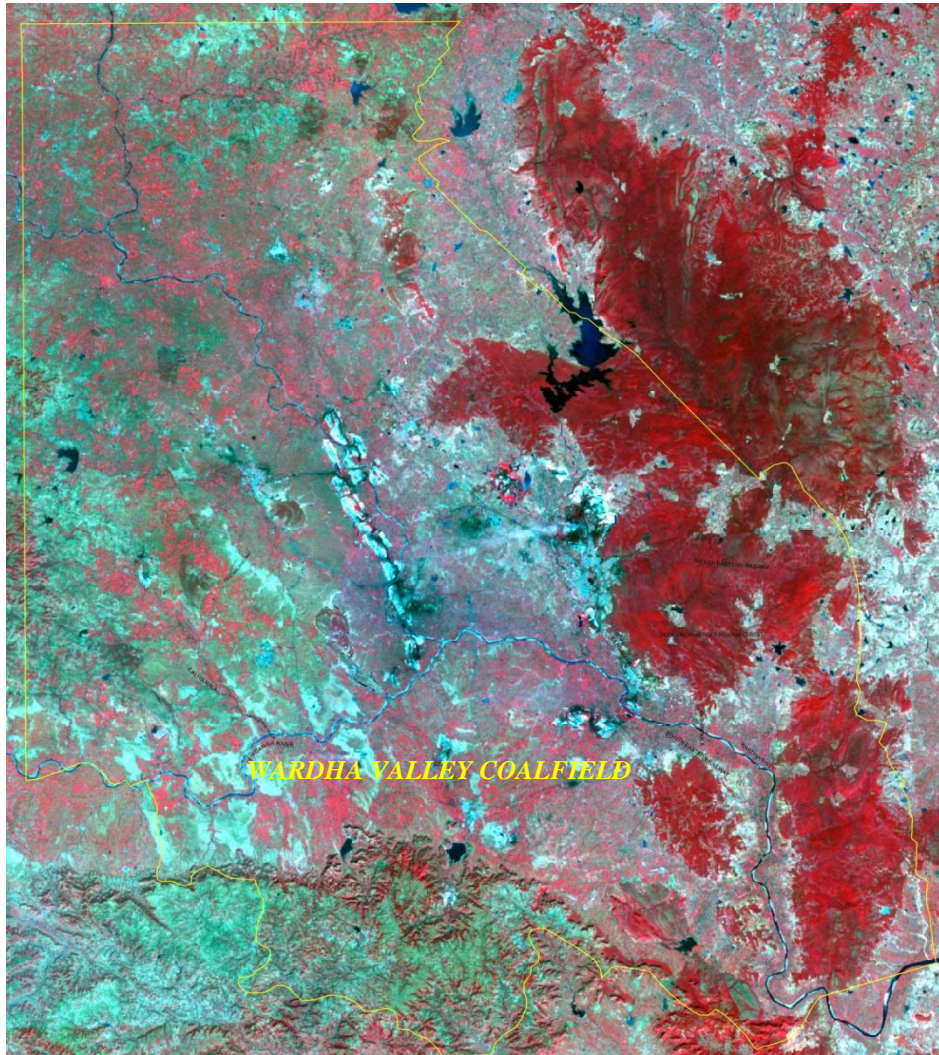


Vegetation cover mapping of Wardha Valley Coalfield based on satellite data for the year- 2013



Submitted to
Western Coalfield Limited



**Vegetation Cover Mapping of Wardha Valley Coalfield
based on Satellite Data for the Year- 2013**

December-2013



**Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi**

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2. Plate No. HQ/REM/ 001: IRS-P6/ LISS-III FCC of Wardha Valley Coalfield

Chapter 1

Introduction

1.1 Project Reference

To monitor the regional impact of coal mining on land use pattern and vegetation cover in the 28 major coalfields at regular interval of three years based on remote sensing satellite data, Coal India Ltd. issued a work order to CMPDI vide letter no.CIL/WBP/ENV/2011/4706 dated 12.10.12. Geo-environmental data base for Wardha Valley coalfield based on satellite data was prepared in the year 2010 under the above project. Impact of coal mining on land environment has to be assessed regularly at interval of three years with respect to the previous data. This report is based on satellite data of 2013 for monitoring the status of land use and vegetation cover in Wardha Coalfield

1.2 Objectives

The objective of the present study is to prepare a regional land use and vegetation cover map of Wardha Valley coalfield on 1:50,000 scale based on satellite data of the year 2013, using digital image processing technique for updation of geo-environmental database and to assess the impact of coal mining and other industrial activities on land use and vegetation cover in the coalfield area.

1.3 Location & Accessibility

Warda Valley Coalfield covering an area of about 7500 sq. Km. lies in the Yavatmal and Chandrapur district of Maharashtra. It is bounded by Latitude 20⁰ 29' 06" to 20⁰ 48' 22" and Longitudes 79⁰ 09' 15" to 79⁰ 26' 39" and located in the central part of India. The coalfield area is covered under Survey of India top-sheet no. 55L/15, 55L/16, 55P/3, 55P/4, 55P/8, 56I/13, 56M/5, 56M/, and 55p/7 on RF 1:50000.

This coalfields holds a premier position in India for having the considerable share of reserve of thermal grades non-coking coal for catering the demand of coal in the western part of country.

Wardha Valley coalfield is well connected by rail and road ways. Chandrapur is the central town in the coalfield which is connected with Nagpur (198 Km) in the north and Wardha (120Km) towards north-west and Kazipet (250) in the south. Chandrapur is connected also via rail with Nagpur in the north and Kazipet in the south, on the main line of South-Central Railways passing through the coalfield.

1.4 Topography & Drainage

The area has almost flat to gently undulating topography developed over Precambrians, Gondwanas and Trap rocks covered with black soil and alluvium. The general slope of the area is towards south. The area is drained mainly by the Wardha, the Penganga and the Erai rivers. The north-eastern Part of the area is drained by Erai river and its tributaries where as southern part of the area is drained by Penganga flowing along the south boundary of the coalfield

1.5 Reserved Forests

The reserved forests in the Wardha Valley coalfield are Tadoba, Balharsha and Bhandak in the western side, Rajura in the southern side, Satna, Raikot, Pardi and Borgaon in the eastern side

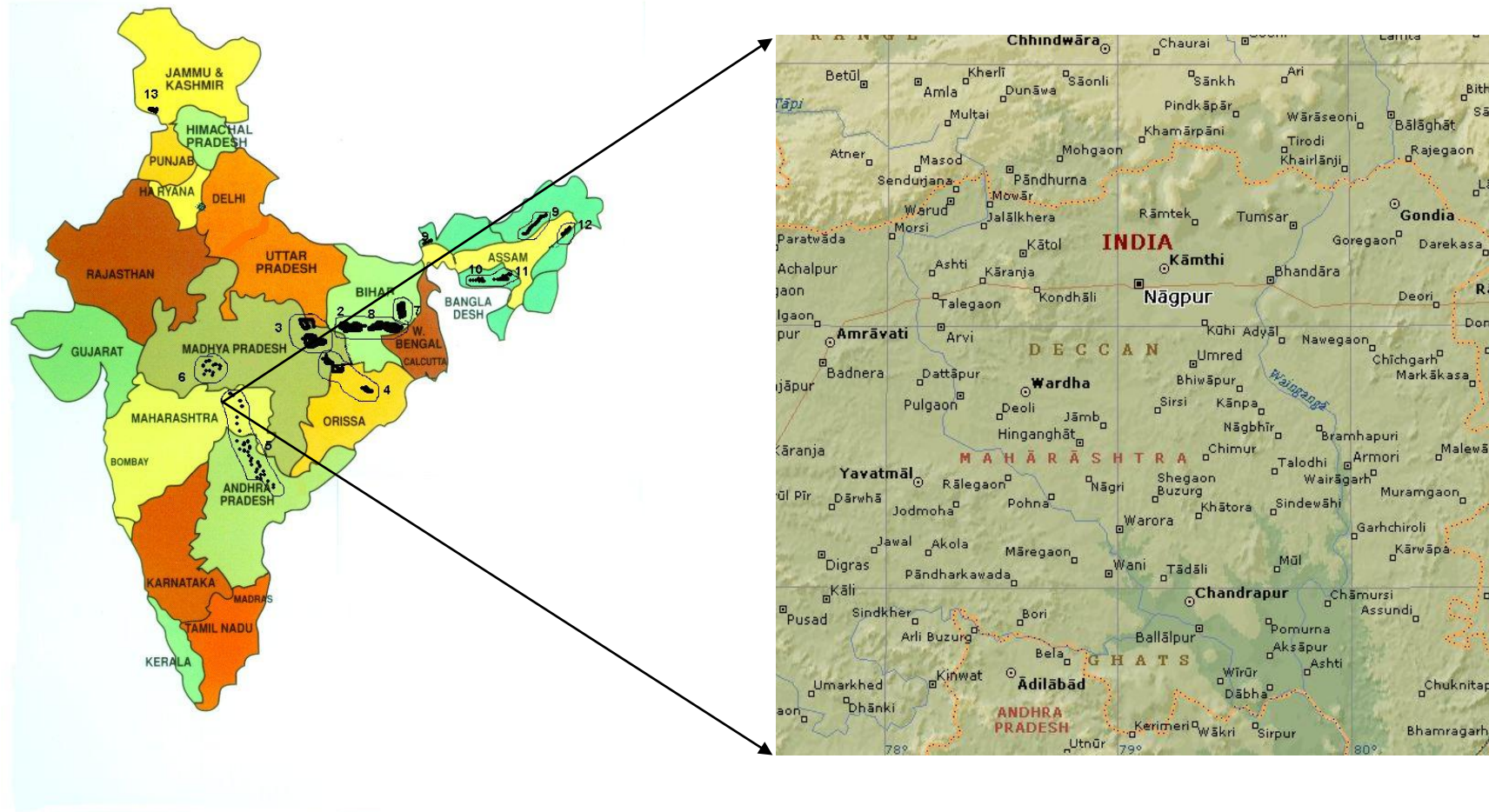


Fig. 1.1 : Location Map of Wardha Valley Coalfield

Chapter 2

Remote Sensing Concepts and Methodology

2.1 Remote Sensing

Remote sensing is the science and art of obtaining information about an object or area through the analysis of data acquired by a device that is not in physical contact with the object or area under investigation. The term *remote sensing* is commonly restricted to methods that employ electro-magnetic energy (such as light, heat and radio waves) as the means of detecting and measuring object characteristics.

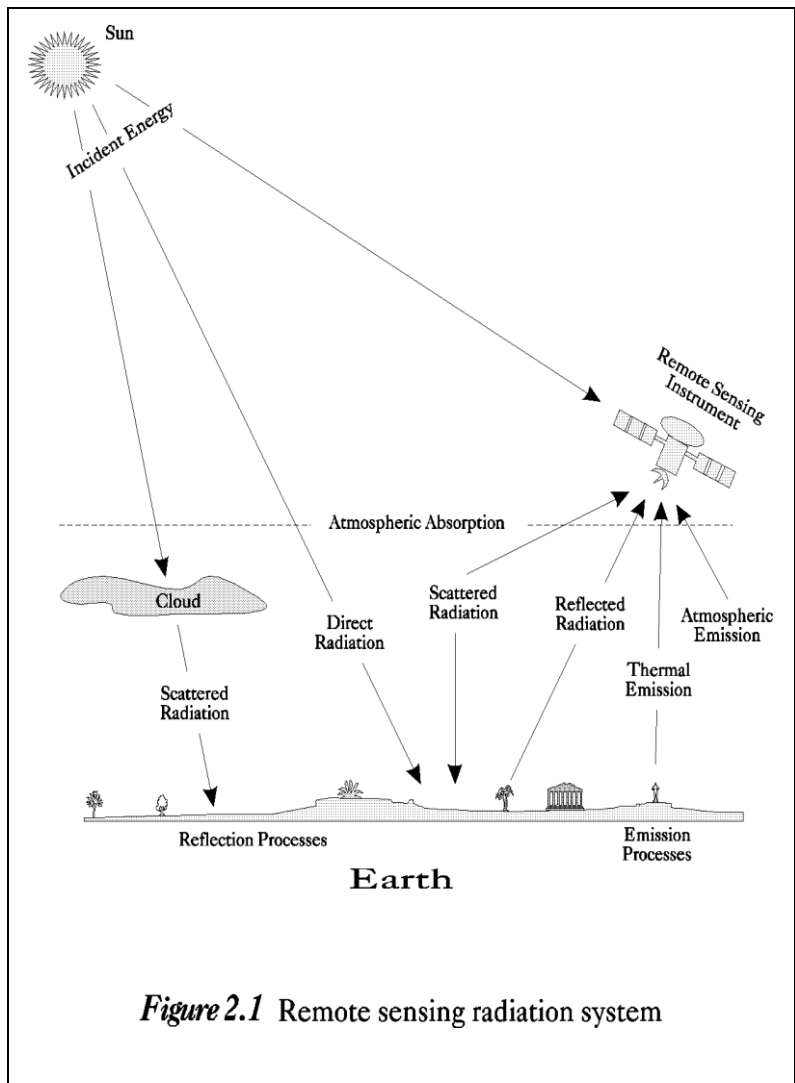


Figure 2.1 Remote sensing radiation system

All physical objects on the earth surface continuously emit electromagnetic radiation because of the oscillations of their atomic particles. Remote sensing is largely concerned with the measurement of electro-magnetic energy from the SUN, which is reflected, scattered or emitted by the objects on the surface of the

earth. Figure 2.1 schematically illustrate the generalised processes involved in electromagnetic remote sensing of the earth resources.

