# KATHMANDU UNIVERSITY

## SCHOOL OF ENGINEERING

## DEPARTMENT OF GEOMATICS ENGINEERING

**A REPORT ON**

**A LAND USE/LAND COVER MAPS OF KASKI DISTRICT**

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# ABSTRACT

This study examines the spatio-temporal changes in land use and land cover (LULC) in Kaski District, Nepal, using high-resolution satellite imagery from Landsat 8/9 (OLI/TIRS) Collection 2 Level-1 for the years 2017, 2020, and 2023. The primary objective was to assess changes in land use patterns and identify key trends driven by urbanization and other environmental factors. A systematic methodology involving data collection, preprocessing, and supervised classification using the Maximum Likelihood Algorithm (MLA) was employed. The findings revealed significant increases in built-up areas, accompanied by a decline in agricultural and vegetative land. These changes highlight rapid urbanization and environmental stress in the region. The generated LULC maps and quantitative analyses provide valuable insights for urban planners and policymakers to promote sustainable land management. The study underscores the importance of leveraging remote sensing and GIS technologies for effective monitoring and decision-making in land resource management.

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| | |
|---|---|
| GIS | Geographic Information System |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| LULC | Land Use Land Cover |
| MLA | Maximum Likelihood Algorithm |

# 1. Introduction

Land Use Land Cover (LULC) analysis plays a crucial role in understanding the dynamic transformations of land use and land cover over time. These changes often reflect patterns of urbanization, agricultural expansion or decline, deforestation, and other land management practices. Monitoring LULC changes provides valuable insights for sustainable land use planning, environmental conservation, and resource management. The use of remote sensing technologies and Geographic Information Systems (GIS) has made it possible to efficiently assess and visualize these changes over vast geographical regions.

Kaski District, has experienced rapid urbanization and land use transformation over the past decade. The district is renowned for its agricultural productivity. However, increasing urban sprawl has raised concerns about land degradation and resource allocation. Understanding the spatio-temporal changes in Kaski District's LULC can help guide sustainable development and environmental conservation efforts.

Rapid urbanization has significantly influenced its LULC dynamics, making it a suitable case study for temporal analysis.

In this study, high-resolution satellite imagery from Landsat 8/9 (OLI/TIRS) Collection 2 Level-1 was utilized to generate LULC maps for the years 2017, 2020, and 2023. The primary objective was to assess spatio-temporal changes and identify significant trends and their implications. By employing remote sensing and GIS techniques, this research aims to provide a comprehensive overview of land use patterns and support future planning initiatives.

## 2. Objectives

The objectives of this study are as follows:

1. To generate high-quality LULC maps of Kaski District for the years 2017, 2020, and 2023 using Landsat 8/9 satellite imagery.
2. To analyze spatio-temporal changes in land use patterns over the selected timeframe.
3. To identify trends and discuss potential factors driving these changes, such as urbanization and environmental pressures.
4. To provide insights for sustainable land management and urban planning in Kaski District.

# 3. Methodology

The methodology followed for this study involved systematic steps for data collection, preprocessing, and classification to generate accurate LULC maps and analyze the spatio-temporal changes.

## Data Collection

| Data | Source |
|---|---|
| **Satellite Imagery** | https://earthexplorer.usgs.gov/ |
| **Administrative Boundaries** | https://opendatanepal.com/dataset/nepal-municipalities-wise-geographic-data-shp-geojson-topojson-kml/resource/06b90abc-1380-46ed-b529-e455de6d794d |

Table 1 : Data Collection

## Preprocessing

1. **Layer Stacking:** Relevant bands were stacked to create composite images suitable for classification.
2. **Radiometric Correction:** Atmospheric distortions were corrected to ensure consistent spectral data.
3. **Georeferencing:** Images were aligned to a standard coordinate system to maintain spatial accuracy.
4. **Clipping:** The images were clipped to the boundary of Kaski District to focus the analysis on the study area.

## LULC Classification

- **Classification Method:** Supervised classification using the Maximum Likelihood Algorithm (MLA) was performed in QGIS. This method was chosen for its accuracy in handling complex datasets.
- **Training Data:** Training classes were selected for key land cover types, including built-up areas, vegetation, agricultural land, water bodies, and barren land.
- **Validation:** Ground truthing and accuracy assessment were conducted to ensure classification reliability.
- **Post-Classification Processing:** Smoothing filters were applied to reduce noise and enhance map clarity.

