Malaviya National Institute of Technology, Jaipur

CED498 Major Project

Analysis of Urbanization Trends in Jaipur using GIS and Remote Sensing

Submitted To:
Dr. Rohit Goyal,
Dr. Urmila Brighu,
Dr. Manoj Kumar Diwakar

Submitted By: ***WRE Group1***

Anjali Anand *2017uce1468*
Ashwini Sen Gupta *2017uce1612*
Amit Kumar Maurya *2017uce1317*

ROADMAP

Introduction

Objective
Of Project

Data &
Methodology

Procedure

Practical Application
In Civil Engineering

Challenges

INTRODUCTION

Urbanization

The movement of people from rural to urban areas with population growth equating to urban migration.

Geographical Information System (GIS)

GIS is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.

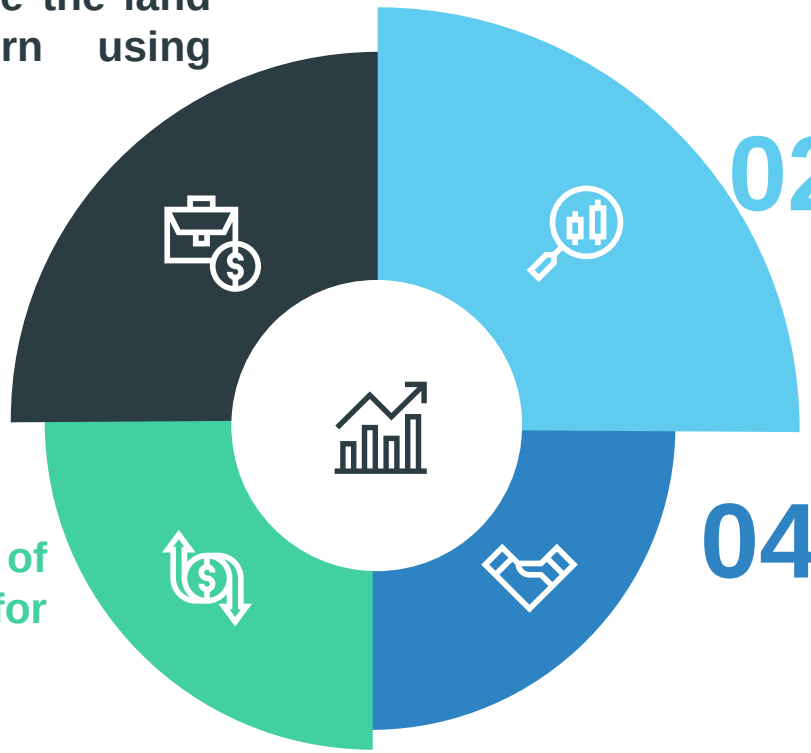
Remote Sensing(RS)

Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance.

OBJECTIVE

The main objective of our project is to analyze urbanization trends for period 1990-2020 and forecast the urbanization pattern for next 20 years in order to support urban sustainable development.

