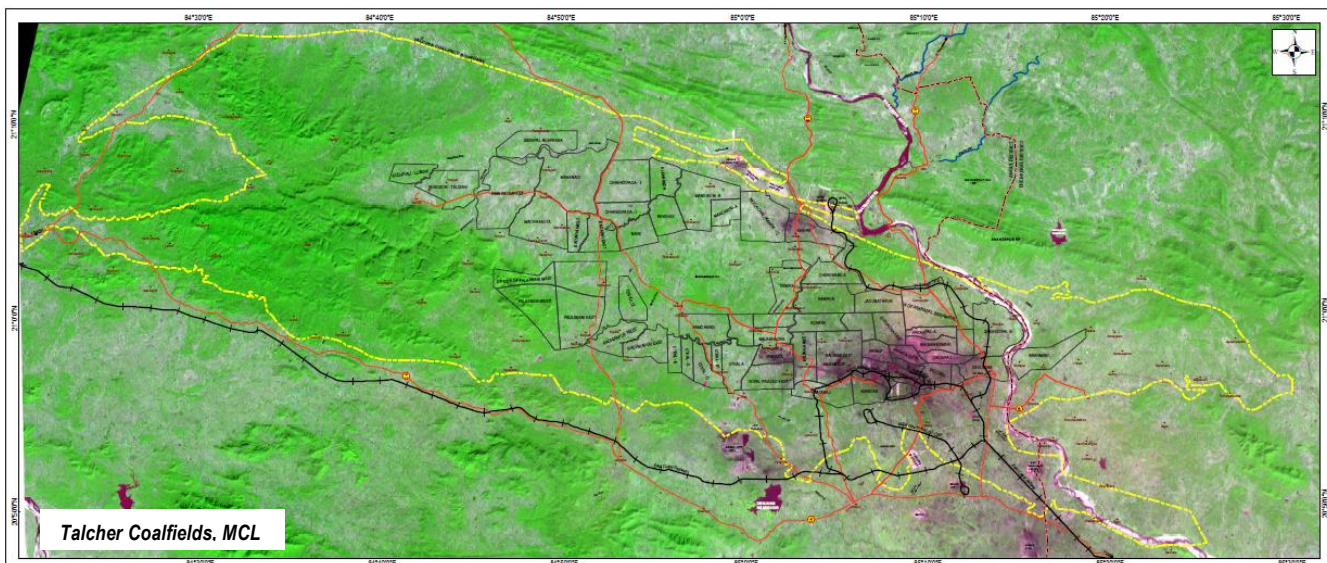


# REPORT ON LAND USE / VEGETATION COVER MAPPING OF TALCHER COALFIELD BASED ON SATELLITE DATA OF THE YEAR 2016



Submitted to  
**MAHANADI COALFIELDS LIMITED**  
**SAMBALPUR**

March 2017

**Report on  
Land Use / Vegetation Cover Mapping of Talcher Coalfield  
based on Satellite date of the year 2016**

*Submitted to*  
**Mahanadi Coalfields Limited  
Sambalpur**

***March - 2017***



**Remote Sensing Cell  
Geomatics Division  
CMPDI(HQ), Gondwana Place,  
Kanke Road, Ranchi – 834 008  
JHARKHAND**

---

## Document Control Sheet

- |                             |  |
|-----------------------------|--|
| (1) Job No.                 | 561410027  |
| (2) Publication Date        | March 2017   |
| (3) Number of Pages         | 35   |
| (4) Number of Figures       | 06   |
| (5) Number of Tables        | 06   |
| (6) Number of Plates        | 01   |
| (7) Number of Drawings      | 02   |
| (8) Title of the Report     | Land Use / Vegetation Cover mapping of Talcher Coalfield using satellite data of the year 2016.                                  |
| (9) Aim of the Report       | Preparation of land use/vegetation cover map of Talcher Coalfields on 1:50,000 scale based on IRS – R2 / L4FX satellite data.    |
| (10) Executing Unit         | Remote Sensing Cell<br>Geomatics Division<br>Central Mine Planning & Design Institute Ltd.<br>Gondwana Place, Kanke Road, Ranchi |
| (11) User Agency            | Mahanadi Coalfields Limited, Sambalpur   |
| (12) Author                 | Rakesh Ranjan Senior Manager (RSC)   |
| (13) Security Restriction   | Restricted Circulation   |
| (14) No. of Copies          | 7  |
| (15) Distribution Statement | Official   |

**List of Figures**

1. Map of India showing the location of Talcher Coalfield.
2. Remote Sensing Radiation System.
3. Electromagnetic Spectrum
4. Expanded Diagram of the visible and infrared regions.
5. Methodology of Land use/ Vegetation cover mapping.
6. Geoid-Ellipsoid Projection relationship.

**List of Tables**

1. Electromagnetic Spectral Regions
2. Characteristics of Satellite Sensor
3. Classification Accuracy Matrix
4. Land use / Vegetation Cover classes identified in Talcher Coalfield.
5. Status of Land Use/ Vegetation Cover pattern in Talcher Coalfield.

**List of Plates**

1. Location Map

**List of Drawings**

1. Land use/ Vegetation cover map of Talcher Coalfield based on IRS –R2 / LISS4FX data of the year 2016.
2. FCC Map of Talcher Coalfield based on IRS –R2 / L4FX data of Year 2016.

# Contents

<b>Description</b>	<b>Page No.</b>
Document Control Sheet	i
List of Figures	ii
List of Tables	ii
List of Plates	ii
<b>1.0 Introduction</b>	<b>1-4</b>
1.1 Project Reference	
1.2 Project Background	
1.3 Objective	
1.4 Location of the Area & Accessibility	
1.5 Physiography	
<b>2.0 Remote Sensing Concept &amp; Methodology</b>	<b>5-19</b>
2.1 Remote Sensing	
2.2 Electromagnetic Spectrum	
2.3 Scanning System	
2.4 Data Source	
2.5 Characteristics of Satellite/Sensor	
2.6 Data Processing	
2.6.1 Geometric Correction, rectification & geo-referencing	
2.6.2 Image enhancement	
2.6.3 Training set selection	
2.6.4 Signature generation & classification	
2.6.5 Creation / Overlay of vector database in GIS	
2.6.6 Validation of classified image	
<b>3.0 Land Use/ Cover Mapping</b>	<b>20-28</b>
3.1 Introduction	
3.2 Land use/ Vegetation cover Classification	
3.3 Data Analysis in Talcher Coalfield	
3.3.1 Settlement	
3.3.2 Vegetation Cover	
3.3.3 Agriculture	
3.3.4 Mining Area	
3.3.5 Wasteland	
3.3.6 Water Bodies	
<b>4.0 Conclusion and Recommendations</b>	<b>29</b>
4.1 Conclusion	
4.2 Recommendations	

# Chapter 1

## Introduction

### 1.1 Project Reference

Coal India Limited requested CMPDI to take up the study based on remote sensing satellite data for creating the geo-environmental data base of coalfields for monitoring the impact of coal mining on land use and vegetation cover. Accordingly, a road map for implementation of the 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 land environment at a regular interval of three years. A work order no. CIL/WBP/Env/2009/2428 dated 29.12.2009 was issued by CIL initially for three years. Subsequently, a revised work order was issued vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 from Coal India Limited for the period 2012-13 to 2016-17 for land reclamation monitoring of all the opencast projects as well as vegetation cover monitoring of 28 major coalfields including Talcher Coalfield as per a defined plan for monitoring the impact of mining on Vegetation Cover.

