Vegetation Cover Mapping of Kamptee Coalfield based on Satellite Data for the Year- 2016

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Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

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Chapter 1

Introduction

1.1 Project Reference

Coal India Ltd requested CMPDI to taken up the study based on remote sensing satellite data for creating the geo-environmental data base of coalfield for monitoring the impact of coal mining on land use pattern and vegetation cover .Accordingly, road map for implementation of project was submitted to coal india Ltd for land use and vegetation cover mapping of 28 major coalfields for creating the geo-environmental data base and subsequent monitoring of impact of coal mining on land environment at regular interval of three years based on remote sensing satellite data . A work order no.CIL/WBP/Env/2009/2428 dated 29.12.2009 was issued by CIL Initially for three years. Subsequently, revised work order was issued vide letter no.CIL/WBP/ENV/2011/4706 dated 12.10.12 from coal india Ltd for the period 20-12-2013to 2016-17for land reclamation monitoring for all open cast mine as well as vegetation cover mapping of 28 major coalfields including Westen coalfield as per a defined plan for monitoring the impact of mining on vegetation cover.

Project Background

Western Coalfield Limited (WCL) ,is subsidiary of coal india Ltd ,dedicated for maintaining the ecological balance in the region has initiated a massive plantation programme on backfilled area ,OB Dump and Waste land. The advent of high resolution , multispectral satellite data has opened a new avenue in the field of mapping and monitoring of vegetation cover. The present study has taken up to access the impact of coal mining on land use and vegetation cover in Western Coalfield with respect to earlier study carried out of Western coalfield in the year 2013.

1.2 Objectives

The Objective of present study to prepare landuse/Cover map of Kamptee Coalfields covering an area 1344.78 Square Km on scale of 1:50000 based on satellite data of the year 2016, creating the geo-environmental data base in respect of land , vegetation cover ,Drainage ,Mining area

,infrastructure etc and regular up-dation of data base at regular interval of three years to assess the impact of coal mining and other activities on land use and vegetation cover in coalfield area.

1.3 Location & Accessibility

Kamptee Coalfield covering an area of about 1344.78 sq.km located in Nagpur district in the Vidarbha region of the Indian state of Maharashtra. It lies north of Kanhan railway station in Nagpur district.The coalfield extends in nort-westerly direction from kanhan railway station towards Saoner. The study area is bounded between North Latitudes 20^0 55’ 00” to $21^0$25’ 00” and East longitudes $78^0$45’00” to 79^0 20’00”and is covered by Survey of India (SoI) topo-sheet Nos. 55K/15, 55K/16, 55O/3, 55O/4, 55O/7, 55O/8, 55O/11, 55O/12. the total coalfield area is about 1344.78 sq. km. 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.Kamptee Coalfield approachable from Nagpur through Nagpur–Jabalpur road ie NH-7.The nearest town is Kanhan and Kamptee town which is 8 Km from Nagpur. Kanhan river is approachable throughout the year. Kanhan railway station lies on the Nagpur- Howrah railway line . Nagpur to Ramtek railway line is 10 km from the Kanhan town. The nearest railway station is kanhan –junction (5km) of South Eastern Central railway on Bombay – Howrah main line. Location map of the kamptee coalfield is given at fig 1.1

1.4 Topography & Drainage

The area exhibits gently undulating terrain and gently slopes towards south and southeast.The main drainage is controlled by southerly flowing Kanhan river which lies about 2 km. Kamptee Coalfield forms a part of the Kanahan river basin.The general flow direction of the Kanhan river is from south to north.Some of the coal block is mainly drained by Nand Nala and its tributaries.The Nand nala is a perennial one and ultimately discharges its water in Nand River.

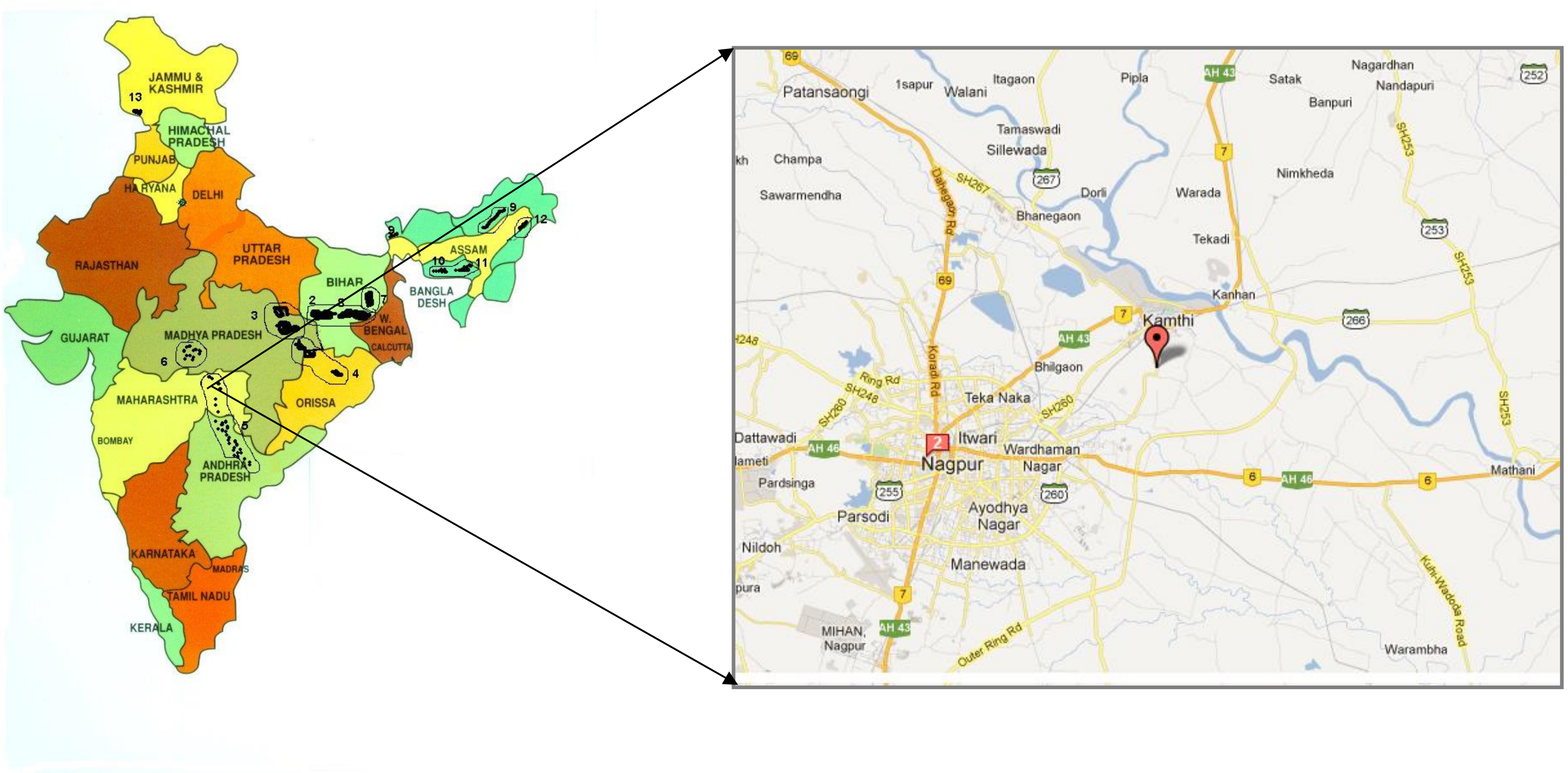


Fig. 1.1 : Location map of Kamptee Coalfield

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.

