
15	*Butea monosperma*	Palas	Fabaceae
16	*Pterocorpus marsupium*	Bija sal	Fabaceae
17	*Bambusa arundinaceae*	Katang bamboo	Graminae

S.No	Botanical name	Common Name	Family
18	*Careya arborea*	Kunbhi	Lecythidaceae
19	*Lagerstroemia parviflora*	Lendia / lenda	Lytheraceae
20	*Acacia nilotica*	Babul	Fabaceae
21	*Albizzia lebbeck*	Shirish	Fabaceae
22	*Cassia siamea*	Kashid	Fabaceae
23	*Leucaena leucocephala*	Subabul	Fabaceae
24	*Borassus flabellifer*	Sindhi	Arecaceae
25	*Zizyphus mauritiana*	Ber	Rhamnaceae
26	*Chloroxylon swietenia*	Bhirra	Rutaceae
27	*Schleichera oleosa*	Kusumb	Sapindaceae

Technical Reclamation of Internal dump / backfilled area

As per mining plan the quarry has to be backfilled. This process of backfilling goes progressively along with mining as per the plan. Thus when one region is being backfilled the other region as per plan gets mined. When mining process is continuing the overburden keeps piling up. Gradually external dump i.e the overburden dump becomes inactive. Internal dumping / backfilling is continued as per the mining plan with the overburden progressively and concurrently till the exhaustion of coal or completion of the project. In the process of progressive and concurrent internal dumping the area of internal dump increases and after attaining the planned height, a portion of the internal dump / backfilled area becomes inactive. These inactive areas are leveled and graded with the help of dozers & graders. Preserved / fresh top soil is spread on the surface of the dump and is continued progressively for biological reclamation i.e. plantation, till the mine is exhausted. Once the mine is exhausted, the entire internal dump / backfilled area including the slopes becomes inactive. The remaining area of internal dump / backfilled area is technically reclaimed by leveling & grading and terracing the slope area for

stabilization. There after spreading of preserved / fresh top soil on the surface of the dump top and slope sides is done, post which biological reclamation i.e. plantation work is undertaken.

Management of void left after completion of extraction

Once the mine is exhausted, the entire internal dump / backfilled area including the slopes becomes inactive. Besides the dump, mine is left with a void, often called Pit Lake, of about 15 to 20% of the total mine area depending on the geo-mining conditions of the mine. While the final mine closure plan is being implemented and since no more dewatering is required, the void is allowed to fill gradually with seepage water and direct rain water. It may take years to fill the void with water up to the top most water tables. It is worth mentioning that during mining operations, some times natural water courses are also disturbed. Wherever possible, these water courses can be channelized or surface run off can be diverted to fill up the void with water at shortest possible time to use it as rain water harvesting structure and water resource of the area.

One successful example of properly managing the mine void is at RAMCO cements ecopark in Tamil Nadu.

Monitoring of reclamation

A robust monitoring mechanism must be put in place to ensure high survival rate of species. A minimum of five years maintenance period should be earmarked with appropriate funds. Geo-tagging of plantation can also be done.

Monitoring of Land reclamation through Satellite Surveillance is being conducted by CMPDI for authenticated and realistic information of Land restoration / reclamation under taken in CIL mines. For example in Chhattisgarh for South Eastern Coalfields Ltd OCM reclamation projects this monitoring is being done every three years.

How to make plantation on dump successful?

1) It is important to dig pits in March / April and give proper exposure to sun before rains.

2) Plantation of saplings in these pits may be done in June-July at the onset of monsoon.

3) In the OB slopes it is better to plant fiber rooted plants like Bamboo and Gliricidia, as these control erosions.

4) Very tall and broad trees on steep slopes should be avoided since these are likely to be uprooted easily.

5) Generally, Neem grows well on all degraded soil such as OB and back filled areas. For example RAMCO in their limestone mine reclamation have heavily relied on neem since it can tolerate high salinity and moderate drought conditions.

6) Arjun can be planted near streams or at the foot of the OB Dump.

7) Planting of fast growing trees and slow growing trees side by side can be avoided as this will block the growth of slow growing trees.

8) Small trees like Aonla near dense branched trees can be avoided.