2.2 Electromagnetic Spectrum

The electromagnetic (EM) spectrum is the continuum of energy that ranges from meters to nanometres in wavelength and travels at the speed of light. Different objects on the earth surface reflect different amounts of energy in various wavelengths of the EM spectrum.

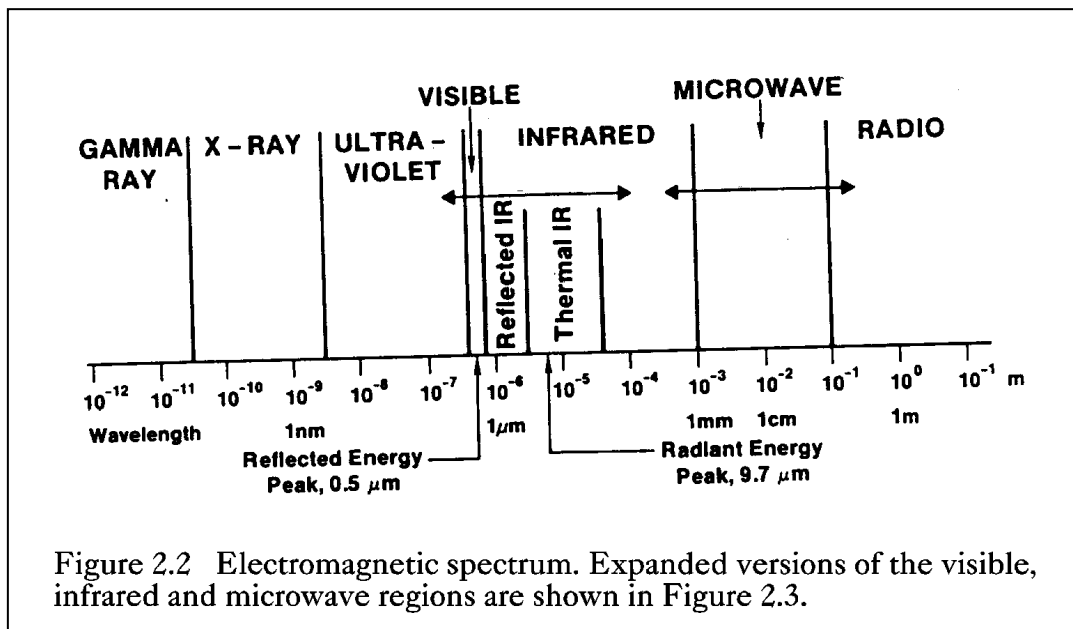


Figure 2.2 Electromagnetic spectrum. Expanded versions of the visible, infrared and microwave regions are shown in Figure 2.3.

Figure 2.2 shows the electromagnetic spectrum, which is divided on the basis of wavelength into different regions that are described in Table 2.1. The EM spectrum ranges from the very short wavelengths of the gamma-ray region to the long wavelengths of the radio region. The visible region (0.4-0.7 μm wavelengths) occupies only a small portion of the entire EM spectrum.

Energy reflected from the objects on the surface of the earth is recorded as a function of wavelength. During daytime, the maximum amount of energy is reflected at 0.5 μm wavelengths, which corresponds to the green band of the visible region, and is called the *reflected energy peak* (Figure 2.2). The earth also

radiates energy both day and night, with the maximum energy 9.7 μm wavelength. This *radiant energy peak* occurs in the thermal band of the IR region (Figure 2.2).

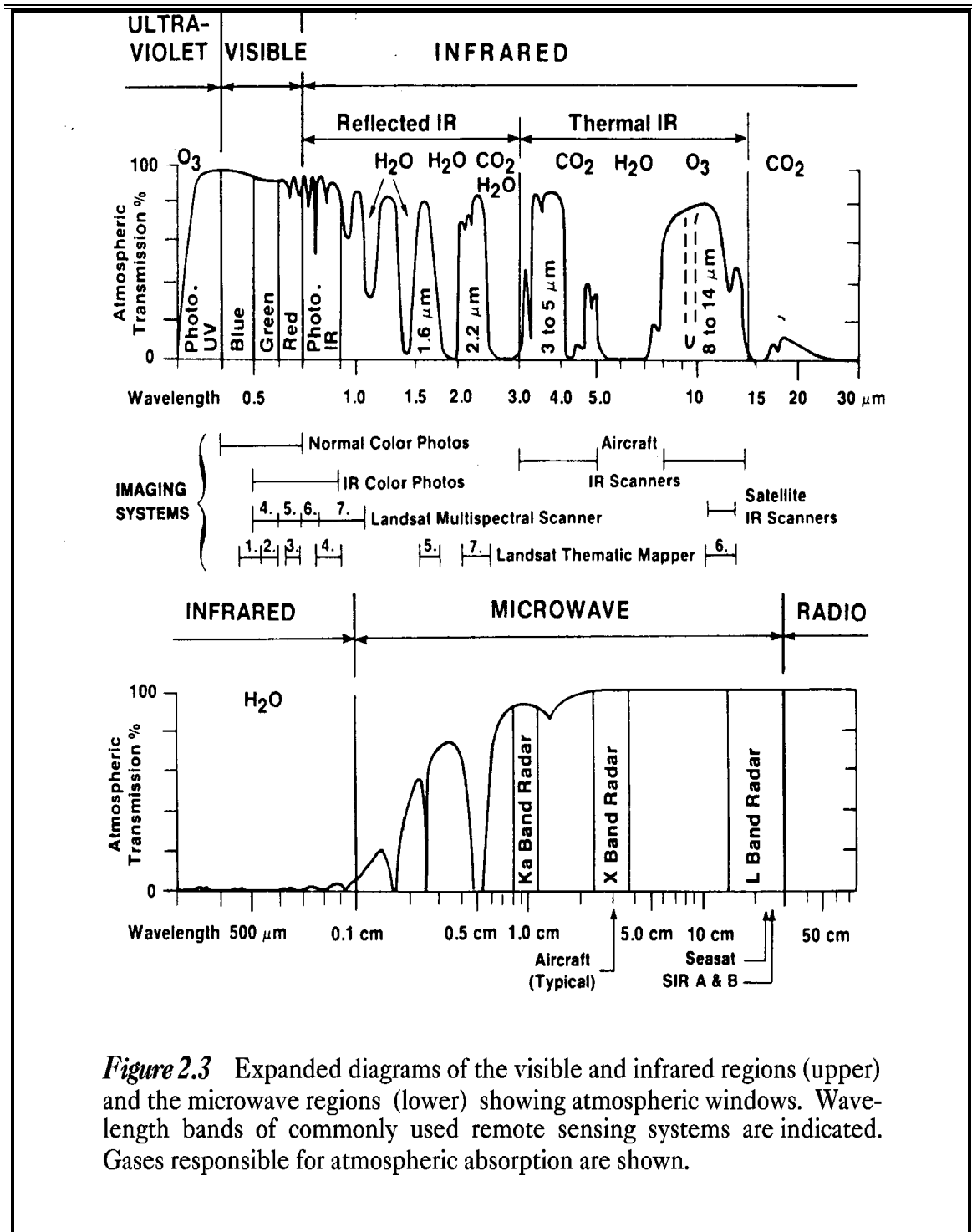


Figure 2.3 Expanded diagrams of the visible and infrared regions (upper) and the microwave regions (lower) showing atmospheric windows. Wavelength bands of commonly used remote sensing systems are indicated. Gases responsible for atmospheric absorption are shown.

Table 2.1 Electromagnetic spectral regions

Region	Wavelength		Remarks
<i>Gamma ray</i>	<	0.03 nm	Incoming radiation is completely absorbed by the upper atmosphere and is not available for remote sensing.
<i>X-ray</i>	0.03 to	3.00 nm	Completely absorbed by atmosphere. Not employed in remote sensing.
<i>Ultraviolet</i>	0.03 to	0.40 μm	Incoming wavelengths less than 0.3mm are completely absorbed by Ozone in the upper atmosphere.
<i>Photographic UV band</i>	0.30 to	0.40 μm	Transmitted through atmosphere. Detectable with film and photo detectors, but atmospheric scattering is severe.
<i>Visible</i>	0.40 to	0.70 μm	Imaged with film and photo detectors. Includes reflected energy peak of earth at 0.5mm.
<i>Infrared</i>	0.70 to	100.00 μm	Interaction with matter varies with wavelength. Absorption bands separate atmospheric transmission windows.
<i>Reflected IR band</i>	0.70 to	3.00 μm	Reflected solar radiation that contains no information about thermal properties of materials. The band from 0.7-0.9mm is detectable with film and is called the <i>photographic IR band</i> .
<i>Thermal IR band</i>	3.00 to 8.00 to	5.00 μm 14.00 μm	Principal atmospheric windows in the thermal region. Images at these wavelengths are acquired by optical-mechanical scanners and special videocon systems but not by film.
<i>Microwave</i>	0.10 to	30.00 cm	Longer wavelengths can penetrate clouds, fog and rain. Images may be acquired in the active or passive mode.
<i>Radar</i>	0.10 to	30.00 cm	Active form of microwave remote sensing. Radar images are acquired at various wavelength bands.
<i>Radio</i>	>	30.00 cm	Longest wavelength portion of electromagnetic spectrum. Some classified radars with very long wavelength operate in this region.

The earth's atmosphere absorbs energy in the gamma-ray, X-ray and most of the ultraviolet (UV) region; therefore, these regions are not used for remote sensing. Details of these regions are shown in Figure 2.3. The horizontal axes show wavelength on a logarithmic scale; the vertical axes show percent atmospheric transmission of EM energy. Wavelength regions with high transmission are called *atmospheric windows* and are used to acquire remote sensing data. Detection and measurement of the recorded energy enables identification of surface objects (by their characteristic wavelength patterns or spectral signatures), both from air-borne and space-borne platforms.

2.3 Scanning System

The sensing device in a remotely placed platform (aircraft/satellite) records EM radiation using a *scanning system*. In scanning system, a *sensor*, with a narrow field of view is employed; this sweeps across the terrain to produce an image. The sensor receives electromagnetic energy radiated or reflected from the terrain and converts them into signal that is recorded as numerical data. In a remote sensing satellite, multiple arrays of linear sensors are used, with each array recording simultaneously a separate band of EM energy. The array of sensors employs a spectrometer to disperse the incoming energy into a spectrum. Sensors (or *detectors*) are positioned to record specific wavelength bands of energy. The information received by the sensor is suitably manipulated and transported back to the ground receiving station. The data are reconstructed on ground into digital images. The digital image data on *magnetic/optical media* consist of picture elements arranged in regular rows and columns. The position of any picture element, *pixel*, is determined on a x-y co-ordinate system. Each pixel has a numeric value, called digital number (DN) that records the intensity of electromagnetic energy measured for the ground resolution cell represented by that pixel. The range of digital numbers in an image data is controlled by the radiometric resolution of the satellite's sensor system. The digital image data are further processed to produce master images of the study area. By analysing the digital data/imagery, digitally/visually, it is possible to detect, identify and classify various objects and phenomenon on the earth surface.

