

## Land Use Land Cover Classification in Jamuna- Kotma Coal Field Region, Anuppur District MP

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**Abstract:** The rate and intensity of land use/land cover (LU/LC) change has increased considerably during the past couple of decades. Mining brings significant alterations in LU/LC specifically due to its impact on forests. Parts of Central India are well endowed with both forests and minerals. Here, the conflict between human interests and nature has intensified over time. Monitoring and assessment of such conflicts are important for land management and policy making. Remote sensing and Geographical Information System have the potential to serve as accurate tools for environmental monitoring. The changing rules of the landscape elements and their distribution in Jamuna Kotma coal mining area are analyzed by means of topomap (1973) and remote sensing images obtained in, 2000, 2009. Using support vector machine classification method, it can be classified into six land-use types: water, agriculture, Forest, mining, settlement and waste land. In 1973 forest area was 174 sq. km. while in 2000 it reduced 96 sq. km. and in 2009 forest area were left only 68 sq. km. Water bodies have increase due to the mining activities. In 2000 mining area was 47 sq km. and in 2009 mining area had increased up to 64 sq km. Agriculture land had been reduced from 167 sq. km. (1973) to 110 sq. km. (2000) to 88 sq. km (2009). Waste lands have been continuously increasing since 1973 (26 sq km) to 2000 (81sq km) to 2009 (93 sq km).

**Keywords:** Land use, Land cover, Change Detection

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### I. Introduction:

Mining is a site-specific activity and is done at the sites where minerals exist. Also, mining is considered as an environmentally hostile activity. Global attention has been drawn towards the environmental impacts of mining and associated activities in mining complexes, and the action that are required to be taken for minimization prevention and mitigation of these impacts. The activities in mining complexes affect all the components of the environment and these effects could be temporary or permanent reversible or irreversible repairable or irreparable and beneficial or harmful. The growth of Indian coal industry has achieved very high rate since independence, especially after nationalization and this is accompanied by production of large volumes of hazardous solid, liquid and gaseous material during various mining and related activities. Due to the Mining activities topography and land use and land cover of the area are exceedingly changed. Forest area declined while the residential area increased. Besides this, waste land and water body has also been changed. It also affected the agricultural area. Land is the most important natural resource which embodies soil, water and associated flora and fauna involving the total ecosystem (Singh and Khanduri 2011; Chitade and Katyar 2010; Javed, 2009). Jamuna Kotma mining area is situated in Anuppur District of M.P. Area falls under SOI toposheet no. 64E/16 and 64I/4 in range of latitude in between 23°0' and 23°15' and longitude in between 81°45' and 82° 05'(fig.1). Anuppur – Chirimiri section of SECL Railway is passing through it. National highway (78) passes along northern side of the area and River Kewai passes along north – south of the study area. The area is gently undulating with the general slope towards River Kewai. The surface attains maximum and minimum elevation of 573.47 and 512.42 m respectively from Mean Sea Level (MSL). The temperature varies from 4.9°C to 44° c. Average annual rainfall is 1430 mm.

