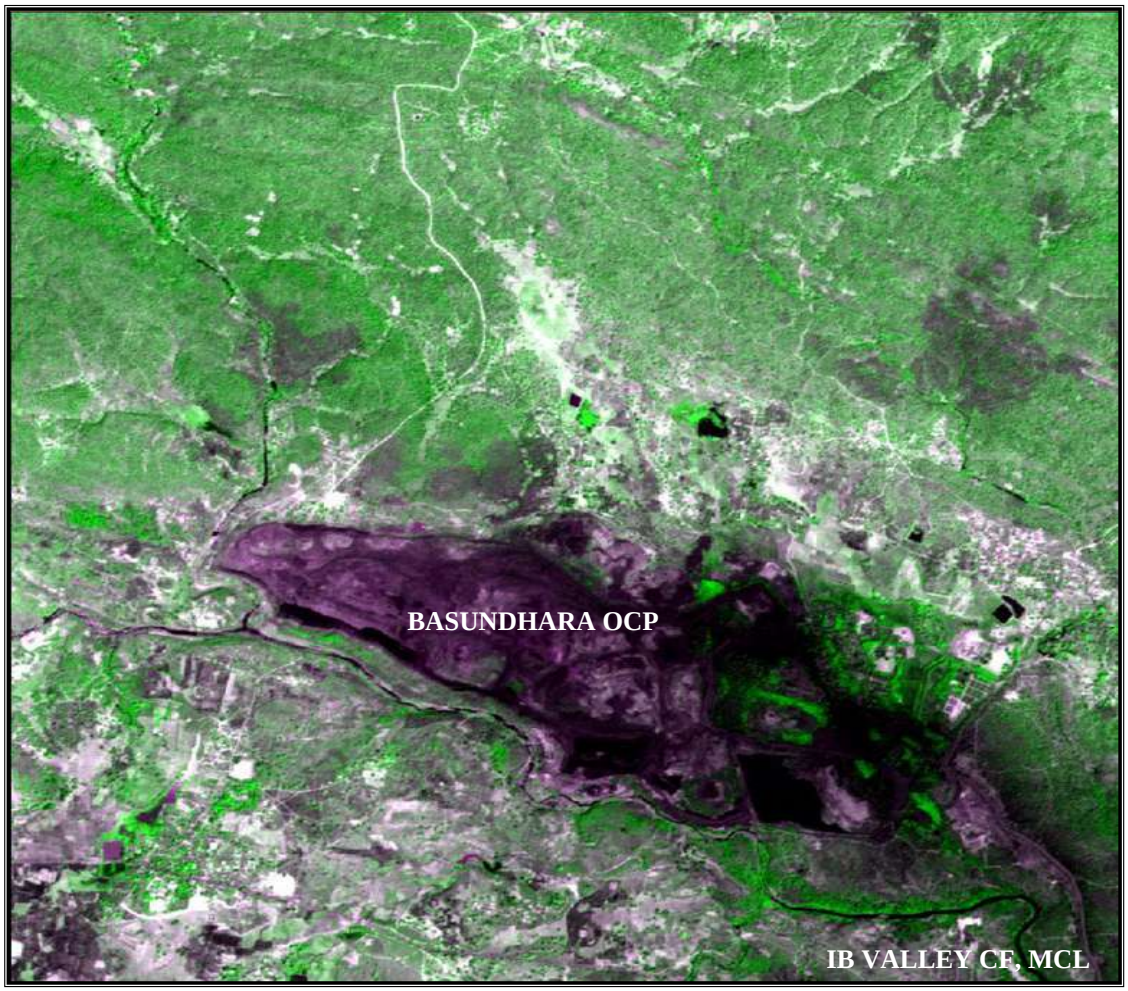
Land Restoration / Reclamation Monitoring of less than 5 m cu.m. (Coal+OB) Capacity Open Cast Coal Mines of Mahanadi Coalfields Limited Based on Satellite Data for the Year 2015



Submitted to

Mahanadi Coalfields Limited

cmpdi
A Mini Ratna Company

Land Restoration / Reclamation Monitoring of less than 5 m. cu. m (Coal + OB) capacity Open Cast Coal Mines of Mahanadi Coalfields Limited Based on Satellite Data for the Year 2015

March-2016

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

Executive Summary

1.0 Project

Land restoration / reclamation monitoring of 3 opencast coal mines of Mahanadi Coalfields Ltd. (MCL) producing less than 5 million cu. m. (Coal + OB) per year based on satellite data, on every three year 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 land in the leasehold area of the various projects. This will help in assessing the progressive status of mined out 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 2035.83 hectares of the 3 OC projects Viz. Basundhara, Garjanbahal and Kaniha considered for monitoring during year 2015; total excavated area is only 462.57 ha , out of which 43.29 ha area (9.36%) has been planted, 183.77 ha area (39.73%) is under backfilling and 235.51 ha area (50.92%) is under active mining. It is evident from the analysis that 49.09% area of the OC projects have already been reclaimed and balance 50.92% area is under active mining. Project wise details are given in Table-1 & Fig -1.

- Of the total area reclaimed by the Company, 9.36% is put under biological reclamation (plantation) and 39.73% is put under technical reclamation.

- On comparing the status of land reclamation for the year 2015 with respect to the year 2012 in different projects, it is evident from the analysis that area under land reclamation has increased from 170.84Ha. (Yr. 2012) to 227.06Ha.(Yr.2015).

- Garjanbahal is an upcoming project and the current status can be used as base data for any future analysis on reclamation monitoring.

