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CONTEMPORARY LAND USE AND LAND COVER PATTERN OF AMBALA DISTRICT, HARYANA: A LANDSAT 8-BASED REMOTE SENSING AND GIS ASSESSMENT FOR 2024

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ABSTRACT

The study looks at the current land use and land cover (LULC) of Ambala district in Haryana using Landsat 8 OLI imagery and GIS techniques. Landsat Collection 2 Level 2 Surface Reflectance data (30m resolution) were processed in QGIS 3.40.9 using the Semi-Automatic Classification Plugin. Six classes were produced: built-up area, cropland, vegetation and tree plantations, water bodies, bare land and scrubland. The Maximum Likelihood Classification was augmented with visual correction and a MNDWI based water refinement. The final raster has 1,682,365 pixels covering 1,514.13 km2. Cropland is by far the most dominant class at 889.82 km2 (58.77%), followed by bare land at 324.49 km2 (21.43%), scrubland at 123.90 km2 (8.18%), built-up area at 121.77 km2 (8.04%), vegetation and tree plantations at 50.59 km2 (3.34%) and water bodies at 3.56 km2 (0.23%). Accuracy assessment using 5,825 validation pixels yielded an overall accuracy of 96.71% and a Kappa coefficient of 0.9451. The results clearly demonstrate the continued dominance of agriculture in the district with settlement development and the open river basin areas being the other key features.

Keywords: LULC, Ambala District, Landsat 8, Remote Sensing, GIS, MLC, MNDWI

1. INTRODUCTION

Land use and land cover analysis provides a wealth of information on the organisation of agriculture, settlements, vegetation, water and open land. Land cover is the physical manifestation of the land (what you can see), land use is the purpose for which the land is being used Anderson et al. (1976). Satellite imagery is of immense value for LULC analysis as it enables synoptic and repeated observations over large areas.

Remote Sensing and GIS are now widely used for regional LULC mapping. Landsat imagery is particularly well suited for this as its multispectral nature and 30m spatial resolution enables the identification of the major LULC classes Jensen (2015), Lillesand et al. (2015), Wulder et al. (2019).

Ambala District is a mix of intensive agriculture and significant urban, cantonment, industrial, institutional, and transport areas, with a number of seasonal rivers (the Markanda, Tangri/Dangri, and Ghaggar) which in turn give rise to work. The predominant land use is in surfaces and areas of sparse vegetation. Earlier work has identified cropland as the predominant land use in Ambala and its tehsils Pandey and Nathawat (2006), Priyanka (2017), Chauhan et al. (2019), Chauhan et al. (2020a), Chauhan et al. (2020b).

The present study is concerned with the mapping of the LULC pattern of Ambala district for 2024, the quantification of the area and percentage of each class, the assessment of classification accuracy and the interpretation of the major spatial characteristics.

2. STUDY AREA

Ambala District is in the north-eastern part of Haryana, right at the point where the alluvial plains give way to the Shivalik foothills. The official area is 1,568.85 km^2 and the rasterised analytical mask used in this study is 1,514.13 km^2.

The bulk of the district is level agricultural plain with rice and wheat as the principal crops, maize and sugarcane also being grown. Tree cover is predominantly in the form of agroforestry plantations, orchards and vegetation along the roads, canals and in the settlements. The seasonal rivers and drainage channels give rise to a variety of combinations of open water, exposed sand and scrub. Ambala is also a major road and rail junction.