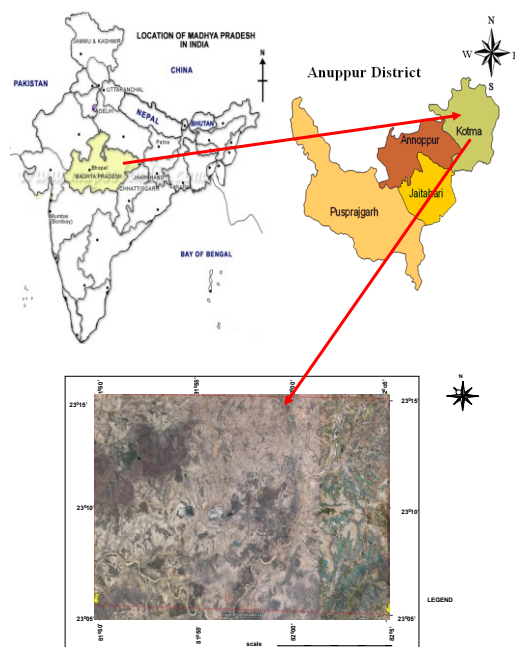


Fig. 1. Location Map of the area

## II. Methodology

### Data Preparation

The study was based on both topomap data and satellite data sources. The later Multi – temporal data were required to study the land use changes over a period of time. **LANDSAT TM satellite data** of 144 paths and 42 row of the area of interest was downloaded from the USGS website. With the help of ERDAS 8.6 Image processing software the downloaded image was import in img. format. These data are stacked in a single file and mosaic with the help of ERDAS software. By overlaying the area of interest on mosaic image the imagery of Kotma, the area was subset with the help of subset tool. Since image orthorectified, the subset image ready for classification. Digital Image classification uses the spectral information represented by the digital numbers in one or more spectral bands and attempts to classify each individual pixel based on this spectral information (Kuang et. al., 2007; Peter et.al., 2005)

The process of image enhancement was applied for clarity and lineament identification. The polynomial of georeferenced rectified image was first classified with the help of classifier menu of ERDAS selecting unsupervised classification option. 10 numbers of classes was chosen for signature classes. Supervised classifications were also performed on the area of interest. Each selection was categorized according to landuse/landcover index and added to signature editor and new color has been assigned. The classification of geomorphologic structure was done by visual interpretation of orthorectified LANDSAT imagery with the help of creating segment of morphological features and then polygoning them.

**Software used** There were number of Remote sensing and GIS software packages. In the present study following software has been used: AutoCAD, Map-Info7.5, ILWIS 3.3, and ERDAS8.6

**Material used:** For various type of analysis, many types of data, materials and software were utilized in the present study. Data – The data used in present studies are as follows-

- a. Satellite data- Land Sat TM and ETM data of 2000
- b. Google Earth Data: Large scale map and terrain data of 2009
- c. Topo map – SOI topo map 64E/ 16 and 64 I/4

For land use/ land cover analysis satellite data and SOI topo map has been utilized. LANDSAT ETM orthorectified Satellite imagery data of the area having Path 144, Row 44 and Path 144, Row 43; dated October 2000

has been downloaded from the Internet and was used for supervised classification of digital image processing to find out land use and land cover classes of the area. The survey of India (SOI) topo map no. 64 E/116 and 64 I/4 was used for creating base line data themes, drainage pattern, water bodies and digital elevation model. Prepared base were modify by the satellite data. The base line data also helps in calculating drainage losses during mining activities in 1:50,000 Scale. The base map themes of the area were made with the help of Digital Elevation Model (DEM) was created with contour and point heights interpolation of the area as given in SOI topo map. The imagery of the mining area was superimposed DEM to create DTM. DEM helps in assessing slope and slope aspects which were important parameters in deciding flow direction of the area. The spectral bands (remotely sensed data) collected by the sensors, were stacked and mosaic. The area of interest was subset with the help of image processing software. The combination of infrared (band 4), red (band 3), and green (band 2) is used to prepare false color composite (FCC) of the area used. The remote sensing data were processed to investigate land use pattern through digital image processing techniques. Suitable image enhancements were then applied on the extracted area of interest. A visual interpretation followed by supervised classification (digital image processing approach) was adopted to classify various land use land cover features. Flow chart of Land use/Land cover mapping given in (fig. 2). Prior to supervised classification several training sets/signatures were collected for applying them for classification. After evaluating the statistical parameters of training sets, the training areas were rectified by deleting non-congruous training sets and creating new ones. The verification of the land use land cover was also carried out in the area with GPS tools.