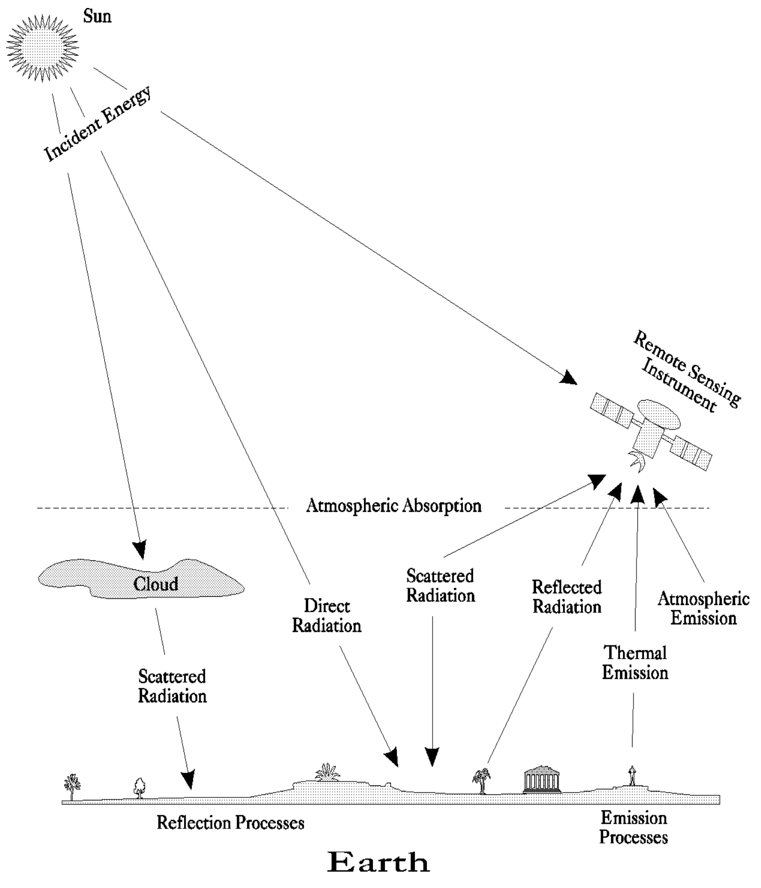


Figure 2.1 Remote sensing radiation system

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.

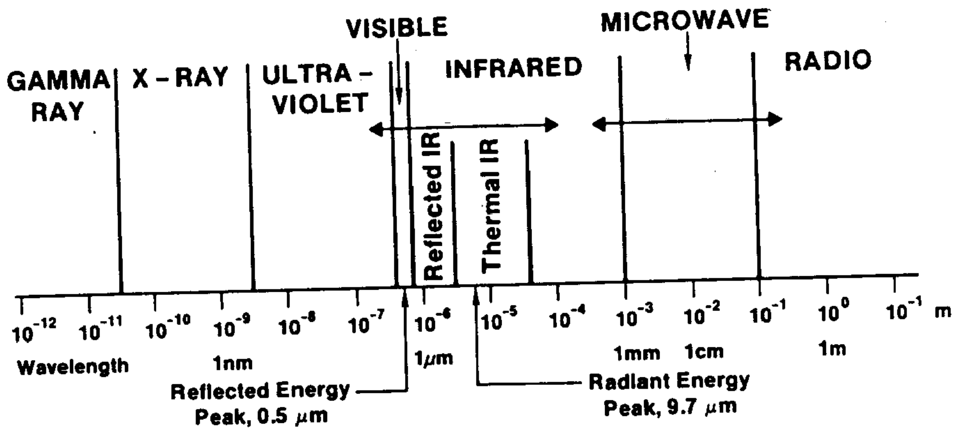


Figure 2.2 Electromagnetic spectrum. Expanded versions of the visible, infrared and microwave regions are shown in Figure 2.3.

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 (0.4-0.7µm 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 0.5µm 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 9.7µm wavelength. This *radiant energy peak* occurs in the thermal band of the IR region (Figure 2.2).

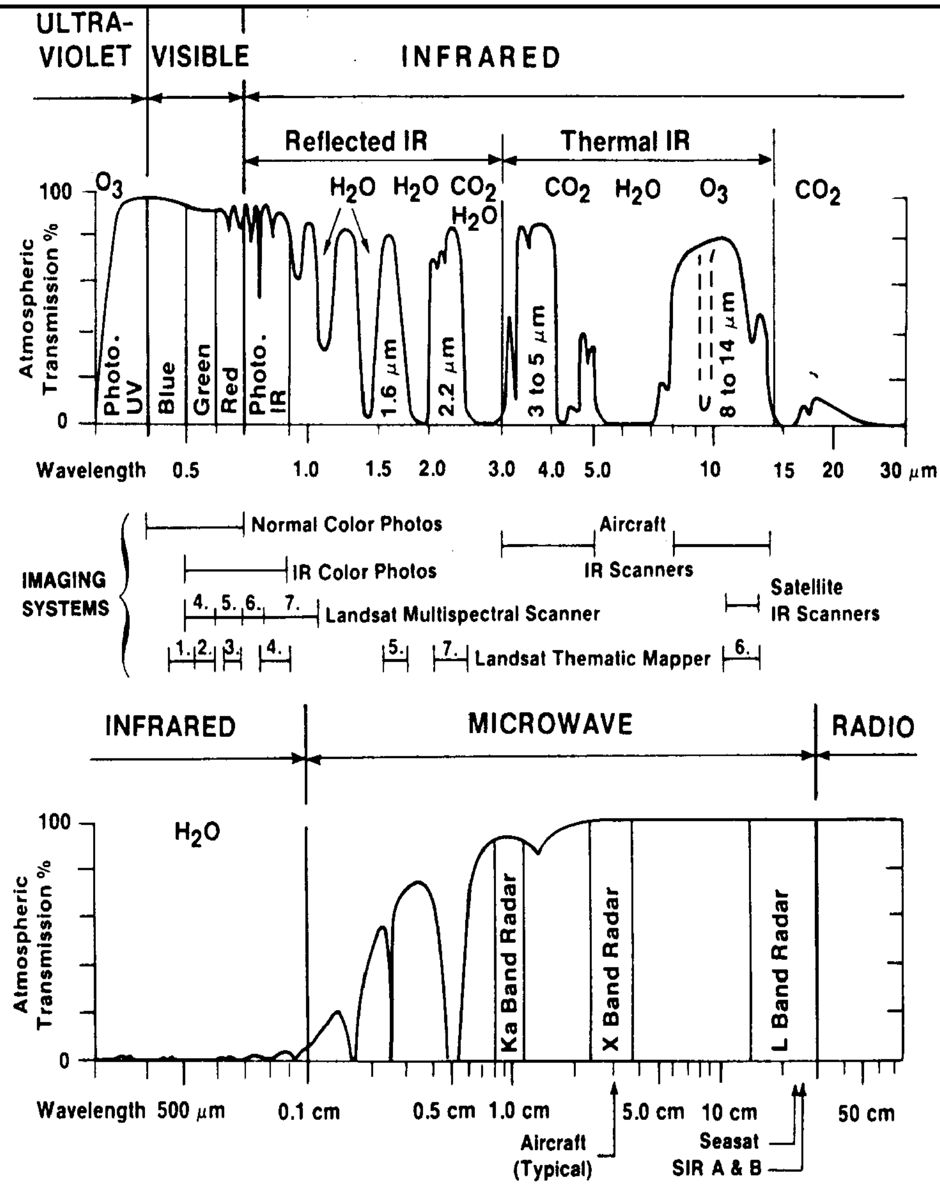


Figure 2.3 Expanded diagrams of the visible and infrared regions (upper) and the microwave regions (lower) showing atmospheric windows. Wavelength bands of commonly used remote sensing systems are indicated. Gases responsible for atmospheric absorption are shown.

Table 2.1 Electromagnetic spectral regions					
Region		**Wavelength**			**Remarks**
Gamma ray		<	0.03	**nm**	Incoming radiation is completely absorbed by the upper atmosphere and is not available for remote sensing.
X-ray	0.03	to	3.00	**nm**	Completely absorbed by atmosphere. Not employed in remote sensing.
Ultraviolet	0.03	to	0.40	**µm**	Incoming wavelengths less than 0.3mm are completely absorbed by Ozone in the upper atmosphere.
Photographic UV band	0.30	to	0.40	**µm**	Transmitted through atmosphere. Detectable with film and photo detectors, but atmospheric scattering is severe.
Visible	0.40	to	0.70	**µm**	Imaged with film and photo detectors. Includes reflected energy peak of earth at 0.5mm.
Infrared	0.70	to	100.00	**µm**	Interaction with matter varies with wavelength. Absorption bands separate atmospheric transmission windows.
Reflected IR band	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 *photographic IR band*.
Thermal IR band	3.00 8.00	to to	5.00 14.00	**µm** **µm**	Principal atmospheric windows in the thermal region. Images at these wavelengths are acquired by optical-mechanical scanners and special vediocon systems but not by film.
Microwave	0.10	to	30.00	**cm**	Longer wavelengths can penetrate clouds, fog and rain. Images may be acquired in the active or passive mode.
Radar	0.10	to	30.00	**cm**	Active form of microwave remote sensing. Radar images are acquired at various wavelength bands.
Radio		>	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-R2/L4FX of the year 2016 having 5.8 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 Kamptee Coalfield**,** Survey of India topo sheet no., 55K/15, 55K/16, 55 L/9,55 L/13,55 O/3 ,55O/4, 55O/8 55 P/1and 55 P/11 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 -2 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-R-2	L4FX	B2 0.28 - 0.31 Green B3 0.25 - 0.38 Red B4 0.27 - 0.30 NIR B5 6.90 MIR	7-bit (128-grey levels)	05.8 m 23.5 m 23.5 m 70.5 m	24 days	India

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.

