Original Research Article

Assessment of Classification and Accuracy of Land use/Land cover in Jabalpur district, Madhya Pradesh: An analysis by Remote Sensing and GIS Application

ABSTRACT

The main purpose of remote sensing is to prepare land use/ land cover (LULC) thematic maps through satellite image classification. So many researchers worked on various image classification techniques and accuracy assessment.LUCC change is posing a seriousproblem to earth's ecosystems. One estimate puts the safe upper boundary for global cropland area to 15% of the total terrestrial area, a level that is only about three percentage point higher than current cropland area, which account for 12% of global land area (Anonymus,2012). Objective of this study is to use remote sensing and GIS to prepare LULC map for the year 2016 in the Jabalpur district, Madhya Pradesh and to assess the accuracy of classified image. A multivariate rule is applied to carry out supervised classification. Five classes of LULC has been chosen to prepare the LULC map and areas coming under these classes are agriculture (59.26%), forest (18.28%) open/barren/wasteland (18.08%), waterbodies (2.68%) and built-up (1.70%). Overall classification accuracy of satellite image obtained in present study was 88.52 percent and kappa coefficient 0.80.

Keywords: LULCClassification,Remote sensing, Geographical Information System, Satellite image Classification.

1. INTRODUCTION

Anthropogenic activities have very obvious impacts on land cover (Patil et al., 2017; Sharma et al., 2012; Sharma et al., 2011). Natural system of environment is affected by land use changes (Sharma et al., 2014; Sharma et al., 2010) and is measured as top most global variable for biological changes (Sharma et al., 2016). Foremost cause of global warming is land use changes over period of time (Lohare et al., 2023a), the degradation of soils in that way on land use sustainability (Sharma et al., 2018), and from the point of protection of biodiversity coming 100 years of LULC changes will have its impact (Chapin et al., 2000). It is extremely significant to say that, the knowledge of land cover is very scanty looking to its environmental impact (Lohare et al., 2023b). Due to scarcity of correct land use / land cover data our understanding about the prediction of effect of LULC very limited. These LULC data, particularly in the form of map are, not ready reference or easily available. The change of LULC in the form of map helps us to accurately monitor that part of land for future sustainable development(Reddy et al., 2019). Earth's surface can be very well depicted spatially and temporally in the form of thematic map with the help of this latest technology i.e. remote sensing (Patil et al., 2013). Satellite image classification is used for preparing a thematic map and this can be accomplished by digital image processing or visual image interpretation. In case of unsupervised classification only computer based color clustering is done to classify a satellite image. However, for supervised classification the cluster which were formed by unsupervised classification visited on field by the persons to check the name of those clusters. Even though this geospatial technique is being applied for several works but its potential for LULC maps has not been utilized properly. Main issue is that for practical applications LULC maps available are not of adequate quality to understand the land cover in effective manner. These maps prepared are on the basis of some ground or reference in formations. In remote sensing data difference in these two in formations are called as an error in classification. These errors deteriorate the map quality and create problem on judgment of LULC to be utilized for further planning purposes. One more issue is quality of spatial data which also affect the quality of thematic prepared after classification. (Johnston &Timlin, 2000).

The quality of remote sensing data (satellite data) is very long topic of discussion but here it is important for the view point of accuracy assessment. Information of land cover may have lost to some extent in the process of simplification of satellite image classification. Therefore, it is very necessary to evaluate the quality of data that was classified using satellite data for the decisions to be taken on the base of this LULC thematic map. So, now in present time satellite image classification accuracy assessment is very important task.

In the terminology of statistics, accuracy has meaning of ‘prejudice’ and correctness between two data sets. Accuracy assessment in remote sensing terms is degree of exactness of classified data. Therefore, correctness of classified data shows the closeness of classified data to real world or close to reality. Error in classification will show the difference in thematic map with reality. So, for processing of satellite data accuracy assessment is very important step. Therefore, the study is carried with the objective to prepare land use/land cover and to make accuracy assessment of classified data of Jabalpur district of Madhya Pradesh for the year 2016 using remote sensing and GIS.

