Urban Expansion and Its Consequences

Impacts on Food Security and Environmental Sustainability

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Presenter:

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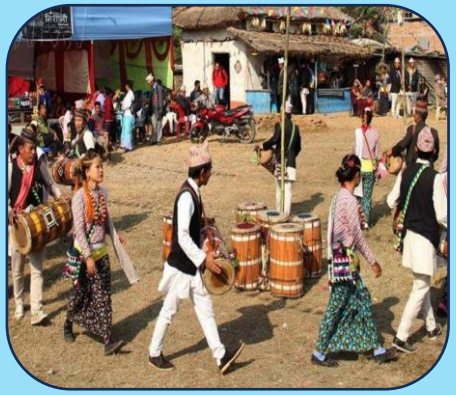
Presentation outline

- INTRODUCTION
- MATERIALS AND METHODS
  - Study Area
  - Data acquisition and preparation
  - Methodological work flow

- RESULTS AND DISCUSSION
  - Comparison of Individually Classified Images
  - From-To Change Analysis
- CONCLUSION

INTRODUCTION: Urbanization: A Transformative Process

Urbanization reshapes relationships



66,240 in 2001
80,376 in 2011
97,633 in 2021

social | cultural | demographic | economic | political

New identities, economies, and social realities emerge beyond mere population growth ~(Love, 2021)

INTRODUCTION: Urbanization: Global and National trend

55%

Current global urban population

As of 2021, around 55% of the global population resided in urban areas.

15% in 30 years

68%

Projected urban population by 2050

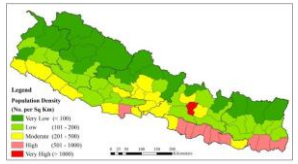
It is projected that approximately 68% of the world's population will live in urban areas by 2050.

~(United Nations Habitat, 2022)

2.9%

Urban population in Nepal in 1952

In 1952, Nepal's urban population was 2.9% with only 10 urban centers.



14% in 60 years

17.1%

Urban population in Nepal in 2011

By 2011, the urban population in Nepal increased to 17.1% with 58 urban centers.

33% in 6 years

50%

Urban population milestone in Nepal

Nepal's urban population exceeded 50% by 2017, reaching 293 urban centers.

16% in 4 years

66.17%

Latest urban population in Nepal for 2021

The latest report shows that Nepal's urban population was 66.17% in 2021.

~(Rijal et al., 2020; NSO, 2023)

INTRODUCTION: Urbanization: Local trend (Godawari Municipality)

December, 2014

Godawari Municipality established by merging five former VDCs.

The municipality was formed by merging the Village Development Committees of Godawari, Badikhel, Bisankhunarayan, Godamchaur, and Thaiba.

March 2017

Municipality area expanded to include 12 previous VDCs.