9) It is necessary to stagger the rows of trees so that each plant gets more sunlight.

10) Wherever possible three tier plantation should be adopted with local species.

11) Plantation grid should have enough space for future and healthy growth of the plants.

12) None of the above steps can make plantation successful unless care is taken for proper leveling, grading and terracing with top soil spreading before taking up any plantation.

13) Also as far as possible proper irrigation facilities must be taken up, preference should be given to drip irrigation since it improves water use efficiency.

14) As far as possible use of inorganic fertilizers should be avoided. Biofertilizers like phosphate solubilizing bacteria, vermicompost, neem cake, bone meal manure should be promoted. It helps in better soil health condition and stimulates growth of plants.

Case Studies on successful mine dump reclamation

Jayant Open Cast Mine Project

It is a coal mine under Northern Coalfields Ltd. It is part of Singrauli coalfield. The Dump of Over Burden consisted of soil and stones, was formed outside the open cast mine. It altered the surface topography and caused severe environmental degradation. It was prone to slide, endangering lives and adjacent properties, the slopes were not stable and maintenance was poor from safety point of view.

The following steps were adopted to reclaim the O.B. Dump No. 2 of Jayant OCP, near Madwani reservoir:

Technical reclamation

- Earthwork in cutting and filling had been done for construction of the Dump, formation of safe and stable slopes, preparation of benches including compacting, dressing, sealing of fissures, gullies and cracks, etc.
- At the top bench length was kept at 565m and slope angle was brought down to 28 degrees. Similarly in the middle location bench length was kept at 528m and slope reduced to 32 degrees.

- Gabion retaining walls had been made of GI wire net cages filled with stone boulders and anchored with bamboo/ wooden bellies/ angle iron. Gabions provide vertical support to the bottom of the slope and help against sliding. These also protect the toe of the reshaped OB dump. At toe the height of walls is kept at 5m and at benches it is kept at 4m.
- Drains on surface, periphery and along benches have been provided at 50 m interval. Thermally bonded non-woven geo-textiles have been wrapped under drain system laid in trenches of cross section 500 mm X 500 mm filled with stone aggregate. Slit perforated PVC pipes of diameter 150 mm have been laid in middle of the trench with 100 mm thick sand cushion at the top to prevent clogging from surface soil. Drains protect the slope surface against rain-cuts and seepage in rainy season. Those make safe way to discharge top and surface water to bottom of the dump. Earthen bunds have been provided at the end of each bench to guard against spilling of water from benches to side slopes.

Biological reclamation

- Saplings have been planted at each bench as well as at top of dump with replacement in case of casualties. Plant roots grip the dump materials up to sufficient depth and increase binding among them. Total plants = 900 nos. (approx.)
- Jute mat/ coir netting of about 25 mm X 25 mm mesh size has been laid on slopes and anchored by pins on dressed and leveled surfaces and in trenches to prevent displacement and to have intimate contact. The mat/ net has been covered with 80 mm thick good agricultural soil mixed with fertilizer, pesticides and saw dust/ hay as base for vegetation.
- Grasses like Stylohamata and Doob (*Cynodon dactylon*) with Baugenvillia has been sown over total slope surfaces including routine maintenance and upkeeping. The grown grasses have been anchored with the mat/ net by pins afterwards. The grasses stop erosion of soil by wind or rain and help to maintain uniform moisture content of the soil underneath.
- An irrigation system has been installed for watering the plants and vegetation areas in benches and slopes. It consists of brass/ glass/ nylon nozzle sprinklers with range 5 m, fitted on 25

mm dia distribution HDPE pipeline. Headers of 50 dia at 100 m interval have been provided.

Technical reclamation of Jayant dump overburden

Biological reclamation of Jayant dump overburden

Gandhisagar Mine overburden dump of SECL

It is located in Korba Mining area of South Eastern Coalfields Ltd.