01 To extract and compare the land cover change pattern using ArcGIS

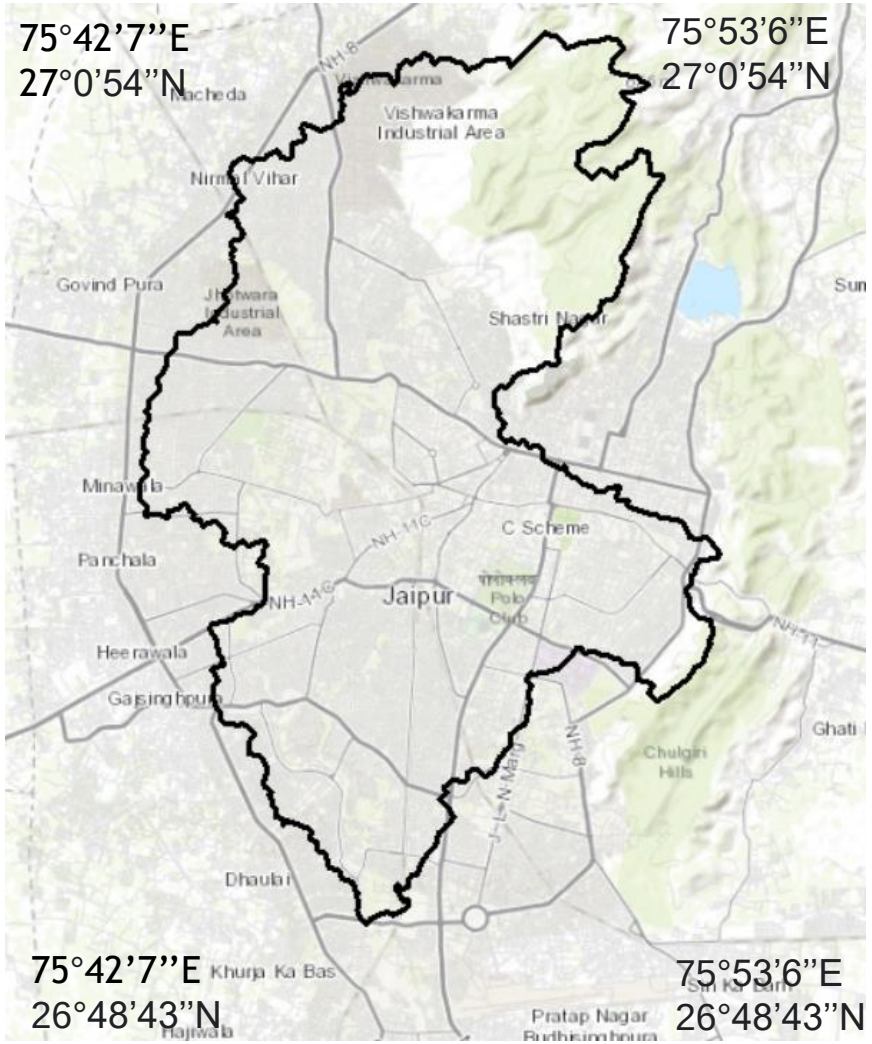


02 To examine the underlying cause-effect relationships in the urban growth process

03 To generate forecast of urbanization trends for next 20 years

04 To examine the impacts of the urbanization trends

STUDY AREA



Area : 118.92 km^2

Average annual temperature : 25.1°C

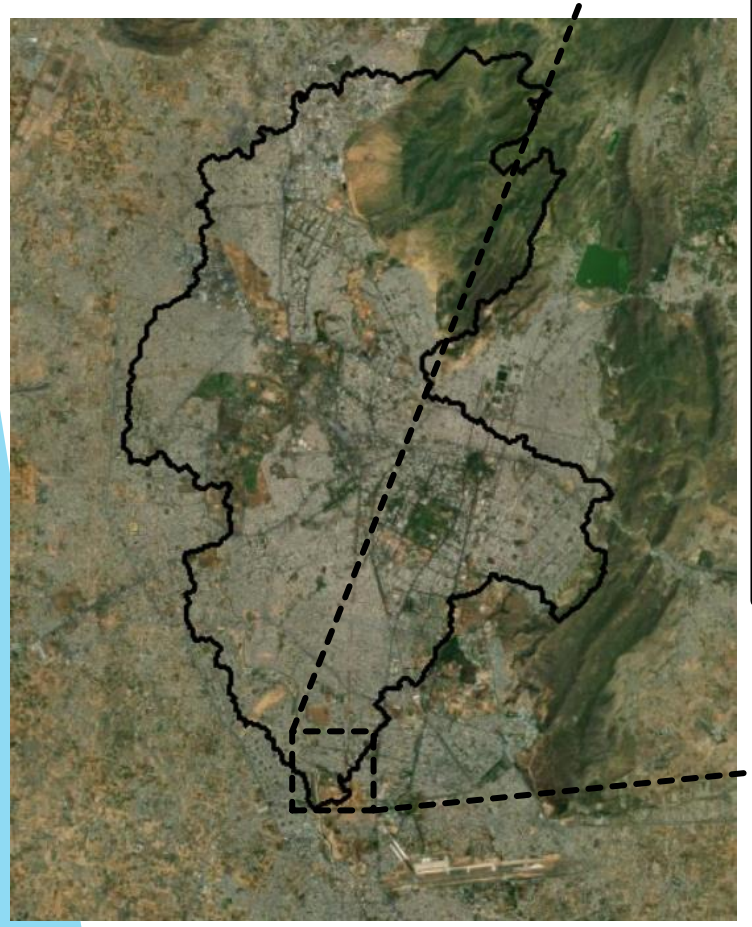
Population Density : 6,500/km^2