2. MATERIAL AND METHODS

2.1 Study area

Jabalpur district of Madhya Pradesh is selected for the study and its longitude and latitudes are 22° 49' 42'' N to 23° 37' 5'' N and 79° 20' 56'' E to 80° 35' 10'' E, and its area is 519757 ha. It covers seven developmental blocks. The maximum temperature 40-43^{0}C goes in the month of May and minimum temperature 8-10^{0}C feels in the month of January. The district observes annual rainfall as 1358 mm. Twenty-eight percent area is irrigated in the district. The district is having 45 percent clay; 25 percent sandy soil area Fig. 1 shows the location of study area.

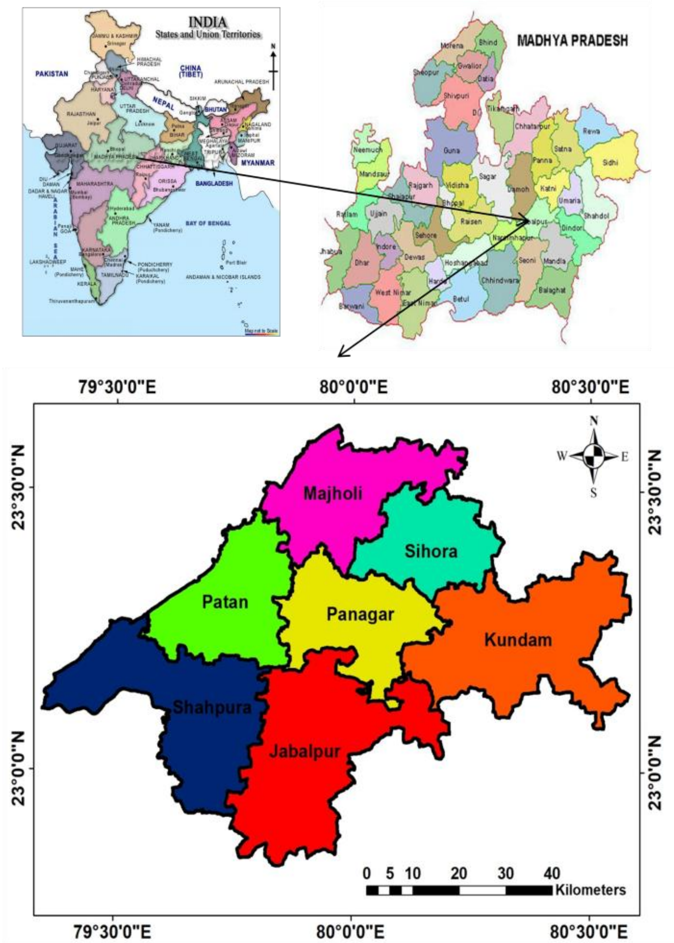

Fig. 1 Location map of study area

2.2Classification of LULC

2.2.1 Satellite Image preliminary processing

Sentinel-2A cloud free satellite data has been used to classify the LULC classes. This data has ten m spatial resolution. Copernicus Open Access Hub website (https://scihub.copernicus.eu/) is the source from which the data has been downloaded. Jabalpur district boundary coincides with T44QMM, T44QML, T44QLL and T44QLM tiles. So, these (LIC,4 tiles) tiles were acquired for the date of 15th December 2016. The projections of these tiles is UTM Zone 44N and geographic coordinate system as WGS 1984. For primary processing of the satellite data QGIS image processing software has been employed to correct atmospheric distortions and to make reflectance files. To get ready for further image processing operations Red Green Blue composite image prepared by using Blue band (band-2), Green band (band-2), Red band (band-4) and Near Infra-Red Band (band-8) of each tile. To prepare RGB combined layer stack tool of ERDAS Imagine Software was used.

The Vector file of Boundary of Jabalpur district used to subset the mosaicked RGB composite tiles. FCC (False Colour Composite) image is prepared by changing band combinations of RGB composite image. The Fig. 2 shows the FCC of study area.