### 1.2 Project Background

Mahanadi Coalfield Ltd. is a subsidiary of Coal India Limited, dedicated for maintaining the ecological balance in the region has initiated a massive plantation programme on backfilled area, OB dumps and wasteland. 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 been taken up to assess the impact of coal mining on land use and vegetation cover in

Talcher Coalfield with respect to the earlier study carried out for Talcher Coalfield in the year 2013.

### **1.3 Objective**

The objectives of the present study is to prepare land use/ cover map of part of Talcher Coalfields covering the mining projects on a scale 1:50,000 based on satellite data of the year 2016 for creating the geo-environmental data base in respect of land use, vegetation cover, drainage, mining area, infrastructure etc. and regular updation of database at regular interval of three years to assess the impact of coal mining and other industrial activities on land use and vegetation cover in the coalfield area.

### **1.3 Location of the Area & Accessibility**

**Talcher coalfield**, bounded by latitudes 23<sup>0</sup>53'N & 21<sup>0</sup>12'N and longitudes 84<sup>0</sup>20'E & 85<sup>0</sup>23'E, covers an area of about 1800 Km<sup>2</sup>. It constitutes south-eastern part of the Lower Gondwana basins within Mahanadi Valley Graben. Major part of the coalfield including the present coal mining area falls in Angul district. A small part of the coalfield in the West lies in Sambalpur district and in the North lies in Deogarh district, whereas another small part lying to the East of the Brahmani River falls in Dhenkanal district. *Location map of the study area is given at Plate 1.*

South-eastern part of the coalfield where the coal mining activities are in progress at present is connected by rail to Bhubaneswar (150 Km), the capital city of Orissa. Bhubaneswar is located on the Howrah-Chennai main railway line. The coalfield is well connected by rail and road to Paradip port. NH-42 connecting Cuttack – Angul - Sambalpur passes more or less parallel to the southern fringe of the coalfield. NH-23 connecting Talcher – Samal - Pal Lahara passes through

the eastern part of the coalfield. Another prominent road connecting Angul - Chhendipada - Deogarh passes through the central part of the coalfield.

A railway line connecting Talcher town with Sambalpur has been constructed and commissioned in August 1998. With the completion of this project the coalfield is now connected to western India via Jharsuguda on Howrah-Mumbai main line.

## **1.4 Physiography**

**Talcher coalfield** can be divided into two parts: (i) eastern part, and (ii) western part. The eastern part, largely covered by the Barakar formation is slightly undulating with an average elevation of approximately 150 m above MSL. The western part, however, comprises largely of steeply sloping Kamthi hillocks. The elevation in the coalfield, in general, varies within 60 m and 567 m above MSL.

The coalfield is drained by the Brahmani River flowing along the eastern fringe of the coalfield. Singhada Jhor, Nandira and Tikra are some of the important tributaries of the Brahmani River.



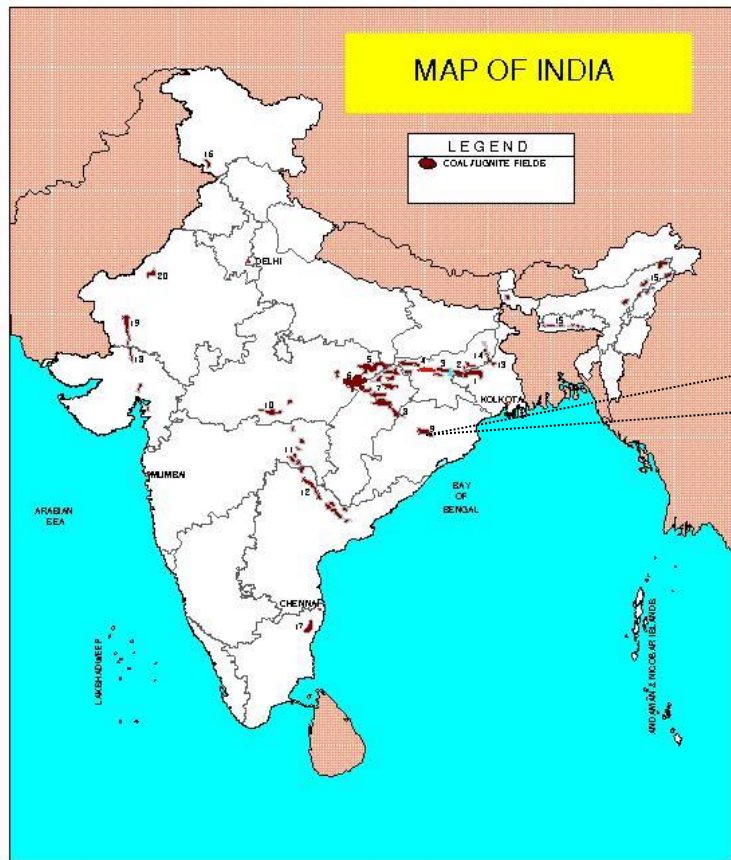


Plate - 1 : Location Map of Talcher Coalfield

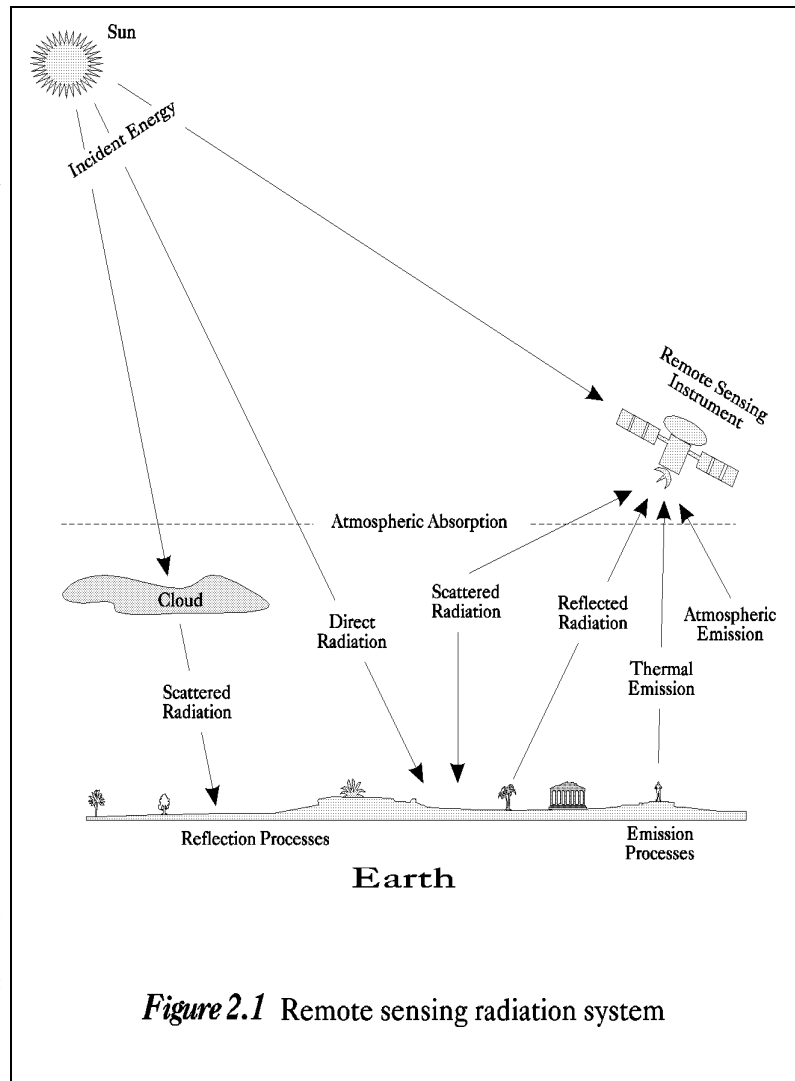
## Chapter 2

### 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 electromagnetic energy (such as light, heat and radio waves) as the means of detecting and measuring object characteristics.