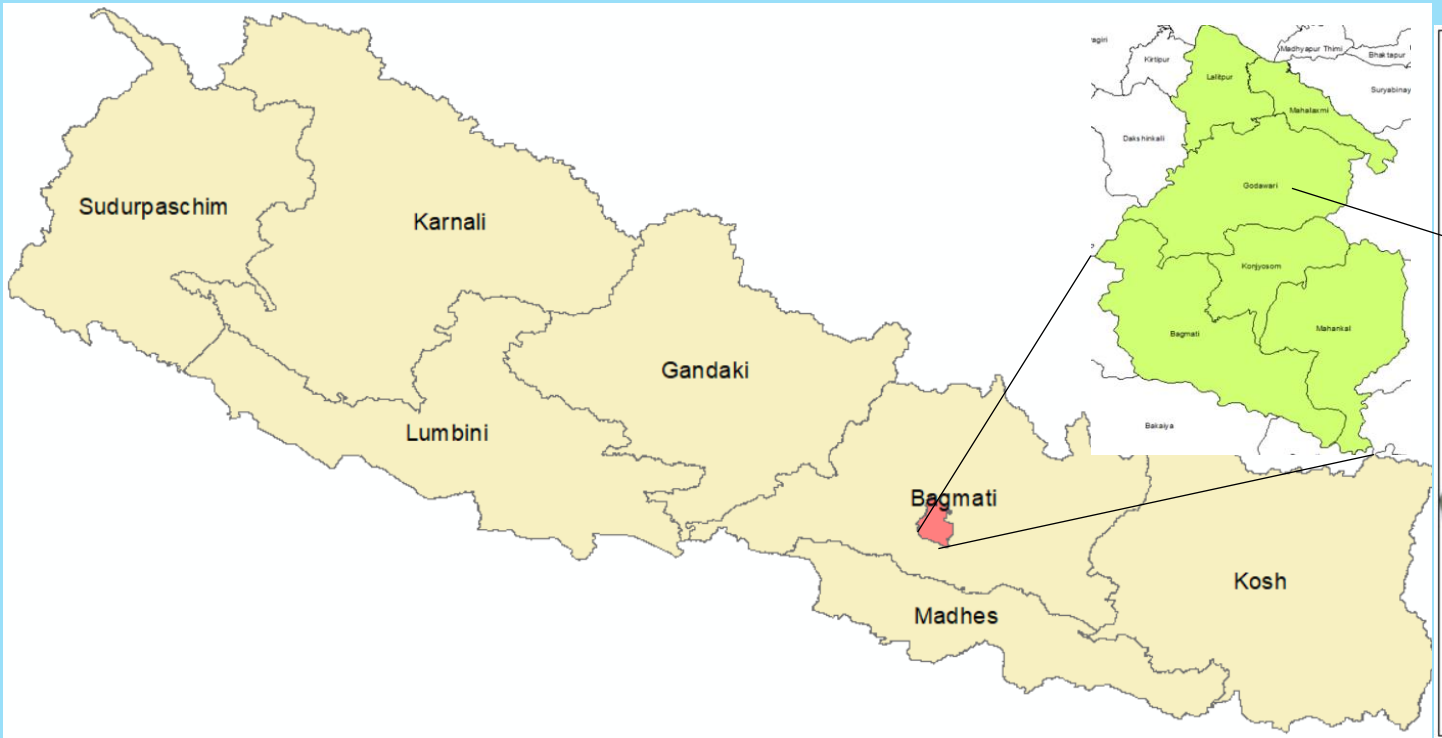
Seven additional VDCs were added: Devichaur, Dukuchhap, Chhampi, Thecho, Chapagaun, Jharuwarasi, and Lele.

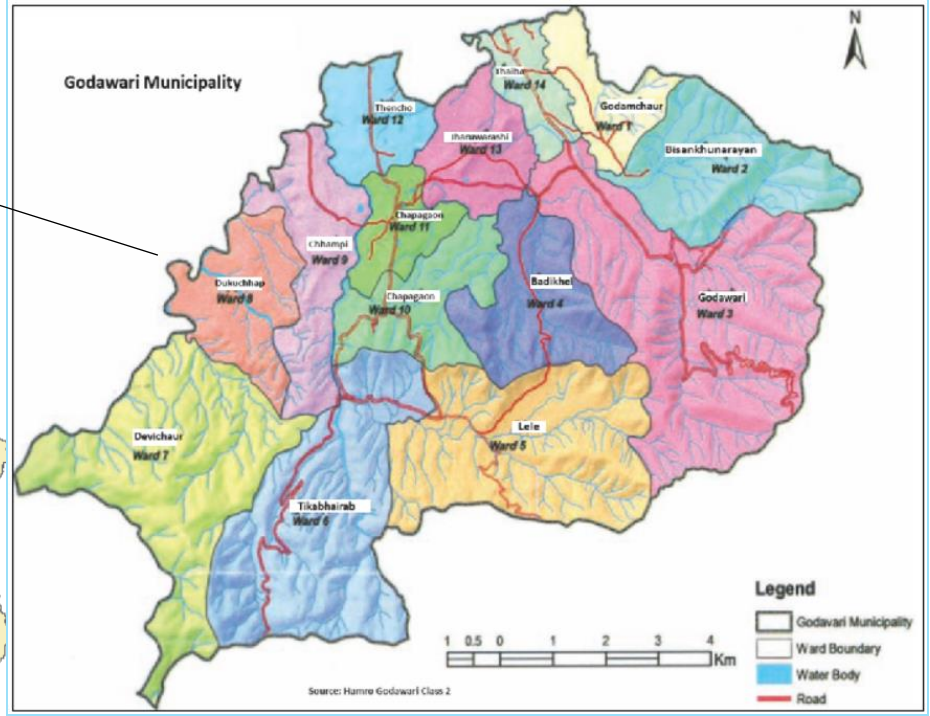
66,240 in 2001 → 21% in 10 years → 80,376 in 2011 → 21% in 10 years → 97,633 in 2021

driven by government decisions merge rural administrative units and designate them as municipalities