TABLE-1

Project wise Land Reclamation Status in OC projects of Mahanadi Coalfields Ltd Based on Satellite data of the Year 2012 and 2015

% Calculated in respect of total Excaveted area Area in Hectare

Sl No.	Projects	Leasehold		Biological Reclamation (Plantation/Vegetation)		Technical Reclamation (Under Backfilling)		Under Active Mining		Total Excaveted Area		Area under Reclamation	
		(i)		(ii)		(iii)		(iv)		(iii+iii+iv)		(ii+iii)	
		2012	2015	2012	2015	2012	2015	2012	2015	2012	2015	2012	2015
1	Basundhara	705.00	705.00	29.96	30.81	107.39	145.45	188.12	161.98	325.47	338.24	137.35	176.26
				9.21	*9.11*	*33.00*	*43.01*	*57.80*	*47.89*			*42.20*	*52.12*
2	Garjanbahal	524.25	653.83	0.00	1.95	0.00	18.19	0.00	6.17	0.00	26.31	0.00	20.14
				0.00	*7.42*	*0.00*	*69.14*	*0.00*	*23.46*			*0.00*	*76.55*
3	Kaniha	601.30	677.00	10.88	10.53	22.61	20.13	43.60	67.36	77.09	98.02	33.49	30.66
				14.12	*10.75*	*29.33*	*20.54*	*56.56*	*68.73*			*43.44*	*31.28*
	Total	1830.55	2035.83	40.84	43.29	130.00	183.77	231.72	235.51	402.56	462.57	170.84	227.06
				10.15	*9.36*	*32.30*	*39.73*	*57.57*	*50.92*	*22.00*	*22.73*	*42.44*	*49.09*

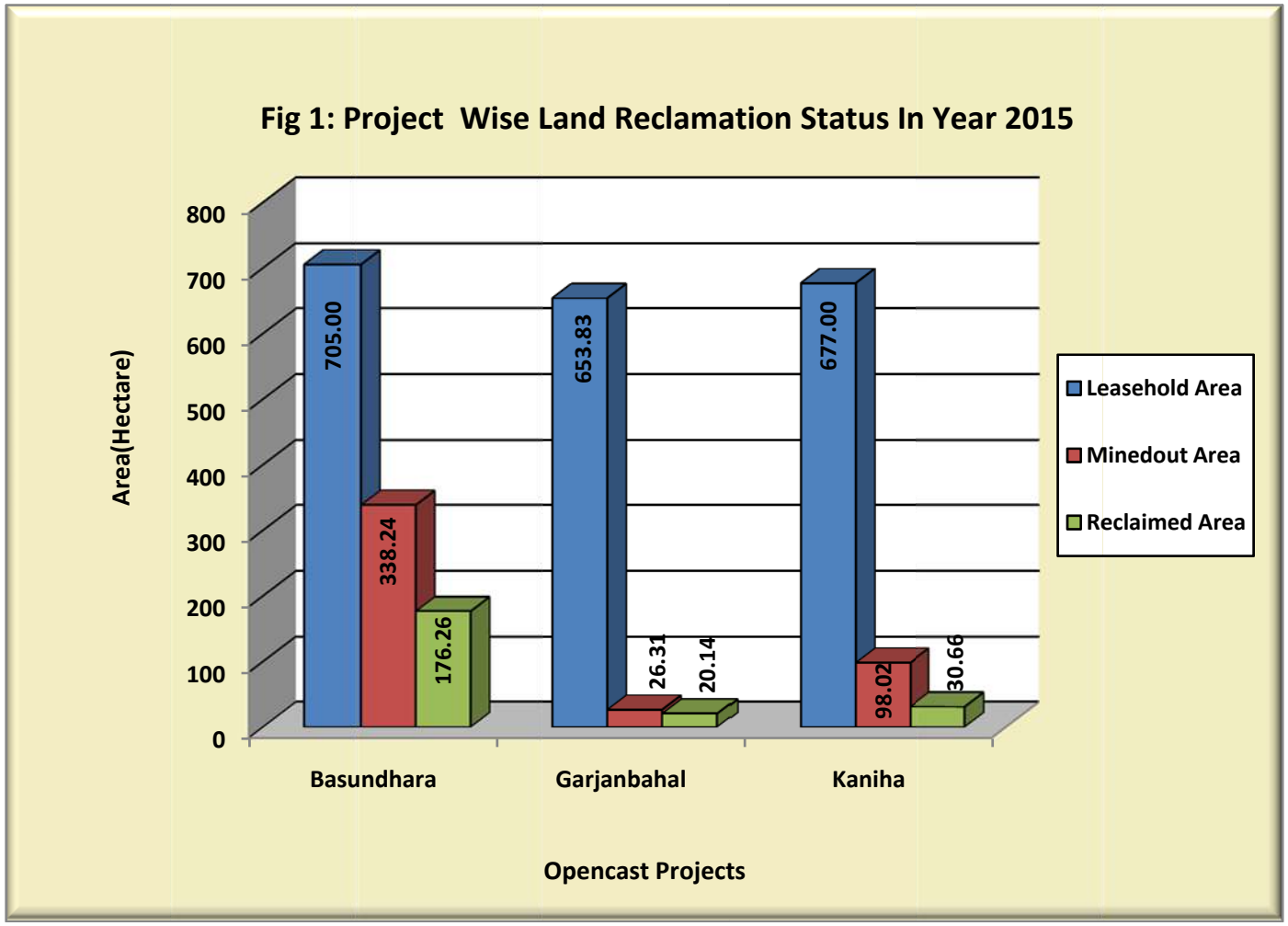


Fig 1: Project Wise Land Reclamation Status In Year 2015
Area(Hectare)
800
700
600
500
400
300
200
100
0
705.00
338.24
176.26
653.83
26.31
20.14
677.00
98.02
30.66
Basundhara
Garjanbahal
Kaniha
Opencast Projects
Leasehold Area
Minedout Area
Reclaimed Area

