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MULTI-LEVEL LAND USE LAND COVER CLASSIFICATION USING GEOSPATIAL TECHNIQUES IN KORBA COAL FIELDS OF CHHATTISGARH INDIA

Mayank Pandey[1*] and Pradeep Verma[2]

[1]Department of Rural Technology and Social Development, Guru Ghasidas Central University, Bilaspur, Chhattisgarh, India

[2]Chhattisgarh Council of Science and Technology, Raipur, Chhattisgarh, India

* Corresponding Author Email id: makepandey1995@gmail.com

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ABSTRACT

The present study is conducted in the Korba Coal fields of Chhattisgarh. To classify the land use and land cover of study area at multi-level, various data sets have been used viz. LANDSAT–8 OLI, Sentinel- 2 and Google earth image. The study showed that the level–I classification has five broad land use and land cover classes such as forest, built- up area, degraded land, agriculture land, water bodies. Among five classes, the forest covered largest area followed by agriculture, degraded land, water bodies and built-up area. Of the total geographical area, the forest cover distributed in 3326.91 km^2 constituted about 50.36% of area. Agriculture area covered in 2010.18 km^2 accounting 30.43% of the total area, while degraded land constitutes about 15.49% area spread in 1023.62 km^2. In contrast, the water bodies covered in 2.12% area occupied 140.10 km^2, while built-up area spread only in 1.6 % area spread in 106 km^2. The classification at Level III helped in site specific micro level planning and development, while level –I and level II classes used for regional planning and development of resources. The paper highlighted the advantages and disadvantages of multilevel classification using various sensors for sustainable planning and development of resources.

Keywords **:** LULC, Forest Degradation, Remote Sensing, GIS, GPS, Land Degradation.

Introduction

Land resources are indispensable and form the base for all natural resources. Monitoring and mapping of land and vegetation resources are vital for planning and development of landscapes (Pandey *et al*., 2022). The land use pattern is significantly influenced by anthropogenic activities like agriculture expansion, urban sprawl and industrial activities including coal mining. Mining is an important economic developmental activity for meeting the energy needs in a many developing countries including India (Thakur *et al*., 2022). Both open cast and underground mining are mainly responsible for shifting of land uses in mined environment. The assessment and characterization of land, water and vegetation resources are critical for devising suitable strategies of management for judicious utilization of natural resources for sustainable development of mining landscape. In this context, satellite remote sensing, GIS and GPS, together known as geospatial techniques have evolved as important tools for monitoring and mapping of natural resources and the environmental changes, it can be used at a range of scales, including the macroscale, and the same image can be used for a range of analysis. Geospatial techniques were widely used to characterize the spatial and temporal land use changes, including the spread of urbanization and changes in the extent of surface water resources and vegetation cover. Several studies have employed geospatial techniques to characterize land use change in coal mining areas in the past (Joshi *et al*., 2006; Thakur *et al*., 2014; Mishra *et al*., 2022). Aderson *et al*. (1976) proposed multi-level LULC classification using various remote sensing and ground-based surveys. The level I and II classification were derived from coarse resolution satellite data at higher spatial scales ranging about 1: 80,000 cm. while the further classification of broad classes into more detailed classes using Aerial remote sensing data at 1:12,000 scale. The classification at Level III helped in site specific micro level planning and development, while level–I and level II classes used for regional planning and development of resources. The paper highlighted the advantages and disadvantages of multilevel classification using various sensors for sustainable planning and development of resources. Reddy *et al*. (1999) employed stratification approach for classification of land cover and vegetation of Jalpaiguri district, West Bengal, India using IRS-1A LISS-II data. Supervised Maximum Likelihood classifier algorithm was used to delineate major land use classes like agriculture (45.2%), tea gardens (10.4%), forest cover (22.82%) and other classes (21.58%). False Colour Composite (FCC) and Normalized Vegetation Difference Index (NDVI) were employed to precisely differentiate forests into dense, degraded and open categories. Stratification approach was further used to classify the forest cover into forest types i.e. Pure Sal forest, Riverine forest, mixed forest and Plantations.