All physical objects on the earth surface continuously emit electromagnetic radiation because of the oscillations of their atomic



**Figure 2.1** Remote sensing radiation system

particles. Remote sensing is largely concerned with the measurement of electromagnetic 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.

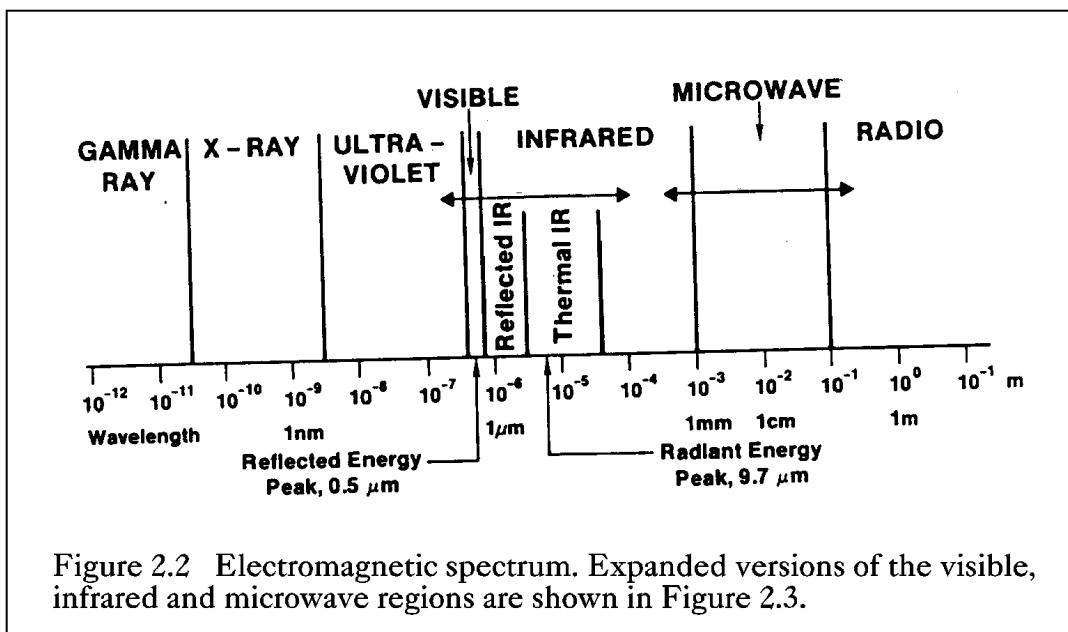
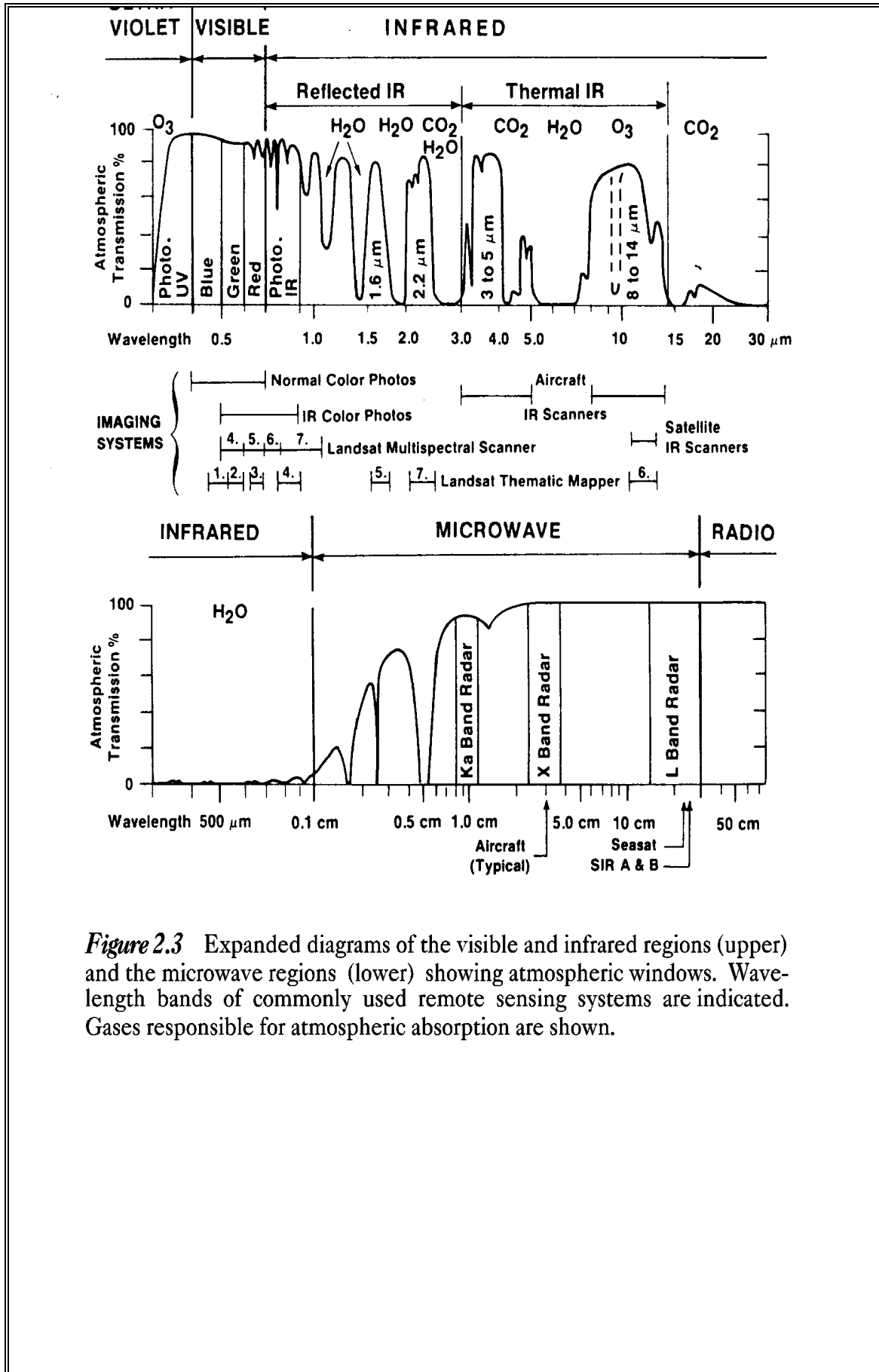


Figure 2.2 shows the electromagnetic spectrum, which is divided on the basis of wavelength into different regions that are described in Table 2.1. The EM spectrum ranges from the very short wavelengths of the gamma-ray region to the long wavelengths of the radio region. The visible region ( $0.4\text{-}0.7 \mu\text{m}$  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  $0.5 \mu\text{m}$  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  $9.7 \mu\text{m}$  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 $\mu\text{m}$	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 $\mu\text{m}$	Transmitted through atmosphere. Detectable with film and photo detectors, but atmospheric scattering is severe.
<i>Visible</i>	0.40 to	0.70 $\mu\text{m}$	Imaged with film and photo detectors. Includes reflected energy peak of earth at 0.5mm.
<i>Infrared</i>	0.70 to	100.00 $\mu\text{m}$	Interaction with matter varies with wavelength. Absorption bands separate atmospheric transmission windows.
<i>Reflected IR band</i>	0.70 to	3.00 $\mu\text{m}$	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 $\mu\text{m}$ 14.00 $\mu\text{m}$	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. The major remote sensing sensors records energy only in the visible, infrared and micro-wave regions. 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), which 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 provides an efficient, speedy and cost-effective method for assessing the changes in vegetation cover certain period of time due to its inherited capabilities of being multi-spectral, repetitive and synoptic aerial coverage.