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 the scarcest 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, M/s. Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 for monitoring of opencast mines of less than 5 million m^3 per annum capacity (Coal +OB) from the year 2012 at intervals of three years. The result of land reclamation status of all such mines is to be published on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed reports are to be submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all open cast projects will have to comply the statutory requirements of Ministry of Environment & Forest (MoEF). Such monitoring will not only facilitate in taking remedial measures against environmental degradation, but also enable Coal companies to utilize the reclaimed land for further 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 2015 carried out for 3 no. of OC projects of capacity less than 5 mcm (coal +OB) for Mahanadi 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 fig 2. Following steps are involved in land reclamation /restoration monitoring:

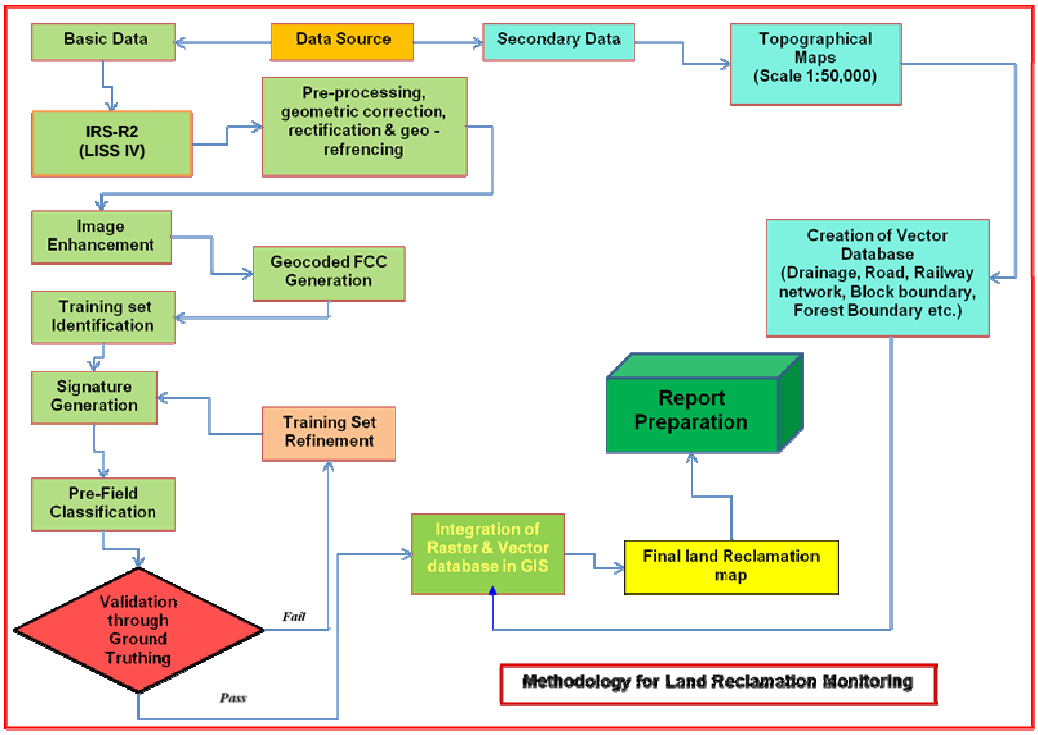


Figure: 2 Methodology for Land Reclamation Monitoring

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 ERDAS IMAGINE 2014 digital image processing s/w. Methodology involves the following major steps:

- Rectification & Georeferencing: 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, georeferencing is required for correction of image data using ground control points (GCP) to make it compatible to SOI toposheet.

- 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 ERDAS IMAGINE 2014 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 ERDAS IMAGINE v. 2014 software and given in table 2.

- 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 Land Reclamation Status in Mahanadi Coalfields Ltd.

4.1 Following 3 OC projects producing less than 5 million m^3. (Coal + OB together) of Mahanadi Coalfields Ltd. have been taken up during the year 2015 for land reclamation monitoring:

- Basundhara
- Garjanbahal
- Kaniha

4.2 Area statistics of different land use classes present in OC projects in the year 2015 is given in Table 2. Land use maps derived from the satellite data is given in Plate no.1 to 3. Land use statuses are shown in Fig. 3 – 5 and field photograph showing plantation and backfilled area in Basundhara project is shown in photo 1.

4.3 Study reveals that 49.09% of excavated area has already been reclaimed by MCL in the OC projects, out of which 9.36% area has been revegitated and 39.73% area are backfilled.