Description of Study Area

Korba district of Chhattisgarh state is well known for coal mining activity, thermal power plants and allied industries. South Eastern Coalfields Limited (SECL) was created on 28.11.1985 with the objective to acquire and take over business of the Bilaspur division of Western Coalfields.

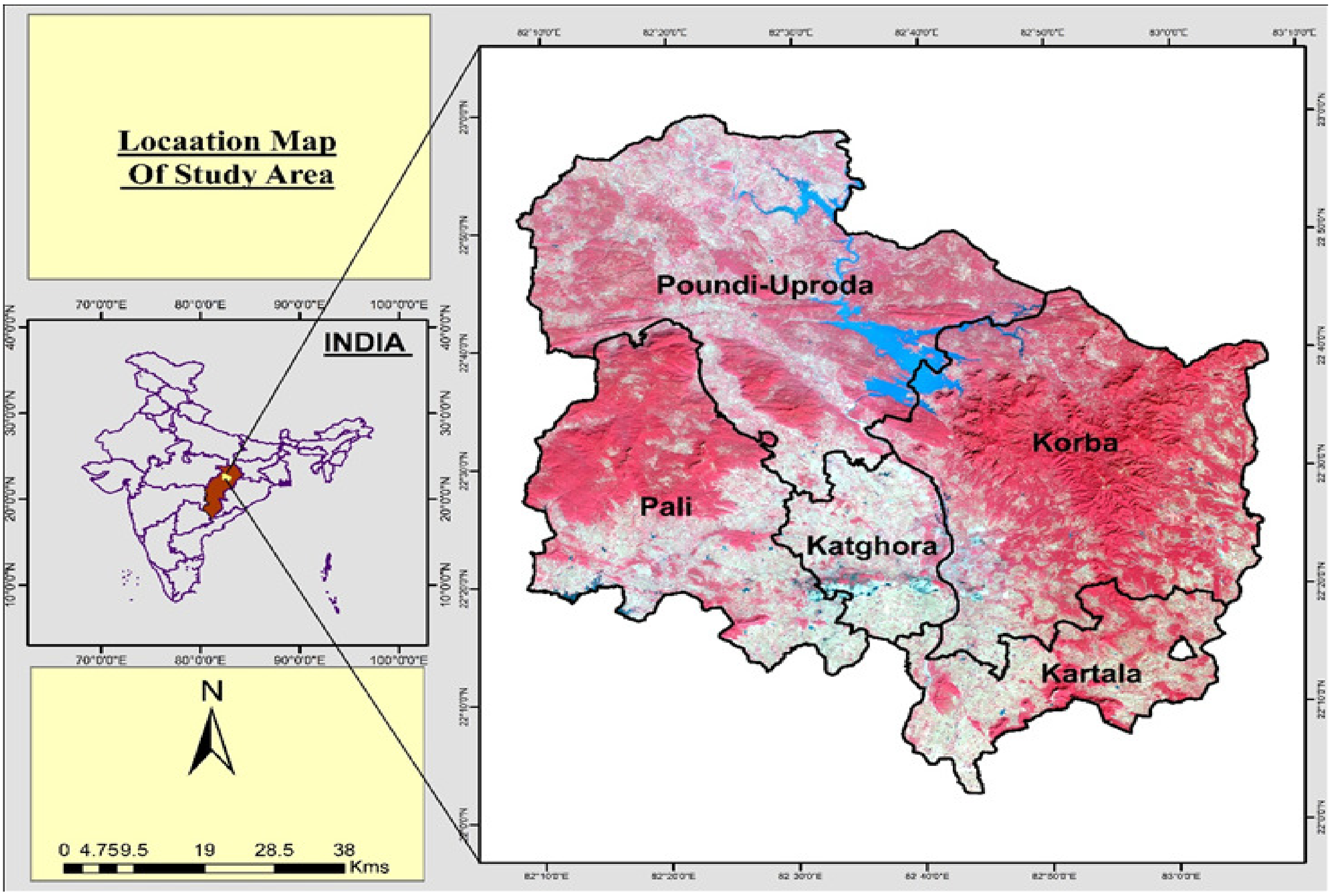

Fig. 1 : Location map of Study Area

Material and Methods

With advancement of geospatial technologies and analytical methods, the land cover mapping has been progressively changing by employing coarse to moderate and finer scales to delineate much explicit categories of land use and vegetation. The study employed multi-tier classification scheme for characterization of land use and land cover using moderate to high resolution satellite imageries, GPS, google earth and ancillary data to discriminate to broad to specific categories. Initially, the broad land use classes were delineated using medium resolution satellite data through supervised classification. Thereafter, these classes were successively classified into specific classes at each level. The spectral and spatial resolutions varied according to the level of classification. In this study the spatial resolution varied from 1 m to 30 m, while the visible and near infra-red bands were used. The Level I classification was performed with Land Sat 8 OLI, 30 m spatial resolution data to delineate 5 broad classes such as 'agriculture', forest, built up, waterbody, degraded lands etc. Subsequently, these broad classes were again divided into two more detailed classes using the high resolution 10 m Sentinel opto-electronic multispectral sensor in Level II. Thus, five categories are reclassified into 10 classes in this level. Each class