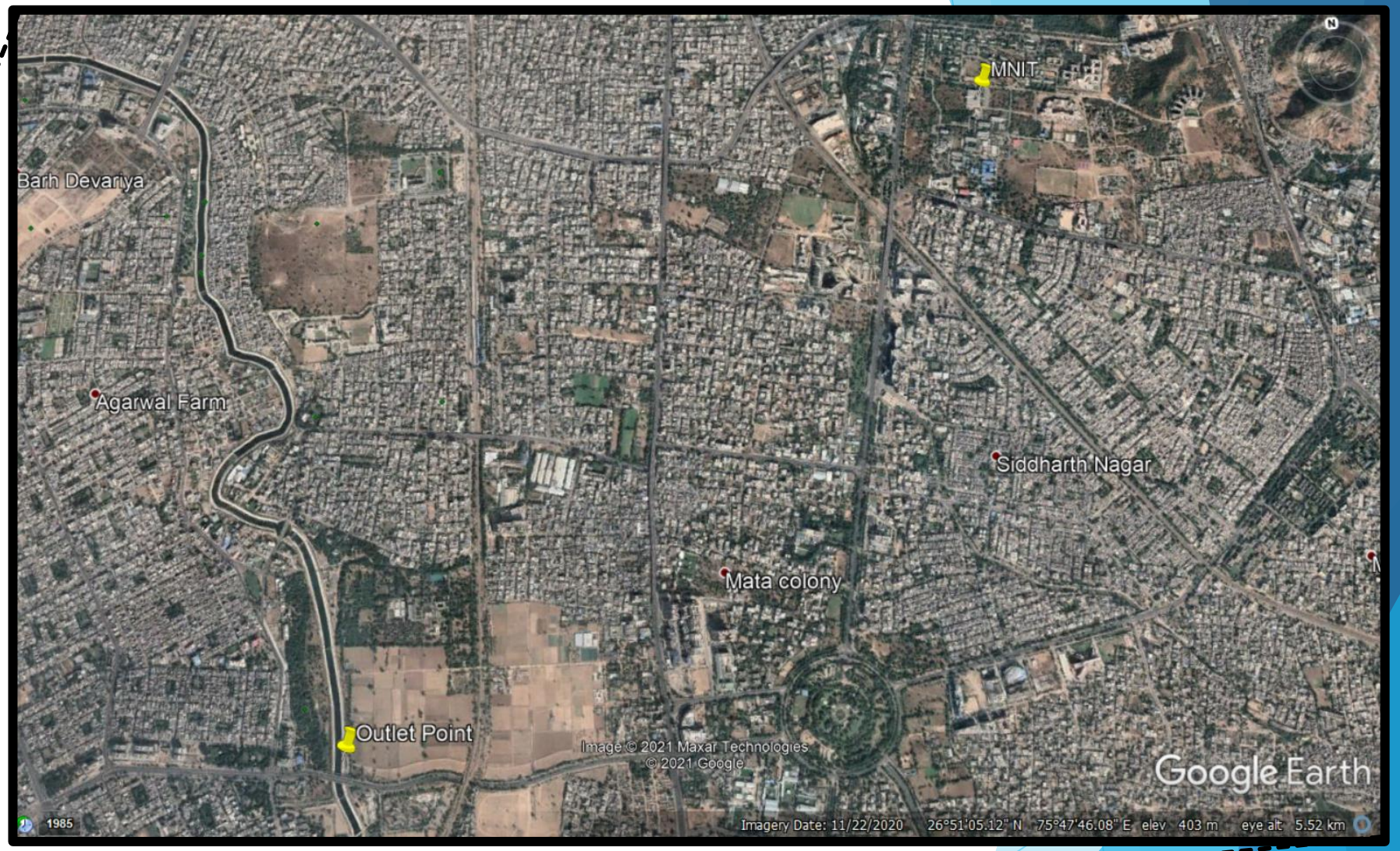
Annual precipitation : 650 mm

Elevation of study area : 431m

Coordinate of outlet point :
26.84N , 75.78E

SATELLITE VIEW OF STUDY AREA





DATA SOURCES

- **For DEM: 30-Meter SRTM Tile Downloader**
- **For Classified Maps: USGS Earth Explorer, Copernicus Open Access Hub**

1990: Landsat 5 (Date-31/12/1990) Band 2,3,4
1995: Landsat 5 (Date-29/12/1995) Band 2,3,4
2000: Landsat 7 (Date-02/12/2000) Band 2,3,4
2008: Landsat 7 (Date-18/10/2008) Band 2,3,4