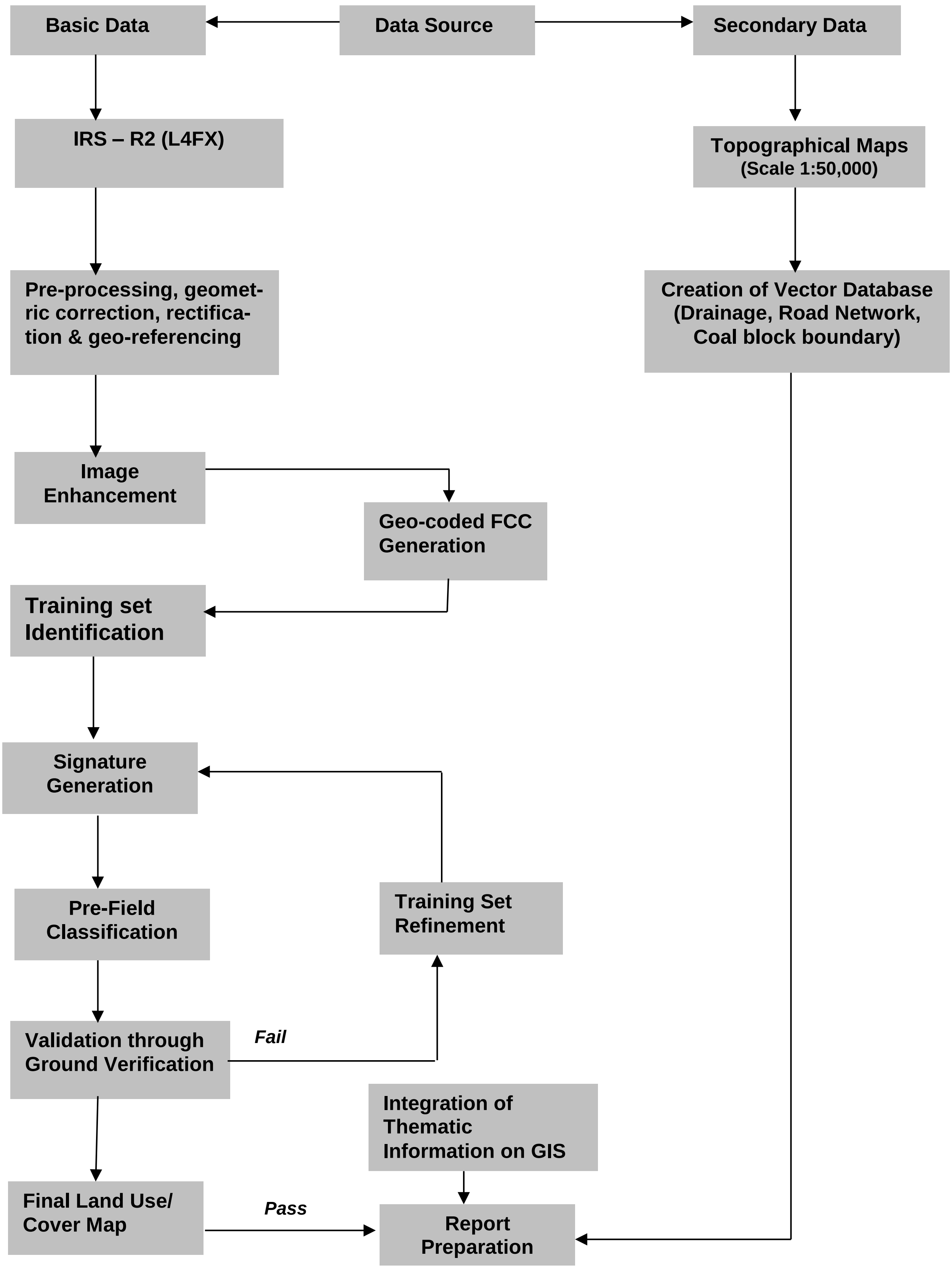


Fig-2.4 –Methodology of Land Use/Vegetation Cover Analysis

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 (SoI) 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*.

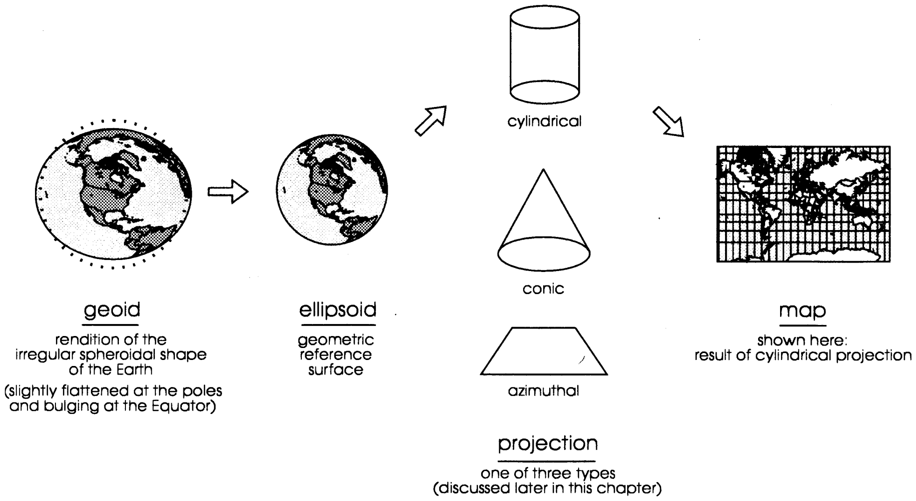


Fig 2.5 : Geoid – Ellipsoid – Projection Relationship

In the present study, ***UTM projection WGS 84 Datum is*** used so as to prepare the map compatible with the SoI topo-sheets**.** Polyconic projection is used in SoI 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 ERDAS IMAGINE v.1014 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 ERDAS

IMAGINE 2014 version s/w. The enhanced and geocoded FCC image of Kamptee coalfield 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, 150 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 2014 version. The classified image for the year 2016 for Kamptee 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 9.3 version 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 Coal quarry, Barren OB Dump and water body was 100%. Classification accuracy in case of Dense forest, Open forest, agriculture land ,waste land, scrubs between 90% to 95%. In case of social forestry, the classification accuracy is 91.30%. Classification accuracy for urban settlement ,rural settlement and Industrial settlement varies from 80.00% to 85.71% due to poor *signature separability index*. Where as classification accuracy for Sand body and Fly ash pond are 80.00% and 66.66% respectively and overall classification accuracy in case of Kamptee Coalfield was estimated as 85.92%.

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 Kamptee 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**	**C11**	**C12**	**C13**	**C14**	**C15**
1	Urban Settlement	**C1**	**05**	03	1	1												
2	Rural Settlement	**C2**	**07**	1	06	1												
3	Industrial Settlement	**C3**	**05**		1	04												
4	Dense Forest	**C4**	**18**				17	1										
5	Open Forest	**C5**	**20**				1	18	1									
6	Scrubs	**C6**	**12**					1	11									
7	Soc. Forestry	**C7**	**08**						1	06	1							
8	Agriculture Land	**C8**	**23**						1	1	21							
9	Waste Upland	**C9**	**17**	1								16						
10	Fly Ash Pond	**C10**	**5**									1	04					
11	Sand Body	**C11**	**03**									1		02				
12	Coal dump	**C12**	**05**									1			04			
13	Coal Quarry	**C13**	**05**													05		
14	Barren OB Dump	**C14**	**06**										1				05	
15	Water Bodies	**C15**	**11**															11
Total no. of observation points			**150**	05	07	05	18	20	12	08	23	17	05	03	05	05	06	11
% of commission				20.00	28.57	40.00	5.55	10.00	25.00	12.50	4.34	18.75	80.00	0.00	0.00	0.00	0.00	0.00
% of omission				60.00	28.57	20.00	5.55	10.00	8.33	8.33	8.70	5.88	40.00	33.33	20.00	0.00	20.00	0.00
% of Classification Accuracy				80.00	85.71	80.00	94.45	90.00	91.66	75.00	91.30	94.11	80.00	66.66	80.00	100.0	100.0	100.0
Overall Accuracy (%)				**85.92**														

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 2016 for Kamptee Coalfield and following land use/cover classes are identified (Table 3.1).