Figure 1

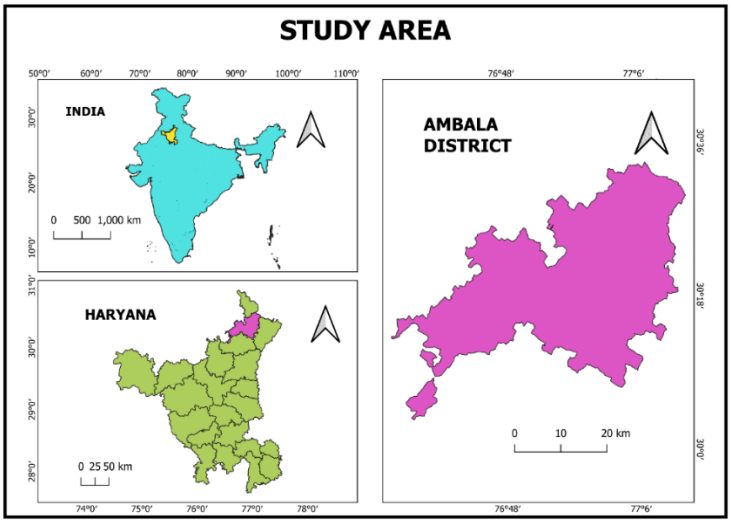


Figure 1 Location of Ambala District, Haryana

3. DATA AND METHODOLOGY

Landsat 8 OLI Collection 2 Level-2 Surface Reflectance data were used for the 2024 assessment. Bands 2, 3, 4, 5, 6 and 7 (the reflective bands) were processed at 30m resolution in WGS 84 / UTM Zone 43N (EPSG:32643). Image preparation and

classification were carried out in QGIS 3.40.9 using the Semi-Automatic Classification Plugin.

The imagery was clipped to the Ambala District boundary and false colour and SWIR composites were produced to aid visual interpretation. Six LULC classes were defined.

Table 1

Table 1 LULC Classification Scheme

Class	Category	Main characteristics
1	Built-up area	Settlements, roads, commercial, institutional and industrial surfaces
2	Cropland	Cultivated agricultural fields
3	Vegetation and tree plantations	Trees, plantations, orchards and dense non-crop vegetation
4	Water bodies	Rivers, canals, ponds and standing water
5	Bare land	Exposed soil, fallow land, river sand and vacant surfaces
6	Scrubland	Sparse shrubs, grasses and scrub-sand surfaces

Representative training Regions of Interest were collected for each category. Maximum Likelihood Classification was used as it assigns each pixel to a class based on the probability of that pixel's spectral signature belonging to that class Richards and Jia (2013).

Post-classification examination was carried out in order to resolve the confusion between built-up surfaces, bare soil, river sand, cropland and scrubland. MNDWI was also used to improve the delineation of open water Xu (2006):

\[MNDWI=\frac{Green-SWIR1}{Green+SWIR1} \]

For Landsat 8 we used Bands 3 and 6. A threshold of MNDWI > 0.00 was applied to the 2024 image.

The accuracy assessment utilised 5,825 validation pixels (separate from the training samples). Producer's accuracy, user's accuracy, omission and commission errors, overall accuracy and Kappa were all calculated.

Figure 2

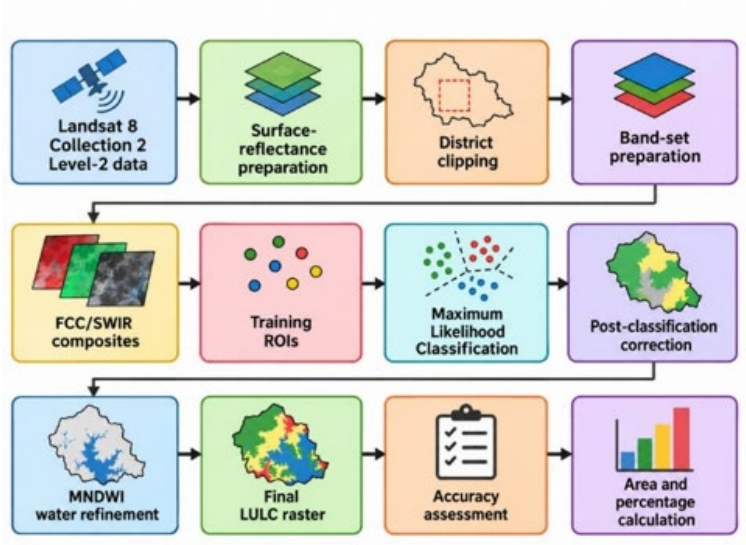


Figure 2 Methodological Framework for 2024 LULC Classification, Prepared by Scholar

4. RESULTS AND DISCUSSION

The 2024 classification still lists Ambala as very much an agricultural district.