## 2.4 Data Source

The following data are used in the present study:

- **Primary Data** –Raw satellite data, obtained from National Remote Sensing Centre (NRSC), Hyderabad, as follows, was used as primary data source for the study.

IRS – R2/ (L4FX); Band 2,3,4,5; Path # 105 Row # 057/058; Date of pass 24.01.2016. The detail specification of the data is also given in Table 2.2.

- **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.

## 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 IRS-R2/L4FX satellite/ sensor that is used in the present study.

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

Platform	Sensor	Spectral Bands in nm	Radiometric Resolution	Spatial Resolution	Temporal Resolution	Country
IRS-R2	L4FX	B2 0.52 - 0/59 Gree B3 0.62 - 0.68 Red B4 0.77 - 0.88 NIR	16-bit (256-grey levels)	5.8 m	24 days	India

NIR: Near Infra-Red

## 2.6 Data Processing

The methodology for data processing carried out in the present study is shown in Figure 2.4. The processing 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) Layer wise theme extraction using GIS
- (g) Final vegetation map preparation.



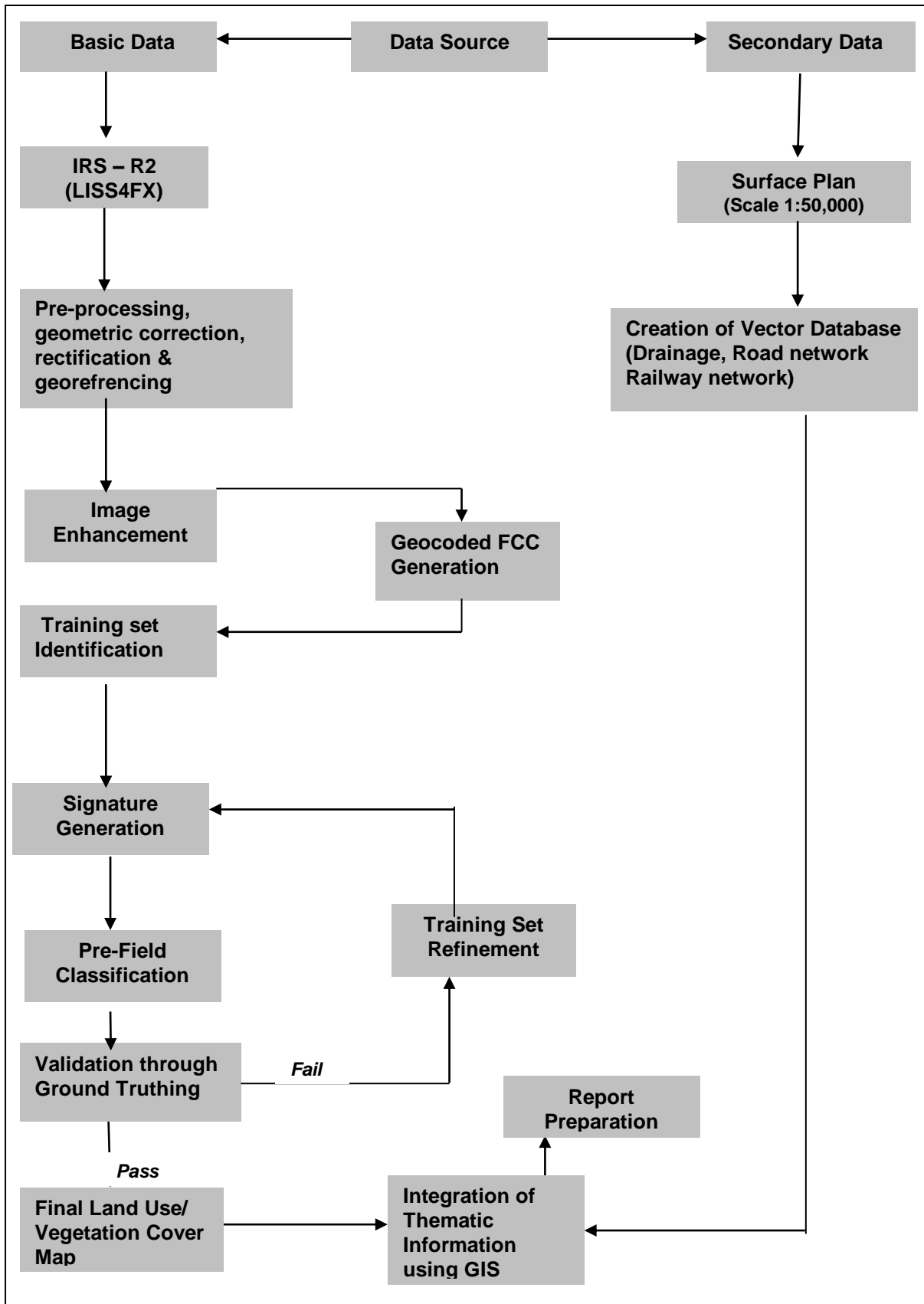


Fig 2.4: Methodology for Land Use / Vegetation Cover Mapping

### 2.6.1 Geometric correction, rectification and georeferencing

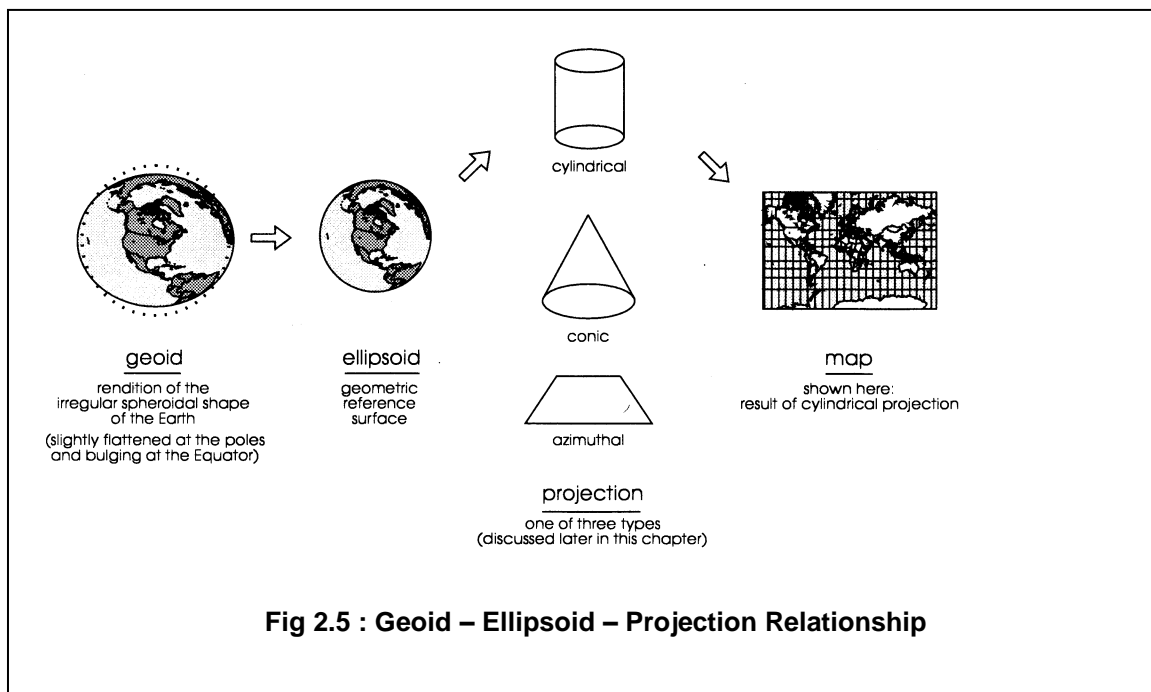
Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to intermittent sensor malfunctions, etc. Systematic errors are corrected at the satellite receiving station itself while non-systematic errors/ 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 geo-referencing 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 this projection is 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 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 were applied on the image data using PCI Geomatica s/w.