	Table 3.1*: *Land use/cover classes identified in Kamptee Coalfield	
	Level -I	***Level -II***
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 3.6 Plantation on Backfilled area
4	***Wasteland***	4.1 Waste upland with/without scrubs 4.2 Fly Ash pond 4.3 Sand Body
5	***Mining***	5.1 Coal Quarry 5.2 Backfilling area 5.3 Water filled Quarry 5.4 Barren OB Dump 5.5 Coal Dump
6	***Water bodies***	6.1 River/Streams /Reservoir

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

1. Plate No. 1 : Drawing No. HQ/REM/ 01 – FCC of Kamptee Coalfield based on IRS-R2,L4FX data of the Year 2016.
2. Plate No.2 : Drawing No: HQ/REM/02- Classified image of Kamptee coalfield on IRS-R2 L4FX data of the year 2016.

3.3 Data Analysis& Change Detection

Satellite data of the year 2016 were processed using ERDAS IMAGINE 2014 version image processing s/w in order to interpret the various land use/cover classes present in the study area of Kamptee Coalfield covering 1344.78 sq.kms. The area of each land use/cover class for Kamptee Coalfield were calculated using ERDAS IMAGINE2014 version s/w and tabulated in Table 3.2 to 3.8 and Comparison of various land use classes in the year 2013 & 2016 are shown in the pie Chart (Fig. 2.7&2.8). Kamptee Coalfield contains 45 coal block whose land use/cover classes are tabulated in Table 3.9(A) and 3.9(B)

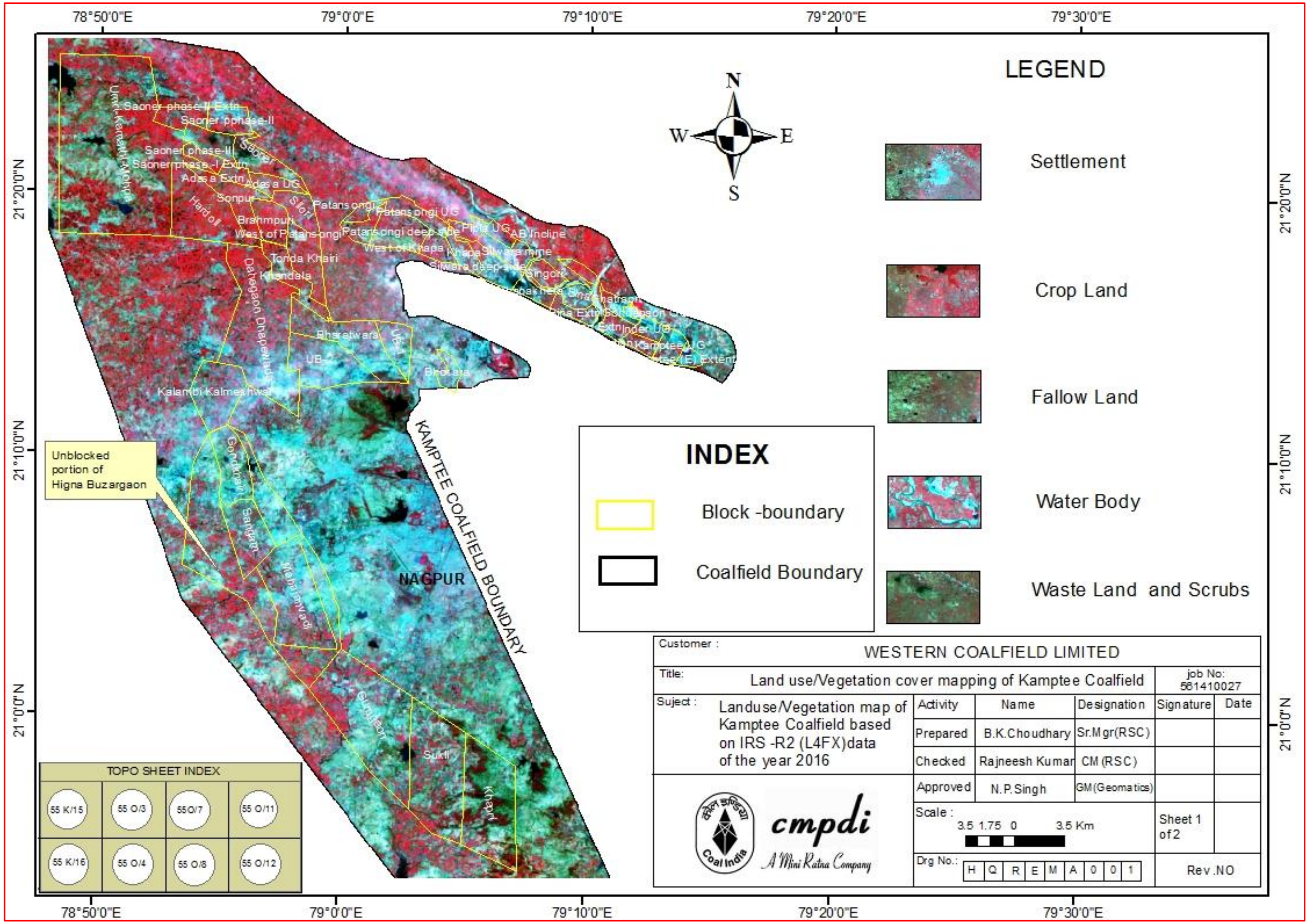
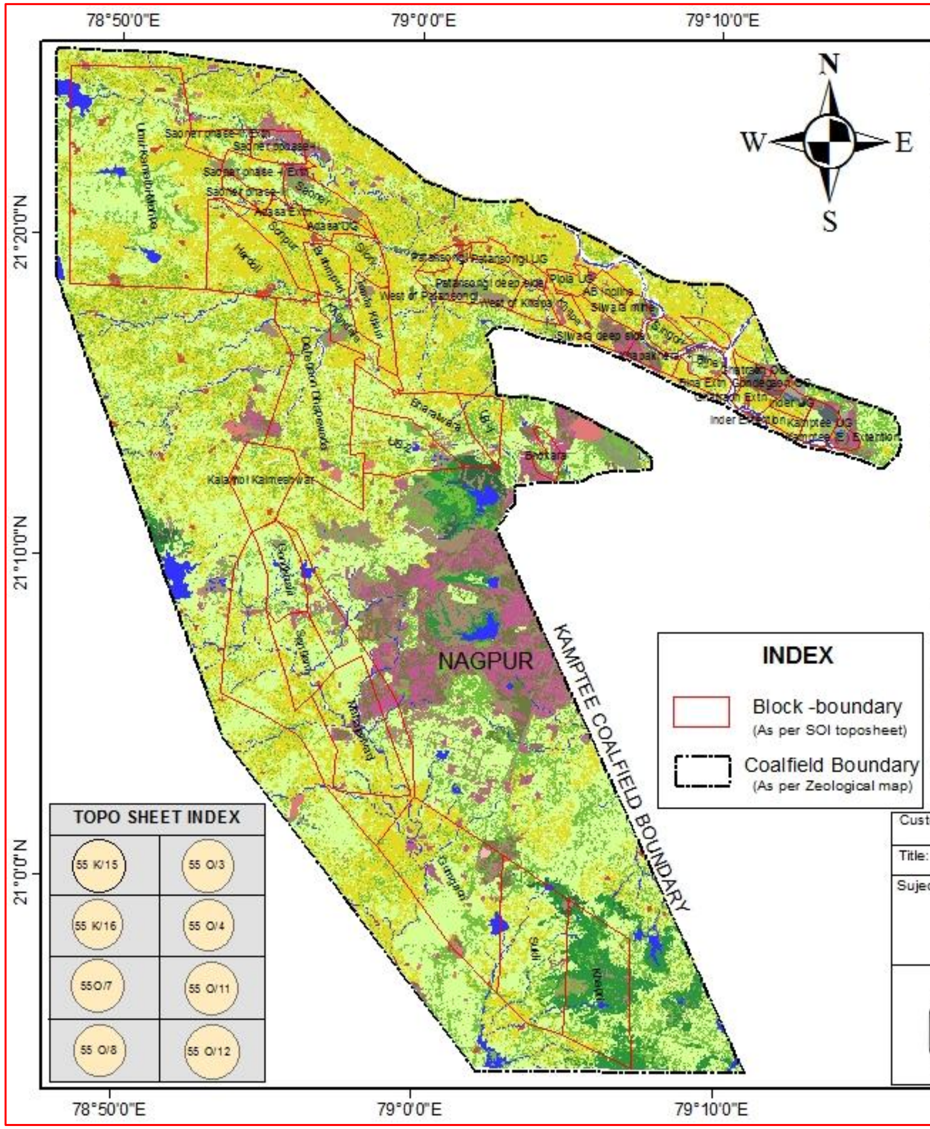