~(Joshi, 2023)

MATERIALS AND METHODS: Study Area (Godawari Municipality)





Extends from 85°15'8" E to 85°24'57" E longitude and from 27°31'40" N to 27°38'57" N latitude.
Area: 96.11 km². Elevation: 457 m to 2,831 (Godawari Municipality, 2021)

MATERIALS AND METHODS: Data acquisition and preparation

01

Data Acquisition

Obtain annual land cover data for Nepal (2000–2019) from the Regional Database System (RDS) portal.

Download administrative boundary data from the National Spatial Data Center in shapefile format.

02

Data Preparation

Process and clip the land cover raster data for 2000, 2005, 2010, 2015, and 2019 to match Godawari Municipality's boundaries.

Develop a batch processing model using the Clip tool in ArcGIS software for spatially clipping the data.

03

Methodology Implementation

Utilize post-classification techniques for assessing the conversion of agricultural and forest land into urban built-up areas.

Compare individually classified images to analyze land cover changes over time.

04

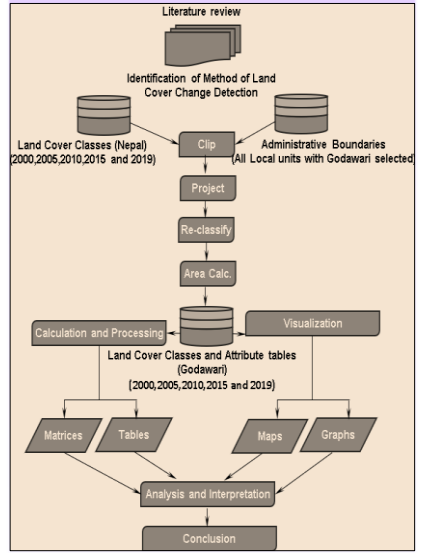
GIS Analysis

Leverage GIS capabilities to support qualitative calculations in post-classification analysis.

Ensure accuracy by assuming the pre-classified land cover data from ICIMOD is reliable for the study.

05

Workflow Diagram

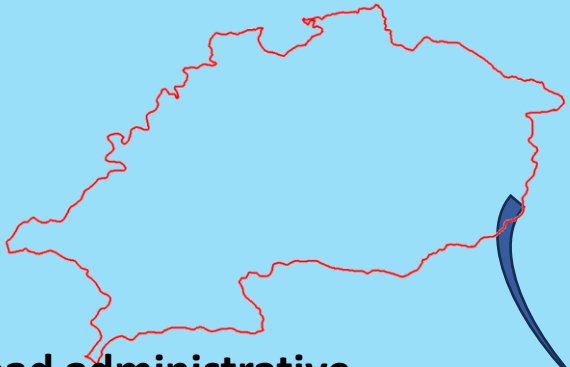


MATERIALS AND METHODS: Data acquisition and preparation-Reclassification

LCCs in the data		Available LCCs in study area		
Grid value	Land cover class	Count	% Coverage	Reclassified to
1	Waterbody	27	0.02	Forest
2	Glacier	×	×	×
3	Snow	×	×	×
4	Forest	68312	57.95	Forest
5	Riverbed	×	×	×
6	Built-up area	1166	1	Built-up area
7	Cropland	46914	39.8	Cropland
8	Bare soil	×	×	×
9	Bare rock	×	×	×
10	Grassland	606	0.51	Forest
11	Other wooded land (OWL)	852	0.72	Forest