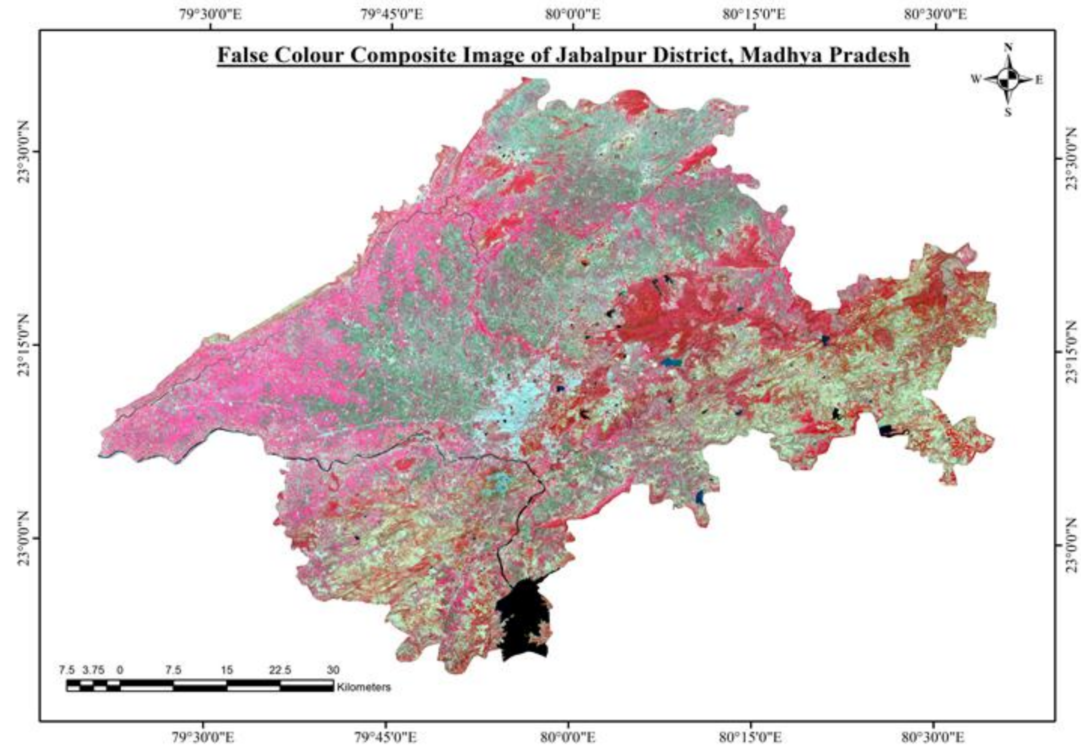

Fig. 2 False Colour Composite image of the study area

2.2.2Supervised Classification

For satellite image classification Supervised classification technique is applied in this work. In supervised classification image developer assigns the name of class to those pixels which are known to him by ground truth survey then computer generates same classes from that spectral range assigned to those pixels in all the satellite image. In other words, it is termed as spectral signature (Eastman, 2003) Training classes are prepared using AOI tools to further reach to supervised classification. At least ten percent of work region in each class is visited at ground level for training the pixels of those classes.

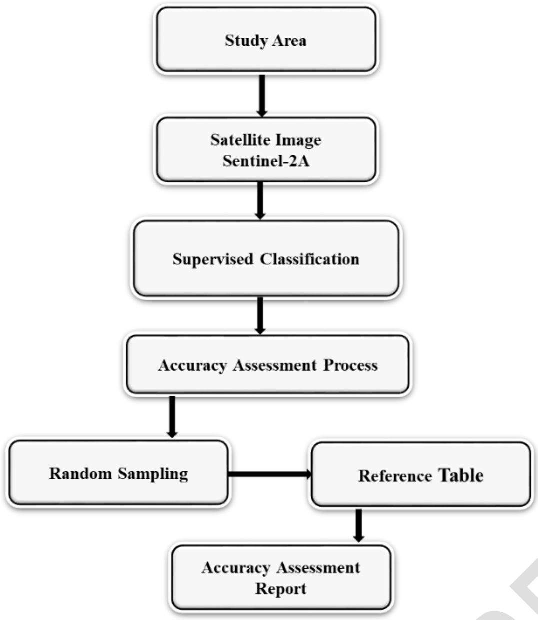

Fig 3. Graphic representation of work flow to prepare LULC and accuracy assessment