Plate 1 : FCC (Band 3, 2, 1) of Kamptee CF based on IRS-P6 (LISS – III) Data of Year – 2016



Classes		Colour	Area Statistics	
Level- I	Level- II		Sq.km	% age
Forest	Open Forest		42.80	03.18
	Dense Forest		06.04	00.45
	Total Forest (A)		48.84	03.63
Scrubs	Scrub(B)		193.08	14.36
Plantation	Social Forest		35.04	02.61
	Plantation on OB		01.42	00.11
	Plantation on Backfilled		00.36	00.03
	Total Plantation		36.82	02.75
	Total Vegetation (A+B+C)		278.74	20.74
Agriculture	Crop Land		380.63	28.30
	Fallow Land		486.35	36.17
	Total Agriculture Land		866.98	64.47
Settlement	Urban		60.42	04.49
	Rural		07.21	00.54
	Industrial		06.24	00.46
	Total Settlement		73.87	05.49
Mining Area	Coal Quarry		02.18	00.16
	Backfilling area		00.47	00.03
	Waterfilled Quarry		00.23	00.02
	Barren OB Dump		02.57	00.19
	Coal Dump		00.30	00.02
	Total Mining area		05.75	00.42
Waste Land	Waste up Land		70.16	05.22
	Fly ash pond		02.50	00.19
	Sand Body		08.00	00.59
	Total Waste Land		80.66	06.00
Water Body	River ,Pond, Stream etc		38.78	02.88
	TOTAL		1344.78	100.00

Customer : WESTERN COALFIELD LIMITED

Title: Land use/Vegetation cover mapping of Kamptee Coalfield — job No: 561410027

Suject : Landuse/Vegetation map of Kamptee Coalfield based on IRS -R2 (L4FX) data of the year 2016

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	Sr.Mgr(RSC)		
Checked	Rajneesh Kumar	CM(RSC)		
Approved	N.P.Singh	GM (Geomatics)		

cmpdi — A Mini Ratna Company

Scale : 3 1.5 0 3 Km

Sheet 2 of 2

Drg No.: H Q R E M A 0 0 2

Rev .NO

Plate 2 : LU / LC Map of Kamptee CF based on IRS-P6 (LISS-III) Data of Year 2016

Fig. 3.2 : Yearwise Comparison of Land use / Vegetation Cover in Kamptee Coalfield

TABLE-3.2 :STATUS OF LAND USE/COVER PATTERN IN KAMPTEE COALFIELD DURING THE YEAR 2013 &2016

LAND USE CLASSES	Year 2013		Year 2016		Change w.r.t Yr 2013		Remarks
	Area(Km^2)	% age	Area(Km^2)	% age	Area(Km^2)	% age	
SETTLEMENT							
Urban	61.58	4.58	60.42	4.49	-1.16	-0.09	Industrial Settlement increases due to commimg up of new industry.
Industrial	5.52	0.41	6.24	0.46	0.72	0.05	
Rural	6.77	0.50	7.21	0.54	0.44	0.04	
Total Settlement	**73.87**	**5.49**	**73.87**	**5.49**	**0.00**	**0.00**	
VEGETATION COVER							
Forest							
Dense Forest	5.56	0.41	6.04	0.45	0.48	0.04	Minor increase in Forest area because of good monsoon and plantation carried out by forestry deptt.
Open Forest	42.12	3.13	42.80	3.18	0.68	0.05	
Total Forest (A)	**47.68**	**3.54**	**48.84**	**3.63**	**1.16**	**0.09**	
SCRUBS							
Scrub (B)	**192.52**	**14.32**	**193.08**	**14.36**	**0.56**	**0.04**	Increase in scrubs because some of fallow Land is converted into Scrubs.
PLANTATION							
Social Forestry	35.30	2.62	35.04	2.61	-0.26	-0.01	Minor decrease in social forestry due to expansion of mining area.
Plantation on Backfilling Area	0.60	0.04	0.36	0.03	-0.24	-0.01	
Plantation on OB Dump	1.26	0.09	1.42	0.11	0.16	0.02	Plantation on OB increases due to massive plantation carried out by WCL.
Total Plantation (C)	**37.16**	**2.75**	**36.82**	**2.75**	**-0.34**	**0.00**	
Total Vegetation Cover(A+B+C)	**277.36**	**20.61**	**278.74**	**20.74**	**1.38**	**0.13**	
AGRICULTURE							
Crop Land	337.40	25.09	380.63	28.30	43.23	3.21	
Fallow Land	534.66	39.76	486.35	36.17	-48.31	-3.59	Fallow land decreases due to increase in mining area ,surface water body and waste land.
Total Agriculture	**872.06**	**64.85**	**866.98**	**64.47**	**-5.08**	**-0.38**	
MINING AREA							
Coal Quarry	1.05	0.08	2.18	0.16	1.13	0.08	Coal quarry increases due to opening of Bhanegaon OCP.
Coal Dump	0.20	0.01	0.30	0.02	0.10	0.01	Area of Coal dump increases due to opening of Bhanegaon OCP.
Barren OB Dump	3.62	0.27	2.57	0.19	-1.05	-0.08	Barren OB dump decreases due to increase in plantation on OB.
Barren Back filling area	0.15	0.01	0.47	0.03	0.32	0.02	
Waterfilled Quarry	0.22	0.02	0.23	0.02	0.01	0.00	Increasesed due to increase in quarry area.
Total Mining Area	**5.24**	**0.39**	**5.75**	**0.42**	**0.51**	**0.03**	
WASTELANDS							
Waste Land with/Without Scrubs	68.14	5.07	70.16	5.22	2.02	0.15	Waste land increases due to conversion of fallow land into waste land .
Fly ash Pond	3.52	0.27	2.50	0.19	-1.02	-0.08	Flyash decreased due to presence of Scrubs.
Sand	7.67	0.57	8.00	0.59	0.33	0.02	Some of fallow land converted into sand body.
Total Waste Land	**79.33**	**5.91**	**80.66**	**6.00**	**1.33**	**0.09**	
WATER BODY							
Water Body	36.92	2.75	38.78	2.88	1.86	0.13	Water Body increased due to good monsoon.
Total Water Body	**36.92**	**2.75**	**38.78**	**2.88**	**1.86**	**0.13**	
Total	**1344.78**	**100.00**	**1344.78**	**100.00**	**0.00**	**0.00**	

