# KATHMANDU UNIVERSITY

## SCHOOL OF ENGINEERING

## DEPARTMENT OF GEOMATICS ENGINEERING

**A REPORT ON**

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

**SUBMITTED TO:**

Sujan Subedi

**SUBMITTED BY:**

Susham Shrestha (029037-21)

**Date Of Submission**

01 Feb 2025

# ACKNOWLEDGEMENT

I would like to express my sincere gratitude to our course instructor, Sujan Subedi Sir, for their invaluable guidance, continuous support, and insightful feedback throughout the development of this mini-project. Their encouragement and expertise were instrumental in helping me successfully complete this project, which is part of the partial fulfillment of the 6th semester in Geomatics Engineering at Kathmandu University, under the subject of Modern Cartography.

I would also like to thank the Department of Geomatics Engineering at Kathmandu University for providing the resources and academic environment that made this project possible. I am grateful to my classmates and friends for their collaboration, constructive suggestions, and moral support during the project.

Lastly, I am deeply thankful to my family for their unwavering encouragement and support, which has been vital throughout my academic journey.

# ABSTRACT

This study examines the spatio-temporal changes in land use and land cover (LULC) in Bhaktapur District, Nepal, using high-resolution satellite imagery from Landsat 8/9 (OLI/TIRS) Collection 2 Level-1 for the years 2010, 2015, and 2020. 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.

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# LIST OF ABBREVATIONS

| | |
|---|---|
| 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.

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

The district lies between 27.65°N to 27.75°N latitude and 85.43°E to 85.52°E longitude, covering an area of approximately 119 square kilometers. Due to its historical and agricultural significance, the region's land use patterns hold both cultural and ecological importance. 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 2015, 2020, and 2024. 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. Study Area

Bhaktapur District, located in the Kathmandu Valley of Nepal, is a rapidly urbanizing region with significant historical and agricultural importance. The district lies between 27.65°N to 27.75°N latitude and 85.43°E to 85.52°E longitude, covering an area of approximately 119 square kilometers.