- The precipitous slope in the initial phase prevented any successful planting of trees. So the first step was development of bench terraces. This enabled cutting down the slope gradient.
- Where it was not possible to develop bench terraces, contour bunds were created.
- Next grass cover was developed with vetiver, dinanath to bind the soil particles together.
- After this trees were planted. Due preference was given to local varieties like neem, karanj, baheda, kachnar, aonla, kadamb, karonda, jharul, gulmohar and the like.
- Catch basins were created around each tree planted to aid in soil and moisture conservation. The result was that trees could establish themselves in a short span. In fact today it is gradually developing into a mini forest. Its success can be gauged from the fact that SECL is now developing it into a tourist spot.

Top of gandhisagar dump under initial plantation

Gandhisagar dump (after plantation)

Sarwamangala Mine overburden dump of SECL

These are also located in Korba Mining area. Initially the land was almost barren devoid of any trees. The success of these plantations is the result of a few changes undertaken at structural and administrative levels. It is a result of close coordination between Chhattisgarh Forest department (Chhattisgarh State Forest Development Corporation) and SECL. SECL already had MoU with CGSFDC for planting trees on dumps. But it had no provision for development of contour bunds or bench terraces.

There was no emphasis on top soil conservation at user agency level. Similarly there was no provision of irrigation of planted trees. But now with renewed vigour and thrust from leadership of forest department and CGSFDC, these provisions have now been incorporated in MoU itself. It has been so successful that with the active efforts from CGSFDC, SECL managed to secure the prestigious Vruksha Mitra award.

Sarwamangala mine dump before plantation

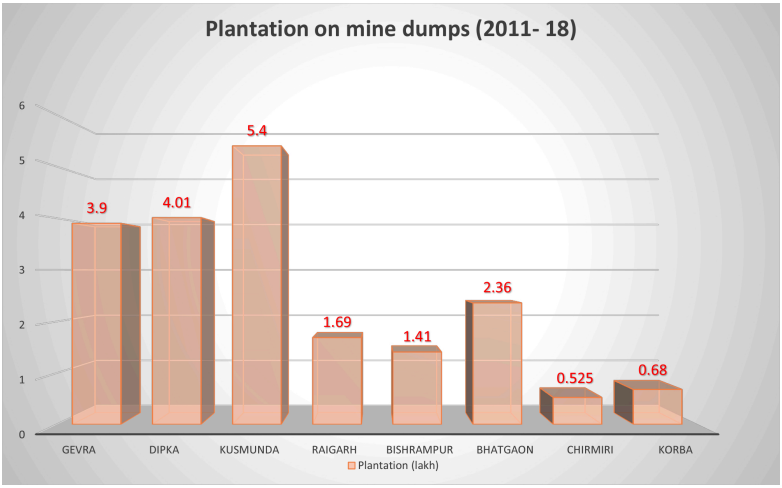
Sarwamangala mine dump after plantation

Role of Forest Department

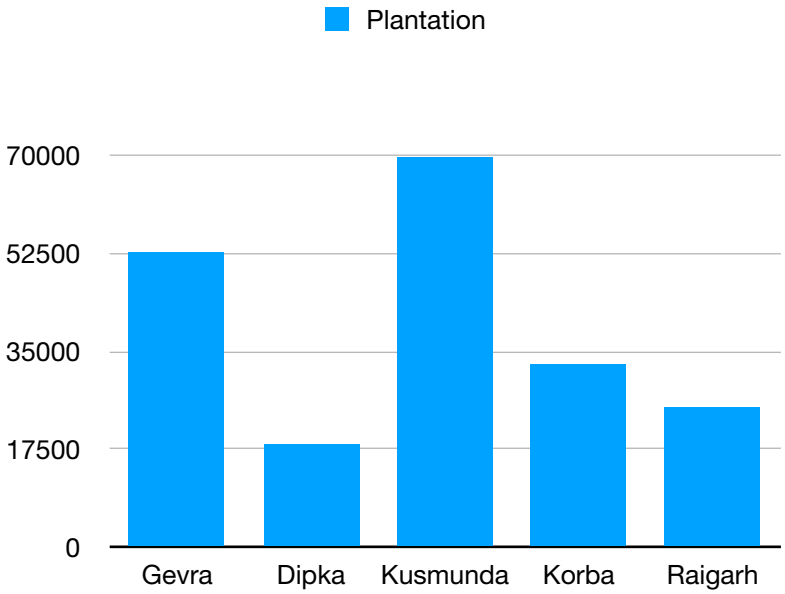
Though the primary responsibility of technical as well as biological reclamation of mine overburden dumps lies with user agency but forest department has an indispensable role to play. A mechanism can be worked out between forest department and user agency especially for plantation works since user agency does not have comparative expertise in this regard. For example in Chhattisgarh there is an MoU between Chhattisgarh State Forest Development Corporation and South Eastern Coalfields Ltd for plantation works to be taken up by department. The MoU is renewed every five years. Moreover under stage I and stage II clearances, the user agency is mandated to adhere to conditions like keeping slope below 28degrees and height of overburden less than 90m for coal mines, the forest department must ensure that these conditions are fulfilled by site inspections. Apart from this training and capacity building activity should be imparted to frontline staff of department like guards on plantation activities on dumps which is infact quite different from routine plantations since here soil is poor in nutrients, subject to erosion, there is also lack of availability of water easily for irrigation purposes. The department should also ensure that plantation activity is undertaken only when the site has been technically reclaimed by user agency since they have technical