2.2.3Accuracy Assessment

In remote sensing verification of satellite image in regards of accuracy assessment is very important process. In accuracy assessment, the correctness of classified image is measured in respect of how much percentage of area of satellite image is correctly classified to ground based data collected during ground truthing. The correctness in classification is measured in quantitative way by generating contingency table / confusion matrix/ error matrix. Error matrix shows the no. of pixel classified in particular class and how much pixels are going in another class. Say for example if total agriculture pixels are 100 then and out of that 90 are going in agriculture and rest 10 are going in other class then this classification is 90 percent correct. In error matrix total of row's sample is recognized as classified data and total of column's sample is identified as ground truth data

The other way of measuring accuracies in error matrix are producer's accuracy, user's accuracy and overall accuracy. In error matrix furthermore to overall accuracy Producer's and user's accuracies are also estimated to find out the individual class accuracies.

Total no. of 453 points obtained during ground truthing was placed on whole classified data to arrive at accuracy assessment using ArcGIS software.

3. RESULTS AND DISCUSSION

3.1LULC Classification

For Satellite image classification supervised classification technique was used in this study. Total area in ha as well as in percentage form is presented in Table 1. The study area was divided in to five LULC class i.e. agriculture, forest, built-up, waste land/open land and water-body. These are the prominent classes for the study area so, only these classes have been taken for classification.

A classified map of LULC of the year 2016 can be depicted in Fig 4.After successful classification of satellite data it is seen that for the year 2016 Jabalpur district is having 59.26 per cent (308018 ha) agriculture, 18.28 per cent (95021.90 ha) forest 18.08 per cent (93962 ha) open/barren/wasteland, 2.68 per cent (13923.80 ha) waterbody and 1.70 per cent (13923.80 ha) built-up land (Table 2). This indicates that main portion of LULC is covered by agriculture and very little part by built-up land.