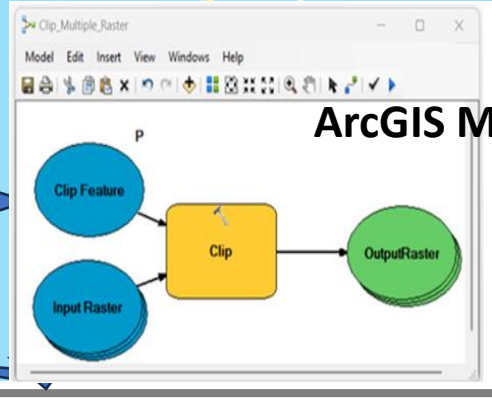
MATERIALS AND METHODS: Data acquisition and preparation

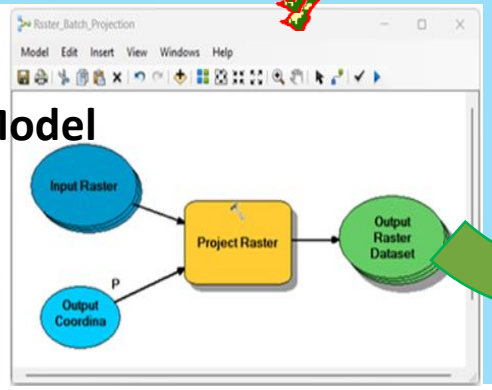
Obtain annual land cover data for Nepal (2000–2019) from the Regional Database System (RDS) portal.