Remote sensing technique (airborne/satellite) in conjunction with traditional techniques harbours in an efficient, speedy and cost-effective method for natural resource management due to its inherited capabilities of being multispectral, repetitive and synoptic areal coverage. Generation of environmental 'Data Base' on land use, soil, forest, surface and subsurface water, topography and terrain characteristics, settlement and transport network, etc., and their monitoring in

near real - time is very useful for environmental management planning; this is possible only with remote sensing data.

2.4 Data Source

The following data are used in the present study:

- **Primary Data**

Remote Sensing Satellite data viz. Resourcesat-IRS-P6/LISS-III of January 2013 having 23.5 m. spatial resolution was used in the present study. The raw digital satellite data was obtained from NRSC, Hyderabad, on CD-ROM media.

- **Secondary Data**

Secondary (ancillary) and ground data constitute important baseline information in remote sensing, as they improve the interpretation accuracy and reliability of remotely sensed data by enabling verification of the interpreted details and by supplementing it with the information that cannot be obtained directly from the remotely sensed data. For **Wardha Valley Coalfield**, Survey of India toposheet no. 55L/15, 55L/16, 55P/3, 55P/4, 55P/8, 56I/13, 56M/5, 56M/, and 55p/7 as well as map showing details of location of area boundary, block boundary and road supplied by WCL were used in the study.

2.5 Characteristics of Satellite/Sensor

The basic properties of a satellite's sensor system can be summarised as:

(a) Spectral coverage/resolution, i.e., band locations/width; (b) spectral dimensionality: number of bands; (c) radiometric resolution: quantisation; (d) spatial resolution/instantaneous field of view or IFOV; and (e) temporal resolution. Table 2.2 illustrates the basic properties of Resourcesat satellite/sensor that was used in the present study.

Table 2.2 Characteristics of the satellite/sensor used in the present project work

Platform	Sensor	Spectral Bands in μm			Radiometric Resolution	Spatial Resolution	Temporal Resolution	Country
Rsource sat (P6)	LISS-III	B2	0.28 - 0.31	Green	7-bit (128-grey levels)	23.5 m	24 days	India
		B3	0.25 - 0.38	Red		23.5 m		
		B4	0.27 - 0.30	NIR		23.5 m		
		B5	6.90	MIR		70.5 m		

NIR: Near Infra-Red MIR: Middle Infra-Red

2.6 Data Processing

The details of data processing carried out in the present study are shown in Figure 2.4. The processing methodology involves the following major steps:

- (a) Geometric correction, rectification and geo-referencing;
- (b) Image enhancement;
- (c) Training set selection;
- (d) Signature generation and classification;
- (e) Creation/overlay of vector database;
- (f) Validation of classified image;
- (g) Final thematic map preparation.

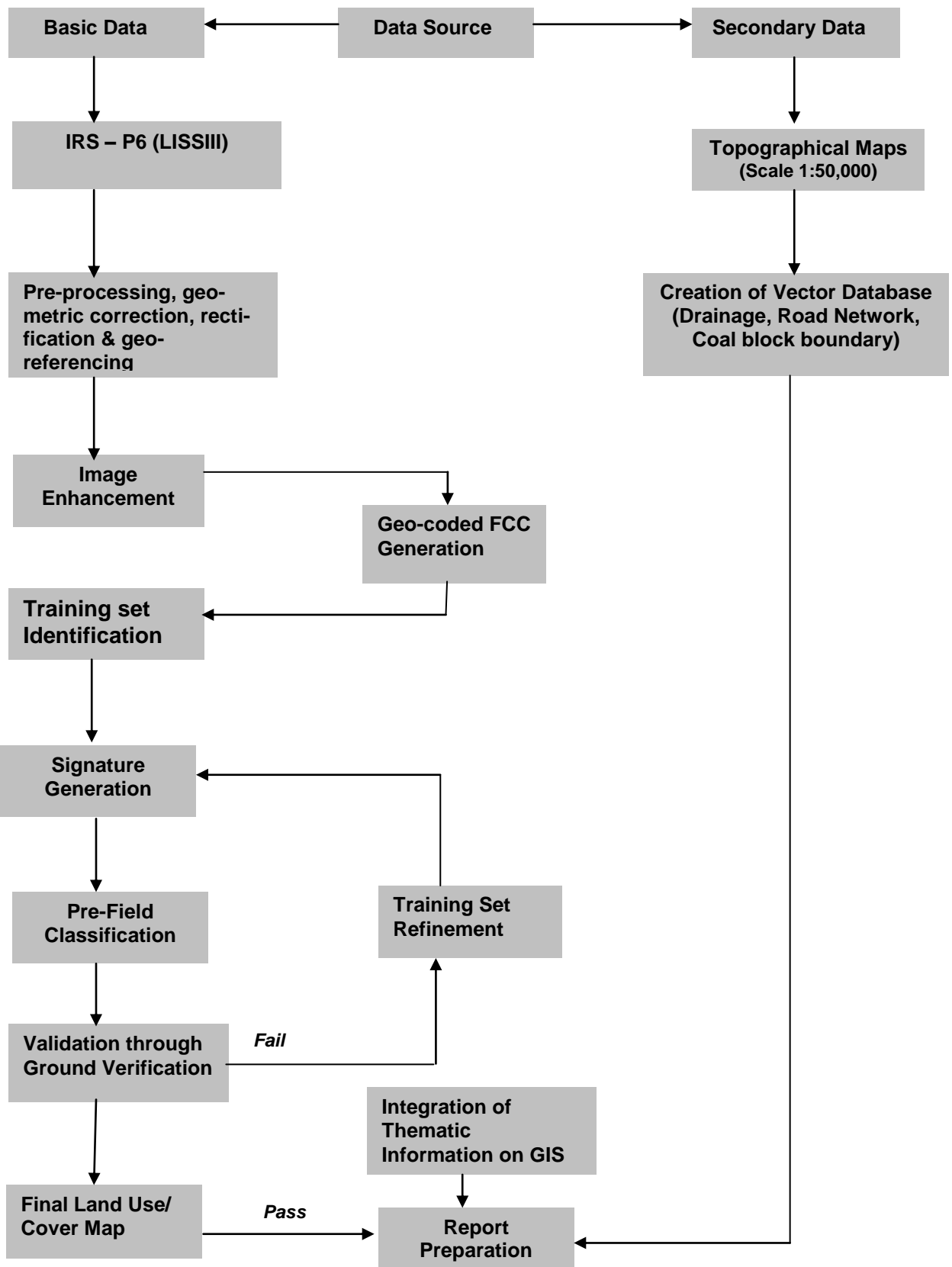


Fig-2.4 –Methodology of Land Use/Vegetation Cover Analysis

2.6.1 Geometric correction, rectification and geo-referencing

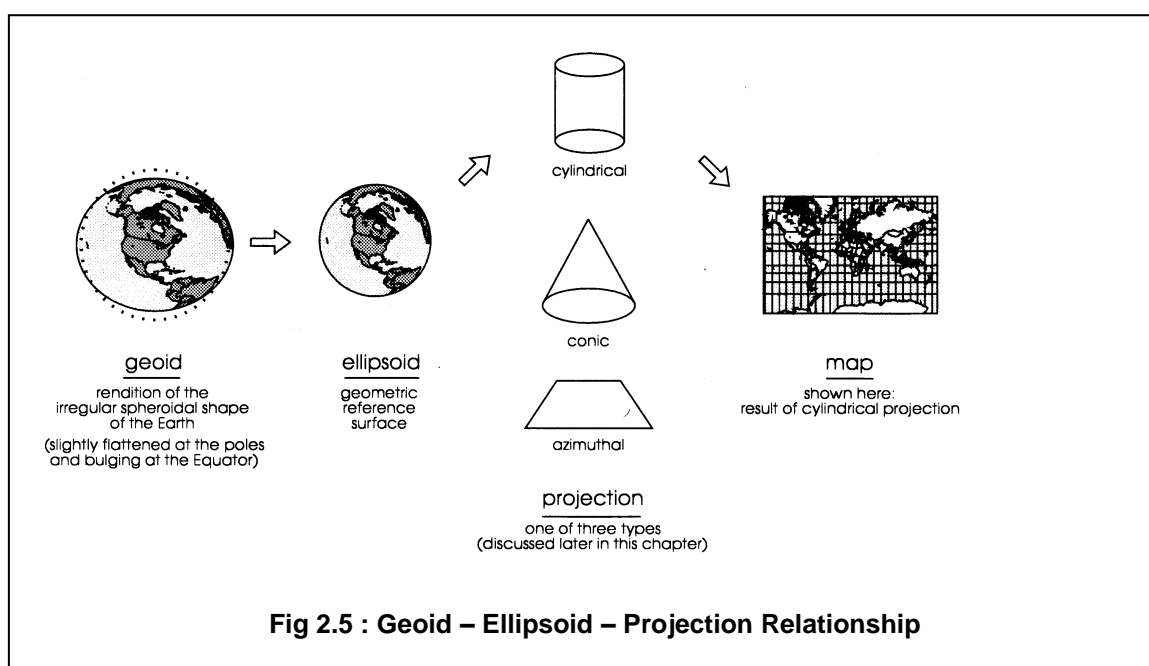
Inaccuracies in digital imagery may occur due to ‘systematic errors’ attributed to earth curvature and rotation as well as ‘non-systematic errors’ attributed to intermittent sensor malfunctions, etc. Systematic errors are corrected at the satellite receiving station itself while non-systematic errors/ random errors are corrected in pre-processing stage.

In spite of ‘System / Bulk correction’ carried out at supplier end; some residual errors in respect of attitude attributes still remains even after correction. Therefore, fine tuning is required for correcting the image geometrically using ground control points (GCP).

Raw digital images contain geometric distortions, which make them unusable as maps. A map is defined as a flat representation of part of the earth’s spheroidal surface that should conform to an internationally accepted type of cartographic projection, so that any measurements made on the map will be accurate with those made on the ground. Any map has two basic characteristics: (a) scale and (b) projection. While *scale* is the ratio between reduced depiction of geographical features on a map and the geographical features in the real world, *projection* is the method of transforming map information from a sphere (round Earth) to a flat (map) sheet. Therefore, it is essential to transform the digital image data from a generic co-ordinate system (i.e. from line and pixel co-ordinates) to a projected co-ordinate system. In the present study georeferencing was done with the help of Survey of India (Sol) topo-sheets so that information from various sources can be compared and integrated on a GIS platform, if required.

An understanding of the basics of projection system is required before selecting any transformation model. While maps are flat surfaces, Earth however is an irregular sphere, slightly flattened at the poles and bulging at the Equator. Map projections are systemic methods for “*flattening the orange peel*” in measurable

ways. When transferring the Earth and its irregularities onto the plane surface of a map, the following three factors are involved: (a) geoid (b) ellipsoid and (c) projection. Figure 2.5 illustrates the relationship between these three factors. The *geoid* is the rendition of the irregular spheroidal shape of the Earth; here the variations in gravity are taken into account. The observation made on the geoid is then transferred to a regular geometric reference surface, the *ellipsoid*. Finally, the geographical relationships of the ellipsoid (in 3-D form) are transformed into the 2-D plane of a map by a transformation process called map projection. As shown in Figure 2.5, the vast majority of projections are based upon *cones*, *cylinders* and *planes*.



In the present study, ***Polyconic projection*** along with ***Modified Everest Ellipsoidal model*** was used so as to prepare the map compatible with the Sol topo-sheets. Polyconic projection is used in Sol topo-sheets as it is best suited for small - scale mapping and larger area as well as for areas with North-South orientation (viz. India). Maps prepared using these projections are a compromise of many properties; it is neither conformal perspective nor equal area. Distances, areas and shapes are true only along central meridian. Distortion increases away

from central meridian. Image transformation from generic co-ordinate system to a projected co-ordinate system was carried out using IMAGINE v.9.3 digital image processing system.