### **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, 90 points were selected to generate the training sets.

### **2.6.4 Signature generation and classification**

Image classification was carried out using the minimum distance 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 PCI Geomatica v10.1 s/w. The classified image for the year 2016 for Talcher Coalfield is shown in Drawing No. HQ/REM/A0/0002.

### **2.6.5 Creation/overlay of vector database in GIS**

Plan showing leasehold areas of mining projects supplied by MCL are superimposed on the image as vector layer in the GIS database. Road network, rail network and drainage network are digitised on different vector layers in GIS database. Layer wise theme extraction was carried out using ArcGIS s/w and imported the same on GIS platform for further analysis.

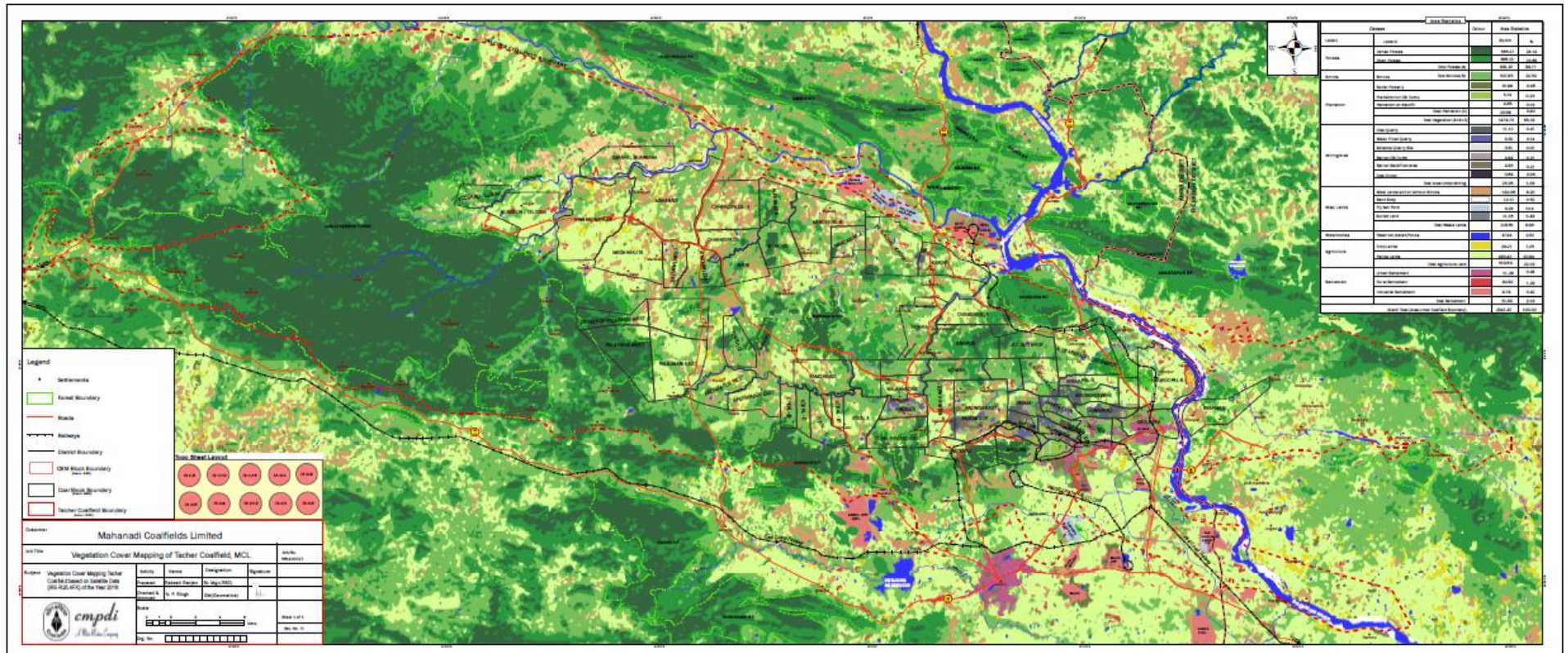
### **2.6.6 Validation of classified image**

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 overall classification accuracy of the satellite data for the year 2016 was found to be 88.59%.

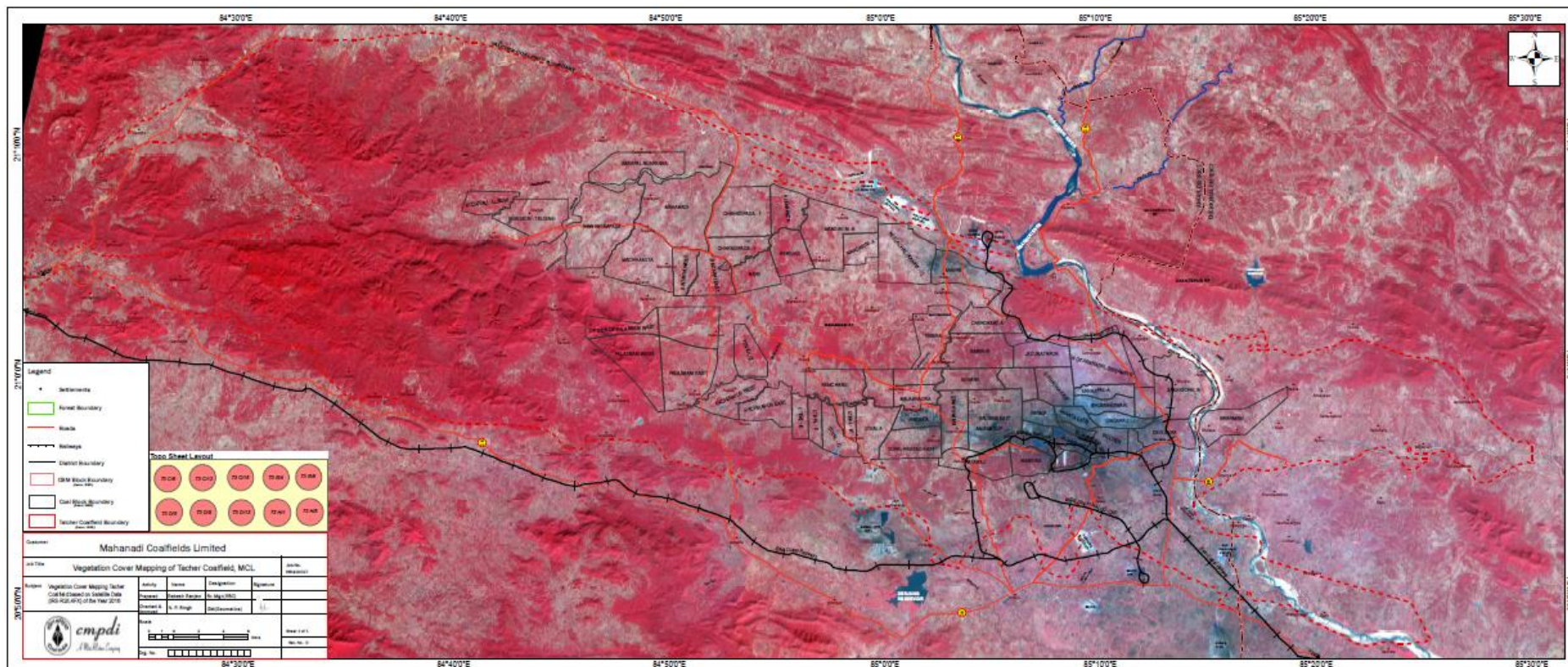
Final Land Use/ Vegetation cover maps prepared on 1:50,000 scale were printed using HP Design jet 4500 PS Colour Plotter scaled to ISO A0 Size due to plotter paper size limitation.