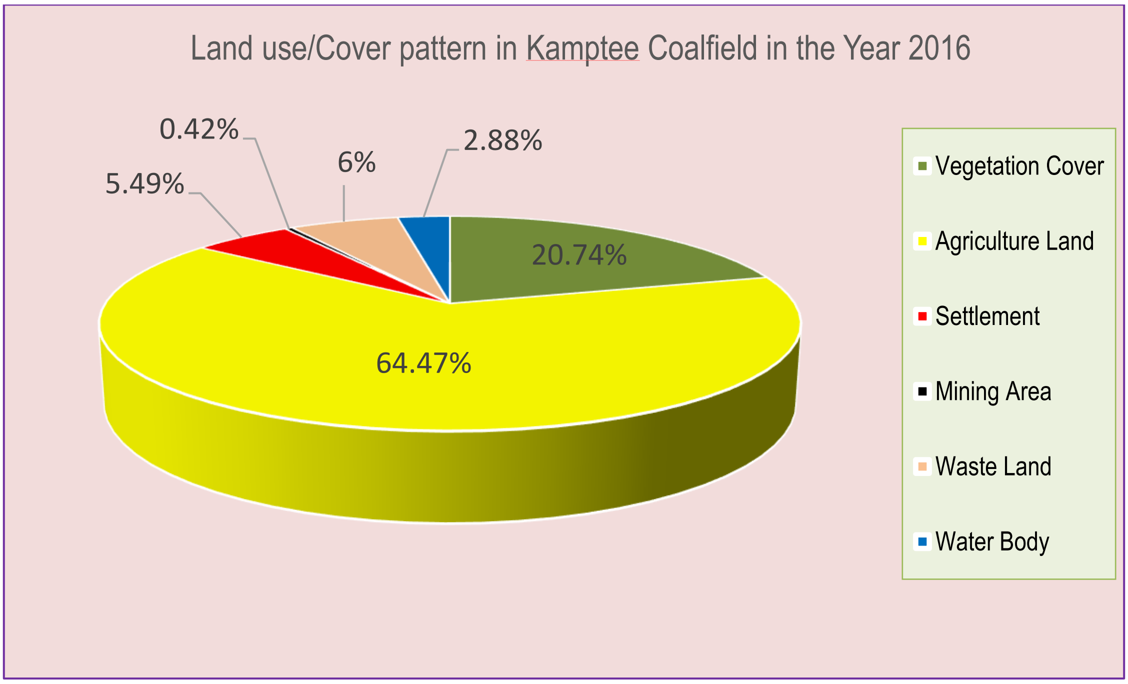


Figure-2.8

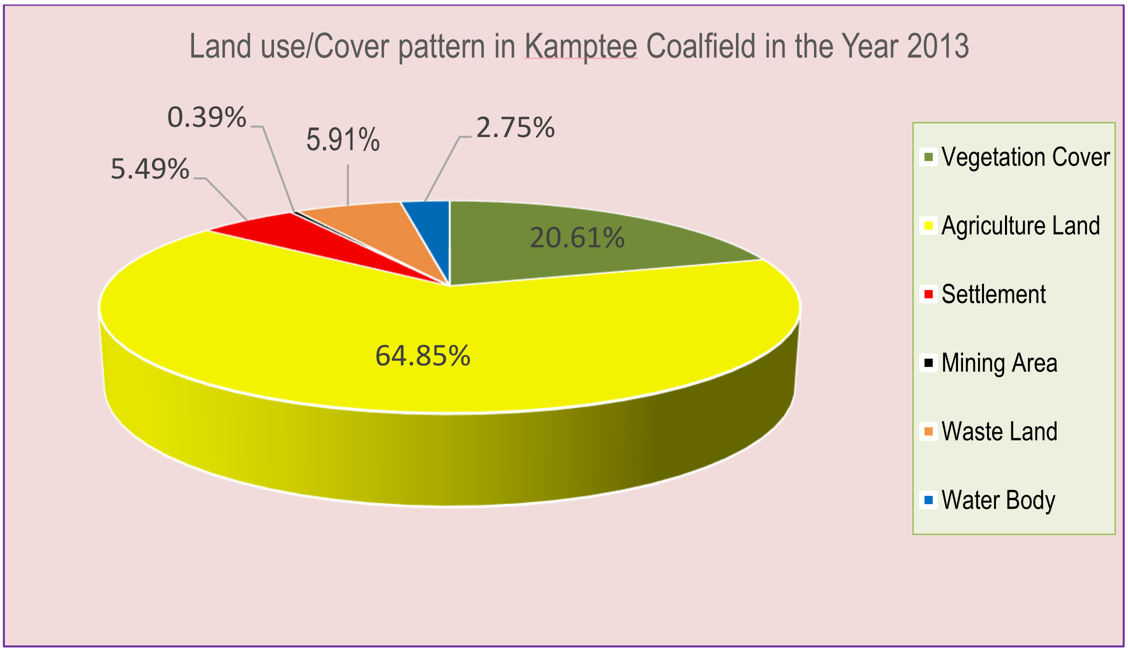


Figure-2.7

3.3.1Settlements

All the man-made constructions covering the land surface are included under this category. Built-up land has been further divided in to rural, urban and industrial classes. In the present study, industrial Settlement indicates only industrial complexes excluding residential facilities. In the year 2013 the total area covered by Industrial Settlements were estimated to be 5.52sq km (0.41%). In year 2016 the estimated area under Industrial Settlements has grown to 6.24sq km (0.46%). There is an increase in Industrial Settlements by 0.72 sq km which is about 0.05% of the total coalfield area. The minor increase in industrial settlement is due to coming up of new industry. However total area covered by settlement is same. 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 KAMPTEE COALFIELD DURING YEAR 2013 & 2016

LAND USE CLASSES	Year 2013		Year 2016		Change w.r.t Yr 2013		Remarks
	Area(Km^2)	% age	Area(Km^2)	% age	Area(Km^2)	% age	
SETTLEMENT							
Urban	*61.58*	*4.58*	*60.42*	*4.49*	*-1.16*	*-0.09*	Industrial Settlement increases due to commimg up of new industry.
Industrial	*5.52*	*0.41*	*6.24*	*0.46*	*0.72*	0.05	
Rural	*6.77*	*0.50*	*7.21*	*0.54*	*0.44*	*0.04*	
Total Settlement	***73.87***	***5.49***	***73.87***	***5.49***	***0.00***	***0.00***	

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 COVER IN KAMPTEE COALFIELD DURING YEAR 2013 & 2016

LAND USE CLASSES	Year 2013		Year 2016		Change w.r.t Yr 2013		Remarks
	Area(Km^2)	% age	Area(Km^2)	% age	Area(Km^2)	% age	
VEGETATION COVER							
Forest							
Dense Forest	5.56	0.41	6.04	0.45	0.48	0.04	Increase in Forest area because of good monsoon and plantation carried out by forestry deptt.
Open Forest	42.12	3.13	42.80	3.18	0.68	0.05	
Total Forest (A)	**47.68**	**3.54**	**48.84**	**3.63**	**1.16**	**0.09**	
SCRUBS							
Scrub (B)	**192.52**	**14.32**	**193.08**	**14.36**	**0.56**	**0.04**	Increase in scrubs because some of fallow Land is converted into Scrubs.
PLANTATION							
Social Forestry	35.30	2.62	35.04	2.61	-0.26	-0.01	Minor decrease in social forestry due to expansion of mining area.
Plantation on Backfilling Area	0.60	0.04	0.36	0.03	-0.24	-0.01	
Plantation on OB Dump	1.26	0.09	1.42	0.11	0.16	0.02	Plantation on OB increases due to massive plantation carried out by WCL.
Total Plantation (C)	**37.16**	**2.75**	**36.82**	**2.75**	**-0.34**	**0.00**	
Total Vegetation Cover(A+B+C)	**277.36**	**20.61**	**278.74**	**20.74**	**1.38**	**0.13**	

Dense forest – Forest having crown density of above 40% comes in this class. In the year 2013 the total area covered by dense forest were estimated to be 5.56 sq km area (0.41%). In year 2016 the estimated area under dense forest has increased to 6.04sq km area (0.45%). There is a increase in area of dense forest to 0.48sq km which is about 0.04% of the total coalfield area which is due to conversion of open forest in to Dense Forest and afforestation .

Open Forest – Forest having crown density between 10% to 40% comes under this class. Open forest cover over Kamptee coalfield which was estimated to be 42.12 sq km (3.13%) in 2013 has been increased to 42.80 sq km (3.18 %) of the total coalfield area in 2016. Thus the increase in open forest area is 0.68 sq km (0.05) % of the total coalfield area. This increase in open forest area is due to good monsoon plantation carried out by forest deptt.

Scrubs – Scrubs are vegetation with crown density less than 10%. Scrubs in the coalfield are seen to be scattered signature all over the area mixed with wastelands. It is observed that Scrubs covered over kamptee field which was estimated to 192.52 sq km(14.36%) in the year 2013 has been increased to 193.08Sq.km(14.36%) of the total coalfield area in the year 2016.The increase of 0.56 sq km area(0.04%) of the total coalfield area is due to conversion of some of Fallow Land into Scrubs.

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 that Social Forestry covers 35.04 sq km area (2.61%)of the coalfield area in 2016 as compared to area covered by scrub of 35.30 sq km area (2.62%) in the year 2013. Minor decrease in area covered by social forestry in the year 2016 is estimated to 0.26 sq km (0.01%). It is due to expansion in mining area.

Plantation over OB Dump and backfilled area – Analysis of the data reveals that WCL has carried out significant plantation on OB dumps during 3 year span of time for maintaining the ecological balance of the area. The plantation on the OB dumps are estimated to be 1.42 sq km,(0.11%) of the coalfield area in the year 2016 as compared to area covered by plantation on OB 1.26 Sq.km(0.09%)in the year 2013. The increase in area covered by plantation on OB is estimated to be 0.16 Sq.km (0.02%) in the year 2016 with respect to Year 2013. This increase is due to massive plantation carried out by WCL. The plantation on backfilled area in the year 2016 has been decreased to 0.24 sqkm that is 0.01%of the total coalfield area . This is due to expansion in mining area.