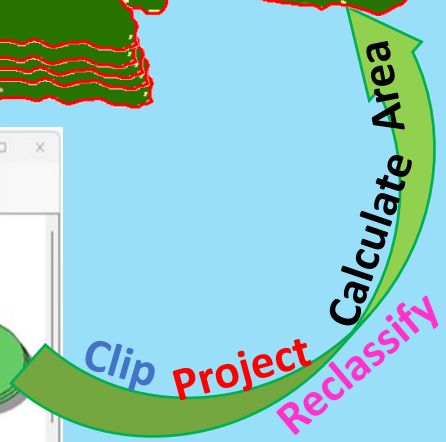


Download administrative boundary data from the National Spatial Data Center

ArcGIS Model

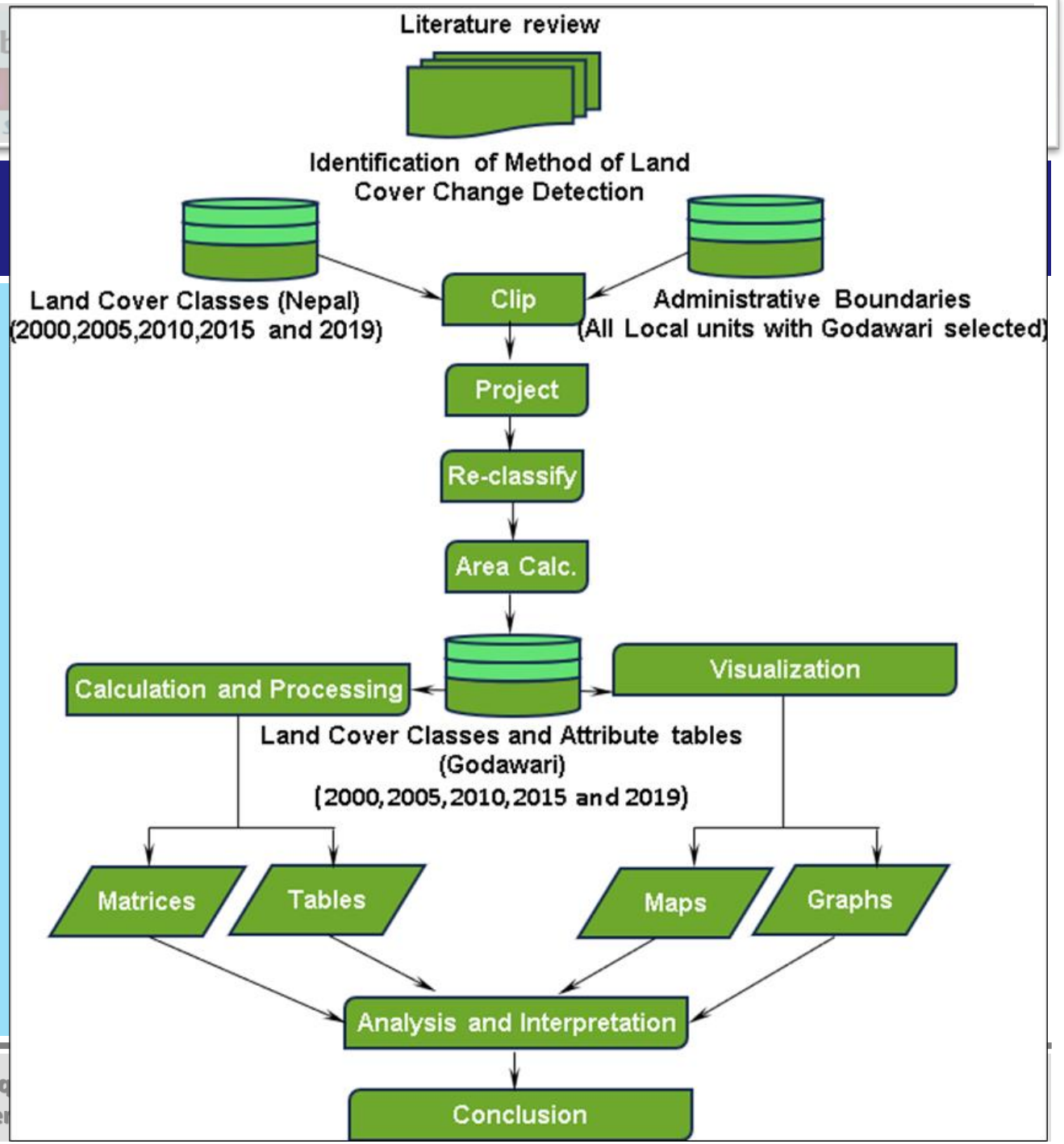






MATERIALS AND METHODS: Workflow

- GIS Analysis of Urban Growth Patterns
  - Tables
  - Maps
  - graphs
- Land Cover Change Trends
  - Individual land cover change
    - Built-up
    - Cropland
    - Forest
  - From-To Change Analysis
    - Change matrix
    - Change map
- Urban Expansion Impact



Change Detection: Methodological Workflow

1. **Choosing methodologies involves multiple factors.**

   The process of selecting methodologies for analyzing the spatio-temporal expansion of built-up areas is influenced by data availability, study area characteristics, and research objectives.

2. **Importance of understanding methodologies.**

   A thorough understanding of available approaches, including their strengths and limitations, is crucial for making informed decisions that align with research goals.

3. **Change detection in various fields.**

   Change detection plays a significant role in environmental monitoring, land use and land cover studies, urban planning, and disaster management, aiding in the analysis of Earth's surface dynamics.

4. **Common approaches to change detection.**

   The most widely used approaches to change detection are pre-classification and post-classification methods, each suited to different study objectives.

Post-classification method was applied

Post-classification Change Detection Analysis

The post-classification approach is highly accurate for change detection because it minimizes the effects of atmospheric conditions, sensor variations, and other factors that may influence raw images.

Detailed land cover transition information

Identifies specific change areas

In the comparison of individually classified images, each image is classified independently, allowing for both quantitative (area calculation) and qualitative (accuracy assessment) comparisons.

Reliance on pre-classified land cover data

Utilizes existing datasets for accuracy

Although the post-classification approach is effective, it is more time-consuming and requires a higher level of expertise in image classification.

High accuracy in change detection

Minimizes effects of external factors

From-To Change Analysis tracks changes from one land cover class to another, providing detailed 'from-to' information on land cover transitions and identifying specific areas where changes have occurred.

Independent classification of images

Quantitative and qualitative comparison

This method relies heavily on the accuracy of pre-classified land cover data developed by the National Land cover Monitoring System, ensuring consistent land cover change assessments.