2.6.2 Image enhancement

To improve the interpretability of the raw data, image enhancement is necessary. Most of the digital image enhancement techniques are categorised as either point or local operations. Point operations modify the value of each pixel in the image data independently. However, local operations modify the value of each pixel based on brightness value of neighbouring pixels. Contrast manipulations/stretching technique based on local operation was applied on the image data using IMAGINE s/w. The enhanced and geocoded FCC image of Wardha Valley Coalfield Coalfield is shown in Plate No. 1.

2.6.3 Training set selection

The image data were 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. Based on the variability of land use/cover condition and terrain characteristics and accessibility, 250 points were selected to generate the training sets.

2.6.4 Signature generation and classification

Image classification was 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 was 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. The aerial extent of each land use class in the coalfield was determined using ERDAS IMAGINE s/w. The classified image for the year 2013 for Wardha Valley Coalfield is shown in Plate No. 2.

2.6.5 Creation/overlay of vector database

Plan showing coal block boundary are superimposed on the image as vector layer in the Arc GIS database. Road network, rail network and drainage network are also digitised on Arc GIS database and superimposed on the classified image.

2.6.6 Validation of classified image

Ground truth survey was carried out for validation of the interpreted results from the study area. Based on the validation, classification accuracy matrix was prepared. The classification accuracy matrix is shown in Table 2.3.

Classification accuracy in case of Plantation on OB Dump, Sand Body and Barren OB Dump was 100%. Classification accuracy in case of Dense Forest and Water Bodies lie between 90% to 100%. In case of open forest, built-up land, the classification accuracy varies from 80.0% to 90.0%. Classification accuracy for scrubs was 73.3% due to poor *signature separability index*. The overall classification accuracy is 90%.

2.6.7 Final land use/vegetation cover map preparation

Final land use/vegetation cover map (Plate - 2) was printed using HP Design jet 4500 Colour Plotter. The maps are prepared on 1:50,000 scale and enclosed as drawing No. 2 along with the report. A soft copy in pdf format is also enclosed .

Table 2.3 : Classification Accuracy Matrix for Wardha Valley Coalfield

Sl. No.	Classes in the Satellite Data	Class	Total Obsrv. Points	Land use classes as observed in the field										
				C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	
1	Urban Settlement	C1	05	5										
2	Dense Forest	C2	10		8	1	1							
3	Open Forest	C3	10		1	8	1							
4	Scrubs	C4	10		1	1	7	1						
5	Social Forestry	C5	10				1	8	1					
6	Agriculture Land	C6	10					1	9					
7	Waste Upland	C7	10							10				
8	Sand Body	C8	10								10			
9	Coal Quarry	C9	10									10		
10	Water Bodies	C10	10										10	
Total no. of observation points			110	05	10	10	10	10	10	10	10	10	10	10
% of commission				00.0	20.0	20.0	30.0	20.0	10.0	0.0	0.0	0.0	0.0	0.0
% of omission				00.0	20.0	20.0	30.0	20.0	10.0	0.0	0.0	0.0	0.0	0.0
% of Classification Accuracy				100.0	80.0	80.0	70.0	80.0	90.0	100.0	100.0	100.0	100.0	100.0
Overall Accuracy (%)			90.000											

Chapter 3

Land Use/ Vegetation Cover Mapping

3.1 Introduction

Land is one of the most important natural resource on which all human activities are based. Therefore, knowledge on different type of lands as well as its spatial distribution in the form of map and statistical data is vital for its geospatial planning and management for optimal use of the land resources. In mining industry, the need for information on land use/ vegetation cover pattern has gained importance due to the all-round concern on environmental impact of mining. The information on land use/ cover inventory that includes type, spatial distribution, aerial extent, location, rate and pattern of change of each category is of paramount importance for assessing the impact of coal mining on land use/ cover.

Remote sensing data with its various spectral and spatial resolution offers comprehensive and accurate information for mapping and monitoring of land use/cover pattern, dynamics of changing pattern and trends over a period of time.. By analysing the data of different cut-off dates, impact of coal mining on land use and vegetation cover can be determined.

3.2 Land Use/Vegtation Cover Classification

The array of information available on land use/cover requires to be arranged or grouped under a suitable framework in order to facilitate the creation of a land use/cover database. Further, to accommodate the changing land use/cover pattern, it becomes essential to develop a standardised classification system that is not only

flexible in nomenclature and definition, but also capable of incorporating information obtained from the satellite data and other different sources.

The present framework of land use/cover classification has been primarily based on the '*Manual of Nationwide Land Use/ Land Cover Mapping Using Satellite Imagery*' developed by National Remote Sensing Centre, Hyderabad. Land use map was prepared on the basis of image interpretation carried out based on the satellite data for the year 2013 for Wardha Valley coalfield and following land use/cover classes are identified (Table 3.1).

Table 3.1: <i>Land use/cover classes identified in Wardha Valley Coalfield</i>	
<i>Level -I</i>	<i>Level -II</i>
1	Built-Up Land
	1.1 Urban 1.2 Rural 1.3 Industrial
2	Agricultural Land
	2.1 Crop Land 2.2 Fallow Land
3	Forest/Vegetation Cover
	3.1 Dense Forest 3.2 Open Forest 3.3 Scrub 3.4 Plantation under Social Forestry 3.5 Plantation on OB Dumps
4	Wasteland
	4.1 Waste upland with/without scrubs 4.2 Sand body
5	Mining
	5.1 Coal Quarry 5.2 Barren OB Dump 5.3 Back Filled
6	Water bodies
	6.1 River/Streams /Reservoir

Following maps are prepared on 1:50,000 scale :

3. Plate No. 1 : Drawing No. HQ/REM/ 02: FCC (IRS – P6 LISS-III data of Wardha Valley coalfield of the year 2013) with Coalfield boundary and other infrastructural details.
4. Plate No. 2 : Drawing No. HQ/REM/ 01 - Land use/Cover Map of Wardha Valley Coalfield based on IRS-P6 LISS-III data..

3.3 Data Analysis & Change Detection

Satellite data of the year 2013 were processed using ERDAS IMAGINE 9.3 image processing s/w in order to interpret the various land use/cover classes present in the study area of Wardha Valley Coalfield covering 7560.66 sq.kms. The area of each land use/cover class for Wardha Valley coalfield were calculated using ERDAS IMAGINE s/w and tabulated in Table 3.2. Comparison of various land use classes between years 2010 & 2013 are shown in the Bar Chart (Fig. 2.6). Wardha valley coalfield contains 113 coal block whose land use/cover classes are tabulated in Table 3.8.



Plate 1 : FCC (Band 3, 2, 1) of Wardha Valley CF based on IRS-P6 (LISS – III) Data of Year – 2013

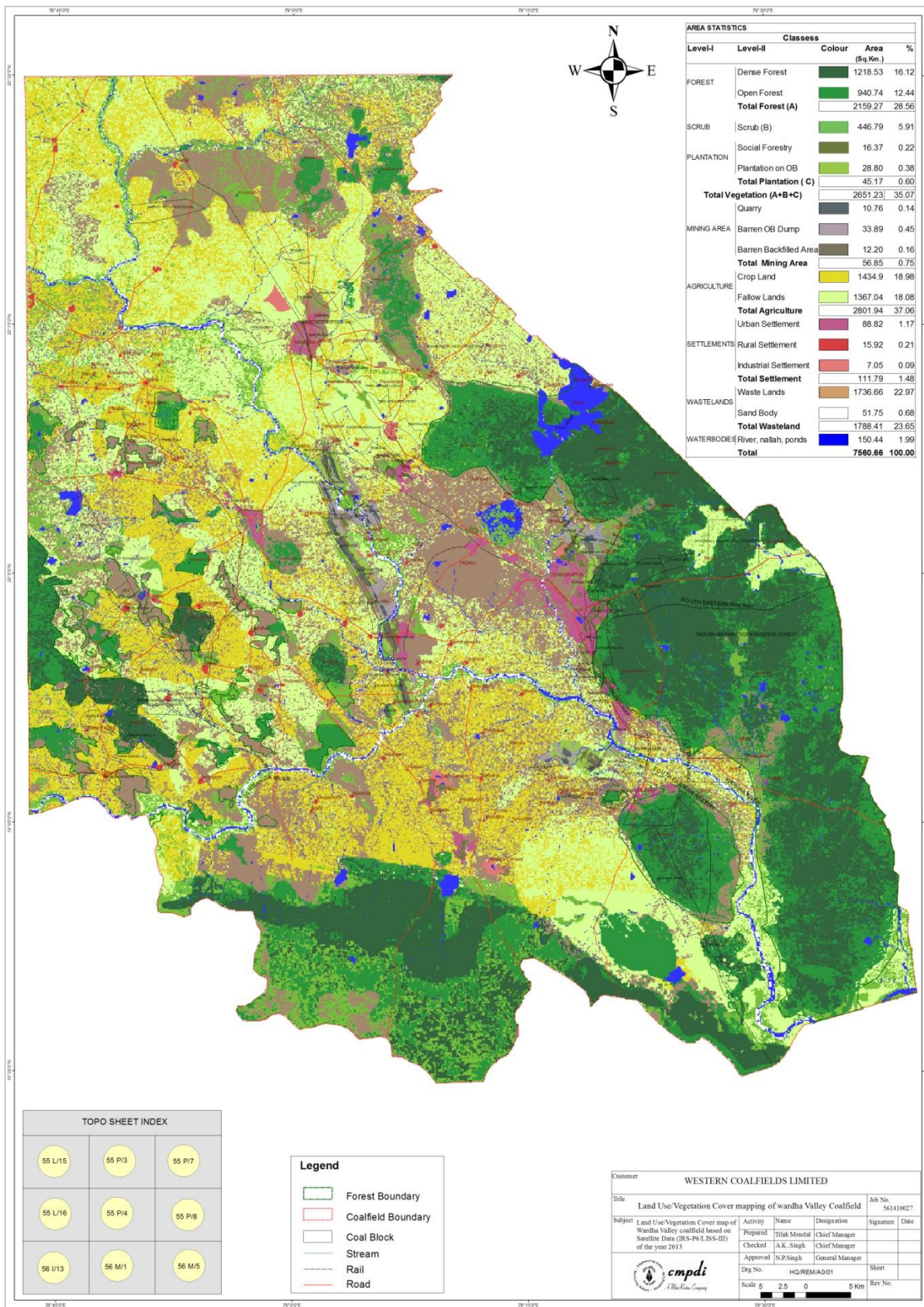


Plate 2 : LU / LC Map of Wardha Valley CF based on IRS-1D (LISS-III) Data of Year 2013

