Land Restoration / Reclamation Monitoring of more than 5 mcm (Coal+OB) Capacity Open Cast Coal Mines of South Eastern Coalfields Limited Based on Satellite Data for the Year 2012

Submitted to
South Eastern Coalfields Limited
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March-2013

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi
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Executive Summary

1.0 Project
Land restoration / reclamation monitoring of 10 opencast coal mines of South Eastern Coalfields Ltd. (SECL) producing 5 million cu.m. and more (Coal+OB) per year based on satellite data, regularly on annual basis.

2.0 Objective
Objective of the land restoration / reclamation monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, and distribution of wasteland, agricultural land and forest in the leasehold area of the project. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3.0 Salient Findings

- Out of the total mine leasehold area of 159.48 Km$^2$ of the 10 opencast projects of SECL viz. Dipka, Gevra, Manikpur, Kusmunda, Dugga, Bishrampur, Chirimiri, Rajnagar, Dhanpur and Jamuna considered for monitoring during 2012-13; total excavated area is 83.61 Km$^2$ (52.46%) of which 42.66 Km$^2$ area (51.02%) has been planted, 22.21 Km$^2$ area (26.55%) is under backfilling and 18.74 Km$^2$ area (22.41%) is under active mining. It is evident from the analysis that 77.59% areas of the OC projects have already been reclaimed and balance 22.41% area is under active mining. Project wise details are given in Table-1 & Fig-1.

- On comparing the status of land reclamation for the year 2012 with respect to the year 2011 in different projects, it is evident from the analysis that area of land reclamation has increased from 64.00 Km$^2$ (Yr. 2011) to 64.87 Km$^2$ (Yr.2012). Out of 10 projects of SECL, Rajnagar OC ranks on top for land reclamation (97.99%) followed by Bishrampur (97.91%) and Dhanpuri (96.35%).

- Area of biological reclamation (plantation) has marginally decreased from 42.90 Km$^2$ (Yr.2011) to 42.66 Km$^2$ (Yr.2012), whereas, the area of technical reclamation (backfilled area) has increased from 21.10
Km² (Yr.2011) to 22.21 Km² (Yr.2012) as in SECL. This increase of 1.11 Km² in area of plantation and backfilled is the result of the efforts of the SECL taken up towards environmental protection.

- It has been observed that in some opencast projects of SECL like Manikpur and Bishrampur, plantation area on backfilled has marginally reduced due to OB dumping on vegetated backfilled area due to constrained of dumping space.

- Project wise land reclamation status in South Eastern Coalfields Limited (SECL) is depicted in Table – 1.

Table -1

Projectwise Land Reclamation Status in Opencast Project of SECL
(> 5 million Cu. M. of Coal+OB) based on Satellite Data of the Year 2012

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project Name</th>
<th>Leasehold (i)</th>
<th>Plantation/Vegetation (ii)</th>
<th>Under Backfilling (iii)</th>
<th>Active Mining (iv)</th>
<th>Total Excavated Area (ii+iii+iv)</th>
<th>Total Reclamed area (ii+iii)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DIPKA</td>
<td>22.26</td>
<td>2.83</td>
<td>2.84</td>
<td>2.70</td>
<td>2.83</td>
<td>3.75</td>
</tr>
<tr>
<td>2</td>
<td>GEVRA *</td>
<td>41.86</td>
<td>7.35</td>
<td>7.44</td>
<td>6.04</td>
<td>6.08</td>
<td>6.69</td>
</tr>
<tr>
<td>3</td>
<td>KUSMUNDA</td>
<td>16.72</td>
<td>3.79</td>
<td>3.87</td>
<td>1.79</td>
<td>2.02</td>
<td>3.40</td>
</tr>
<tr>
<td>4</td>
<td>MANIKPUR *</td>
<td>19.44</td>
<td>2.97</td>
<td>2.79</td>
<td>1.46</td>
<td>1.84</td>
<td>1.48</td>
</tr>
<tr>
<td>5</td>
<td>DUGGA</td>
<td>5.41</td>
<td>1.81</td>
<td>1.81</td>
<td>1.08</td>
<td>1.22</td>
<td>0.38</td>
</tr>
<tr>
<td>6</td>
<td>BISHRAMPUR</td>
<td>15.23</td>
<td>8.36</td>
<td>8.06</td>
<td>3.18</td>
<td>3.20</td>
<td>0.25</td>
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<td>7</td>
<td>CHIRIMIRI</td>
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<td>0.92</td>
<td>0.94</td>
<td>0.10</td>
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<td>9</td>
<td>DHANPURI</td>
<td>14.59</td>
<td>3.96</td>
<td>3.96</td>
<td>2.15</td>
<td>2.38</td>
<td>0.20</td>
</tr>
<tr>
<td>10</td>
<td>JAMUNA</td>
<td>8.85</td>
<td>4.15</td>
<td>4.21</td>
<td>1.22</td>
<td>1.32</td>
<td>0.71</td>
</tr>
<tr>
<td>TOTAL (SECL)</td>
<td></td>
<td>159.48</td>
<td>42.90</td>
<td>42.66</td>
<td>21.10</td>
<td>22.21</td>
<td>17.08</td>
</tr>
</tbody>
</table>