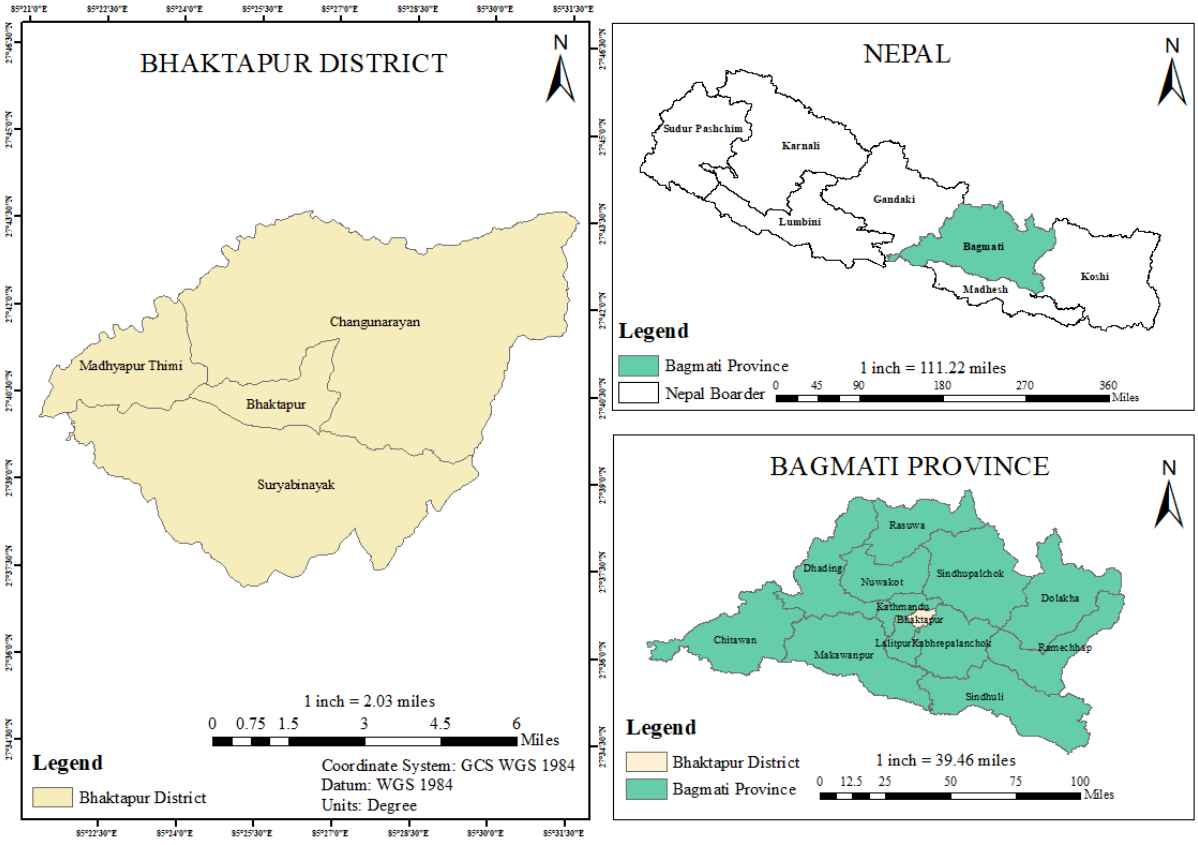



Figure 1 : Study Area

# 3. Objectives

The objectives of this study are as follows:

1. To generate high-quality LULC maps of Bhaktapur District for the years 2010, 2015, and 2020 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 Bhaktapur District.

# 4. 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 Bhaktapur 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.