TABLE – 3.2: STATUS OF LAND USE/COVER PATTERN IN WARDHA VALLEY COALFIELD DURING YEAR 2010 & 2013

LAND USE CLASSES	Year-2010		Year-2013		Change w.r.t. Yr 2010		Remarks
	Area (Km ²)	%	Area (Km ²)	%	Area (Km ²)	%	
SETTLEMENTS							
Rural Settlements	15.92	0.21	15.92	0.21	0.00	0.00	More urbanisation in mining area and around small town.
Urban Settlements	76.97	1.02	88.82	1.17	11.85	0.16	
Industrial Settlements	7.05	0.09	7.05	0.09	0.00	0.00	
Total Settlements	99.94	1.32	111.79	1.48	11.85	0.16	
VEGETATION COVER							
FOREST							
<i>Dense Forest</i>	1227.57	16.24	1218.53	16.12	-9.04	-0.12	Converted to open forest due to deforestation
<i>Open Forest</i>	1051.39	13.91	940.74	12.44	-110.65	-1.46	
Total Forest (A)	2278.96	30.14	2159.27	28.56	-119.69	-1.58	
SCRUBS							
<i>Scrubs (B)</i>	347.75	4.60	446.79	5.91	99.04	1.31	On account of good monsoon scrub has been increased
PLANTATION							
<i>Social forestry</i>	15.99	0.21	16.37	0.22	0.38	0.01	Increase in plantation around settlements
<i>Plantation on OB</i>	25.76	0.34	28.80	0.38	3.04	0.04	Increase in plantation over OB dump.
Total Plantation (C)	41.75	0.55	45.17	0.60	3.42	0.05	
Total Vegetation (A+B+C)	2668.46	35.29	2651.23	35.07	-17.23	-0.23	
MINING AREA							
Coal Quarry	10.57	0.14	10.76	0.14	0.19	0.00	Minor change due to mining
Barren OB Dump	35.92	0.48	33.89	0.45	-2.03	-0.03	Barren OB dumps are planted.
Barren Backfilled	11.25	0.15	12.20	0.16	0.95	0.01	Quarry have been backfilled for restoration
Total Mining Area	57.74	0.76	56.85	0.75	-0.89	-0.01	
AGRICULTURE							
Crop Land	1913.25	25.31	1434.90	18.98	-478.35	-6.33	Due to poor signature separability fallow land misclassified in crop land
Fallow Land	717.91	9.50	1367.04	18.08	649.13	8.59	
Total Agriculture	2631.16	34.80	2801.94	37.06	170.78	2.26	
WASTELANDS							
Waste land	1942.47	25.69	1736.66	22.97	-205.81	-2.72	Due to conversion of wasteland in agriculture.
Sand Body	52.04	0.69	51.75	0.68	-0.29	0.00	
Total Wasteland	1994.51	26.38	1788.41	23.65	-206.10	-2.73	
WATERBODIES							
River, nallah, pond etc.	108.85	1.44	150.44	1.99	41.59	0.55	
TOTAL	7560.66	100.00	7560.66	100.00	0.00	0.00	

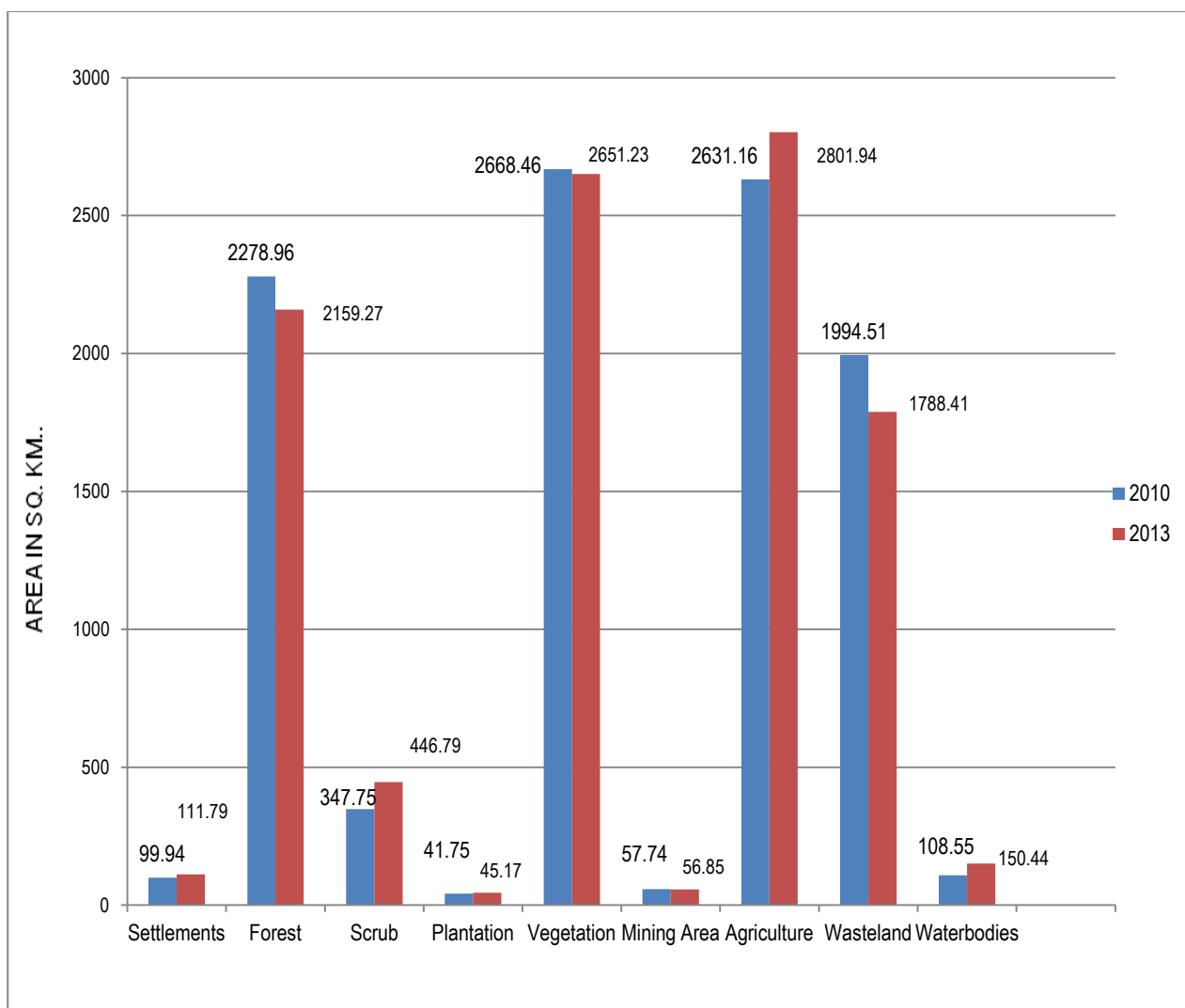


Fig. 2.6 : Yearwise Comparison of Land use / Vegetation Cover in Wardha Valley Coalfield

3.3.1 Settlements

All the man-made constructions covering the land surface are included under this category. Built-up land has been further divided into rural, urban and industrial classes. In the present study, industrial settlement indicates only industrial complexes excluding residential facilities. In the year 2010 the total area covered by settlements were estimated to be 99.94 sq km (1.32%). In year 2013 the estimated area under settlements has grown to 111.79 sq km (1.48%). There is an increase in Settlements by 11.85 sq km which is about 0.16% of the total area. This increase is due to more urbanisation in mining and around small town..

The details of the land use under this category are shown in Table 3.3 as follows:

TABLE – 3.3

STATUS OF CHANGE IN SETTLEMENTS IN WARDHA VALLEY COALFIELD DURING YEAR 2010 & 2013

LAND USE CLASSES	Year-2010		Year-2013		Change w.r.t. Yr 2010		Remarks
	Area (Km ²)	%	Area (Km ²)	%	Area (Km ²)	%	
SETTLEMENTS							
Rural Settlements	15.92	0.21	15.92	0.21	0.00	0.00	More urbanisation in mining area and around small town.
Urban Settlements	76.97	1.02	88.82	1.17	11.85	0.16	
Industrial Settlements	7.05	0.09	7.05	0.09	0.00	0.00	
Total Settlements	99.94	1.32	111.79	1.48	11.85	0.16	

3.3.2 Vegetation cover Analysis

Vegetation cover in the coalfield area comprises following five classes:

- Dense Forest
- Open Forest
- Scrubs
- Plantation on Over Burden(OB) Dumps / Backfilled area, and
- Social Forestry

There has been significant variation in the land use under the vegetation classes within the area as shown below in Table 3.4.

TABLE – 3.4

STATUS OF CHANGE IN VEGETATION IN WARDHA VALLEY COALFIELD DURING YEAR 2010 & 2013

LAND USE CLASSES	Year-2010		Year-2013		Change w.r.t. Yr 2010		Remarks
	Area (Km ²)	%	Area (Km ²)	%	Area (Km ²)	%	
VEGETATION COVER							
FOREST							
<i>Dense Forest</i>	1227.57	16.24	1218.53	16.12	-9.04	-0.12	Converted to open forest due to deforestation
<i>Open Forest</i>	1051.39	13.91	940.74	12.44	-110.65	-1.46	
<i>Total Forest (A)</i>	2278.96	30.14	2159.27	28.56	-119.69	-1.58	
SCRUBS							
<i>Scrubs (B)</i>	347.75	4.60	446.79	5.91	99.04	1.31	On account of good monsoon scrub has been increased
PLANTATION							
<i>Social forestry</i>	15.99	0.21	16.37	0.22	0.38	0.01	Increase in plantation around settlements
<i>Plantation on OB</i>	25.76	0.34	28.80	0.38	3.04	0.04	Increase in plantation over OB dump.
Total Plantation (C)	41.75	0.55	45.17	0.60	3.42	0.05	
Total Vegetation (A+B+C)	2668.46	35.29	2651.23	35.07	-17.23	-0.23	

Dense forest – Forest having crown density of above 40% comes in this class. In the year 2010 the total area covered by dense forest were estimated to be 1227.57 sq km(16.24%). In year 2013 the estimated area under dense forest has reduced to 1218.53 sq km (16.12%). There is a decrease in dense forest by 9.04 sq km which is about 0.12% of the total area on account of conversion to open forest due to deforestation.

Open Forest – Forest having crown density between 10% to 40% comes under this class. Open forest cover over Wardha Valley coalfield which was estimated to be 1051.39 sq km (13.91%) in 2010 has been decreased to 940.74 sq km, i.e.12.44 % of the coalfield area in 2013. Thus the decrease in open forest is 110.65 sq km which is 1.46 % of the total coalfield area. This reduction is due to deforestation by local inhabitants.

Scrubs – Scrubs are vegetation with crown density less than 10%. Scrubs in the coalfield are seen to be scattered signature al over the area mixed with wastelands. There is 446.79 sq km. of scrubs, i.e. 5.91% of the coalfield area in 2013. In year

2010 the scrubs covered 347.75 sq km which were 4.60% of the coalfield area. There is a increase of 99.04 sq km which is 1.31% of the coalfield area .The increase is on account of good monsoon.

Social Forestry – Plantation which has been carried out on wastelands, along the roadsides and colonies on green belt come under this category. Analysis of data reveals Social Forestry covers 16.37 sq km, which is 0.22% of the coalfield area in 2013. In 2010 the area covered under social forestry was 15.99 sq km (0.21%) . there is an increase of 0.38 sq km (0.01%). This increase is due to plantation around settlements.

Plantation over OB Dump and backfilled area – Analysis of the data reveals that WCL has carried out significant plantation on OB dumps as well as backfilled areas during the period for maintaining the ecological balance of the area. The plantation on the OB dumps and backfilled areas are estimated to be 28.80 sq km, i.e. 0.38% of the coalfield area in 2013. In year 2010 the plantation on OB Dumps were estimated to cover an area of 25.76 sq km which was 0.34% of the coalfield area. There is an increase of 3.04 sq km (0.04%) in plantation over OB dumps. This is due to plantation done on OB dumps.

3.3.3 Mining Area

The mining area was primarily been categorized as.

- Coal Quarry
- Barren OB Dump

To make the study more relevant and to give thrust on land reclamation, in the current study some more classes have been added as follows:

- Barren Backfilled Area
- Coal Dumps
- Water filled Quarry

In the year 2010 the coal quarry was estimated to be 10.57 sq km (0.14%) which has increased to 10.76 sq km (0.14%) in the year 2013. This minor increase is due to increase in production of coal from Open cast areas. In the year 2010 the barren

OB dump was estimated to be 35.92 sq km (0.48%) which has been decreased to 33.89 sq km (0.45%) in the year 2013. This decrease is due to increase in plantation on OB dump. In the year 2010 the barren backfilled area was estimated to be 11.25 sq km (0.15%) which has been increased to 12.20 sq km (0.16%) in the year 2013. The status of land Use in the mining area over the Wardha Valley Coalfield is shown in the table 3.5 below.