Time-consuming and expertise-dependent

Requires higher level of expertise

Results and Discussion: Land Cover Comparison

LandCover	LC_2000	LC_2005	LC_2010	LC_2015	LC_2019
Built-up	0.95	1.51	1.83	2.12	6.50
Cropland	38.25	31.31	33.62	35.24	33.18
Forest	56.91	63.08	60.46	58.55	56.42

Built-up area increased 6.84 times from 2000 to 2019.

6.84×

Built-up Area Increase

Cropland area reduced from 38.25% to 33.18% in 2000 to 2019.

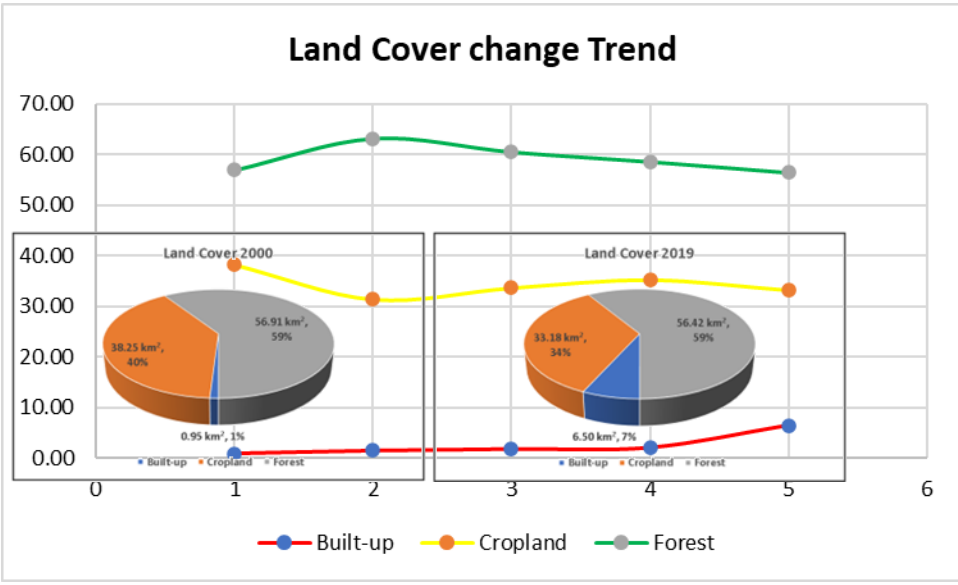
33.18%

Cropland Area Decrease

Forest area declined from 56.91% to 56.42% in 2000 to 2019.