of level II was further bifurcated into two classes using a very high resolution google earth image merged with high resolution sentinel and GPS data. Thus, finally 20 classes were delineated at level III. The classes within each level are mutually exclusive and exhaustive. This standardized, multilevel classification system allows spatially explicit comparisons of land-use and land cover.

Results and Discussion

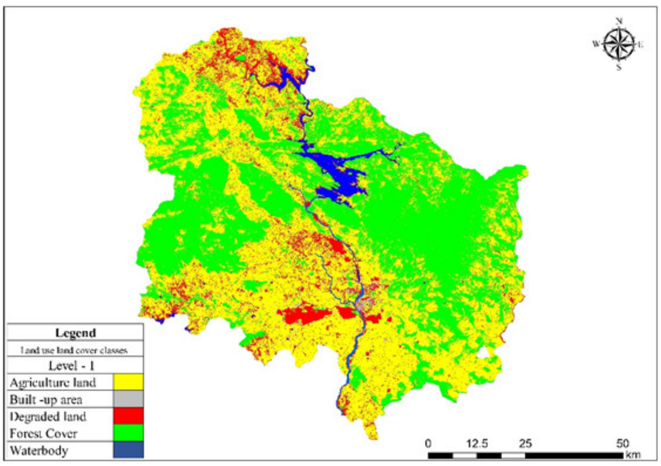

Fig. 1 : Land use and land cover classification of the study area using Landsat OLI - 8 satellite data (level-1 classification)

Table 1 : Land use and land cover classification of the study area using coarse resolution satellite data (level-1 classification)

S.No.	Class Name	Area (km²)	Area (%)
1	Agriculture land	2010.18	30.43
2	Built-up area	106.00	1.60
3	Degraded land	1023.62	15.49
4	Forest cover	3326.91	50.36
5	Waterbody	140.10	2.12
	Total Area	**6606.81**	**100.00**

Characterization of the land use and vegetation cover of study area was performed at three levels. The level–I classification delineated the five broad land use and land cover classes viz. forest, built- up area, degraded land, agriculture land, water bodies (Table 1 and Fig. 2). Among five classes, the forest covered largest area followed by agriculture, degraded land, water bodies and built-up area. Of the total geographical area, the forest cover distributed in 3326.91 km^2 constituted about 50.36% of area. Agriculture area covered in 2010.18 km^2 accounting 30.43% of the total area, while degraded land constitutes about 15.49% area spread in 1023.62 km^2. In contrast, the waterbodies covered in 2.12% area occupied 140.10 km^2, while built-up area spread only in 1.6 % area spread in 106 km^2 (Table 1, Fig.1).