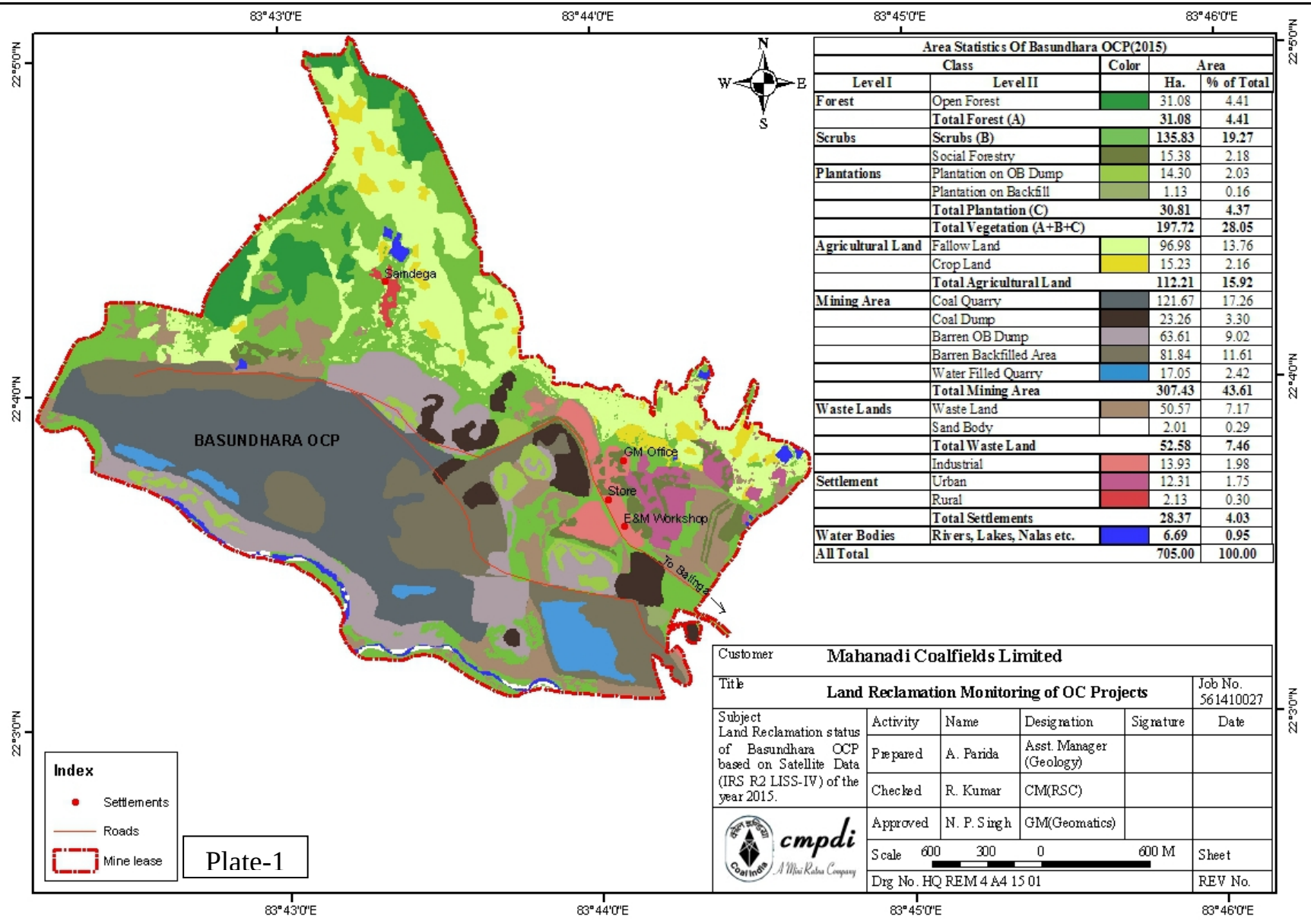
4.4 Analysis of satellite data indicates that area of plantation has increased from 40.84Ha. (2012) to 43.29Ha. (2015). This increase of 2.45Ha.plantation areas in three years indicate that MCL is committed for reclamation of mine land for maintaining the ecological balance in the region. It has been observed in some of the projects natural vegetation has also started growing on stabilized old backfilled areas and OB dumps due to increase in soil fertility.

4.5 On comparing the status of land reclamation for the year 2015 with respect to the year 2012 in different projects, it is evident from the analysis that area of land reclamation has increased from 170.84Ha. (Yr. 2012) to 227.06Ha. (Yr.2015).

Table 2: STATUS OF LAND RECLAMATION IN MCL BASED ON SATELLITE DATA OF THE YEAR 2015

(Area in Hectare)

		BASUNDHARA		GARJANBAHAL		KANIHA		TOTAL	
		Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	60.31	9.22	0.00	0.00	60.31	2.96
	Open Forest	31.08	4.41	87.32	13.36	0.00	0.00	118.40	5.82
	Total Forest	31.08	4.41	147.63	22.58	0.00	0.00	178.71	8.78
SCRUBS	Scrubs	135.83	19.27	125.57	19.21	39.67	5.86	301.07	14.79
PLANTATION	Social Forestry	15.38	2.18	1.95	0.30	10.53	1.56	27.86	1.37
	Plantation on OB Dump	14.30	2.03	0.00	0.00	0.00	0.00	14.30	0.70
	Plantation on Backfill	1.13	0.16	0.00	0.00	0.00	0.00	1.13	0.06
	Total Plantation *(Biological Reclamation)*	30.81	4.37	1.95	0.30	10.53	1.56	43.29	2.13
	Total Vegetation	**197.72**	**28.05**	**275.15**	**42.09**	**50.20**	**7.42**	**523.07**	**25.69**
ACTIVE MINING	Coal Quarry	121.67	17.26	0.00	0.00	52.29	7.72	173.96	8.54
	Coal Face	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Coal Dump	23.26	3.30	6.17	0.94	13.48	1.99	42.91	2.11
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled With Water	17.05	2.42	0.00	0.00	1.59	0.23	18.64	0.92
	Total Area under *Active Mining*	**161.98**	**22.98**	**6.17**	**0.94**	**67.36**	**9.94**	**235.51**	**11.57**
RECLAIMED	Barren OB Dump	63.61	9.02	18.19	2.78	18.23	2.69	100.03	4.91
	Area Under Backfilling	81.84	11.61	0.00	0.00	1.90	0.28	83.74	4.11
	Total Area under *Technical Reclamation*	**145.45**	**20.63**	**18.19**	**2.78**	**20.13**	**2.97**	**183.77**	**9.03**
	Total Area under Mine Operation	**307.43**	**43.61**	**24.36**	**3.72**	**87.49**	**12.91**	**419.28**	**20.60**
WASTELAND	Waste Lands	50.57	7.17	54.42	8.32	142.81	21.09	247.80	12.17
	Fly Ash Pond / Sand Body	2.01	0.29	0.00	0.00	0.00	0.00	2.01	0.10
	Total Wasteland	**52.58**	**7.46**	**54.42**	**8.32**	**142.81**	**21.09**	**249.81**	**12.27**
WATERBODIES	Reservoir, nallah, ponds	6.69	0.95	8.44	1.29	6.86	1.01	21.99	1.08
	Total Waterbodies	**6.69**	**0.95**	**8.44**	**1.29**	**6.86**	**1.01**	**21.99**	**1.08**
AGRICULTURE	Crop Lands	15.23	2.16	19.28	2.95	24.23	3.58	58.74	2.89
	Fallow Lands	96.98	13.76	264.44	40.44	348.61	51.49	710.03	34.88
	Total Agriculture	**112.21**	**15.92**	**283.72**	**43.39**	**372.84**	**55.07**	**768.77**	**37.76**
SETTLEMENTS	Urban Settlement	12.31	1.75	0.00	0.00	0.00	0.00	12.31	0.60
	Rural Settlement	2.13	0.30	6.18	0.95	14.21	2.10	22.52	1.11
	Industrial Settlement	13.93	1.98	1.56	0.24	2.59	0.38	18.08	0.89
	Total Settlement	**28.37**	**4.03**	**7.74**	**1.19**	**16.80**	**2.48**	**52.91**	**2.60**
	Grand Total	**705.00**	**100.00**	**653.83**	**100.00**	**677.00**	**100.00**	**2035.83**	**100.00**