56.42%

Forest Area Decrease

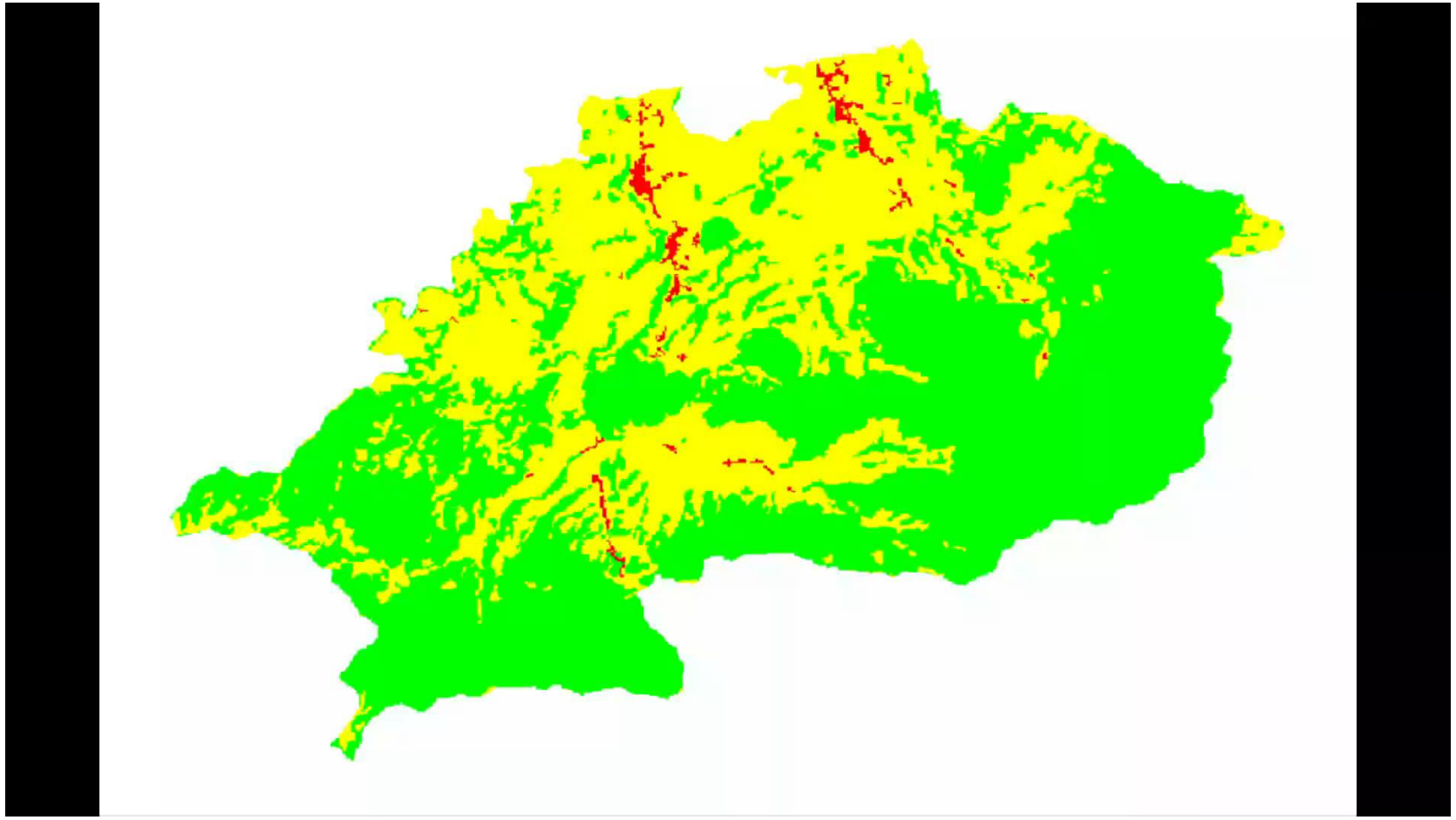


Forest: the largest coverage, declining trend with initial increment

Cropland: second largest coverage, declining trend with slight increment in the middle

Built-up: the smallest coverage, always inclining trend

Results and Discussion: Land Cover Comparison



Results and Discussion: From-To Change Analysis

6.84 times

Significant increase in built-up areas

The built-up area grew nearly seven-fold (6.84 times) from 2000 to 2019, indicating a substantial change in land cover.

650 hectares

Current built-up land area

In 2019, approximately 650 hectares of land were categorized as built-up, showcasing the extent of urban development.

78%

Conversion from cropland to built-up

Of the built-up land in 2019, a significant 78% was converted from cropland, illustrating the impact of urban expansion on agricultural land.

7.4%

Conversion from forest to built-up

Only 7.4% of the built-up area in 2019 was converted from forest, highlighting the limited impact on forested regions compared to cropland.

14.6%

Previously built-up land

Only 14.6% of the built-up area in 2019 was already classified as built-up in 2000, indicating significant new development.