TABLE – 3.5

Status of change in Mining Area in Wardha Valley Coalfield during the year 2010 & 2013

LAND USE CLASSES	Year-2010		Year-2013		Change w.r.t. Yr 2010		Remarks
	Area (Km ²)	%	Area (Km ²)	%	Area (Km ²)	%	
MINING AREA							
Coal Quarry	10.57	0.14	10.76	0.14	0.19	0.00	Minor change due to mining
Barren OB Dump	35.92	0.48	33.89	0.45	-2.03	-0.03	Barren OB dumps are planted.
Barren Backfilled	11.25	0.15	12.20	0.16	0.95	0.01	Quarry have been backfilled for restoration
Total Mining Area	57.74	0.76	56.85	0.75	-0.89	-0.01	

3.3.4 Agricultural Land

Land primarily used for farming and production of food, fibre and other commercial and horticultural crops falls under this category. It includes crop land (irrigated and unirrigated) and fallow land (land used for cultivation, but temporarily allowed to rest)

Total agricultural land is 2801.94 sq km in year 2013, which is 37.06 % of the coalfield area. In year 2010 the total agricultural area was estimated to be 2631.16 sq km which was 34.80% of the coalfield area. There is an increase of 170.78 sq km which is 2.26% of the coalfield due to conversion of waste land in agricultural land. The details are shown below in Table 3.6.

TABLE – 3.6

Status of change in Agricultural land in Wardha Valley Coalfield during the year 2010 & 2013

LAND USE CLASSES	Year-2010		Year-2013		Change w.r.t. Yr 2010		Remarks
	Area (Km ²)	%	Area (Km ²)	%	Area (Km ²)	%	
AGRICULTURE							
Crop Land	1913.25	25.31	1434.90	18.98	-478.35	-6.33	Due to poor signature separability fallow land misclassified in crop land
Fallow Land	717.91	9.50	1367.04	18.08	649.13	8.59	
Total Agriculture	2631.16	34.80	2801.94	37.06	170.78	2.26	

3.3.5 Wasteland

Wasteland is degraded and unutilised class of land which is deteriorating on account of natural causes or due to lack of appropriate water and soil management. Wasteland can result from inherent/imposed constraints such as location, environment, chemical and physical properties of the soil or financial or management constraints.

The land use pattern within the area for waste lands is shown below in Table – 3.7. the waste land was estimated to be 1994.51 sq km (26.38%) in the year 2010. In the year of 2013, waste land is estimated to be 1788.41 sq km (23.65%). So there is a decrease of 206.10 sq km i.e. (2.73%) of the total coalfield area due to conversion of waste land into agricultural land on account of good monsoon over the last few years. The details are shown below in Table 3.7.

TABLE – 3.7

Status of Change in Wastelands in Wardha Valley Coalfield during the year 2010 & 2013

LAND USE CLASSES	Year-2010		Year-2013		Change w.r.t. Yr 2010		Remarks
	Area (Km ²)	%	Area (Km ²)	%	Area (Km ²)	%	
WASTELANDS							
Waste land	1942.47	25.69	1736.66	22.97	-205.81	-2.72	Due to conversion of wasteland in agriculture.
Sand Body	52.04	0.69	51.75	0.68	-0.29	0.00	
Total Wasteland	1994.51	26.38	1788.41	23.65	-206.10	-2.73	

3.3.6 Water bodies

It is the area of impounded water includes natural lakes, rivers/streams and man made canal, reservoirs, tanks etc. The water bodies in the study area had been estimated to be 108.85 sq km in year 2010, which is 1.44% of the coalfield area. In 2013 it have been estimated to be 150.44 sq km which is 1.99% of the total area. So there is an increase of 41.59 sq. km. in water bodies which is 0.55% of the total coalfield area.

TABLE – 3.8 : BLOCKWISE LAND USE/ VEGETATION COVER STATUS IN WARDHA VALLEY COALFIELD

Sl. No.	Name of Block	Area in Sq. Km.																					
		Vegetation					Agriculture			Settlement			Waste Land			Mining Area				Water	Total		
		Dense Forest	Open Forest	Scrub	Social Forestry	Plantn. on OB	Sub Total	Crop	Fallow	Sub Total	Rural	Urban	Industrial	Sub Total	Waste Land	Sand body	Sub Total	Coal Quarry	Over Burden	Back Filled	Sub Total	Body	Area
1	BHATADI DEEP	0.78	2.88	0.30			3.96	0.18	0.42	0.60	0.12			0.12	1.81	0.02	1.83		0.00		0.00	0.02	6.54
2	MOTAGHAT				0.11	0.28	0.39		0.15	0.15					0.02		0.02		0.29	0.01	0.30		0.87
3	LOHARA EAST	3.43	0.09				3.51		0.00	0.00													3.52
4	LOHARA WEST	6.84	1.38	0.33			8.56															0.24	8.80
5	PAUNI-EXTN.			0.00			0.00	0.20	0.15	0.34					0.45		0.45		0.00		0.00	0.01	0.81
6	SASTI UG/OC	0.05	0.51	0.32		0.01	0.89	1.80	3.62	5.43		2.43		2.43	2.85		2.85		0.03		0.03	0.19	11.83
7	BALARPUR			1.09		0.20	1.29	0.70	2.46	3.16		1.11		1.11	3.76	0.69	4.45		0.76		0.76	1.33	12.10
8	DHUPTALA			0.09		0.53	0.61	0.24	3.07	3.31					1.30		1.30	0.15	0.31	0.00	0.47	0.17	5.85
9	SASTI	0.00		0.09		0.63	0.72	0.22	1.17	1.39					0.18		0.18	0.32	0.00	0.43	0.75	0.06	3.10
10	WIRUR	1.21	1.46	0.03			2.70	0.08	0.23	0.32					0.21		0.21						3.23
11	CHINCHOLI	0.02	1.27	0.00			1.29		3.01	3.01													4.30
12	KOLGAON			0.39			0.39	0.38	0.25	0.63					0.35		0.35	0.55	0.38		0.94		2.31
13	GHUGUS OC	0.00		0.48		0.96	1.44	0.00	0.01	0.01				0.49	0.00	0.50	0.36	0.01	1.46	1.82	0.02	3.79	
14	KOLAR PIMPRIDEEP			0.04		0.25	0.29	0.30	0.62	0.91				0.15	0.02	0.16		0.44		0.44	0.07	1.87	
15	NEW MAJRI UG			0.39		1.40	1.79	2.29	2.02	4.30	0.04	0.01		0.05	0.86	0.00	0.86	0.22	0.12	0.64	0.98	0.00	7.99
16	NEW MAJRI OC			0.08		0.49	0.56		0.01	0.01		0.12	0.00	0.12	0.08		0.08	0.75	0.07	0.28	1.09		1.86
17	JUNA KUNADA			0.74		0.08	0.81	0.00	0.17	0.17					0.07	0.14	0.21		0.00	0.00	0.00	0.16	1.36
18	TELWASA			0.26			0.26		0.12	0.12					0.07	0.28	0.34		0.08		0.08	0.20	1.01
19	DHORWASA & EXTN.			0.04			0.04		0.03	0.03					0.19		0.19	0.44	0.27		0.71		0.96
20	SIRNA OC			0.18			0.18		0.02	0.02					0.02		0.02		0.08		0.08	0.07	0.37
21	CHARGAON OC			0.00			0.00		0.00	0.00					0.01		0.01		0.11		0.11	0.03	0.16
22	N. NAKODA					0.01	0.01	0.06	0.07	0.13					0.11		0.11		0.34		0.34		0.59
23	KONDHA NARDOLA VII			0.00			0.00	2.51	8.04	10.55	0.17			0.17					0.09		0.09	0.20	11.00
24	KILONI OC							0.97	2.05	3.01		0.03	0.29	0.32	0.18		0.18					0.02	3.53
25	MANORA DEEP-II	0.00	0.21	0.02			0.23	0.67	2.51	3.18			0.12	0.12	0.07		0.07						3.59
26	WARORA EAST			0.34			0.34	0.64	1.68	2.33	0.01	2.22		2.24	2.68		2.68						7.59
27	MAJRA			0.02			0.02	2.15	3.26	5.42													5.43
28	YEKONA-I							0.22	1.32	1.54					0.63		0.63						2.16
29	YEKONA II			0.84			0.84	0.07	4.43	4.50					0.12	0.02	0.14					0.01	5.49
30	CHIKALGAON			0.32			0.32	2.12	1.54	3.66		1.19		1.19	0.84		0.84					0.08	6.09
31	RAJUR			0.00			0.00	5.15	3.30	8.45	0.11			0.11	4.49		4.49					0.09	13.14
32	MAKRI MANGLHI	0.89					0.89	0.32	0.03	0.35					0.39		0.39					0.01	1.64
33	MANA OC							0.00	0.02	0.02					0.18		0.18						0.20

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Sl. No.	Name of Block	Vegetation					Agriculture			Settlement				Waste Land			Mining Area				Water Body	Total Area	
		Dense Forest	Open Forest	Scrub	Social Forestry	Plantn. on OB	Sub Total	Crop	Fallow	Sub Total	Rural	Urban	Industrial	Sub Total	Waste Land	Sand body	Sub Total	Coal Quarry	Over Burden	Back Filled			Sub Total
34	VISAPUR			0.02			0.02	0.04	0.65	0.69					0.47	0.17	0.64					0.19	1.53
35	H.LALPET OC							0.03	0.29	0.32					0.23	0.05	0.28					0.03	0.64
36	JUNAD OC			0.04			0.04		0.04	0.04					0.04	0.09	0.13	0.09	0.38		0.47	0.11	0.79
37	DRC-678 UG / DURGAPUR EXTN.	3.90	6.84	0.59	1.17		12.51					2.61		2.61	0.05		0.05		0.00		0.00		15.16
38	ANANDVAN			0.41			0.41	0.66	1.61	2.27					1.29		1.29						3.96
39	CHINORA			0.17			0.17	0.61	1.89	2.50					0.70		0.70						3.38
40	AGARZARI UG+OC	4.65	0.71	0.02			5.39																5.39
41	KOSAR DONGARGAON	1.74		0.04			1.78	0.08	4.11	4.19					1.19		1.19					0.04	7.20
42	MAKRI MANGLI-I			0.15			0.15	3.87	0.23	4.10					0.93		0.93					0.12	5.30
43	MAKRI MANGLI-III			0.00			0.00	1.24	0.11	1.35					0.26		0.26						1.61
44	MAKRI MANGLI-IV							0.89	0.04	0.93	0.14			0.14	0.13		0.13					0.00	1.20
45	NAKODA SOUTH			0.08			0.08	0.32	0.57	0.89					0.46	0.13	0.58		0.01		0.01	0.16	1.73
46	KOLGAON SAONGI			1.45		0.33	1.77	5.37	1.35	6.73	0.10			0.10	2.21	0.04	2.25	0.16			0.16	0.02	11.04
47	BHANDAK			0.11	0.05		0.17	0.94	2.31	3.24		0.04		0.04	0.83		0.83		0.01		0.01	0.05	4.34
48	YEKONA EXTN			0.00			0.00	0.43	6.99	7.42					1.95		1.95					0.02	9.38
49	MANA							0.03	0.17	0.20					0.45		0.45						0.65
50	NERADMALEGAON			0.01			0.01	0.03	4.00	4.03					0.63	0.01	0.64					0.09	4.77
51	JUNAD-II			0.37			0.37	0.01	0.18	0.19	0.05			0.05	0.40	0.08	0.48	0.12	0.65		0.77	0.03	1.88
52	MUGOLI			0.76		0.38	1.14	0.11	0.24	0.35				0.19	0.02	0.22	0.60	0.08	0.02		0.70	0.02	2.42
53	HIWARDARA SINDHWADHONA			0.04			0.04		4.61	4.61	0.43			0.43	1.07		1.07					0.16	6.31
54	BHATALI			0.06			0.06	6.16	10.28	16.44	0.06	0.43		0.49	1.93		1.93					0.26	19.18
55	BAHMINI-PALASSGAON & RAJURA MANIKGARH	5.76	10.36	2.69			18.82	8.97	11.68	20.65	0.04	2.75		2.80	12.93	1.66	14.59		0.01		0.01	1.57	58.44
56	BHIVKUND A	0.80	3.31	0.00			4.12	1.24	1.59	2.83		3.74		3.74	4.06	0.05	4.11		0.00		0.00	0.09	14.89
57	BHIVKUND	0.00		0.50			0.51	0.75	3.85	4.60				2.95	0.83	3.78		0.03		0.03	1.19	10.11	
58	JOGAPUR-SIRSI	10.49	16.07	0.19			26.76	0.59	6.76	7.35				2.93		2.93						0.48	37.52
59	SUBAI	0.62	1.77				2.38		1.11	1.11													3.49
60	GAURI-I,II PAUNI-OC	0.00		0.02		0.18	0.21	2.05	1.81	3.86	0.10			0.10	1.99		1.99	0.11	0.48		0.59	0.09	6.85
61	BALARPUR DEEP	0.01		0.50			0.51	0.89	0.97	1.86					0.76	0.26	1.02		0.00		0.00	0.30	3.70
62	MATHRA DEEP SIDE	0.01	1.63				1.64	0.44	0.47	0.91		0.02		0.02	3.21		3.21		0.00		0.00	0.05	5.83
63	MATHRA	0.00					0.00	0.36	0.87	1.23					2.12		2.12		0.01		0.01	0.05	3.41
64	GAURI DEEP			0.03			0.03	0.10	0.01	0.11					0.27		0.27						0.41
65	BELGAON							0.92	2.67	3.59												0.03	3.62