# 4. Results

### 2017 LULC Map

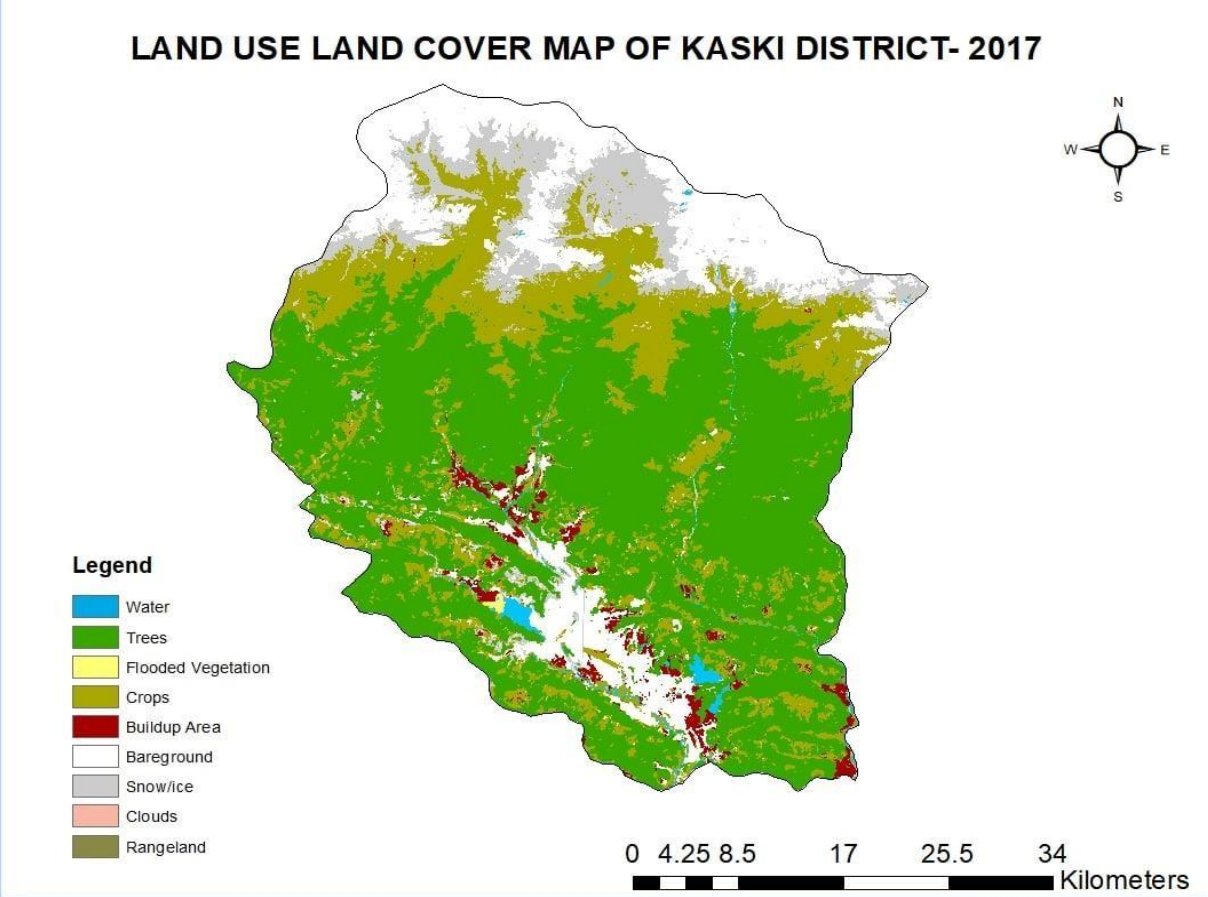


*Figure 1 LULC MAP OF 2017*

| S.N | LULC Category | Percentage |
|---|---|---|
| **1** | Water | 2.1% |
| **2** | Forest | 61.8% |
| **3** | Flooded Vegetation | 0.3% |
| **4** | Crops | 3.7% |
| **5** | Built-up Area | 13% |
| **6** | Rangeland | 16% |
| **7** | Bare ground | 3.2% |