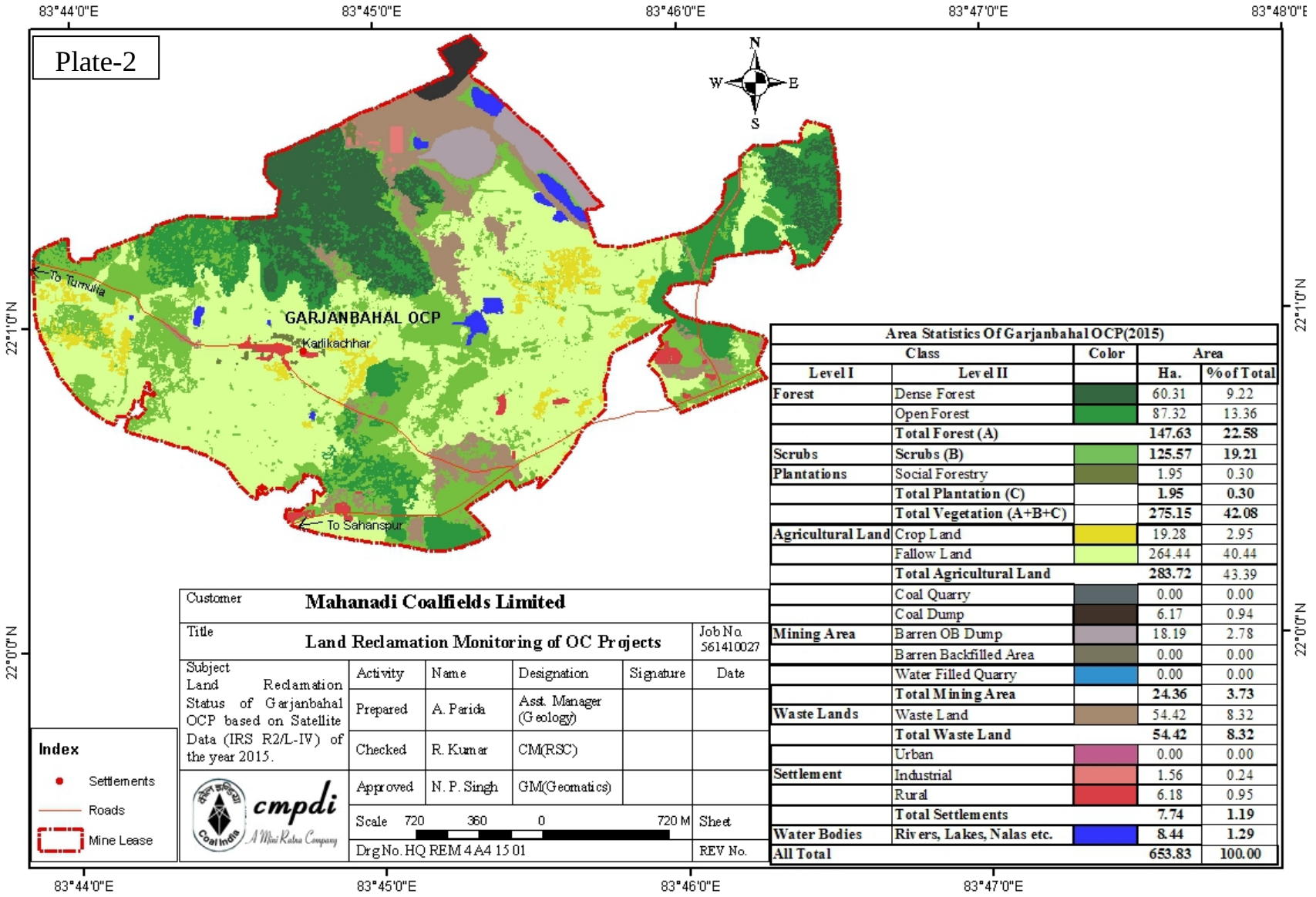


Area Statistics Of Basundhara OCP(2015)

