**Assessment of Land Use Land Cover Accuracy Using Geospatial Technology**

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1. Introduction

The conversion of natural land cover to human-dominated land use systems impacts the environment, and satellite imagery provides essential data for assessing these changes (Hill et al., 2008). Land use classification supports policy-making, business, and environmental protection (Rwanga and Ndambuki, 2017). Geospatial technologies like Remote Sensing (RS) and GIS are crucial for modeling forest variables and spectral reflectance (Das and Singh, 2016). Accuracy assessment, comparing classified images with ground truth data, ensures data quality (Congalton, 1991). Metrics such as Producer's and User's Accuracy, and Kappa coefficient are used to evaluate classification accuracy (Foody, 2002). This study aimed to classify LULC and assess classification accuracy.

1. Materials and Methods:

This paper covers the analysis of LULC classification and mapping and accuracy assessment.

* 1. **Study Area:**

Dakshina Kannada, located in Karnataka, India, is a coastal district spanning an area of 4,845.6 km², with geographical coordinates between 12°27'28.798"N to 13°11'16.437"N latitude and 74°46'40.689"E to 75°40'19.386"E longitude (Figure 1).



Figure 1: Study area map of Dakshina Kannada (Landsat image).

The district has an elevation range from 0.0 m to 1,115 m above mean sea level, bordered by the Western Ghats to the east and the coastline to the west. The climate is hot and dry in the summer, with heavy rainfall of 4,030 mm during the monsoon, and mildly temperate and humid in the winter (Naik et al., 2023).

* 1. **Data collection, Image Pre-Processing and Image Processing:**

Classification process and analysis of the different LULC classes were done using Landsat 8 OLI-TIRS satellite images acquired on 2020 from United States Geological Survey (USGS) Earth Explorer (<https://earthexplorer.usgs.gov/>) (Table 1). Each Landsat image was georeferenced to the WGS84 datum and Universal Transverse Mercator Zone 43 North coordinate system (Aber *et al.,* 2019).An intensive pre-processing such as geo-referencing with the reference to SOI toposheets (scale 1:50,000) and mosaicking were carried out in order to Ortho-rectify the satellite images. The study area was extracted by layer stacking and the image was then enhanced with false color composition (FCC), true color composition (TCC) and principle component analysis (PCA) in ArcGIS 10.8 software (Asare *et al.,* 2020).

Table 1: Data specification

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Satellite** | **Sensor** | **Path/Row** | **Spatial resolution (m)** | **Acquisition Date** | **Cloud Cover (%)** | **Source** |
| Landsat 8  | OLI-TIRS | 145/51146/51 | 3030 | 03/02/202026/12/2020 | <20<20 | USGS Earth Explorer |

* 1. **Analysis and Assessment of LULC Classification and LULC Accuracy:**
		1. **LULC Classification:** The pre-processed 2020 satellite image was classified using the Supervised Maximum Likelihood Classification (MLC) algorithm in ArcGIS 10.8, based on training signature files (Richards & Richards, 2022). Considering the spatial resolution of the satellite sensors six LULC classes were identified: built-up, barren land, forest, sand, agricultural land and water bodies.
		2. **Accuracy Assessment:** The overall accuracy is calculated using simple descriptive statistics by dividing the sum of the principal diagonal by the total pixels in the confusion matrix. Kappa analysis, a multivariate technique, provides the Khat statistic to measure agreement or accuracy (Güler et al., 2007). The Overall Accuracy and Khat statistic is computed as:

Overall accuracy = $\frac{\sum\_{i=1}^{r}x\_{ii}}{x}$ , Where $x\_{ii}$ is the diagonal numbers in the confusion matrix and $x$ is the total number of samples

Khat statistic,$ K=\frac{N(\sum\_{i=1}^{r}x\_{ii})-(\sum\_{i=1}^{r}\left(x\_{i+}.x\_{+i}\right))}{N^{2}-\sum\_{i=1}^{r}(x\_{i+}.x\_{+i})}$, Where; r = number of rows and columns in the error matrix, N = total number of observations (pixels) included in matrix, $x\_{ii}$ = number of observations in row i and column I (on the major diagonal), $x\_{i+}$ = marginal total of observations in row i, and $x\_{+i}$ = marginal total of observations in column i.