* The mine leasehold area has been revised
Fig. 1: Land reclamation status in OC projects of SECL in the year-2012
1.0 Background

1.1 Land is the most important natural resource which embodies soil, water, flora - fauna and total ecosystem. All human activities are based on the land which is most scarce natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do effect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.

1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2009/2428 dated 29.12.2009 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation. status of all the opencast coal mines having production of more than 5 million m$^3$ per annum (coal + OB taken together per annum) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining. Further, a revised work order was issued vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 from Coal India Limited for the period 2012-13 to 2016-17. According to this work order, all mines in CIL with output capacity of 5 million cu. m (coal +OB) shall be monitored every year and all mines below this capacity shall be monitored at an interval of 3 yrs. All coalfields in CIL shall also be monitored at an interval of 3 yrs as per a defined plan. The result of land reclamation status of all such mines to be put on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detail report to be submitted to Coal India and respective subsidiaries.
1.3 Land reclamation monitoring of all opencast coal mining projects would also comply the statutory requirements of Ministry of Environment & Forest (MoEF). Such monitoring would not only facilitate in taking timely mitigation measures against environmental degradation, but would also enable coal companies to utilize the reclaimed land for larger socio-economic benefits in a planned way.

1.4 Present report is embodying the finding of the study based on satellite data of the year 2012 carried out for all the OC projects producing more than 5 million cu.m. of coal+OB for South Eastern Coalfields Ltd.

2.0 Objective

Objective of the land reclamation/restoration monitoring is to assess the area of backfilled, plantation, OB dumps, social forestry, active mining area, settlements and water bodies, distribution of wasteland, agricultural land and forest land in the leasehold area of the project. This is an important step taken up for assessing the progressive status of mined land reclamation and for taking up remedial measures, if any, required for environmental protection.

3.0 Methodology

There are number of steps involved between raw satellite data procurement and preparation of final map. National Remote Sensing Centre (NRSC) Hyderabad, being the nodal agency for satellite data supply in India, provides only raw digital satellite data, which needs further digital image processing for extracting the information and map preparation before uploading the same in the website. Methodology for land reclamation monitoring is given in given in Fig 2. Following steps are involved in land reclamation/restoration monitoring:
3.1 **Data Procurement:** After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC. Secondary data like leasehold boundary, topo sheets are procured for creation of vector database.

3.2 **Satellite Data Processing:** Satellite data are processed using PCI GEOMATICA / ERDAS IMAGINE digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Geo-referencing:** Inaccuracies in digital imagery may occur due to ‘systematic errors’ attributed to earth curvature and rotation as well as ‘non-systematic errors’ attributed to satellite receiving station itself. Raw digital images contain geometric distortions, which make them unusable as maps. Therefore,
geo-referencing is required for correction of image data using ground control points (GCP) to make it compatible to Sol topo sheet.

- **Image enhancement:**
  To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using PCI Geomatica / ERDAS IMAGINE 9.3 s/w. and enhance the image quality for interpretation.

- **Training set selection**
  Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**
  Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between the classes that resulted from computing
divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**
  The area of each land use class in the leasehold is determined using PCI Geomatica v10.1 / ERDAS IMAGINE v. 9.3 software.

- **Overlay of Vector data base**
  Vector data base created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**
  Pre-field map is prepared for validation of the classification result

3.3 **Ground Truthing:**
Selective ground verification of the land use classes are carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 **Land reclamation database on GIS:**
Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut-off dates.