Class		Color	Area	
Level I	Level II		Ha.	% of Total
Forest	Open Forest		31.08	4.41
	Total Forest (A)		**31.08**	**4.41**
Scrubs	**Scrubs (B)**		**135.83**	**19.27**
	Social Forestry		15.38	2.18
Plantations	Plantation on OB Dump		14.30	2.03
	Plantation on Backfill		1.13	0.16
	Total Plantation (C)		**30.81**	**4.37**
	Total Vegetation (A+B+C)		**197.72**	**28.05**
Agricultural Land	Fallow Land		96.98	13.76
	Crop Land		15.23	2.16
	Total Agricultural Land		**112.21**	**15.92**
Mining Area	Coal Quarry		121.67	17.26
	Coal Dump		23.26	3.30
	Barren OB Dump		63.61	9.02
	Barren Backfilled Area		81.84	11.61
	Water Filled Quarry		17.05	2.42
	Total Mining Area		**307.43**	**43.61**
Waste Lands	Waste Land		50.57	7.17
	Sand Body		2.01	0.29
	Total Waste Land		**52.58**	**7.46**
	Industrial		13.93	1.98
Settlement	Urban		12.31	1.75
	Rural		2.13	0.30
	Total Settlements		**28.37**	**4.03**
Water Bodies	Rivers, Lakes, Nalas etc.		6.69	0.95
All Total			705.00	100.00

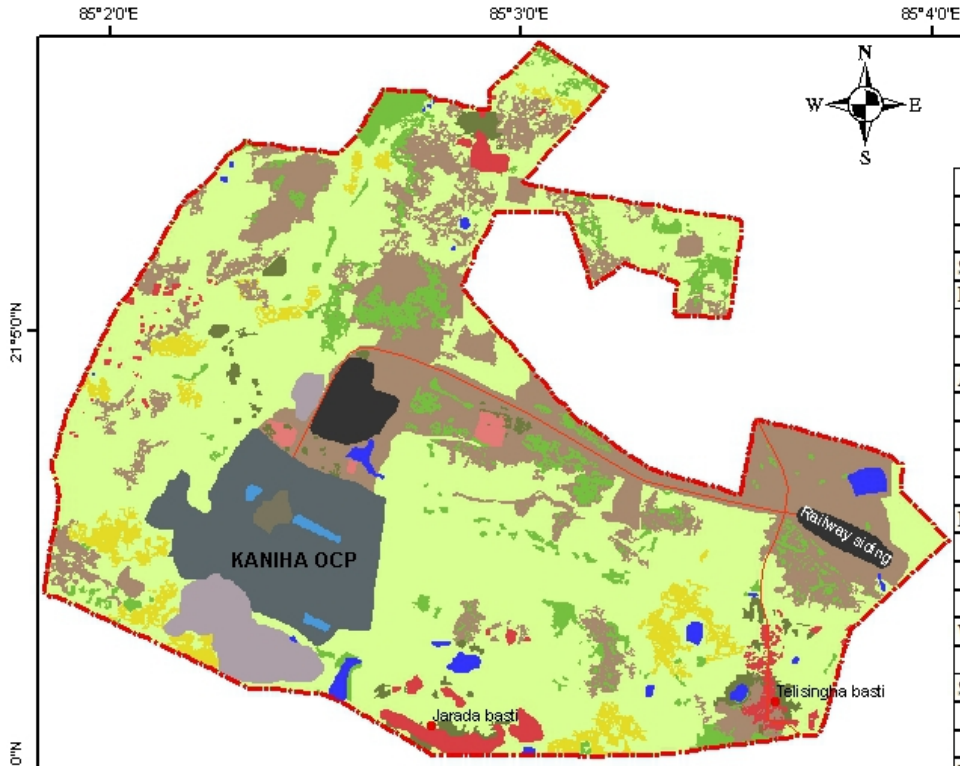
Customer	Mahanadi Coalfields Limited				
Title	Land Reclamation Monitoring of OC Projects				Job No. 561410027
Subject: Land Reclamation status of Basundhara OCP based on Satellite Data (IRS R2 LISS-IV) of the year 2015.	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Asst. Manager (Geology)		
	Checked	R. Kumar	CM(RSC)		
cmpdi A Mini Ratna Company	Approved	N. P. Singh	GM(Geomatics)		
	Scale 600 300 0 600 M				Sheet
	Drg No. HQ REM 4 A4 15 01				REV No.

Plate-2



Area Statistics Of Garjanbahal OCP(2015)

Class		Color	Area	
Level I	Level II		Ha.	%of Total
Forest	Dense Forest		60.31	9.22
	Open Forest		87.32	13.36
	Total Forest (A)		**147.63**	**22.58**
Scrubs	**Scrubs (B)**		**125.57**	**19.21**
Plantations	Social Forestry		1.95	0.30
	Total Plantation (C)		**1.95**	**0.30**
	Total Vegetation (A+B+C)		**275.15**	**42.08**
Agricultural Land	Crop Land		19.28	2.95
	Fallow Land		264.44	40.44
	Total Agricultural Land		**283.72**	43.39
	Coal Quarry		0.00	0.00
	Coal Dump		6.17	0.94
Mining Area	Barren OB Dump		18.19	2.78
	Barren Backfilled Area		0.00	0.00
	Water Filled Quarry		0.00	0.00
	Total Mining Area		**24.36**	**3.73**
Waste Lands	Waste Land		54.42	8.32
	Total Waste Land		**54.42**	**8.32**
	Urban		0.00	0.00
Settlement	Industrial		1.56	0.24
	Rural		6.18	0.95
	Total Settlements		**7.74**	**1.19**
Water Bodies	**Rivers, Lakes, Nalas etc.**		**8.44**	**1.29**
All Total			**653.83**	**100.00**



Area Statistics Of Kaniha OCP(2015)				
Class		Color	Area	
Level I	Level II		Ha.	% of Total
Scrubs	Scrubs (A)		39.67	5.86
Plantations	Social Forestry		10.53	1.56
	Total Plantation (B)		10.53	1.56
	Total Vegetation (A+B)		50.20	7.42
Agricultural Land	Fallow Land		348.61	51.49
	Crop Land		24.23	3.58
	Total Agricultural Land		372.84	55.07
	Coal Quarry		52.29	7.72
	Coal Dump		13.48	1.99
Mining Area	Barren OB Dump		18.23	2.69
	Barren Backfilled Area		1.90	0.28
	Water Filled Quarry		1.59	0.23
	Total Mining Area		87.49	12.91
Waste Lands	Waste Land		142.81	21.09
	Total Waste Land		142.81	21.09
Settlement	Industrial		2.59	0.38
	Rural		14.21	2.10
	Total Settlements		16.80	2.48
Water Bodies	Rivers, Lakes, Nalas etc.		6.86	1.01
All Total			677.00	100.00