1. Results and Discussion
	1. LULC Status of Dakshina Kannada in 2020:

Six major LULC types are classified for the year 2020 and the simple statistics about the percentage and areal coverage of each LULC for the year 2020 which is derived based on the classification results are summarized in Table 2.The classification results of Dakshina Kannada for the year 2020 obtained from Landsat image is represented in Figure 2. In 2020, the greatest share of LULC, from all classes was forest and agriculture land, which covers an area of 2154.7 Km2 and 1525.2 Km2 each accounting for 44.47% and 31.47% of total land of the district respectively. Followed by water body with an area 506.68 Km2 (10.46%) and built up area with 384.59 Km2 (7.93%) and least covered with sand and barren land accounted each for 3.80% and 1.87% with an area of 184.24 Km2 and 90.2 Km2 respectively.

Table 2: Summary of area statistics for the map of 2020 in Dakshina Kannada District.

|  |  |
| --- | --- |
| **Category** | **Land cover in 2020** |
| **Area (Km2)** | **%** |
| Forest | 2154.7 | 44.47 |
| Agriculture land | 1525.2 | 31.47 |
| Built up land | 384.59 | 7.93 |
| Water body | 506.68 | 10.46 |
| Barren land | 90.2 | 1.87 |
| Sand | 184.24 | 3.80 |
| Total | 4845.6 | 100 |



Figure 2: LULC classification map of Dakshina Kannada using Landsat 8 OLI-TIRS 2020.

* 1. Accuracy Assessment of LULC Thematic Map 2020:

The 2020 LULC map achieved an overall accuracy of 92% and a kappa coefficient of 0.88, with producer's accuracy exceeding 85% for all classes except barren land (67%). User's accuracy was over 90% for all classes, except for sand and barren land, which showed significant confusion due to their similar reflection values (Table 3).

Table 3: Summary of the error matrix of the accuracy assessment of the LULC map.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Classified | Reference | Total | User Accuracy(%) | Kappa (K) |
| **Sand** | **Water body** | **Built up land** | **Barren land** | **Agriculture land** | **Forest** |
| Sand | 7 | 0 | 5 | 3 | 4 | 0 | 19 | 37 | 0 |
| Water body | 0 | 53 | 1 | 0 | 3 | 0 | 57 | 93 | 0 |
| Built up land | 0 | 0 | 37 | 0 | 1 | 0 | 38 | 97 | 0 |
| Barren land | 0 | 0 | 0 | 6 | 1 | 1 | 8 | 75 | 0 |
| Agriculture land | 0 | 0 | 0 | 0 | 157 | 11 | 168 | 93 | 0 |
| Forest | 0 | 0 | 0 | 0 | 11 | 199 | 210 | 95 | 0 |
| Total | 7 | 53 | 43 | 9 | 177 | 211 | 500 | 0 | 0 |
| Producer Accuracy (%) | 100 | 100 | 86 | 67 | 89 | 94 | 0 | 92 | 0 |
| Kappa (K) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.880183 |

1. **Conclusion and Recommendation:**

The study successfully mapped and quantified the Land Use and Land Cover (LULC) distribution in the study area using remote sensing and GIS, identifying forest and agricultural land as the dominant land covers. The Maximum Likelihood Classification (MLC) algorithm applied in ArcGIS 10.8 achieved a high overall accuracy of 92% and a Kappa coefficient of 0.88, indicating reliable classification results. These findings provide valuable insights for informed decision-making, aiding sustainable land use management and environmental conservation efforts in the region.

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