Table 2

Table 2 LULC Distribution of Ambala District, 2024

LULC category	Area (km²)	Percentage
Built-up area	121.77	8.04
Cropland	889.82	58.77
Vegetation and tree plantations	50.59	3.34
Water bodies	3.56	0.23
Bare land	324.49	21.43
Scrubland	123.9	8.18
Total	**1,514.13**	**100**

Source: Computed from the final classified raster.

Figure 3

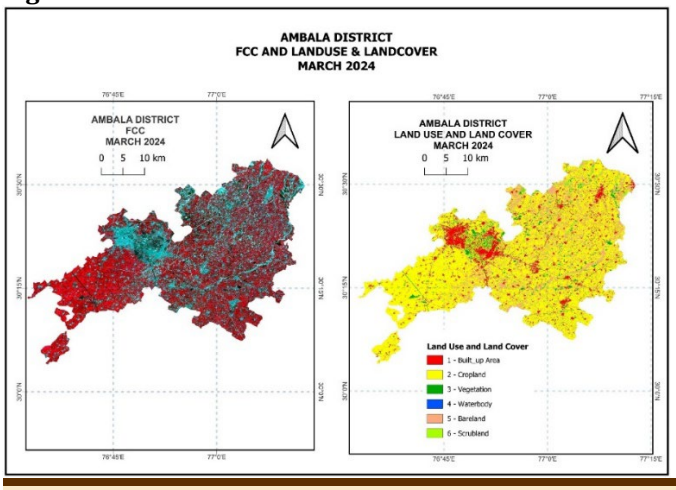


Figure 3 Land use and Land Cover Map of Ambala District, 2024

Figure 4

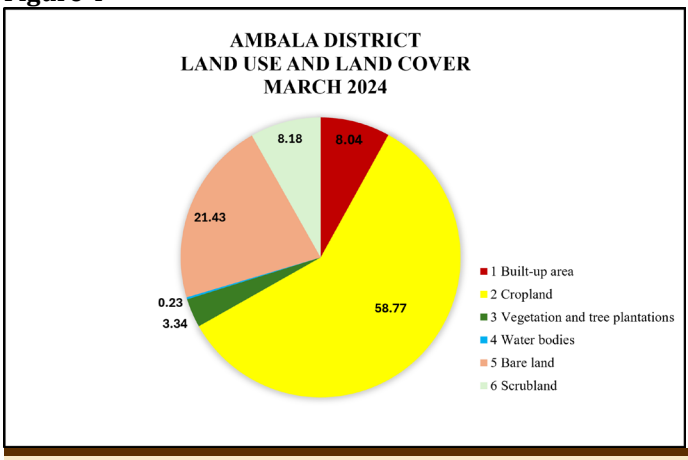


Figure 4 Percentage Distribution of LULC Categories in Ambala District, 2024

Cropland was 58.77% of the district and remained the dominant land use. Large areas of cultivated land were found outside the main settlement areas which again confirms the essentially agrarian nature of the district. Agriculture was however much more fragmented around Ambala City, Ambala Cantonment, the villages and the major transport corridors.

Bare land was the second largest category at 21.43%. This should not be read as entirely bare and unproductive land as it includes harvested and fallow land, exposed soil, river sand, vacant land, brick kiln land etc. The seasonality of agriculture will obviously have some bearing on the extent of this category.

Scrubland was 8.18% and was predominantly found in sandy river channels, floodplain areas and on the margins of open areas. Bare land and scrubland in combination made up some 29.61% of the area. Their significance is in the extent to which exposed and sparsely vegetated land occurs throughout the area, though there is some degree of spectral overlap which makes separation a bit of an issue.

8.04% was built up land (Ambala City, Ambala Cantonment, towns, villages, roads and so on). The rural settlements tended to produce mixed pixels as the buildings were scattered throughout with courtyards, vegetation and exposed soil.

Vegetation and tree plantations = 3.34%. This covers agroforestry plantations, orchards, roadside vegetation and institutional greenery so should not be read as natural forest only.

Water bodies were only 0.23%. The mapped value is the amount of detectable open water surface plus some identifiable water logged areas at the time of satellite acquisition, not the total amount of water resources available.