Table 2 : LULC DATA OF 2017

**2020 LULC Map**

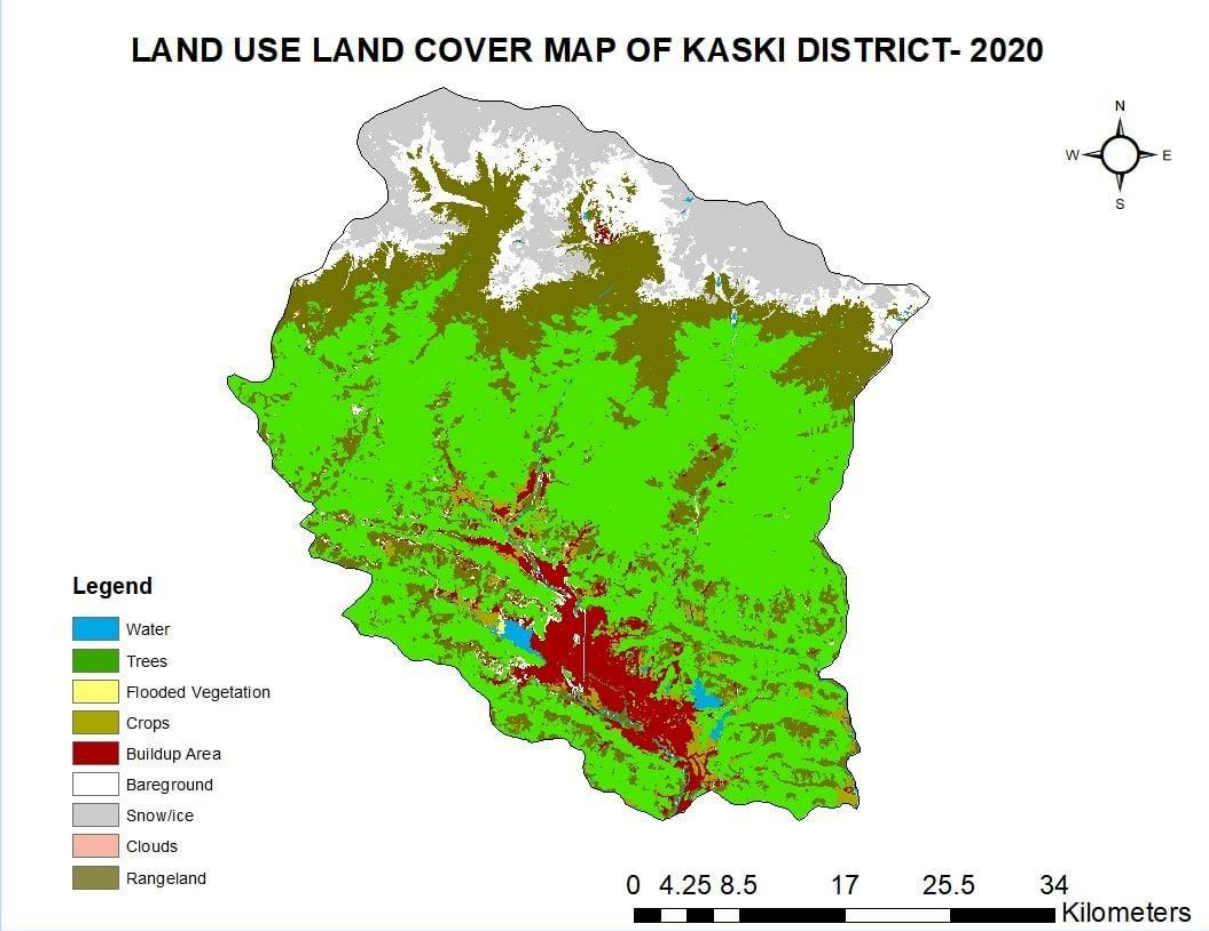


*Figure 2 LULC MAP OF 2020*

| S.N | LULC Category | Percentage |
|---|---|---|
| **1** | Water | 2.1% |
| **2** | Forest | 58.8% |
| **3** | Flooded Vegetation | 0.2% |
| **4** | Crops | 3.7% |
| **5** | Built-up Area | 15% |
| **6** | Rangeland | 19% |
| **7** | Bare ground | 2% |