# 5. Results

### 2010 LULC Map

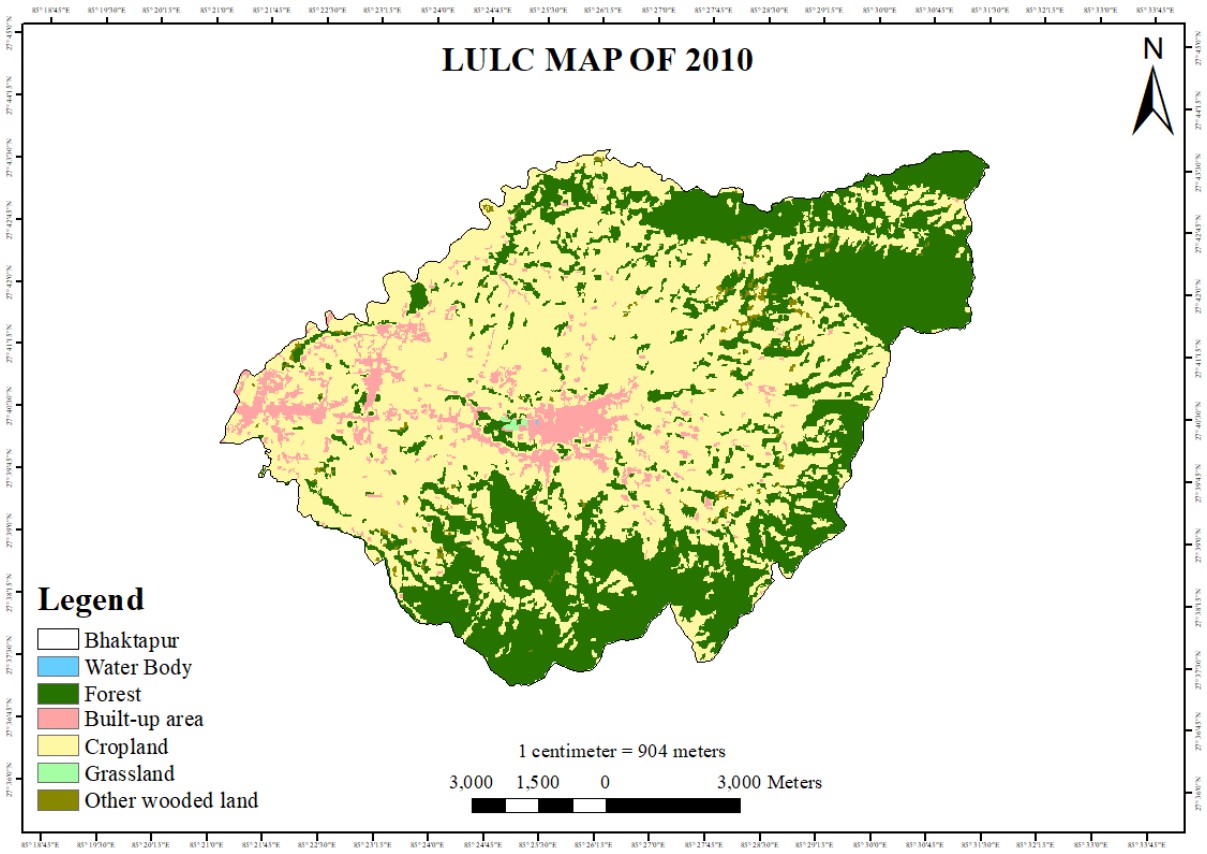



Figure 2: LULC MAP OF 2010

The analysis of the 2010 LULC map shows that cropland was the dominant land cover category, accounting for 56.32% of the total area. Forested areas covered approximately 36.79% of the district, highlighting the region's lush greenery during this period. Built-up land was minimal, occupying only 5.91%, while grassland, open woodland (OWL), and water bodies collectively formed a very small portion of the district.

| S.N | LULC Category | Percentage |
|---|---|---|
| 1 | Water Body | 0.004516 |
| 2 | Forest | 36.788253 |
| 3 | Built-up Land | 5.911384 |
| 4 | Cropland | 56.315239 |
| 5 | Grassland | 0.085158 |
| 6 | OWL | 0.895449 |