expertise in this regard and availability of better machinery.

As a reference some of the works that Chhattisgarh forest department is doing through Chhattisgarh State Forest Development Corporation (CGRVVN) are as under:



In the graph the plantation details are in lakhs. So from 2011-18, CGRVVN has undertaken plantation of around 20 lakh in mining areas of South Eastern Coalfields Ltd. Gevra, Dipka, Kusmunda and the like mentioned in graph are the major coal producing mine areas of SECL. Gevra OCM is one of largest mine producing areas in Asia.



For the year 2019, the plantation works undertaken by Forest department of Chhattisgarh through CGRVVN are shown in graph in mine dump areas of SECL. So, in 2019 alone 1.75 lakh trees have been planted in five mine dump areas of SECL.

As has been previously mentioned SECL has MoU with CGRVVN (2019-20 to 2023-24) under which a range of works other than plantation works are also undertaken for reclamation of mine dumps. These are:

S.No	Work	Unit	Rate (Rs)
1	Raising of nurseries, supply of seedlings in polypots, digging pits, plantation of seedlings in required place, weeding, app of fertilizer and pesticide, fire protection, watering during 2019-20 and subsequent maintenance from 2020-21 to 2023-24 on OB dump	per plant	293.09
2	Grass bed size 2mx0.5mx0.5m for 2019-20	per no.	100.04
3	Barbed wire fencing with RCC post, 1.2m high fencing with 1.8m long RCC post placed every 2.5m apart embedded in cement concrete blocks (1:5:10) and every 15th post last but one end post and corner post strutted on both sides and end post on one side only. Provided with 6 horizontal line and two diagonal of barbed wire 9.38kg per 100m between two posts fitted and fixed with iron clips made in RCC posts as per instruction of in-charge of work in 2019-20 with subsequent maintenance from 2020-21 to 2022-23.	RMT	367.8

This is taken from SECL order no. एसईसीएल/बीएसपी/वन/वृक्षा (19-20)/कार्यआदेश/छगरावविनिलि/2019/82 dt 20.8.19.

Greening of dumps, its re-vegetation helps to create an ecological niche in that area. As the leaves, branches and twigs fall down on the surface, they get worked on through enzymatic action by soil micro-flora and help in bio-geochemical nutrient cycling. Thus, they help to release organic carbon and nitrogen to soil for plants. Trees with their penetrative root system hold the soil, reduce erosion and improve its evapotranspiration profile as well as its infiltration characteristics. Trees also help to moderate the micro-climate of the region. Dust, Soot, particulates, aerosol get trapped by these plants. Hence they aid in tackling air pollution too. Thus we can say that greening of dumps is indispensable for ecological restoration of any mine area and for this noble purpose the role of forest department cannot be underscored any further. Both user agency and forest department should work hand in hand to tackle this problem and come up with innovative solutions.

ABOUT THE AUTHOR

Animesh Goverdhan is a State Forest Service Officer. Presently he is Assistant Conservator of Forest. He has done his graduation from University of Delhi (Delhi College of Engineering). He has also penned another book on 'Oxyzone- The Magical Forest of Raipur'.