Table 2.3: Classification Accuracy Matrix for Talcher Coalfield in the year 2016

Sl.#	Vegetation\Land use classes as observed in the field	Built-up land	Vegetation Cover	Agriculture	Wasteland	Mining Area	Water Bodies	Total no. of observation points (Z)	% of observation points	% of classification accuracy	% of omission
<b>Land use/vegetation cover Classes based on Satellite Data</b>											
(b)	Vegetation Cover		16	2				18	20.00	<b>88.89</b>	11.12
(g)	Mining Area				1	7		8	8.89	<b>87.5</b>	12.5
(c)	Agriculture		2	18				20	22.22	<b>90.00</b>	10.00
(d)	Wasteland	1			24		1	26	28.89	<b>92.31</b>	7.69
(a)	Built-up land	13			1			14	15.56	<b>92.86</b>	7.14
(h)	Water Bodies					1	4	5	5.56	<b>80.0</b>	20.0
<b>Total no. of observation points (X)</b>		14	18	20	26	8	5	90	-	<b>88.59</b>	-
<b>% of Commission</b>		7.14	11.11	10.00	7.69	12.5	20.0				



Drg.- 1 : Vegetation Cover Map of Talcher Coalfield based on Satellite Data of the year 2016



Drg. - 2 : FCC Map (Band 3, 2, 1) of Talcher Coalfield based on Satellite Data of the year 2016



## Chapter 3

### Land Use/ Vegetation Cover Monitoring

#### 3.1 Introduction

The need for information on land use/ vegetation cover has gained importance due to the all-round concern on environmental impact of mining. The information on land use/cover inventory that includes 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 / vegetation cover. Moreover, with passage of time, demand for coal has increased many folds and therefore production from the mines has also increased and hence the mining areas also kept on increasing. Therefore, it is important to know the existing land use pattern and the changes that have occurred during previous years, so as to predict the possible changes due to mining in future around the existing coal mines. Remote sensing data with its various spectral and spatial resolutions, offers comprehensive and accurate information for mapping and monitoring of land use/cover over a period of time.

Realising the need of monitoring of land use/ vegetation cover and land reclamation in Talcher coalfields; CIL/MCL requested the services of CMPDI to prepare land use/ vegetation cover map for assessing the impact of coal mining on land use pattern and vegetation cover using remote sensing data at an interval of three years which will help in formulating the mitigative measure, if any required for environmental protection in the coal mining area.

The present study incorporates the findings on Land use / Vegetation Cover pattern in the Talcher Coalfield, MCL based on satellite data of the year 2016. Similar study has also been done previously in the year 2013.

## 3.2 Land Use / Vegetation Cover Classification

The array of information available on land use/ vegetation cover requires be arranging or grouping under a suitable framework in order to facilitate the creation of database. Further, to accommodate the changing land use/vegetation 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 Agency, Hyderabad, which has further been modified by CMPDI for coal mining areas. Land use/vegetation cover map was prepared on the basis of image interpretation carried out based on the satellite data for the year 2016. Following land use/cover classes are identified in the Talcher coalfield region (Table 3.1).

<b>Table 3.1 Land use / Vegetation Cover classes identified in Talcher Coalfield</b>		
	<b>LEVEL -I</b>	<b>LEVEL-II</b>
1	<b>Vegetation Cover</b>	1.1 Dense Forest 1.2 Open Forest 1.3 Scrub 1.4 Plantation under Social Forestry 1.5 Plantation on OB Dumps 1.6 Plantation over Backfilled Areas
2	<b>Mining Area</b>	2.1 Coal Quarry 2.2 Advance Quarry Site 2.3 Barren OB Dump 2.4 Barren Backfill 2.5 Coal Dump 2.6 Water Filled Quarry
3	<b>Agricultural Land</b>	3.1 Crop Land; 3.2 Fallow Land
4	<b>Wasteland</b>	4.1 Waste upland with/without scrubs 4.2 Gullied Land 4.3 Fly Ash Pond 4.4 Sand Body
5	<b>Settlements</b>	5.1 Urban 5.2 Rural 5.3 Industrial
6	<b>Water Bodies</b>	6.1 River/Streams /Reservoir

### 3.3 Data Analysis

Satellite data of the year 2016 was processed using PCI Geomatica image processing s/w in order to interpret the various land use and vegetation cover classes present in the Talcher coalfield. The analysis was carried out for entire coalfield covering about 2341.87 sq. km. The area of each class was calculated and analysed using PCI Geomatica *Digital Image Processing* s/w and *ArcGIS* s/w. Analysis of land use / vegetation cover pattern in Talcher Coalfield for the year 2016 was carried out and details of the analysis are and shown in the tables below; In the present study, the study area is covering the entire geological boundary of Talcher Coalfield which comes to 2341.87 sq. kms. The distribution of Vegetation Cover statistics classes covering the Talcher Coalfield is detailed in the Table -3.2 below:

TABLE – 3.2

## COMPARISON OF STATUS OF LAND USE &amp; VEGETATION COVER PATTERN IN TALCHER COALFIELD IN THE YEAR 2013 &amp; 2016

LAND / VEGETATION COVER CLASSES	Year 2013		Year 2016		Changes w.r.t 2013		Remarks
	Area	%	Area	%	Area	% of total	
<b>VEGETATION COVER</b>							
Dense forest	565.34	24.14	565.27	24.14	(-) 00.07	(-) 00.003	<i>Changes in vegetation cover are due to marginal decrease in dense forest cover &amp; scrubs due to biotic interference.</i>
Open Forest	362.89	15.50	366.10	15.63	(+) 03.21	(+) 00.137	
Scrubs	533.78	22.79	527.35	22.52	(-) 06.43	(-) 00.275	
Plantation under Social Forestry	9.57	0.41	10.88	0.46	(+) 01.31	(+) 00.056	
Plantation over Backfill	3.51	0.15	4.36	0.19	(+) 00.85	(+) 00.036	
Plantation on OB Dump	5.80	0.25	5.74	0.25	(-) 00.06	(-) 00.003	
<b>Sub Total</b>	<b>1480.89</b>	<b>63.24</b>	<b>1479.70</b>	<b>63.18</b>	<b>(-) 01.19</b>	<b>(-) 00.051</b>	
<b>MINING AREA</b>							
Coal Quarry/Active Mining Area	8.81	0.38	11.11	0.47	(+) 02.30	(+) 00.098	<i>Changes due to expansion of existing mining projects and increase in coal production.</i>
Advance Quarry Site	0.06	0.00	0.31	0.01	(+) 00.25	(+) 00.011	
Coal Dump	0.46	0.02	0.64	0.03	(+) 00.18	(+) 00.008	
Barren Backfilled Area	5.18	0.22	4.95	0.21	(-) 00.23	(+) 00.330	
Barren OB Dump	5.41	0.23	4.94	0.21	(-) 00.47	(-) 00.020	
Water Filled Quarry	2.62	0.11	3.31	0.14	(+) 00.69	(+) 00.029	
<b>Sub Total</b>	<b>22.54</b>	<b>0.96</b>	<b>25.26</b>	<b>1.08</b>	<b>(+) 02.72</b>	<b>(+) 00.116</b>	
<b>AGRICULTURAL LAND</b>							
Crop Land	31.51	1.35	29.21	1.25	(-) 02.30	(-) 00.098	<i>Decrease in agricultural area is due to increase in industrial and mining activities in the agricultural area.</i>
Fallow Land	492.14	21.01	490.42	20.94	(-) 01.72	(-) 00.073	
<b>Sub Total</b>	<b>523.65</b>	<b>22.36</b>	<b>519.63</b>	<b>22.19</b>	<b>(-) 04.02</b>	<b>(-) 00.172</b>	
<b>WASTELAND</b>							
Waste upland	192.71	8.23	192.06	8.20	(-) 00.66	(-) 00.028	<i>Due to industrialisation in the area.</i>
Fly-Ash Pond	1.77	0.08	3.28	0.14	(+) 01.51	(+) 00.064	
Sand Body	10.92	0.47	12.11	0.52	(+) 01.19	(+) 00.051	
Gullied Land	11.16	0.48	11.16	0.48	(+) 00.00	(+) 00.000	
<b>Sub Total</b>	<b>216.57</b>	<b>9.25</b>	<b>218.61</b>	<b>9.33</b>	<b>(+) 02.04</b>	<b>(+) 00.087</b>	
<b>SETTLEMENTS</b>							
Urban	11.19	0.48	11.28	0.48	(+) 00.09	(+) 00.004	<i>Changes are due to industrialisation in the area.</i>
Rural	30.30	1.29	30.32	1.29	(+) 00.02	(+) 00.001	
Industrial	9.57	0.41	9.73	0.42	(+) 00.16	(+) 00.007	
<b>Sub Total</b>	<b>51.06</b>	<b>2.18</b>	<b>51.33</b>	<b>2.19</b>	<b>(+) 00.27</b>	<b>(+) 00.012</b>	
<b>WATER BODIES</b>	<b>47.16</b>	<b>2.01</b>	<b>47.34</b>	<b>2.02</b>	<b>(+) 00.18</b>	<b>(+) 00.008</b>	
<b>TOTAL</b>	<b>2341.87</b>	<b>100.00</b>	<b>2341.87</b>	<b>100.00</b>			

### 3.3.1 Settlement/ Built-up land

All the man-made constructions covering the land surface are included under this category. Built-up land has been divided in to rural, urban and industrial classes based on availability of infrastructure facilities. In the present study, industrial settlement indicates only industrial complexes excluding residential facilities. The percentage of settlement shown in the analysis here is in terms of total land use cover only.

Settlements in Talcher Coalfield covers an area of 51.33 km<sup>2</sup> (2.19%) out of the total coalfield area of 2341.87 km<sup>2</sup>. Analysis of the satellite data of the year 2016 indicated that settlement coming under the coalfield boundary of Talcher was distributed between *Urban* (11.28 km<sup>2</sup>: 0.48%), *Rural* (30.32 km<sup>2</sup>: 1.29%) and *Industrial* (9.73 km<sup>2</sup>: 0.42%) (Refer Table 3.2).

### 3.3.2 Vegetation cover Analysis

Vegetation cover is an association of trees and other vegetation type capable of producing timber and other forest produce. It is also defined as the percentage of soil which is covered by green vegetation. Leaf area index (LAI) is an alternative expression of the term vegetation cover which gives the area of leaves in m<sup>2</sup> corresponding to an area of one m<sup>2</sup> of ground. Primarily vegetation cover is classified into the following three sub-classes based on crown density as per modified FAO-1963 (Food & Agricultural Organisation of United Nations) norms: (a) dense forest (crown density more than 40%), (b) open/degraded forest (crown density between 10% to 40%), and (c) scrubs (crown density less than 10%). The plantation that has been carried out on wasteland along the roadside and on the overburden dumps / Backfilled areas is also included under vegetation cover as social forestry and plantation on over-burden dumps respectively. The percentage of vegetation cover shown in the analysis here are in terms of total landuse cover only.

Analysis of the satellite data of the year 2016 indicated that vegetation cover in the Talcher Coalfield boundary occupies 1479.70 km<sup>2</sup> (63.18%). Out of which, *dense forest* covers an area of 565.27 km<sup>2</sup> (24.14%), *open forest* covers area of 366.10 km<sup>2</sup> (15.63%); *Scrubs* has covered 527.35 km<sup>2</sup> (22.52%), Plantation on OB dumps occupies 5.74 km<sup>2</sup> (0.25%), Plantation on Backfill occupies 4.36 km<sup>2</sup> (0.19%) and Plantation under Social Forestry occupies 10.88 km<sup>2</sup> (0.46%) in 2016 (Refer Table 3.2).

### 3.3.3 Agriculture

Land primarily used for farming and production of food, fibre and other commercial and horticultural crops falls under this category. It includes crop land and fallow land. *Crop lands* are those agricultural lands where standing crop occurs on the date of satellite imagery or land is used for agricultural purposes during any season of the year. Crops may be either kharif or rabi. *Fallow lands* are also agricultural land which is taken up for cultivation but temporarily allowed to rest, un-cropped for one or more season. In this study, both crop land and fallow land has been combined in single class namely agricultural land.

Analysis of the satellite data of the year 2016 indicated that agriculture land coming under the coalfield boundary of Talcher Coalfield covered an area of 519.63 km<sup>2</sup> (22.19%); out of which *crop land* covers an area of 29.21 km<sup>2</sup> (1.25%) and *Fallow Land* covers area of 490.42 km<sup>2</sup> (20.94%) (Refer Table 3.2)

### 3.3.4 Mining

The mining area includes the area of existing quarry, old quarries filled with water, advance quarry sites, Coal Stock/Dumps, Coal Faces, Barren Backfilled areas, Barren over-burden dumps and allied activities.

The mining area in Talcher Coalfield covers 25.26 km<sup>2</sup> (1.08%) in the year 2016. *Coal quarry* constitutes 11.11 km<sup>2</sup> (0.47%), Advance Quarry Site constitutes 0.31

km<sup>2</sup> (0.01%), Barren OB Dumps constitute 4.95 km<sup>2</sup> (0.21%), Barren Backfill area constitutes 4.95 km<sup>2</sup> (0.21%), *Coal dumped/ stocks* constitute 0.64 km<sup>2</sup> (0.03%) and *Water Filled Quarries* cover area of 3.31 km<sup>2</sup> (0.14%).

### **3.3.5 Wasteland**

Wasteland is a degraded and under-utilised class of land that has deteriorated 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 other management constraints (NWDB, 1987).

Analysis of data reveals that waste land in the Talcher Coalfield occupies 218.61 km<sup>2</sup> (9.33%) out of which *Waste upland with or without scrubs* occupies 192.06 km<sup>2</sup> (8.20%), Fly Ash Ponds constitute 3.28 km<sup>2</sup> (0.14%), Gullied Land constitutes 11.16 km<sup>2</sup> (0.48%) and *Sand bodies* constitute 12.11 km<sup>2</sup> (0.52%) in 2016.

### **3.3.6 Surface Water bodies**

Analysis of data reveals that water bodies in Talcher Coalfield occupy area of 47.34 km<sup>2</sup> (2.02%).

Block wise Land Use / Vegetation Cover details of the coal blocks in the Talcher Coalfield has been calculated and the same is given hereunder in Table 3.3.