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

The area covered by coal quarry is estimated to be 2.18 sq km (0.16%) in the year 2016 as compared to 1.05 sq.km (0.08%) in the year 2013.It reveals that area of Coal quarry has increased to 1.13 sq km (0.08%) in the year 2016. This increase is due to opening of Bhanegaon OC mine and area covered under coal dump has also increased from 0.20sq km (0.01%) in the year 2013 to 0.30 sq.km (0.02%) in the year 2016.This increase is due to increase in production of coal. In the year 2013 the barren OB dump was estimated to be 3.62sq km (0.27%) which has been decreased to 2.57 sq km (0.19%) in the year 2016. This decrease of 1.05 area (0.08%) is due to increase in plantation on OB in the year

2016.However,the overall mining area is estimated to increase from 5.24 sq.km(0.39%) in the year 2013 to 5.75 sq.km(0.42%) in the year 2016. This increase in mining area is due to increase of coal production and opening of new mine .The status of land Use in the mining area over the Kamptee Coalfield is shown in the table 3.5 below.

TABLE – 3.5

Status of change in Mining Area in Kamptee Coalfield during the year 2013 & 2016

LAND USE CLASSES	Year 2013		Year 2016		Change w.r.t Yr 2013		Remarks
	Area(Km^2)	% age	Area(Km^2)	% age	Area(Km^2)	% age	
MINING AREA							
Coal Quarry	*1.05*	*0.08*	*2.18*	*0.16*	1.13	0.08	Coal quarry increases due to opening of Bhanegaon OCP.
Coal Dump	*0.20*	*0.01*	*0.30*	*0.02*	0.10	0.01	Area of Coal dump increases due to opening of Bhanegaon OCP.
Barren OB Dump	*3.62*	*0.27*	*2.57*	*0.19*	-1.05	-0.08	Barren OB dump decreases due to increase in plantation on OB.
Barren Back filling area	*0.15*	*0.01*	*0.47*	*0.03*	0.32	0.02	
Waterfilled Quarry	*0.22*	*0.02*	*0.23*	*0.02*	0.01	0.00	Increasesed due to increase in quarry area.
Total Mining Area	***5.24***	***0.39***	***5.75***	***0.42***	***0.51***	***0.03***	

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 estimated to 866.98sq km in year 2016, which is 64.47% of the coalfield area. In year 2013 the total agricultural area was estimated to be 872.06sq km which was 64.85% of the coalfield area. There is an decrease of 5.08 sq km in agriculture land , which is 0.38% of the coalfield area are due to conversion of some of fallow land into water body , waste land and sand body also.

The details are shown below in Table 3.6.

TABLE – 3.6

Status of change in Agricultural land in Kamptee Coalfield during the year 2013 & 2016

LAND USE CLASSES	Year 2013		Year 2016		Change w.r.t Yr 2013		Remarks
	Area(Km^2)	% age	Area(Km^2)	% age	Area(Km^2)	% age	
AGRICULTURE							
Crop Land	*337.40*	*25.09*	*380.63*	*28.30*	43.23	3.21	
Fallow Land	*534.66*	*39.76*	*486.35*	*36.17*	-48.31	-3.59	Fallow land decreases due to increase in mining area ,surface water body and waste land.
Total Agriculture	***872.06***	***64.85***	***866.98***	***64.47***	***-5.08***	***-0.38***	

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 79.33sq km (5.91%) in the year 2013. Whereas in the year of 2016, waste land is estimated to be 80.66 sq km area (6.00%). So there is a increase of 1.33sq km i.e. (0.09%) of the total coalfield area due to conversion of some of fallow land in waste land. The details are shown below in Table 3.7.

TABLE – 3.7

Status of Change in Wastelands in Kamptee Coalfield during the year 2013 & 2016

LAND USE CLASSES	Year 2013		Year 2016		Change w.r.t Yr 2013		Remarks
	Area(Km^2)	% age	Area(Km^2)	% age	Area(Km^2)	% age	
WASTELANDS							
Waste Land with/Without Scrubs	*68.14*	*5.07*	*70.16*	*5.22*	*2.02*	*0.15*	Waste land increases due to conversion of fallow land into waste land .
Fly ash Pond	*3.52*	*0.27*	*2.50*	*0.19*	*-1.02*	*-0.08*	Flyash decreased due to presence of Scrubs.
Sand	*7.67*	*0.57*	*8.00*	*0.59*	*0.33*	*0.02*	Some of fallow land converted into sand body.
Total Waste Land	***79.33***	***5.91***	***80.66***	***6.00***	***1.33***	***0.09***	

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 36.92sq km in the year 2013, which is 2.75% of the coalfield area. In 2016 it has been increased to 38.78 sq km which is 2.88% of the coalfield area. So there is an increase of area 1.86sq. km.(0.13%) in water bodies due to sufficient rain water .

Table:3.8

Status of Change in Surface Water body in Kamptee Coalfield during the year 2010 & 2013

LAND USE CLASSES	Year 2013		Year 2016		Change w.r.t Yr 2013		Remarks
	Area(Km^2)	% age	Area(Km^2)	% age	Area(Km^2)	% age	
WATER BODY							
Water Body	*36.92*	*2.75*	*38.78*	*2.88*	*1.86*	*0.13*	Water Body increased due to good monsoon.
Total Water Body	***36.92***	***2.75***	***38.78***	***2.88***	***1.86***	***0.13***	

Table 3.9(A) Blockwise Landuse/Vegetation Cover Status in Kamptee Coalfield

Area in Sq.Km

Sl.no	Name of block	Dense Forest	Open Forest	Total Forest	Scrubs	Plantation on OB	Plantation on Backfill	Social Forestry	Total plantation	Total vegetation	Crop Lands	Fallow Lands	Total Agiculture Land	Coal Quarry	Backfilling area	Barren OB dump	Water filled Quarry	Coal dump	Total Mining area	Waste up land	Fly ash pond	Sand body	Total waste land	Urban Settlement	Rural Settlement	Industrial Settlement	Total settlement	Water body	Total water body	Total area (Sq.km)
1	Khapri	0.31	14.27	14.58	4.47			0.01	0.01	19.06	0.85	6.95	7.80							1.43			1.43	0.01	0.03		0.04	0.37	0.37	28.70
2	Sukll	0.38	2.71	3.09	4.76			0.54	0.54	8.39	6.07	15.04	21.11							0.63			0.63	0.18	0.04		0.22	1.18	1.18	31.53
3	Gumgaon				5.85			1.39	1.39	7.24	12.60	16.99	29.59							1.05		0.03	1.08	4.28	0.07	0.33	4.68	1.60	1.60	44.19
4	Mahajanvadi		0.01	0.01	1.68			1.18	1.18	2.87	8.01	10.95	18.96							0.73		0.05	0.78	2.06			2.06	1.26	1.26	25.93
5	Sangam				1.01					1.01	3.66	6.52	10.18							0.09	0.01	0.07	0.17	0.36	0.09		0.45	0.50	0.50	12.31
6	Gondkhairi		0.01	0.01	1.61			0.02	0.02	1.64	0.32	8.13	8.45							0.45			0.45	0.19			0.19	0.57	0.57	11.30
7	Kalambi Kalmeshwar				1.67					1.67	5.06	6.33	11.39							0.05		0.10	0.15		0.31		0.31			13.52
8	Dhaegaon Dhapewada				6.03			0.19	0.19	6.22	15.56	15.82	31.38							0.90		0.65	1.55	0.86	0.29	0.46	1.61	0.65	0.65	41.41
9	Bharatwada	0.89	0.11	1.00	1.67					2.67	4.16	8.74	12.90							1.29		0.04	1.33		0.05		0.05	0.20	0.20	17.15
10	Khandala				1.47					1.47	2.59	2.60	5.19							0.96			0.96		0.06		0.06	0.18	0.18	7.86
11	Tonda Khairi				0.67					0.67	5.37	2.34	7.71							0.57			0.57		0.10		0.10	0.19	0.19	9.24
12	Brahmpuri				0.51					0.51	4.29	1.38	5.67							0.03			0.03		0.03		0.03	0.13	0.13	6.37
13	Silori				0.71			0.09	0.09	0.80	3.79	1.00	4.79									0.07	0.07		0.06		0.06	0.18	0.18	5.90
14	Adasa UG				0.63					0.63	2.16	0.70	2.86							0.06			0.06		0.01		0.01	0.17	0.17	3.73
15	Sonpur				1.10			0.02	0.02	1.12	6.07	1.54	7.61							0.02			0.02		0.20		0.20	0.04	0.04	8.99
16	Hardoli				2.09					2.09	13.08	4.12	17.20							0.01		0.01	0.02		0.43		0.43	0.40	0.40	20.14
17	Adasa Extn				0.26					0.26	1.43	0.72	2.15												0.06		0.06	0.05	0.05	2.52
18	Saoner phase-iii				0.26					0.26	0.82	1.36	2.18							0.08			0.08		0.03		0.03	0.09	0.09	2.64
19	Saoner phase-1 extn				0.58					0.58	1.49	2.94	4.43							0.87			0.87							5.88