Customer	Mahanadi Coalfields Limited				
Title	Land Reclamation Monitoring of OC Projects				Job No. 561410027
Subject	Activity	Name	Designation	Signature	Date
Land Reclamation Status of Kaniha OCP based on Satellite Data (IRS R2 L-IV) of the year 2015.	Prepared	A. Parida	Asst. Manager (Geology)		
	Checked	R. Kumar	CM(RSC)		
cmpdi A Mini Ratna Company	Approved	N.P.Singh	GM(Geomatics)		
	Scale 550 275 0 550 M				Sheet
	Drg No. HQ REM 4 A4 15 01				REV No.

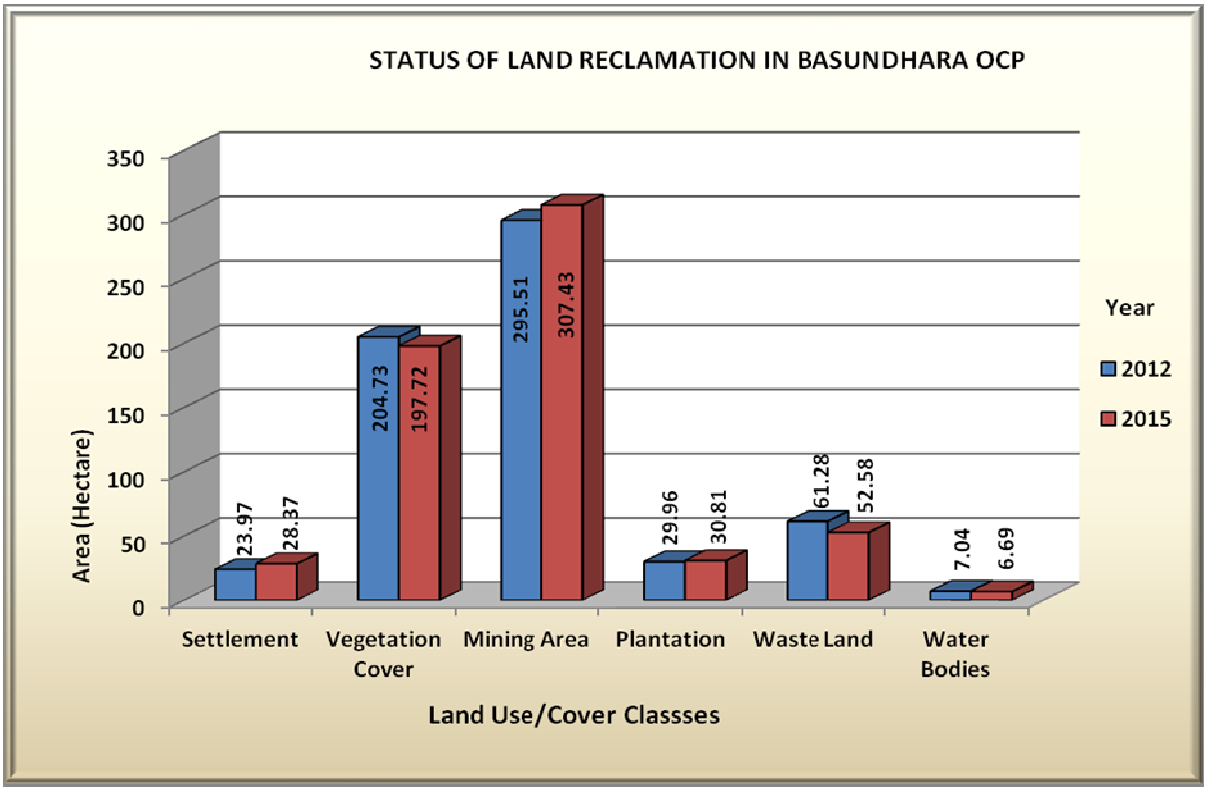


FIGURE - 3

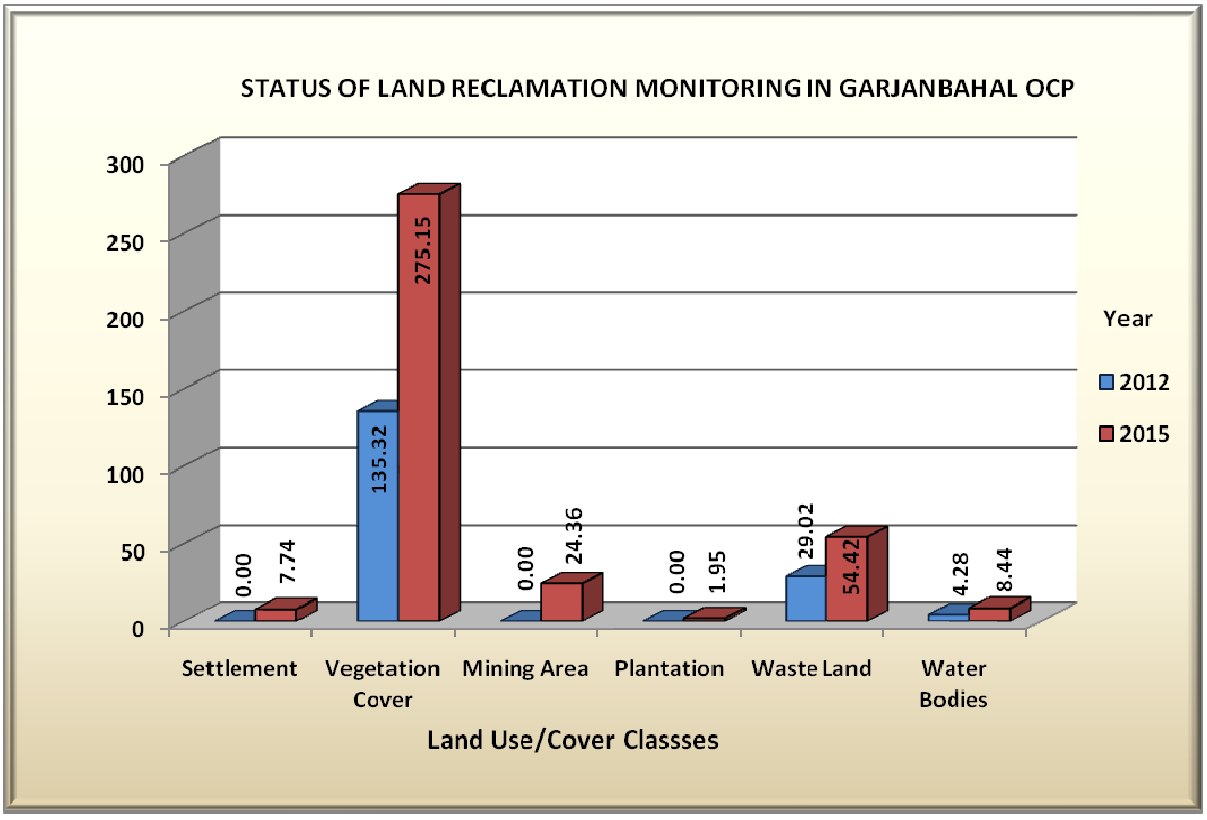