Table 3.3

**BLOCK WISE LAND USE / VEGETATION COVER DETAILS OF THE COAL BLOCKS IN  
TALCHER COALFIELD BASED ON SATELLITE DATA OF THE YEAR 2016**

(Area in Km<sup>2</sup>)

Sl.	PROJECT NAME	LAND USE / COVER CLASSES																			Total Area		
		US	RS	IS	DF	OF	SC	PUSF	POBD	PUBF	CL	FL	WUL	GL	SB	CQ	AQS	BOD	CD	BBF		WFQ	WB
41	JAGGANATH	1.68	0.00	0.03	0.00	0.37	2.44	0.14	0.13	0.01	0.00	0.54	0.30	0.00	0.00	0.00	0.18	0.00	0.19	0.00	0.00	0.00	6.01
42	TALCHER	0.00	0.01	0.01	0.00	0.00	0.67	0.00	0.00	0.16	0.00	0.47	0.02	0.00	0.00	0.00	1.10	0.01	1.19	0.02	0.30	0.32	4.28
43	ANANTA EXT	0.00	0.00	0.00	0.02	1.44	3.69	0.00	0.00	0.00	0.00	0.95	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.33
44	BALBHADRA 1	0.00	0.39	0.00	0.00	0.17	3.77	0.00	0.00	0.00	0.18	9.68	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.17
45	NUAGAON	0.00	0.03	0.00	0.00	0.23	2.80	0.01	0.00	0.00	0.02	2.16	0.64	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	5.90
46	BALABHADRA	0.62	0.00	0.00	0.00	0.00	0.76	0.00	0.17	0.00	0.00	0.18	0.08	0.00	0.00	0.00	0.01	0.00	0.13	0.00	0.00	0.00	1.95
47	HANDIDHUA	0.00	0.00	0.00	0.33	0.48	4.87	0.09	0.00	0.00	0.12	4.28	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.02
48	RAMCHANDI	0.00	0.00	0.00	1.71	6.55	4.01	0.00	0.00	0.00	0.02	1.25	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.37
49	RABIPUR	0.00	0.00	0.03	0.00	0.00	0.13	0.00	0.10	0.30	0.00	0.00	0.03	0.00	0.00	0.00	0.95	0.00	0.19	0.08	1.00	0.00	2.81
50	BHARATPUR1	0.00	0.06	0.12	0.00	0.14	1.10	0.00	0.01	0.00	0.00	2.21	0.15	0.00	0.00	0.00	0.00	0.00	0.72	0.00	0.00	0.00	4.51
51	ARKHAPAL A	0.00	0.00	0.00	0.68	0.20	1.61	0.00	0.00	0.00	0.04	0.86	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.58
52	UTKALE	0.00	0.20	0.00	0.00	0.00	0.83	0.24	0.00	0.00	1.42	14.67	3.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.37
53	MACHHAKUTA	0.00	0.02	0.00	0.74	1.47	2.66	0.16	0.00	0.00	0.27	0.89	2.51	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	8.83
54	ALKANANDA	0.00	0.61	0.00	0.00	0.03	5.25	0.08	0.00	0.00	3.53	15.90	4.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.19
55	NEW_PATRAP	0.00	0.00	0.00	0.07	1.19	5.58	0.00	0.00	0.00	0.41	11.84	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.27
56	PALASBANI	0.00	0.00	0.00	10.19	4.30	2.63	0.00	0.00	0.00	0.00	1.29	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.64
57	PALASBANI1	0.00	0.00	0.00	0.90	1.00	3.78	0.00	0.00	0.00	0.10	1.24	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.31
58	TENTULOI	0.00	0.00	0.00	2.98	2.47	0.87	0.00	0.00	0.00	0.00	0.99	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.06
59	DIPSIDE OF	0.00	0.00	0.00	0.53	1.70	4.97	0.00	0.00	0.00	0.10	5.20	1.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.42
60	DIPSIDE 1	0.00	0.19	0.00	0.00	0.40	6.94	0.02	0.00	0.00	0.26	3.28	1.39	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	12.50
61	TRIBIRA	0.00	0.04	0.00	0.00	1.66	2.12	0.02	0.00	0.00	0.06	4.33	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.01
62	CHANDRABIL	0.00	0.00	0.00	0.03	2.55	2.96	0.00	0.00	0.00	0.00	0.47	0.05	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.43
63	KUDANALI	0.00	0.54	0.00	0.00	0.34	3.70	0.00	0.00	0.00	0.00	4.66	1.66	0.00	3.31	0.31	0.00	0.00	0.00	0.00	0.00	0.00	14.52
64	SARAPAL NU	0.00	0.00	0.00	0.00	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.03	0.09	0.00	0.06	0.00	0.00	0.00	0.40
65	CHHENDIPADA 2	0.00	0.12	0.00	0.00	0.02	1.05	0.12	0.31	0.36	0.00	0.91	1.01	0.00	0.00	0.00	0.67	0.00	0.17	0.08	0.21	0.86	5.89
66	HINGULA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Note:** Details of Abbreviation used in the Table 3.4

Code	Class Name	Code	Class Name	Code	Class Name	Code	Class Name	Code	Class Name
US	Urban Settlement	SC	Scrubs	FL	Fallow Land	CD	Coal Dumps	FAP	Fly Ash Ponds
RS	Rural Settlement	PUSF	Plantation under Social Forestry	CQ	Coal Quarry	WFQ	Water Filled Quarry	WB	Water Bodies
IS	Industrial Settlement	POBD	Plantation over OB Dumps	AQS	Advance Quarry Site	SB	Sand Body		
DF	Dense Forest	POBF	Plantation over Backfill	BOBD	Barren OB Dumps	WUL	Waste upland		
OF	Open Forest	CL	Crop Land	BBF	Barren Backfill	GL	Gullied Land		

---

## Chapter 4

### Conclusion & Recommendations

#### 4.1 Conclusion

In the present study, land use/Vegetation cover map of Talcher Coalfield is prepared based on IRS-R2/ L4FX data of 2016 in order to generate the database on vegetation cover and land use pattern for the year 2016 for effective natural resource management and its planning. The Land use/vegetation cover analysis will help to analyse and monitor the impact of mining and other industrial activities in the area.

Study reveals that Talcher Coalfields covers an area of about 2341.87 km<sup>2</sup>. Settlements coming under the coalfield boundary cover area of 51.33 km<sup>2</sup> which is 2.19% of the total coalfield area. Vegetation cover constitutes 1479.70 km<sup>2</sup> (63.18%), Mining activities is on 25.26 km<sup>2</sup> area which is 1.08% of the total coalfield area whereas agriculture and wasteland are on 519.63 km<sup>2</sup> (22.19%) and 218.61 km<sup>2</sup> (9.33%) respectively. Water bodies cover an area of 47.34 km<sup>2</sup> (2.02%).The detailed data analysis is given under Table-3.2.

#### 4.2 Recommendations

Keeping in view the sustainable development together with coal mining in the area, it is recommended that;

- a) Similar study should to be carried out regularly at interval of 3 years to monitor the change in land use/vegetation cover in the coalfield for assessing the impact of coal mining and take the remedial measures required, if any.
- b) Efforts for afforestation should be given thrust in the coalfield on wasteland and mined out area to maintain the ecological balance in the region.



*cmpdi*  
*A Mini-Ratna Company*

## Central Mine Planning & Design Institute Ltd.

(A Subsidiary of Coal India Ltd.)

Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand

Phone : (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851

Website : [www.cmpdi.co.in](http://www.cmpdi.co.in), Email : [cmpdihq@cmpdi.co.in](mailto:cmpdihq@cmpdi.co.in)