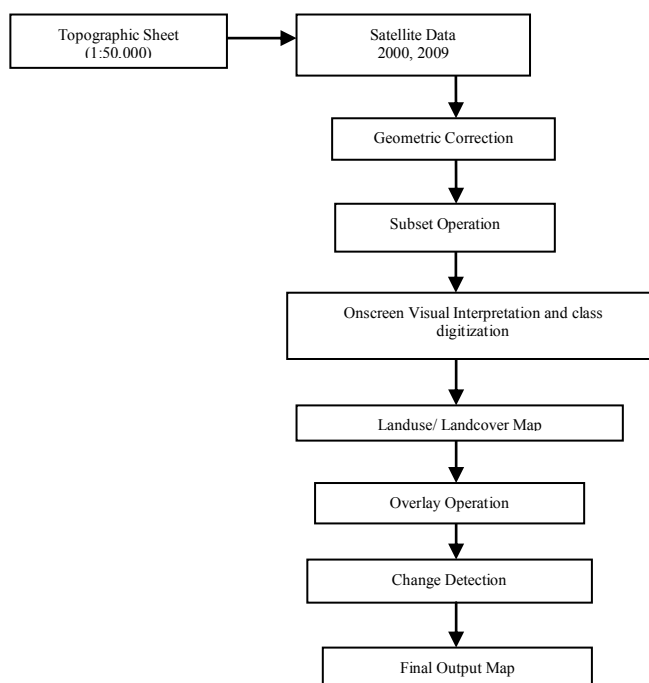


Fig.2 Flow chart of Methodology

### **Land use/Land cover**

Digital elevation model of the area with superimposed proposed mine area showing general slope of the area towards south east (fig.3). The northeast area having higher elevation has a slope towards the Hasdeo river valley. The southeast area showing a depressed valley which drain outs the water from the area. FCC of the area shows that dense forest occupies north eastern part of the area while rest of the area is having localized forest cover (Fig.4, 5 & 6). Maximum part of the area is under arable land use.

### **Land use/ Land cover classification**

Land cover refers to the material/ object present in the particular terrain e.g. vegetation, water bodies, rocks/soils and other resulting form from land transformations. Although land use is generally inferred based on the cover, yet both the terms land use and land cover being closely related are interchangeable (Chaudhary et. al., 2008; Bhaumik and Tiwari 2008).Land refers to man's activities on land utilitarian in nature, where as land cover denotes to vegetation and artificial constructions. Visual interpretation technique was used for the detection, identification, delineation and characterization of land use and land cover types occurring in the

physiological study area. The remote sensing images had been analyzed utilizing a variety of observable elements of a spectrum like size, shape, shadow, tone or color, texture, repetition of pattern, site, association and resolution (Estes and Simonett 1975). For the interpretation of the data, the false color composite paper prints were checked with the help of light table. A classification scheme had been finalized after careful scrutiny of the satellite data and the ancillary information gathered during the course of field surveys. Efforts were made to visit the study area several area times to verify the classification of land use/land cover features delineated and depicted in the satellite imageries. After careful scrutiny, final map is prepared (Tomos 2007; Tripathi et. al., 2007). The base map was prepared using survey of India (SOI) topographical sheets in 1:50,000 scale. Important land features like roads, rivers, railway lines etc were marked on the base maps. The details of the satellite imageries were transferred on the tracing films using simple light table. The final maps contained borders, legends and titles. Since the verification of the land use/land cover features physically on the ground, as depicted on satellite imageries of earlier dates can not be done .a new approach had been suggested by Indian space Research organization (ISRO) to overcome this difficulty. As per this, the current satellite data (2000) and (2009) was used as a template to analyze the old topographical sheet (1973). Copies of land use/land cover maps were superimposed. The rate of change in the various land use land cover categories had been varying very fast. The major causality was forest, followed by agricultural/cultivable land. The area under barren and blank category increased all through these years. Data obtained from satellite remote sensing images had been successfully used by number of worker in the assessment and monitoring of changes in land use/land cover classes. (Dobson et.al., 1992; Sinha et.al., 1982; Saxena and Pandey 1992; Majumdar and Sarkar 1994; Saraf et.al., 1995; Prakash, et.al., 1997) The decline in the forest area can be attributed mainly due to mining activities Mining related changes in the land use/ land cover have also been recorded by Garg and Sahai (1989), Kushwaha, and Oesten, (1995), Kushwaha et. al., (2000). A part from mining and industrial development, a large part of forests alarmingly damaged by other anthropogenic activities: Legal and illegal firewood and timber collection overgrazing by cattle, extension of urban area etc. Based on image signatures, supervised classification and final estimation of land use land cover coverage of the existing study area were recorded from the year of 1973 to 2009 (Table 5). Table 1 shows the Land Use classes of study area from topographic Map in 1973. Table 2 shows the Land Use classes of study area of Landsat data from 2000. Table 3 shows the Land Use classes of study area based on the Google Image Classification from 2009. Table 4 shows the coal mining area of Jamuna Kotma region.