4.0 **Work Plan**
4.1 Ten opencast projects of SECL producing more than 5 million cubic m. (Coal + OB together) during the year 2012 which have been taken up for land restoration / reclamation monitoring based on the RESOURCESAT-1(L-IV) satellite data using PCI Geomatics / ERDAS Imaging digital image processing s/w on GIS platform. Land
reclamation monitoring will be carried out regularly on annual basis to assess the progressive status of land restoration / reclamation in the above opencast mines. The report of this study has been uploaded on the website of CMPDI, CIL & SECL in public domain.
5.0 **Land Reclamation Status in South Eastern Coalfields Limited**

5.1 Following ten opencast projects of SECL producing 5 million cubic m. or more (coal+OB) together were taken up for land reclamation monitoring during the year 2012.

- Dipka
- Gevra
- Kusmunda
- Manikpur
- Dugga
- Bishrampur
- Chirimiri
- Rajnagar
- Dhanpuri
- Jamuna

5.2 Area statistics of different land use class present in the mine leasehold of the above 10 projects of SECL for the year 2012 are shown in the Table - 5.1. Land use maps derived from satellite data are shown in Plate 5.1 - 5.10. Land reclamation status of the above mentioned projects, were also prepared for the year 2008, 2009, 2010 and 2011. Year wise changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig.5.1 - 5.10.

5.3 Study reveals that in the projects of SECL as mentioned above, out of total 83.61 Km$^2$ excavated area; 64.87 Km$^2$ area (77.59%) is under reclamation, out of which 42.66 Km$^2$ (51.02%) area has already been revegetated and 22.21 Km$^2$ (26.55%) area are under backfilling.

5.4 After analyzing the satellite data of the year 2011 and 2012, it is evident that area of land reclamation has increased from 64.00 Km$^2$ in the year 2011 and to 64.87 Km$^2$ in the year 2012 in the above OC projects of SECL in a period of one year. There is an increase of
0.87 Km² reclaimed area in SECL with respect to the year 2011, out of which, there is a marginal decrease of 0.24 Km² in biological reclamation and 0.99 Km² increase in the areas under technical reclamation (barren backfilling) corresponding to the year 2011. This may be due to more areas coming under technical reclamation.

5.5 Study indicates that in Manikpur and Bishrampur projects, area of plantation have reduced marginally with respect to the year 2011 because of the OB dumping on vegetated backfilled / OB Dump area due to constrained of dumping space.

5.6 Overall, all the projects considered for this report indicate either an increase or static trend in plantation except for Manikpur and Bishrampur OCPs and increase in area under backfilling except for Chirimiri as compared to 2011.

5.7 Out of 10 projects of SECL, Rajnagar OCP ranks on top for land reclamation (97.99%) followed by Bishrampur (97.91%) and Dhanpuri (96.35%) in the year 2012-13.
Table 5.1
Status of Land Use / Reclamation in OC Mines (>5 mcu.m) of South Eastern Coalfields Ltd. based on Satellite data of the Year 2012

| Land Use | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % 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| Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area | % | Area |%
Figure 5.1

STATUS OF LAND RECLAMATION IN DIPKA OCP

Figure 5.2

STATUS OF LAND RECLAMATION IN GEVRA OCP
Figure 5.3

STATUS OF LAND RECLAMATION IN KUSMUNDA OCP

Figure 5.4

STATUS OF LAND RECLAMATION IN MANIKPUR OCP
Figure 5.5

STATUS OF LAND RECLAMATION IN DUGGA OCP

Figure 5.6

STATUS OF LAND RECLAMATION IN BISHRAMPUR OCP
STATUS OF LAND RECLAMATION IN CHIRIMIRI OCP

Figure 5.7

STATUS OF LAND RECLAMATION IN RAJNAGAR OCP

Figure 5.8
Figure 5.9

STATUS OF LAND RECLAMATION IN DHANPURI OCP

Figure 5.10

STATUS OF LAND RECLAMATION IN JAMUNA OCP
Photograph – 1: *Plantation on OB Dump in Dipka Opencast Project*

Photograph – 2: *Plantation in Gevra Opencast Project*
Photograph – 3: *Plantation on OB Dump in Kusmunda Opencast Project*

Photograph – 4: *Plantation on OB Dump in Manikpur Opencast Project*
Photograph – 5: *Plantation on OB Dump in Dugga Opencast Project*

Photograph – 6: *Plantation on OB Dump in Bishrampur Opencast Project*
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Photograph – 8: *Plantation on OB Dump in Rajnagar Opencast Project*
Photograph – 9: *Plantation on OB Dump in Dhanpuri Opencast Project*

Photograph – 10: *Plantation on OB Dump in Jamuna Opencast Project*