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Sl. No.	Name of Block	Vegetation					Agriculture			Settlement				Waste Land			Mining Area				Water Body	Total Area		
		Dense Forest	Open Forest	Scrub	Social Forestry	Planth. on OB	Sub Total	Crop	Fallow	Sub Total	Rural	Urban	Industrial	Sub Total	Waste Land	Sand body	Sub Total	Coal Quarry	Over Burden	Back Filled			Sub Total	
66	WARORA WEST (NORTHERN PART)			0.03			0.03	0.00		0.00		0.83		0.83	0.56		0.56							1.43
67	WARORA WEST(SOUTHERN PART)			0.17			0.17	0.29	0.36	0.65	0.08	0.65		0.73	0.77		0.77							2.32
68	TAKLI-JENA-BELLORA(N)			0.02			0.02	1.14	3.93	5.07												0.07		5.16
69	EAST OF EKARJUNA			1.54			1.54	1.46	4.14	5.60					2.65		2.65					0.24		10.03
70	BARANJ I/IV	0.03	0.01				0.04	1.92	3.71	5.63		0.04	1.21	1.25	0.57		0.57					0.05		7.54
71	BANDAK WEST			0.89	0.02		0.92	0.10	0.20	0.31		0.06		0.06	0.67		0.67		0.01		0.01			1.96
72	BANDAK EAST			0.70	0.41		1.10	0.25	0.24	0.49		1.03		1.03	0.48		0.48							3.11
73	UKNI			0.03		0.16	0.19		0.10	0.10				0.07		0.07	1.04	0.06	0.92	2.02				2.38
74	NILJAI			0.10		0.10	0.20		0.00	0.00				0.49		0.49	0.75	0.42	0.83	1.99				2.69
75	NILJAI DEEPSIDE			0.13		0.35	0.48		0.00	0.00				0.77		0.77		0.18		0.18				1.43
76	BELLORA			0.23			0.23		0.14	0.14				0.70		0.70	0.03	0.05		0.08				1.16
77	BELLORA NAIGAON			0.02			0.02		0.06	0.06				0.16		0.16	0.04	0.58		0.62				0.86
78	BELLORA DEEP SIDE			0.07			0.07	0.02	1.04	1.06				0.75		0.75								1.88
79	GHUGUS NAKODA UG			0.74		0.34	1.08		0.11	0.11		0.00		0.05	0.35	0.40	0.01	0.03		0.03		0.90		2.52
80	MUGOLI NIRGUDA DEEP OC			0.15		0.20	0.35	0.57	0.30	0.86	0.13			0.13	0.22	0.01	0.24					0.06		1.64
81	PISGAON			0.20			0.20	2.98	0.25	3.22				0.33		0.33						0.06		3.81
82	CHINCHALA							1.60	0.09	1.69				0.60		0.60								2.29
83	BORDA EXTN			1.37			1.37	0.22	7.92	8.14				5.26		5.26						2.46		17.23
84	NORTH OF GHONSA/BORDA			1.49			1.49	0.15	2.32	2.46				6.40		6.40						0.16		10.51
85	UB-2			0.16			0.16	1.11	0.21	1.31				2.68		2.68						0.01		4.17
86	KUMBARKHANI			0.32			0.32	1.43	0.85	2.29	0.42			0.42	2.32	0.04	2.35					0.11		5.49
87	PARSODA			0.07			0.07	1.59	0.17	1.76				0.44	0.07	0.51						0.18		2.52
88	PARSODA-DARA			0.01			0.01	0.35	0.10	0.45				0.52	0.02	0.54						0.07		1.07
89	DURGAPUR OC					0.44	0.44											0.25	0.08	0.32				0.76
90	SINHALA DEEP OC	0.01	0.07	0.00		0.02	0.11										0.19	0.10	0.55	0.84				0.95
91	DURGAPUR OC		0.01			1.26	1.27					0.01		0.01	0.04		0.04		0.00	0.39	0.39			1.71
92	UB-1	0.80	0.61	0.01		0.25	1.67							0.00		0.00	0.26	0.03	0.24	0.53				2.20
93	DURGAPUR	0.21	0.87	0.23	0.04	0.02	1.38					1.00		1.00	0.09		0.09		0.01	0.02	0.02			2.50
94	CHAND RAYATEWARI	0.01	0.01	0.00	1.53		1.55					2.58		2.58										4.13
95	MAHAKALI		0.01	0.06	0.05		0.11					1.82		1.82										1.94
96	H.LALPET	0.22	0.70	0.53	0.00		1.44	0.13	0.33	0.46		0.23		0.23	0.92		0.92							3.05
97	MANDGAON	0.18	0.33				0.51	0.04	0.16	0.20				0.14		0.14								0.84
98	MANA	0.04					0.04	0.07	0.35	0.42				0.33		0.33								0.80
99	PADAMPUR DEEP			0.03		0.19	0.22	0.00	0.02	0.02				0.19	0.05	0.23	0.02	1.20		1.23	0.04			1.75
100	PDAMPUR				0.15	0.40	0.55										0.10	0.17	0.03	0.30				0.85

Sl. No.	Name of Block	Vegetation					Agriculture			Settlement				Waste Land			Mining Area				Water Body	Total Area		
		Dense Forest	Open Forest	Scrub	Social Forestry	Plantn. on OB	Sub Total	Crop	Fallow	Sub Total	Rural	Urban	Industrial	Sub Total	Waste Land	Sand body	Sub Total	Coal Quarry	Over Burden	Back Filled			Sub Total	
101	BHATADI						0.01	0.06	0.06					0.38		0.38								0.44
102	LOHARA EXTN.	2.75	0.51	0.02																				3.28
103	UKNI DEEP			0.65	0.00	0.16	0.81		0.23	0.23				0.17		0.17	0.14	0.01				0.16		1.37
104	UKNI DEEP EXTN					0.05	0.05	0.06	0.18	0.24				0.11		0.11		0.04			0.04	0.00		0.44
105	PIMPALGAON DEEP					0.20	0.20	0.10	0.14	0.25				0.08		0.08		0.02			0.02			0.55
106	PIMPALGAON			0.00		0.24	0.24	0.14	0.06	0.20				0.02		0.02	0.32	0.10	0.26		0.68			1.14
107	TAKLI-JENA-BELLORA(S)			0.01			0.01	0.60	2.33	2.93												0.06		3.00
108	TELWASA OC			0.02			0.02		0.01	0.01				0.02	0.06	0.08	0.07	0.25			0.32	0.03		0.46
109	CHINCHPALLI KELZAR - MECL PROMOTIONAL	18.58	5.83	0.98			25.39		8.16	8.16						0.04	0.04					0.22		33.81
110	PAWANCHORA - MECL PROMOTIONAL	17.95	54.06	9.40			81.41	14.74	85.48	100.22	0.31		0.31	60.27		60.27						2.94		245.15
111	MADHRI - MEC PROMOTIONAL			1.34			1.34	5.61	2.47	8.09				4.41	0.06	4.46						0.22		14.11
112	GAURI DEEP-II ANTARGAON	0.00		0.02			0.03	1.96	0.69	2.65	0.05		0.05	2.63		2.63								5.35
113	KOLAR PIMPRI					0.16	0.16	0.02	0.04	0.06				0.02		0.02	0.38	0.67			1.05	0.00		1.30
	Total	82.00	111.51	36.40	3.53	10.26	243.71	97.07	244.21	341.27	2.35	24.96	1.62	28.93	166.48	5.27	171.75	7.23	9.24	6.15	22.62	16.01		824.30

Chapter 4

Conclusion & Recommendation

4.1 Conclusion

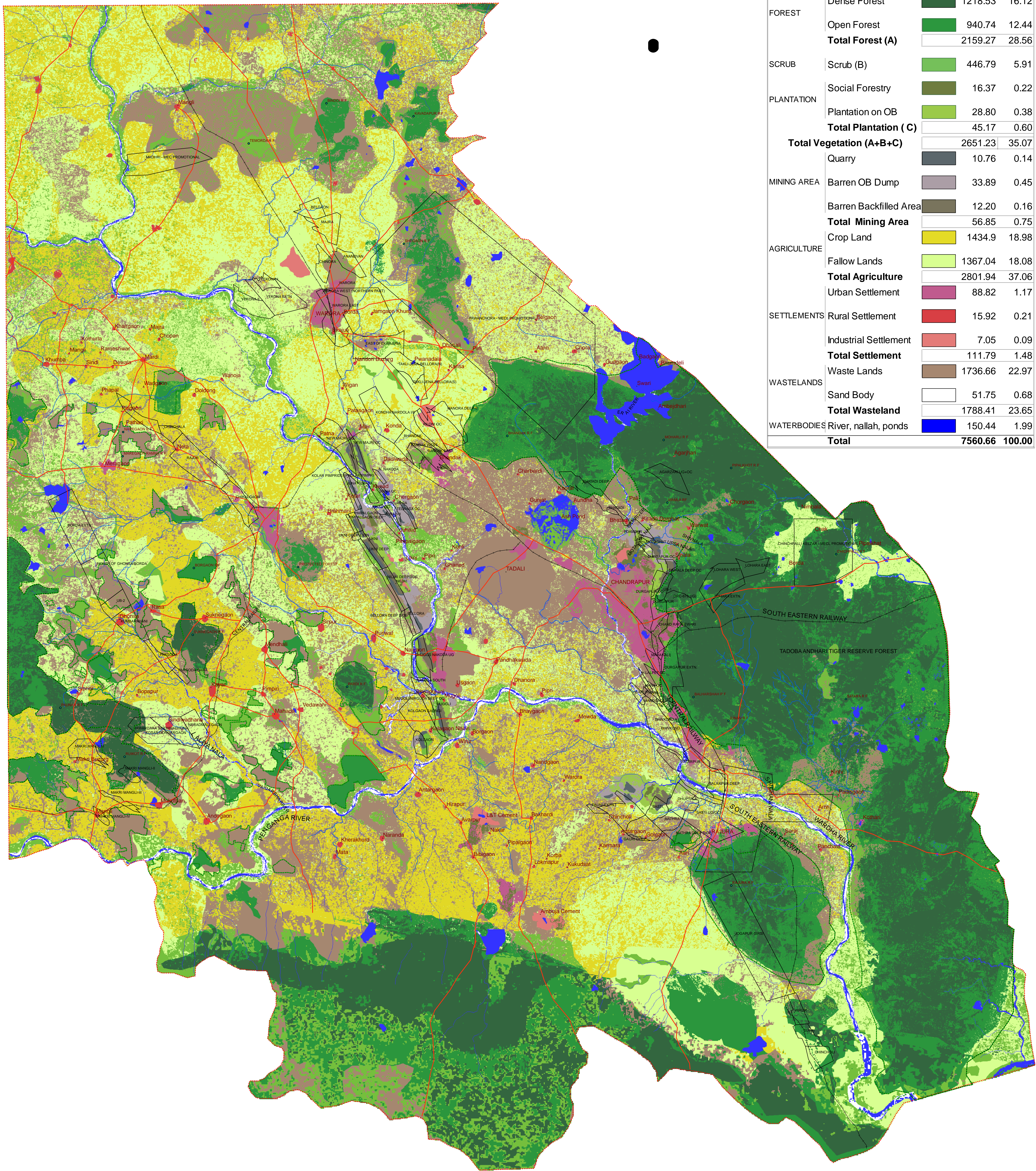
In the present study, land use/ vegetation cover mapping has been carried out based on IRS-P6/ LISS-III satellite data of January, 2013 in order to monitor the impact of coal mining on land environment which may helps in formulating the mitigation measures required, if any.