Table:3.9(B) Blockwise Landuse/Cover Status in Kamptee Coalfield

Area in Sq.Km

Sl.no	Name of block	Dense Forest	Open Forest	Total Forest	Scrubs	Plantation on OB	Plantation on Backfill	Social Forestry	Total plantation	Total vegetation	Crop Lands	Fallow Lands	Total Agiculture Land	Coal Quarry	Backfilling area	Barren OB dump	Water filled Quarry	Coal dump	Total Mining area	Waste up land	Fly ash pond	Sand body	Total waste land	Urban Settlement	Rural Settlement	Industrial Settlement	Total settlement	Water body	Total water body	Total area (Sq.km)
20	Saoner PH-II				0.48			0.08	0.08	**0.56**	1.6	1.13	**2.73**							0.77			**0.77**	1.14	0.02		**1.16**	0.28	**0.28**	**5.50**
21	Saoner ph-ii extn				0.92			0.03	0.03	**0.95**	2.13	1.78	**3.91**							0.05			**0.05**	0.06	0.01		**0.07**	0.05		**4.98**
22	Patansaongi				0.22			0.04	0.04	**0.26**	1.07	0.46	**1.53**							0.03		0.07	**0.10**		0.13		**0.13**	0.11	**0.11**	**2.13**
23	West of patansaongi				0.62			0.13	0.13	**0.75**	1.41	0.94	**2.35**							0.4		0.10	**0.50**		0.11		**0.11**	0.22	**0.22**	**3.93**
24	Patansaongi UG				0.43					**0.43**	2.83	1.17	**4.00**							0.12			**0.12**	0.17	0.07		**0.24**			**4.79**
25	Patansaongi deep side				1.06			0.02	0.02	**1.08**	3.40	1.96	**5.36**							1.51	0.03	0.14	**1.68**	0.08			**0.08**	0.35	**0.35**	**8.55**
26	Pipla UG				0.28			0.06	0.06	**0.34**	1.82	0.59	**2.41**											0.13			**0.13**			**2.88**
27	Khapa				0.12			0.01	0.01	**0.13**	2.20	0.71	**2.91**							0.16			**0.16**	0.46			**0.46**			**3.66**
28	West of Khapa		0.01	0.01	0.28					**0.29**	2.07	0.88	**2.95**							0.04		0.11	**0.15**	0.13	0.01		**0.14**	0.20	**0.20**	**3.73**
29	Silwara dip side				0.23			1.00	**1.00**	**1.23**	2.28	0.76	**3.04**							0.44			**0.44**	1.32			**1.32**			**6.03**
30	AB incline				0.15			0.01	**0.01**	**0.16**	1.42	0.4	**1.82**											0.09			**0.10**			**2.08**
31	Silwara mine				0.61			0.14	**0.14**	**0.75**	2.71	1.10	**3.81**							0.17		0.05	**0.22**	0.20			**0.20**			**4.98**
32	Singori		0.01	0.01	0.80					**0.81**	1.53	0.73	**2.26**									0.05	**0.05**	0.12			**0.12**	0.12	**0.12**	**3.36**
33	Bina				0.32			0.27	**0.27**	**0.69**	0.51	1.70	**2.21**							0.15		0.14	**0.29**	0.13			**0.13**	0.09	**0.09**	**3.41**
34	Ghatraon extn				0.06			0.28	**0.28**	**0.34**	1.54	0.51	**2.05**							0.15	0.15	0.17	**0.47**	0.01	0.15		**0.16**	0.18	**0.18**	**3.20**
35	Inder OC				0.29	0.09		0.11	**0.11**	**0.40**	0.99	0.35	**1.34**	0.07	0.42	0.23		0.07	**0.79**	0.13			**0.13**	0.06			**0.06**			**2.72**
36	Inder extn				0.07			0.01	**0.01**	**0.08**	1.41	0.88	**2.29**									0.08	**0.08**					0.06	**0.06**	**2.51**
37	Kamptee OC				0.04	0.35		0.18	0.18	**0.57**	0.52	1.10	**1.62**	0.73	0.08	0.44	0.04		**1.29**	0.08		0.32	**0.40**	0.14			**0.14**	0.14	**0.14**	**4.16**
38	Kamptee (E) extn					0.21		0.23	**0.23**	**0.44**				0.06		0.25	0.15	0.01	**0.47**	0.18		0.06	**0.24**	0.79			**0.79**	0.04	**0.04**	**1.98**
39	Gondegaon OC					0.06								0.07	0.42	0.23	0.04		**0.76**	0.02			**0.02**							**0.78**
40	Ghatraon OC				0.13	0.04		0.07	**0.07**	**0.20**	0.63	0.30	**0.93**	0.96	0.02	0.05	0.04	0.14	**1.21**	0.24			**0.24**			0.02	**0.02**			**2.60**
41	Khapa Khera		0.01	0.01	0.25			0.64	**0.64**	**0.90**	0.51	0.28	**0.79**							0.22		0.12	**0.34**	0.6		0.30	**0.90**	0.23	**0.23**	**3.16**
42	Bokhara				0.66			0.26	**0.26**	**0.92**		0.80	**0.80**							0.7			**0.70**	0.79			**0.79**			**3.21**
43	Bina extn				0.10					**0.10**	1.76	0.99	**2.75**									0.13	**0.13**	0.01			**0.01**	0.09	**0.09**	**3.08**
44	Umri kamathi mohpa		0.09	0.05	15.20		0.02	0.33	**0.33**	**15.58**	30.96	45.01	**75.97**							0.89		0.05	**0.94**	0.32	1.15	0.18	**1.65**	3.20	**3.20**	**97.34**
45	Saoner		0.01	0.01	1.59			0.11	**0.11**	**1.71**	1.90	1.95	**3.85**							1.55			**1.55**	0.41	0.04		**0.45**	0.13	**0.13**	**7.69**
	Total	**1.58**	**17.24**	**18.78**	**61.94**	**0.75**	**0.02**	**7.45**	**7.45**	**88.83**	**164.58**	**180.65**	**345.23**	**1.89**	**0.94**	**1.20**	**0.27**	**0.22**	**4.52**	**17.22**		**2.61**	**20.02**	**15.10**	**3.55**	**1.29**	**19.95**	**13.25**	**13.20**	**491.75**

Chapter 4

Conclusion & Recommendation

4.1 Conclusion

In the present study, land use/ vegetation cover mapping has been carried out based on IRS-R2/ L4FX satellite data of the year2016 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 Vegetation cover which includes dense forests, open forests, scrubs, avenue plantation & plantation on over-burden dumps, covers an area of 278.74km^2 (20.74%) in the year 2016. As compared to year 2013 study there is a increase in overall vegetation cover by 1.38km^2 (0.13%) this is mainly because massive plantation carried out by WCL. Area of scrubs has increased by 0.56Sq.Km (0.04%). because of good monsoon. The analysis further indicates that total agricultural land which includes both crop and fallow land has been decreased to 5.08km^2 (0.38 %) .This is due to some of fallow land occupied by sand body, plantation and conversion into waste land. The mining area which includes coal quarry, barren OB dump, barren backfilled area, covers 5.75km^2 (0.42%). As compared to 2013 there is a minor increase i.e 0.51Sq.Km (0.03%) in areas in the year 2016 .This is due to increase in mining operations started in Bhanegaon OCP and increase in mining activity. Wasteland covers79.33km^2 (5.91%) in 2013 and 80.66 km^2 (6.00%) in 2016. Waste lands have increased to 1.33 Sq.Km area (0.09%) because some fallow land has been converted in waste land . Surface water bodies covered area of 38.78 km^2 (2.88%).in year 2016 as compared to 36.92 Sq.Km (2.75%) in year 2013 .Hence area covered by water body has been increased to 1.86Sq.Km(0.13%) as compared to year 2013 due to good monsoon.

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 Kamptee 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.