Table 2 : LULC DATA OF 2010

**2015 LULC Map**

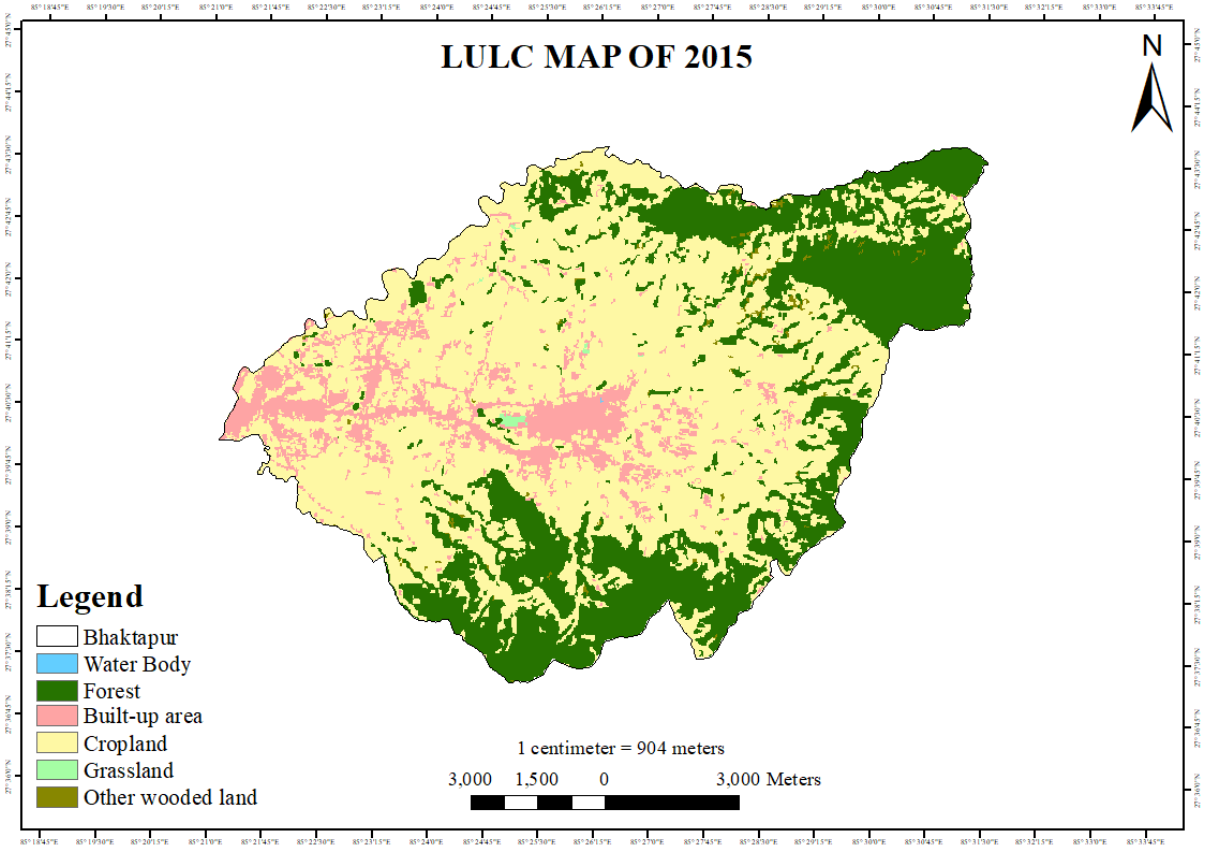



Figure 3: LULC MAP OF 2015

By 2015, noticeable changes had occurred. Cropland increased slightly to 59.46%, maintaining its dominance. However, the forested area decreased significantly to 30.26%, indicating a decline in vegetation cover. Built-up land rose to 9.61%, signifying the start of increased urbanization activities.

| S.N | LULC Category | Percentage |
|---|---|---|
| 1 | Water Body | 0.003226 |
| 2 | Forest | 30.261409 |
| 3 | Built-up Land | 9.613821 |
| 4 | Cropland | 59.458989 |
| 5 | Grassland | 0.129027 |
| 6 | OWL | 0.533528 |

