Comparison Between Supervised and Unsupervised Classification Methods

Study Area: Fatikchhari Upazila

Year: 2025

1. Introduction

Land Use and Land Cover classification is an important step toward understanding the spatial distribution of both natural and artificial features in a landscape. Remote sensing-based classification aids in environmental monitoring, urban planning, agricultural assessment, and resource management. In this paper, Sentinel-2 imagery has been analyzed to generate the LULC maps of Fatikchhari Upazila using two different methods:

- Unsupervised Classification (K-means)
- Supervised Classification (Random Forest)

The main objective, therefore, was to assess both methods by comparing their accuracy and reliability using the ground-truth points derived from Google Earth Pro.

2. Methodology

2.1 Data Collection

➤ Satellite dataset: Sentinel-2 SR Harmonized (January–October 2025).

➤ Bands used: B2, B3, B4 for both methods, plus B8, B11, B12 for supervised classification.

➤ GT points for the accuracy assessment were collected in Google Earth Pro for the following five classes: Agriculture, Settlement, Vegetation, Barren, Waterbody.These GT points were exported as five separate assets and used for accuracy assessment.

2.2 Unsupervised Classification

- ➢ Method: K-means clustering
- ➢ Number of clusters: 5 (equal to number of classes)
- ➢ In GEE, clustering was done using the following: ee.Clusterer.wekaKMeans(5)
  The accuracy was calculated using GT points after clustering.

2.3 Supervised Classification

- ➢ Method: Random Forest RF classifier with 225 trees

- ➢ Training data: GT points of all five classes combined into one data set.

- ➢ RF model trained using the spectral bands B2, B3, B4

- ➢ Classified image validated using the same GT dataset to compute accuracy.

2.4 Accuracy Assessment

Accuracy was measured using:

- ❖ Confusion Matrix
- ❖ Overall Accuracy (OA)
- ❖ Kappa Coefficient

3. Results and Discussion

3.1 Accuracy Results

Method	Overall Accuracy	Kappa Coefficient
Unsupervised (K-means)	0.2292	0.0793
Supervised (RF)	0.1597	–0.0084

3.2 Discussion

The unsupervised classification produced higher accuracy than the supervised approach:

- → K-means OA = 22.92%, while
- → Random Forest OA = 15.97%.

The Kappa coefficient also indicates a better agreement in the unsupervised method, κ = 0.079, than in the supervised classification, κ ≈ –0.008, implying poor classification agreement.

Why supervised performed worse

This low accuracy in supervised classification may be due to several factors:

- ✖ Insufficient or unbalanced training data
- ✖ Ground truth point error
- ✖ Only 6 bands are used; adding indices (NDVI, NDWI, NDBI) can increase the accuracy.
- ✖ Seasonal variability in Sentinel-2 data
- ✖ GT points may overlap mixed land cover areas

4. Conclusion

The study compared supervised vs. unsupervised LULC classification for Fatikchhari Upazila using Sentinel-2 imagery. Based on the accuracy assessment: Unsupervised classification performed better. The Supervised Random Forest performed poorly due to the limitation in training data. For future improvement: i)Add vegetation, built-up, and water indices (NDVI, NDBI, NDWI) Increase and balance GT points Employ different validation points when evaluating accuracy.ii) Apply seasonal filtering or cloud-free composites The findings emphasize the role of high-quality training data in supervised classification.