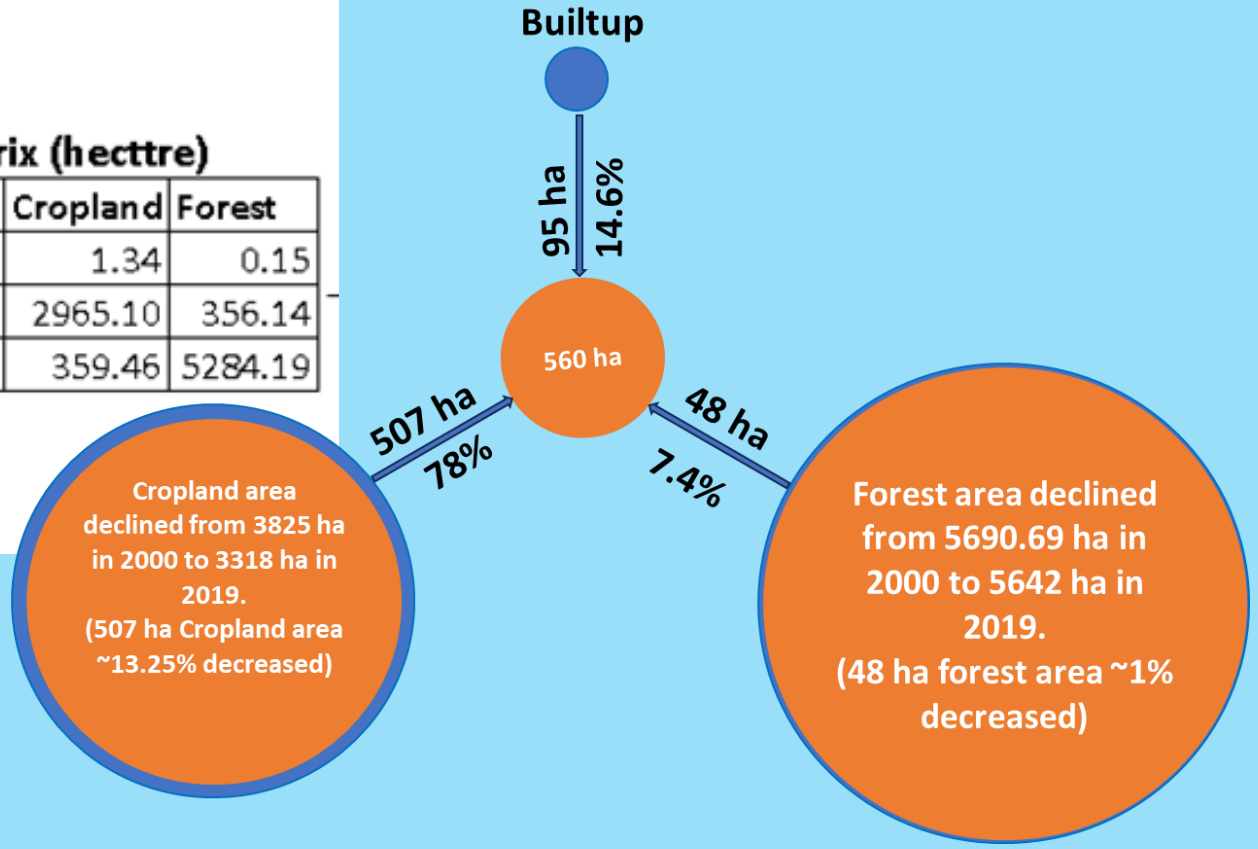
Results and Discussion: From-To Change Analysis

Area in Attribute Table

LC_00_19	LC_Area(hectre)
Built-up -Built-up	89.58
Built-up -Cropland	1.34
Built-up -Forest	0.15
Cropland -Built-up	508.07
Cropland -Cropland	2965.10
Cropland -Forest	356.14
Forest -Built-up	39.96
Forest -Cropland	359.46
Forest -Forest	5284.19

Change Matrix (hecttre)

Land Cover	Built-up	Cropland	Forest
Built-up	89.58	1.34	0.15
Cropland	508.07	2965.10	356.14
Forest	39.96	359.46	5284.19



Conclusion

- **Urban Expansion Impact**
  - Built-up areas are expanding at the cost of cropland, raising food security concerns.
  - Urban growth is encroaching on forests, threatening biodiversity and ecological stability.
  - The ongoing shift between cropland and forest reveals a fragile equilibrium

Cropland vs Urban Areas

1. Reduction of arable land due to the rapid growth of built-up areas.
2. Concerns for food security as arable land diminishes.

Forest Areas vs Urban Expansion

1. Threat to biodiversity as forest areas are converted into urban spaces.
2. Disruption of ecosystems leading to increased vulnerability to natural disasters.

Conclusion …

- **Need for Sustainable Planning**
  - **These findings underscore the urgent need for urban planning that ensures food security and environmental sustainability.**
- **Final Message**
  - **"Balancing urban growth with sustainable land use is essential for our future."**

Thanks!

ANY QUESTIONS?

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