Table 3 : LULC DATA OF 2015

**2020 LULC Map**

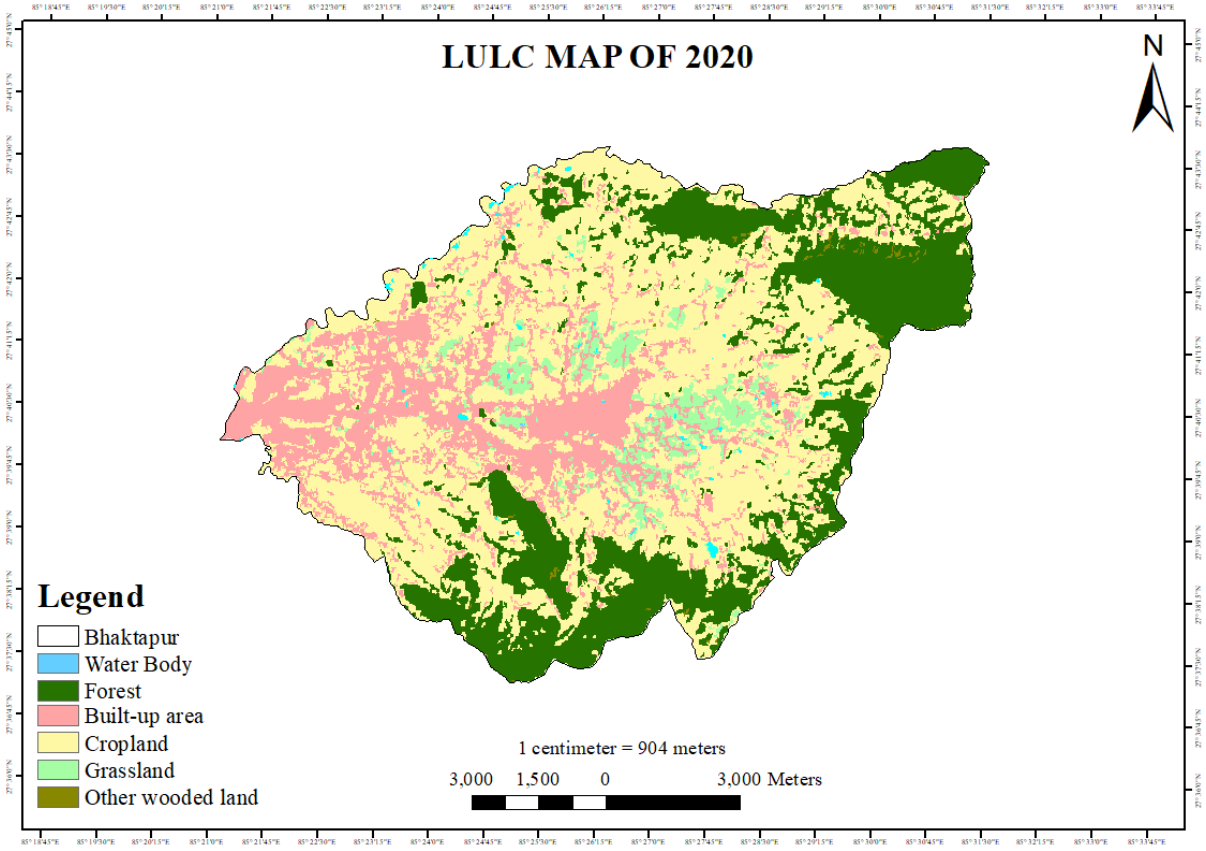



Figure 4 : LULC MAP OF 2020

The LULC map for 2020 demonstrated further transformations. Built-up land surged to 19.57%, highlighting ongoing urban expansion. Cropland, though still substantial, reduced to 49.41%. The forest cover declined further to 25.80%. A significant rise in grassland to 4.60% suggests possible land-use changes driven by agricultural or deforestation activities.

| S.N | LULC Category | Percentage |
|---|---|---|
| 1 | Water Body | 0.007096 |
| 2 | Forest | 25.797066 |
| 3 | Built-up Land | 19.569565 |
| 4 | Cropland | 49.414861 |
| 5 | Grassland | 4.604983 |
| 6 | OWL | 0.253539 |

Table 4 : LULC DATA OF 2020

| LULC Category | 2010 (%) | 2015 (%) | 2020 (%) |
|---|---|---|---|
| Water Body | 0.0045 | 0.0032 | 0.0071 |
| Forest | 36.79 | 30.26 | 25.80 |
| Built-Up Land | 5.91 | 9.61 | 19.57 |
| Cropland | 56.32 | 59.46 | 49.41 |
| Grassland | 0.09 | 0.13 | 4.60 |
| OWL | 0.90 | 0.53 | 0.25 |

Table 5 : LULC DATA OF 2010,2015,2020

The analysis of LULC changes from 2010 to 2020 highlights key trends driven by urbanization and environmental factors. Built-up land witnessed a dramatic increase, tripling its extent over the decade, driven by population growth and infrastructure development. Cropland, which initially increased in 2015, experienced a decline by 2020, likely due to the conversion of agricultural fields into urban settlements.

The decline in forest cover is a notable environmental concern. The reduction from 36.79% in 2010 to 25.80% in 2020 reflects deforestation and land clearing for urban and agricultural activities. Grassland expansion by 2020 may represent transitional land-use phases or natural re-vegetation.