FIGURE - 4

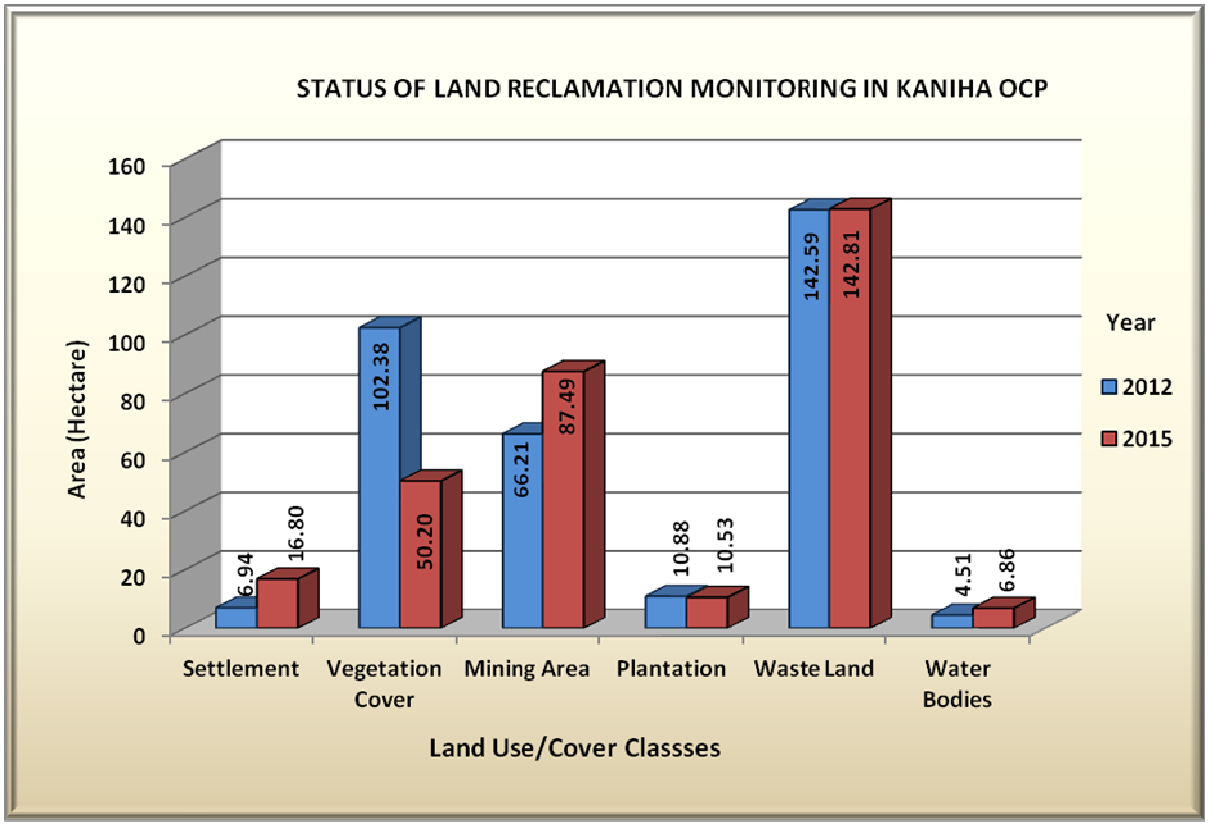

STATUS OF LAND RECLAMATION MONITORING IN KANIHA OCP
Area (Hectare)
160
140
120
100
80
60
40
20
0
6.94
16.80
102.38
50.20
66.21
87.49
10.88
10.53
142.59
142.81
4.51
6.86
Settlement
Vegetation Cover
Mining Area
Plantation
Waste Land
Water Bodies
Land Use/Cover Classses
Year
2012
2015

FIGURE – 5

Photo 1: Plantation on External OB Dump (Basundhara OCP)

Photo 2: Plantation on External OB Dump (Basundhara OCP)

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