### III. Result and Discussion

Satellites data studies depicted that impact of coal mine have both positive and negative. Due to the mining topography of the area has been changed which have negative impact. Forest covers have been declined and its impacts can be visualized on biodiversity characterization, which is a negative sign of environmental impact. In 1973 forest area was 174 sq. km. In 2000 it reduced and remained as 96 sq. km and in 2009 forest area was only left 68 sq. km. Water bodies have increase due to the mining activities. In 2000, mining area is was 47 sq km. and in 2009 mining area was increased as 64 sq km. Agriculture land has been reduced from 167 sq. km.(1973) to 110 sq. km. (2000) to **88 sq. km** in 2009. This shows also a negative impact. Waste lands had been continuously increasing, due to increase in mining overburden dumping site. In 1973 it was 26 sq. km which becomes 84 sq.km in 2000 and 104 sq.km in 2009. Settlement has also shows increasing pattern. It covered 58 sq.km, 81 sq. km. and 93 sq.km in 1973, 2000, and 2009, respectively.

**Table 1 Land Use classes of study area (1973)**

SN	Land use type		Area (Sq.m.)	Total Area (sq.m.)
1	forest	General	90425543.1	174715645.1
		PF	41342033.6	
		RF	42948068.4	
2	Water body	Pond	43656123.2	43996809.2
		Dry Pond	340686.0	
3	Settlement		58192660.3	58192660.3
4	Wasteland		26475177.7	26475177.7
5	Agriculture		167793595.8	167793595.8
<b>TOTAL</b>				<b>471173888.1</b>

**Table 2 Land Use classes of study area (2000)**

Class	Area (Ha.)	Area (Sq.m.)
<b>Agriculture</b>	11005.1931	110051931.00
<b>Forest</b>	9621.0653	96210653.00
<b>Mining</b>	4709.125	47091250.00
<b>Settlement</b>	8124.3101	81243101.00
<b>water</b>	5221.2013	52212013.00
<b>waste Land</b>	8436.4940	84364940.00
<b>TOTAL</b>	<b>47117.3888</b>	<b>471173888.00</b>

**Table 3 Google Image Classification (2009)**

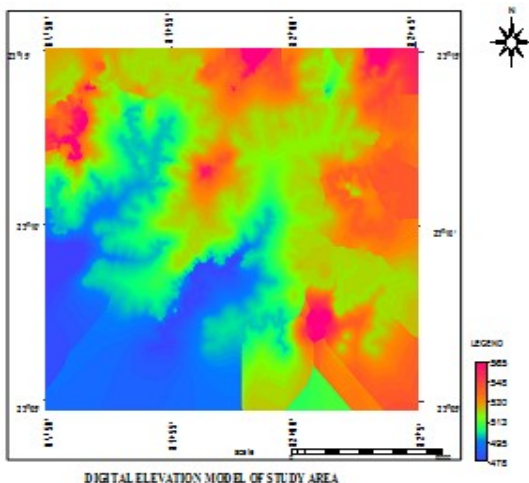
Land Use Classes	Area (Sq KM)	Area in (Sq.m.)
Agriculture	88.041410	88041410
Forest	68.112022	68112022
Mining	64.601250	64601250
Settelment	93.143101	93143101
water	53.215003	53215003
waste Lend	104.061102	104061102
<b>Total</b>	<b>471.17388</b>	<b>471173888</b>