These findings underscore the importance of sustainable urban planning and environmental conservation measures. Policymakers should consider land-use zoning strategies and green infrastructure development to mitigate environmental impacts and promote balanced growth.

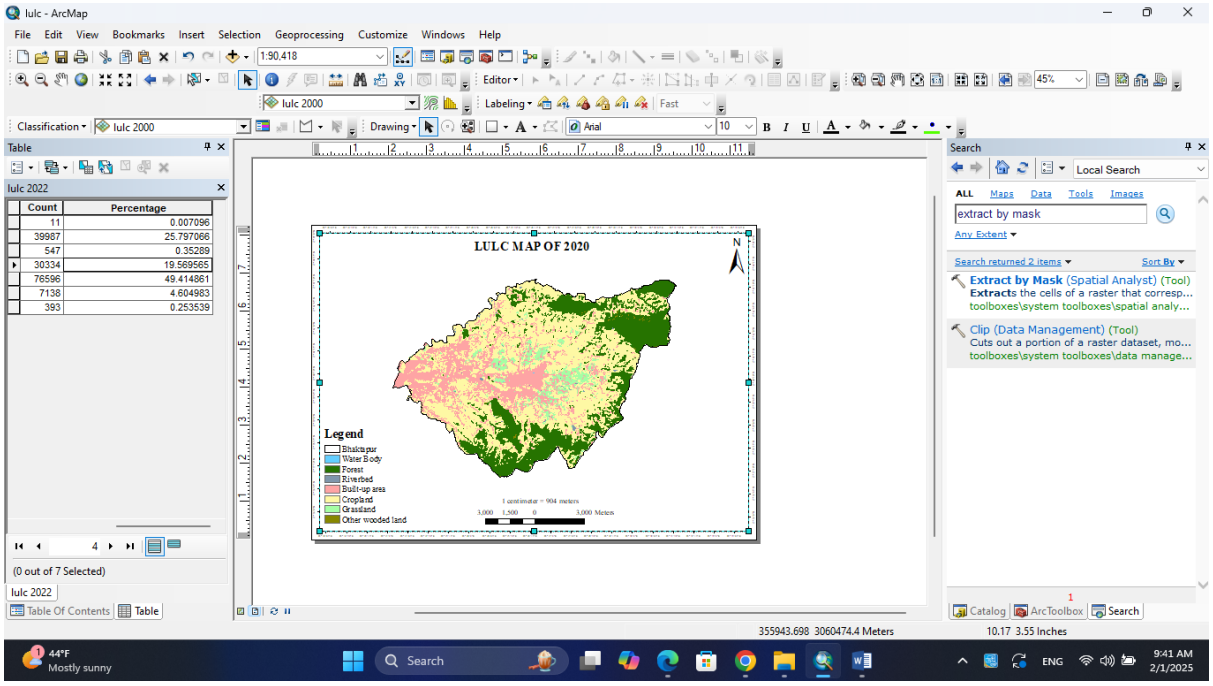
# 6. Conclusion

This study demonstrates notable spatio-temporal changes in LULC within Bhaktapur District from 2010 to 2020. 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.

# 7. Annex


lulc - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
Table
lulc 2022
Count Percentage
11 0.007096
39987 25.797066
547 0.35289
30334 19.569565
76596 49.414861
7138 4.604983
393 0.253539
(0 out of 7 Selected)
Table Of Contents Table
LULC MAP OF 2020
N
Legend
Shakrapur
Water Body
Forest
Riverbed
Built-up area
Cropland
Grassland
Other wooded land
Search
Local Search
extract by mask
Extract by Mask (Spatial Analyst) (Tool)
Clip (Data Management) (Tool)
Catalog ArcToolbox Search
355943.698 3060474.4 Meters
10.17 3.55 Inches
44°F Mostly sunny
Search
ENG
9:41 AM 2/1/2025