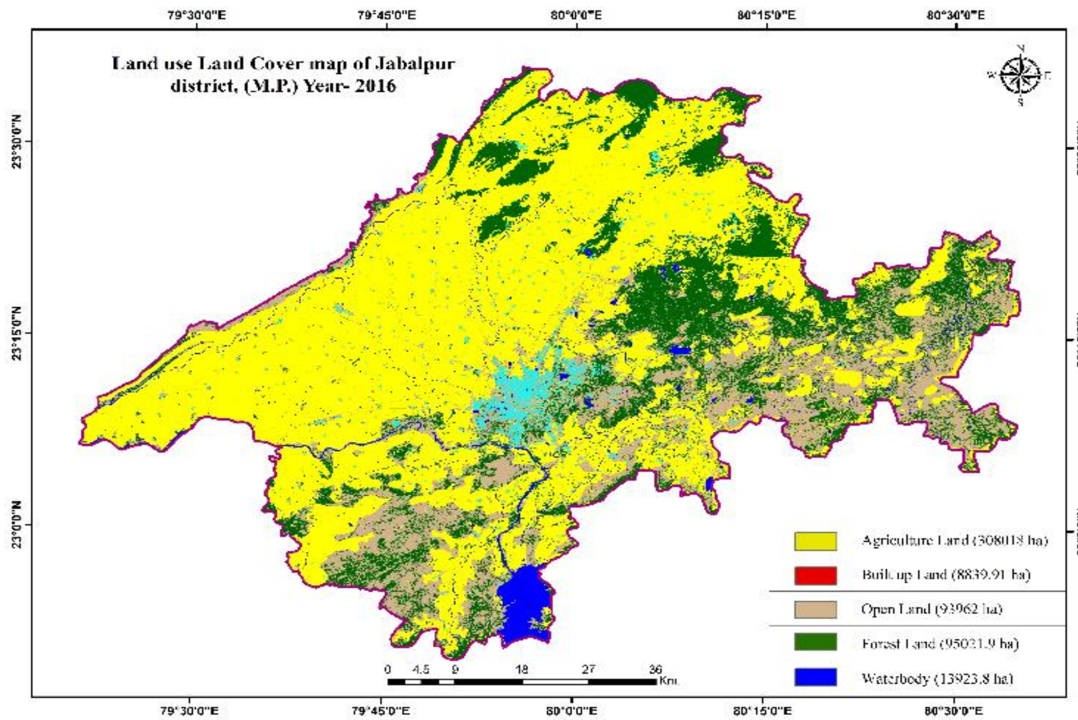

Fig. 4 LULC map of the study area for the year 2016

Table 1: Area under different LULC classes

LULC Class	**2016 LULC Area**	
	ha	**%**
Agriculture	308018	59.26
Built-up Land	8839.91	1.70
Open/Barren/Waste Land	93962	18.08
Forest	95021.90	18.28
Waterbody	13923.80	2.68
Total	519765.61	100

3.2Accuracy Assessment

Error matrix was estimated to get the reliable classified LULC map and can be depicted presented in Table 2. 88.52 per cent overall accuracy was found of classified satellite image for the year 2016.The estimation of producer's accuracy of unlike classes of classified image showed that 96.86 percent producer's accuracy was obtained for agricultural land which is highest among all other classified classes.However, for rest of the classes producer's accuracy was obtained as 88.31 percent, 85.36 percent, 81.81 percent and 25 percent, for forest, open/barren/waste land, waterbodies and built-up land respectively. In addition to producer's accuracy, user's accuracy was also estimated for all the LULC classes. For waterbody, agriculture land, open/barren/waste land, forest and built-up land the user's accuracy was estimated as 100 percent, 91.82 percent, 84.33 percent, 82.92 percent and 70 percent respectively. The kappa coefficient (k̂) was estimated as 0.80.

The above all values show that LULC map prepared applying supervised classification technique is accurately classified.

Table 2: Error (Confusion) matrix for the year 2016

Confusion (Error) Matrix Year-2016 Reference (Ground Truth) Data						
Class Value	**Agriculture**	**Built-up Land**	**Open/Barren/ Waste Land**	**Forest**	**Waterbody**	**Total**
Agriculture	**247**	13	2	6	1	269
Built-up Land	0	**7**	3	0	0	10
Open/Barren/ Waste land	5	5	**70**	3	0	83
Forest	3	3	7	**68**	1	82
Waterbody	0	0	0	0	**9**	9
Total	255	28	82	77	11	**453**

Land Use Land Cover (LULC) Classes	
Agricultural land	AL
Built-up Land	BL
Open/Barren/Waste land	OL
Forest	FT
Water bodies	WB

Overall Accuracy
= {(247+7+70+68+9)/453}×100
= (401/453) ×100
= 88.52%

Producer's Accuracy	User's Accuracy
AL=(247/255)*100= 96.86%	AL=(247/269)*100= 91.82%
BL=(7/28)*100= 25%	BL=(7/10)*100= 70%
OL=(70/82)*100= 85.36%	OL=(70/83)*100= 84.33%
FT=(68/77)*100= 88.31%	FT=(68/82)*100= 82.92%
WB=(9/11)*100= 81.81%	WB=(9/9)*100= 100%

Kappa coefficient

$$= \frac{(401\times 453) - (255\times 269) + (28\times 10) + (82\times 83) + (77\times 82) + (11\times 9)}{(453)^2 - \{(255\times 269) + (28\times 10) + (82\times 83) + (77\times 82) + (11\times 9)\}}$$

= 0.80

4. CONCLUSION

This study demonstrates the successful application of RS and GIS for the classification of LULC map and then assessment of accuracy of classified LULC map. Among all LULC classes agriculture is the dominant class with 59.26 percent (308018 ha) for the year 2016 in Jabalpur district of Madhya Pradesh. Overall classification accuracy was estimated as 88.52% and kappa coefficient (k̂) as 0.80. Value of overall accuracy and kappa coefficient shows excellent classification of satellite image.To maintain the sustainability and accurate assessment of LULC of any area, this type of accuracy assessment should be made.

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