**Table 4 Coal Mining Area**

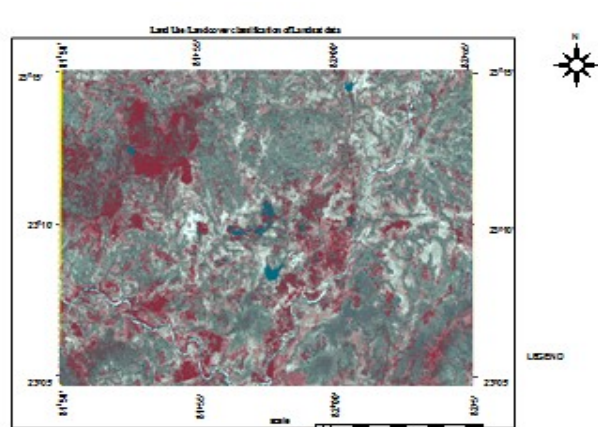
S.N.	Name of Mine	Area (Sq. m)
1.	Govinda colliery	4650000
2.	Meera Incline	6882600
3.	Kotma West open cast Mine	6880500
4.	Bartarai and Amadand Colliery	6850000
5.	Jamuna 9 & 10 Inclines	8061400
6.	Bhadra colliery 7& 8 Incline	5583600
7.	Jamuna open cast Mine	10143150
8.	Jamuna 1 & 2 Mine(Underground)	9090000
9.	Amadand open cast mine	8660000
	<b>Total</b>	<b>64601250</b>

**Table 5. Landuse Changes from 1973 to 2000 to 2009Area in Square Meter**

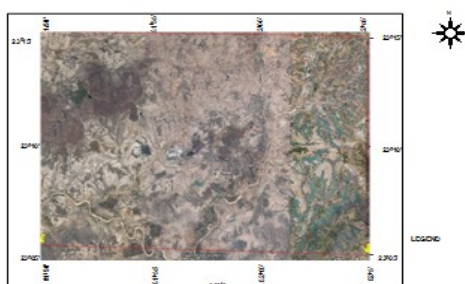
S.N.	Land use type	Year 1973	Year 2000	Year 2009	Changes between 1973 to 2000	Changes between 2000 to 2009	Changes between 1973 to 2009
1.	Agriculture	167793595.8	110051931	88041410	-57741664.8	-22010521	-79752185.8
2.	Forest	174715645.1	96210653	68112022	-78504992.1	-28098631	-106603623.1
3.	Mining		47091250	64601250	+47091250	+17510000	+64601250.0
4.	Settelment	58192660.3	81243101	93143101	+23050440.7	+11900000	+34950440.7
5.	water	43996809.2	52212013	53215003	+8215203.8	+1002990	+9218193.8
6.	waste Land	26475177.7	84364940	104061102	+57889762.3	+19696162	+77585924.3
	<b>TOTAL (sq. m.)</b>	<b>471173888.1</b>	<b>471173888</b>	<b>471173888</b>			



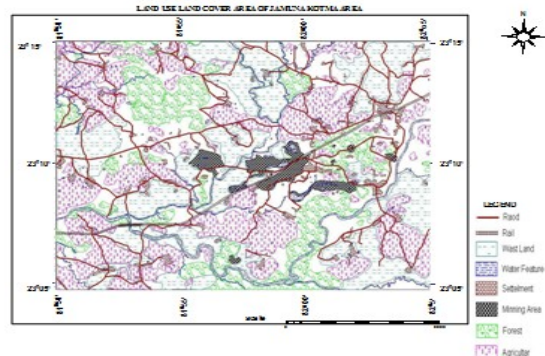
**Fig.3 Digital Elevation Model of Area**



**Fig 4. LU/LC classification of Year 2009**



**Fig 5. Google earth image of coal mines area 2000**



**Fig 6. Land Use Land Cover of Year 2009**

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