5. ACCURACY ASSESSMENT

The final classification achieved high overall accuracy.

Table 3

Table 3 Class-wise Accuracy

LULC category	Producer's accuracy (%)	User's accuracy (%)
Built-up area	82.91	99.81
Cropland	100	99.95
Vegetation and tree plantations	100	99.67
Water bodies	58.02	100
Bare land	99.93	85.92
Scrubland	84.6	97.36

Overall accuracy = 96.71%

Kappa coefficient = 0.9451

Figure 5

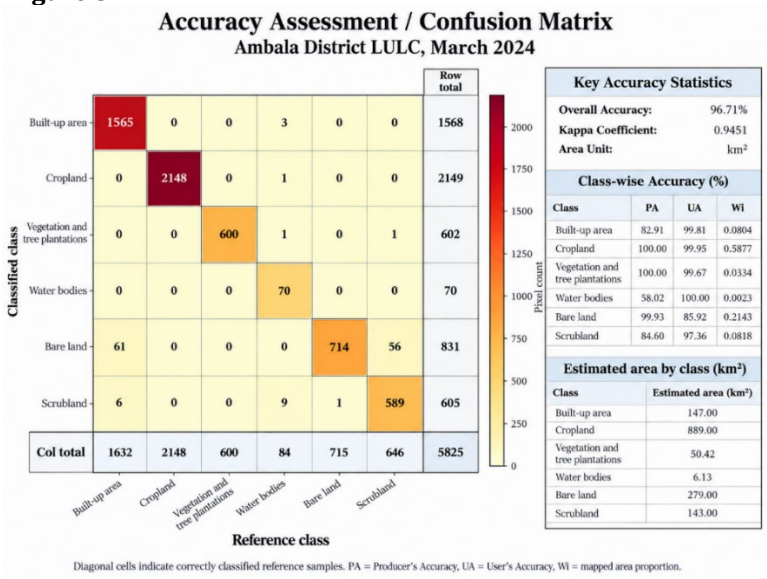


Figure 5 Producer's and user's Accuracy of the 2024 LULC Classification

Cropland and vegetation were very accurate. Built-up land had very good user's accuracy but comparatively poor producer's accuracy (indicating some mixed settlement pixels were omitted). Water was very reliable where it was mapped, though its producer's accuracy was lower (some actual water surfaces were missed). Bare land also showed some confusion with both built-up and scrub.

6. PLANNING IMPLICATIONS AND LIMITATIONS

The results have very direct implications for land resource planning. The preponderance of cropland is a very clear indicator of the continued importance of agricultural land. The 8.04% built up area figure is equally telling in terms of the need to plan for settlement and infrastructure development within an agricultural landscape.

Bare and scrub-covered river basin areas shouldn't be automatically considered as 'unused' land simply because they are bare and scrubbed, as some of these areas are in fact hydrologically and geomorphologically dynamic. Likewise vegetation and tree plantations should be seen as part of the agricultural and agroforestry system.

The primary limitations are due to the 30m spatial resolution of Landsat, the mixing of pixels and the spectral similarity between dry soil, river sand, fallow, built-up and scrub. The appearance of agricultural land will also vary with crop stage, harvest and moisture. Validation was essentially image-based rather than a full-blown synchronised field survey.

7. CONCLUSION

The study confirms that Ambala district was still overwhelmingly agricultural in 2024 with cropland at 58.77% of the mapped area. Bare land was 21.43%, scrubland 8.18%, built up area 8.04%, vegetation and tree plantations 3.34% and water bodies 0.23%.

The landscape is a mix of intensive agriculture, considerable settlement development and vast areas of open and sparsely vegetated land. The interpretation of bare land and scrubland is particularly sensitive as both are subject to the seasonal effects of agriculture and the river basin.

The overall classification accuracy of 96.71% and Kappa value of 0.9451 indicate high reliability. The integration of Maximum Likelihood Classification, post-classification correction and MNDWI water refinement provides an effective framework for district-level LULC mapping. The resulting 2024 map offers a useful spatial baseline for agricultural planning, settlement management and future LULC change analysis.

CONFLICT OF INTERESTS

None.

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None.

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