Table 3 : LULC DATA OF 2020

**2023 LULC Map**

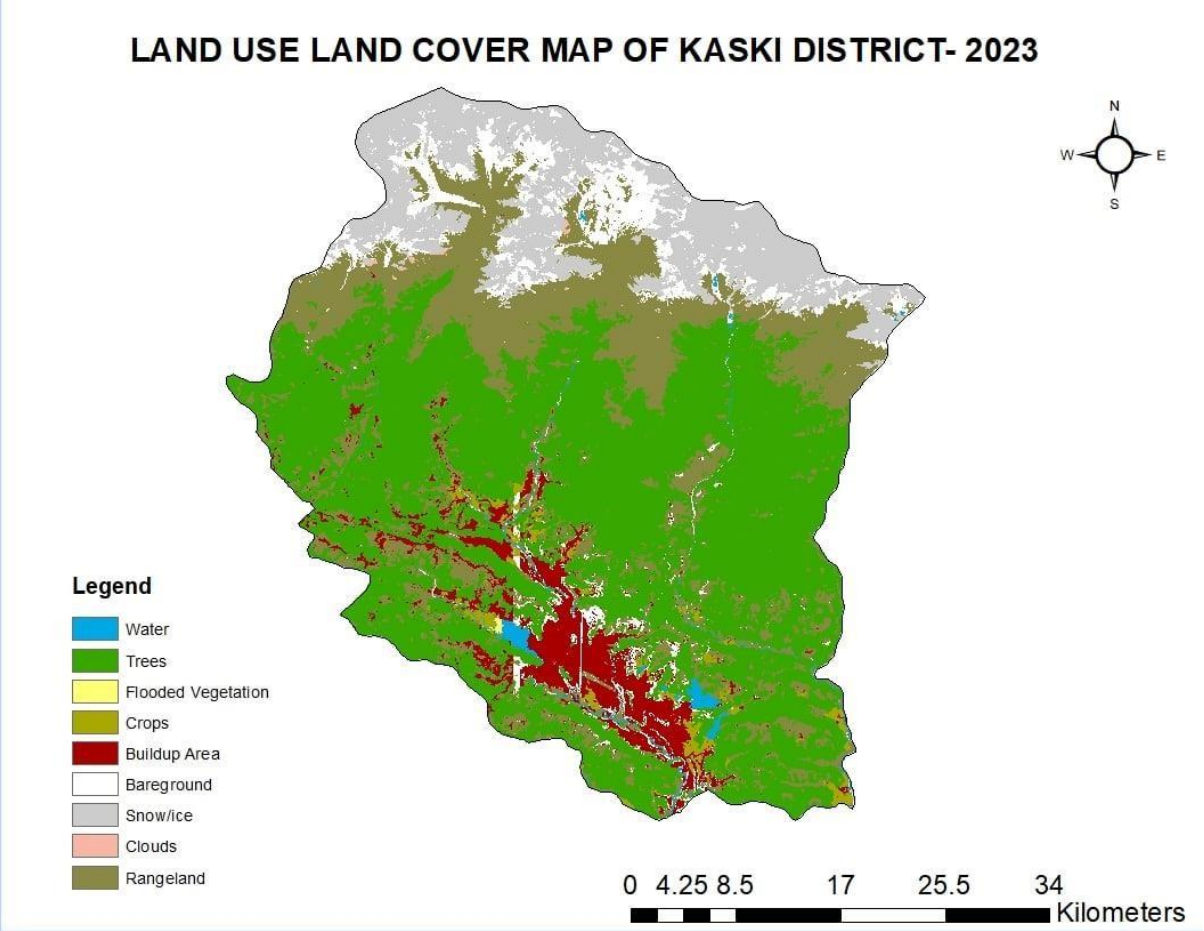


*Figure 3 LULC MAP OF 2023*

| S.N | LULC Category | Percentage |
|---|---|---|
| **1** | Water | 2.1% |
| **2** | Forest | 57% |
| **3** | Flooded Vegetation | 0.2% |
| **4** | Crops | 3% |
| **5** | Built-up Area | 16% |
| **6** | Rangeland | 18% |
| **7** | Bare ground | 4.5% |

Table 4 : LULC DATA OF 2023

| LULC Category | 2017 (%) | 2020 (%) | 2023 (%) |
|---|---|---|---|
| Water | 2.1 | 2.1 | 2.1 |
| Forest | 61.8 | 60 | 57.2 |
| Flooded Vegetation | 0.3 | 0.2 | 0.2 |
| Crops | 3.7 | 3.7 | 3 |
| Built-up Area | 13 | 15 | 16 |
| Rangeland | 16 | 18 | 17 |
| Bare ground | 3.2 | 2 | 4.5 |

Table 5 : LULC DATA OF 2017,2020,2023

The analysis of LULC changes from 2017 to 2023 highlights key trends driven by urbanization and environmental factors. The LULC data from 2017 to 2023 reveals significant land cover changes, particularly in forest cover, which declined from 61.8% in 2017 to 57.2% in 2023, likely due to deforestation or land conversion. Built-up areas have expanded from 13% to 16%, indicating urbanization at the expense of other land uses. Cropland has slightly decreased, possibly due to land-use shifts or urban encroachment. Rangeland initially increased in 2020 but slightly declined by 2023, suggesting fluctuations in land management practices. Meanwhile, bare ground decreased in 2020 but rose again in 2023, potentially due to land degradation or seasonal variations. Water cover remained stable at 2.1%, and flooded vegetation remained minimal. Overall, the trend suggests ongoing deforestation, urban expansion, and land-use shifts that could impact environmental sustainability and resource availability.

# 5. Conclusion

This study demonstrates notable spatio-temporal changes in LULC within Kaski District from 2017 to 2023. The rapid urbanization has led to a decline in agricultural and vegetative land, indicating a need for sustainable land management practices. The findings provide valuable insights for urban planners and environmental policymakers.

The LULC changes reveal key trends, including increasing built-up areas and diminishing agricultural land. These changes are primarily driven by urbanization and population growth. To mitigate environmental degradation and maintain a balance between development and conservation, strategic planning is essential. Preservation of green spaces and sustainable urban development must be prioritized to ensure long-term ecological balance.

This research emphasizes the importance of using remote sensing and GIS technologies to monitor and manage land resources effectively. Future studies can incorporate higher-resolution imagery and advanced machine learning techniques for more accurate classification and analysis.