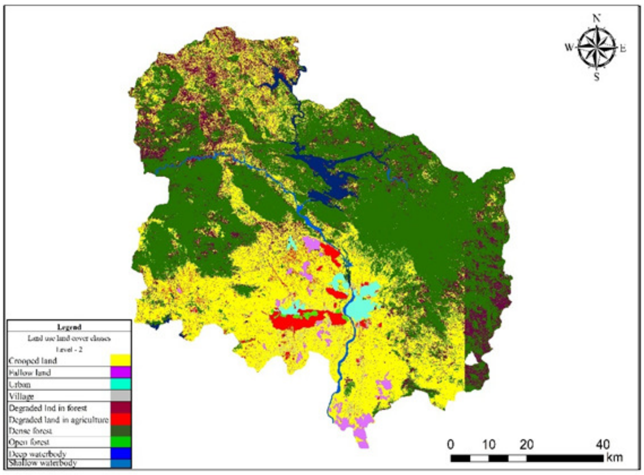

Fig. 2 : Land use and land cover classification of the study area using sentinel satellite data (Level-II classification)

Table 2 : Land use and land cover of the study area using medium resolution satellite data (level-II classification)

S. No.	Class Name	Area (km²)	Area (%)
1	Cropped area	1678.21	25.40
2	Fallow area	332.17	5.03
3	Urban area	79.5	1.20
4	Rural area	26.5	0.40
5	Degraded land under agriculture	829.3	12.55
6	Degraded land under forest	194.32	2.94
7	Dense forest	1836.2	27.79
8	Open forest	1490.61	22.56
9	Waterbody perennial	121.8	1.84
10	Waterbody seasonal	18.2	0.28
	Total Area	6606.81	100.00

The level–II classification was performed to further delineate broad land cover classes into specific sub-classes. Under this classification, each land use and land cover were divided into two classes. The forest was divided into dense forest and open forest classes, similarly agriculture into cropped area and fallow land, degraded land into degraded agriculture and degraded forest lands, water bodies into perennial and seasonal waterbodies, while built-up land into urban and rural built-up lands (Table 3, Fig. 3). Dense forest was covered in 27.79 % of the total area spread in 1836.2 km^2 area, where as open forest distributed in 22.56 % area accounting 1490.61 km^2 area, agriculture cropped area spread in 25.40 % with 1678.21 km^2 area, fallow area limited accounting for 5.03 % with 323.17 km^2 area. The degraded land under agriculture was about 12.55 % covered in 829.3 km^2 and in forest spread in 2.94 % covered in 194.32 km^2. In contrast, perennial water bodies spread in 1.84 % area accounting 121.8 km^2, while seasonal water bodies spread in 0.28 % area covered in 18.2 km^2 area, urban area spread in 1.20 % occupied 79.5 km^2 area, while rural area spread in 0.40 % covered in only 26.5 km^2 (Table 3, Fig. 3).

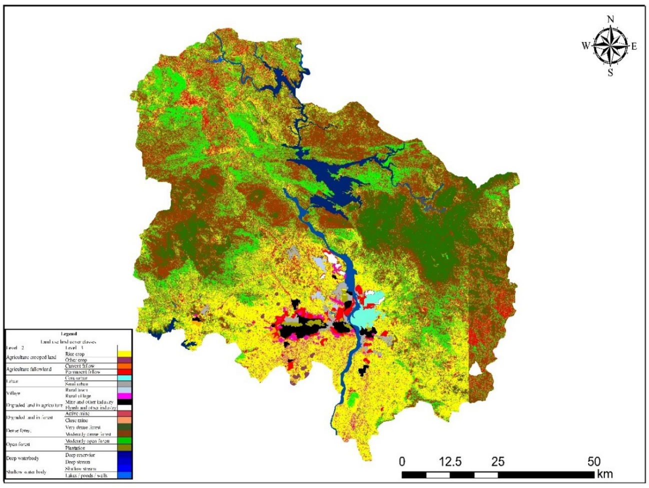

Fig. 3 : Land use and land cover classification of the study area using sentinel merged with google earth image (level-III classification)