Study reveals that the total area of settlements which includes urban, rural and industrial settlements in the Wardha Valley coalfields covers 111.79 km² (1.48%) area. There is an increase in settlements by 11.85 sq km over the 2010 study primarily on account of more urbanisation in mining area and around small town. Vegetation cover which includes dense forests, open forests, scrubs, avenue plantation & plantation on over-burden dumps, covers an area of 2651.23 km² (35.07%). As compared to 2010 study there is a decrease in overall vegetation cover by 17.23 km² (0.23%) this is mainly because there is a reduction in dense and open forest areas due to deforestation. Area of scrubs has increased by 99.04 km². because of good monsoon. The analysis further indicates that total agricultural land which includes both crop and fallow land has increased by 170.78 km² (2.26 %) because of conversion of waste land into agricultural land due to good monsoon over the last few years in Wardha Valley coalfield. The mining area which includes coal quarry, barren OB dump, barren backfilled area, covers 56.85 km² (0.75%). As compared to 2010 there is a minor decrease in areas under mining operations because plantation has been done on over burden and backfilled. Wasteland covers 1788.41 km² (23.65%) in 2013 and 1994.51 km² (26.38%) in 2010. Waste lands have reduced because some wasteland has been converted in fallow land due to good monsoon. Surface water bodies covered area of 150.44 km² (1.99%).

The detail statistical analysis is given under Table-3.2.

4.2 Recommendation

It is essential to maintain the ecological balance for sustainable development of the area together with coal mining in Wardha Valley Coalfield. It is recommended that land reclamation of the mining area should be taken up on Top Priority by WCL. Such study should be carried out regularly to assess the impact of coal mining on land use pattern and vegetation cover in the coalfield to formulate the remedial measures, if any, required for mitigating the adverse impact of coal mining on land environment. Such regional study will also be helpful in assessing the environmental degradation /upgradation carried out by different industries operating in the coalfield area.



AREA STATISTICS				
Classess				
Level-I	Level-II	Colour	Area (Sq.Km.)	%
FOREST	Dense Forest		1218.53	16.12
	Open Forest		940.74	12.44
	Total Forest (A)		2159.27	28.56
SCRUB	Scrub (B)		446.79	5.91
PLANTATION	Social Forestry		16.37	0.22
	Plantation on OB		28.80	0.38
	Total Plantation (C)		45.17	0.60
Total Vegetation (A+B+C)			2651.23	35.07
MINING AREA	Quarry		10.76	0.14
	Barren OB Dump		33.89	0.45
	Barren Backfilled Area		12.20	0.16
Total Mining Area			56.85	0.75
AGRICULTURE	Crop Land		1434.9	18.98
	Fallow Lands		1367.04	18.08
	Total Agriculture		2801.94	37.06
SETTLEMENTS	Urban Settlement		88.82	1.17
	Rural Settlement		15.92	0.21
	Industrial Settlement		7.05	0.09
Total Settlement			111.79	1.48
WASTELANDS	Waste Lands		1736.66	22.97
	Sand Body		51.75	0.68
Total Wasteland			1788.41	23.65
WATERBODIES	River, nallah, ponds		150.44	1.99
Total			7560.66	100.00


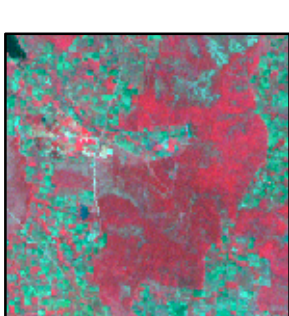
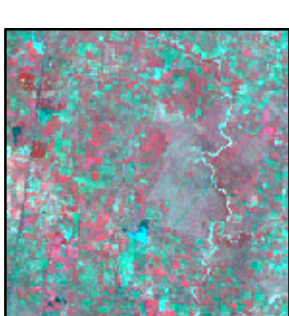
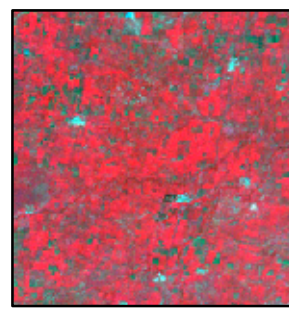
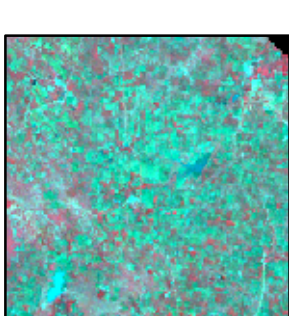
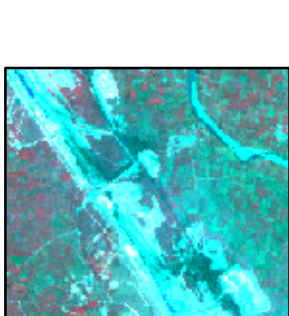
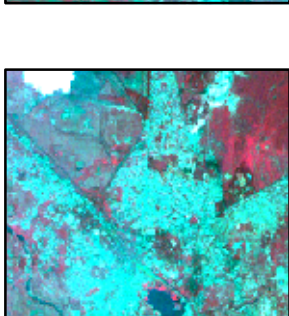
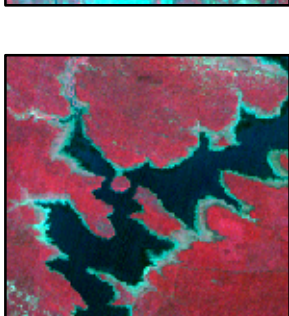
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55 L/16	55 P/4	55 P/8
56 I/13	56 M/1	56 M/5

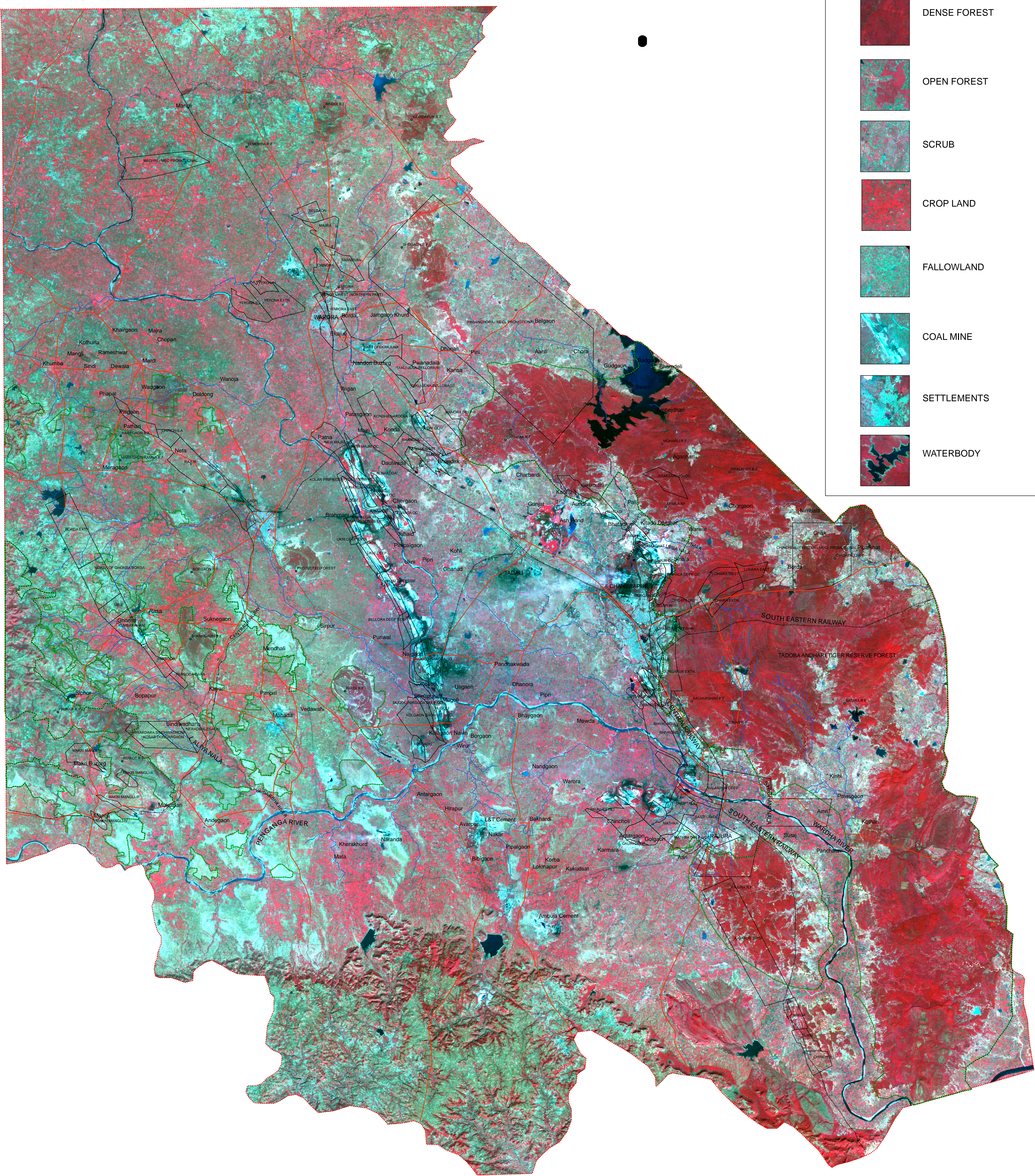
Legend	
	Forest Boundary
	Coalfield Boundary
	Coal Block
	Stream
	Rail
	Road

Customer						WESTERN COALFIELDS LIMITED					
Title		Land Use/Vegetation Cover mapping of wardha Valley Coalfield				Job No.		561410027			
Subject		Land Use/Vegetation Cover map of Wardha Valley coalfield based on Satellite Data (IRS-P6/LISS-III) of the year 2013				Activity		Name		Designation	
		Prepared		Tilak Mondal		Chief Manager				Signature	
		Checked		A.K..Singh		Chief Manager				Date	
		Approved		N.P.Singh		General Manager					
		Drg No.		HQ/REMA/01						Sheet	
		Scale		5 2.5 0 5 Km						Rev No.	



LEGEND

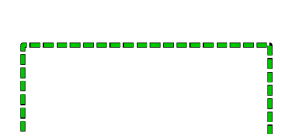

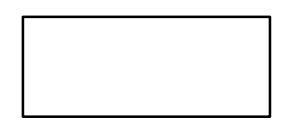
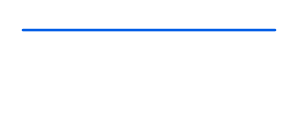

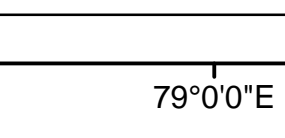
-  DENSE FOREST
-  OPEN FOREST
-  SCRUB
-  CROP LAND
-  FALLOWLAND
-  COAL MINE
-  SETTLEMENTS
-  WATERBODY




TOPO SHEET INDEX

55 L/15	55 P/3	55 P/7
55 L/16	55 P/4	55 P/8
56 I/13	56 M/1	56 M/5

Legend

-  Forest Boundary
-  Coalfield Boundary
-  Coal Block
-  Stream
-  Rail
-  Road

Customer						WESTERN COALFIELDS LIMITED									
Title						Land Use/Vegetation Cover mapping of wardha Valley Coalfield						Job No. 561410027			
Subject						Activity		Name		Designation		Signature		Date	
FCC of Wardha Valley coalfield based on Satellite Data (IRS-P6/LISS-III) of the year 2013						Prepared		Tilak Mondal		Chief Manager					
						Checked		A.K.Singh		Chief Manager					
						Approved		N.P.Singh		General Manager					
						Drg No.		HQ/REM/A0/02				Sheet			
						Scale 6 3 0 6 Km						Rev No.			



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