Table 3 : Land use and land cover of the study area using high resolution satellite data (level-III classification)

S. No.	Class Name	Area (km²)	Area (%)
1	Rice crop	1165.20	17.64
2	Other crop	645.20	9.77
3	Current fallow	774.10	11.72
4	Permanent fallow	372.50	5.64
5	Core urban	51.20	0.77
6	Semi urban	23.40	0.35
7	Rural town	20.40	0.31
8	Rural village	18.40	0.28
9	Active mined area	1.80	0.03
10	Close mined area	0.93	0.01
11	Mine and other industry	43.60	0.66
12	Fly ash and other industry	23.50	0.36
13	Very dense forest	825.30	12.49
14	Moderately dense forest	1010.20	15.29
15	Moderately open forest	1480.61	22.41
16	Plantation	10.20	0.15
17	WB deep reservoir	98.50	1.49
18	WB deep stream	18.20	0.28
19	WB shallow stream	12.30	0.19
20	WB lakes/ponds/wells	11.27	0.17
		6606.81	

Conclusion

The present investigations showed that multi resolution spatial data of coarse to fine scales were found to be very useful in multi-tier classification for delineating broad to specific land cover classes. The land cover classification, exploiting time series of satellite images with low to high spatial resolutions could be fruitful to distinguish among classes based on the fact they have different spatial and temporal profiles. Land use classification is important for understanding the impact of mining activities on the environment and functioning of ecosystems. The magnitude and nature of changes could be precisely detected using multi temporal and spatial data retrieved from various satellites operating at different periods. The present study proved that the multi-level data was found to be effectively employed in monitoring landuse and vegetation characterization with desired precision levels.

References

Anderson, J.R. (1976). *A land use and land cover classification system for use with remote sensor data* (Vol. 964). US Government Printing Office.

Joshi, C., Leeuw, J.D., Skidmore, A.K., Duren, I.C.V. and van Oosten, H. (2006). Remotely sensed estimation of forest canopy density: A comparison of the performance of four methods. *International Journal of Applied Earth Observation and Geoinformation,* 8(2): 84–95.

Mishra, A., Swamy, S.L., Thakur, T.K., Kumar, A. and Pandey, M. (2022). Impact of coal mining on land use changes, deforestation, biomass, and C losses in Central India: Implications for offsetting CO2 emissions. *Land Degradation & Development,* 33(18): 3731-3747.

Pandey, M. and Mishra, A. (2022). Assessment of land reclamation and landscape dynamics using geospatial techniques in open cast coal mines of Korba, Chhattisgarh, India. *Plant Archives,* 22(2): 456-461.

Pandey, M., Mishra, A., Swamy, S.L., Thakur, T.K. and Pandey, V.C. (2022). Impact of coal mining on land use dynamics and soil quality: Assessment of land degradation vulnerability through conjunctive use of analytical hierarchy process and geospatial techniques. *Land Degradation & Development*, 33(16): 3310-3324.

Reddy, S., Sridevi, G., Raman, I.V. and Rao, V.V. (1999). Techniques of classification for land use/land cover with special reference to forest type mapping in Jaldapara wildlife sanctuary, Jalpaiguri district, West Bengal- a cause study. *Journal of the Indian Society of Remote Sensing* 27(4): 217-224.

Thakur, T., Swamy, S.L. and Nain, A.S. (2014). Composition, structure and diversity characterization of dry tropical forest of Chhattisgarh using satellite data. *Journal of forestry research*, 25(4): 819-825.

Thakur, T.K., Dutta, J., Upadhyay, P., Patel, D.K., Thakur, A., Kumar, M. and Kumar, A. (2022). Assessment of land degradation and restoration in coal mines of Central India: A time series analysis. *Ecological Engineering,* 175, 106493.