2010: Landsat 7 (Date-14/12/2010) Band 2,3,4
2015: Landsat 8 (Date-04/12/2015) Band 3,4,5
2018: Sentinel 2 (Date-26/12/2018) Band 8,4,3
2020: Sentinel 2 (Date-01/12/2020) Band 8,4,3
2021: Sentinel 2 (Date-07/03/2021) Band 8,4,3

- **For Data Validation: Google Earth Pro, Bhuvan-Indian Geo-Portal of ISRO**

METHODOLOGY

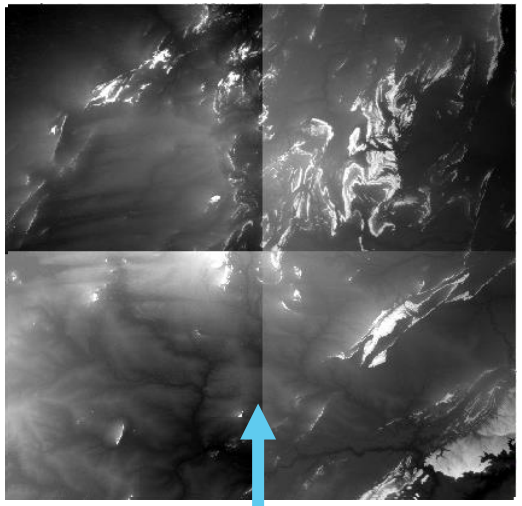
Maximum Likelihood Classification

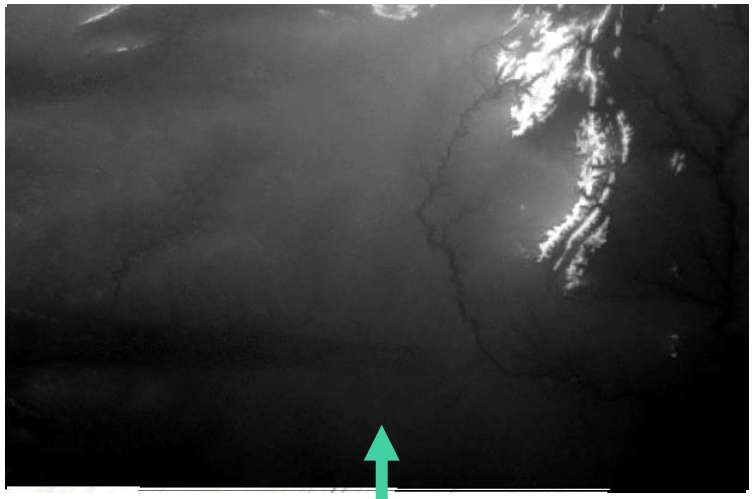
Accuracy Assessment by Error Matrix Method

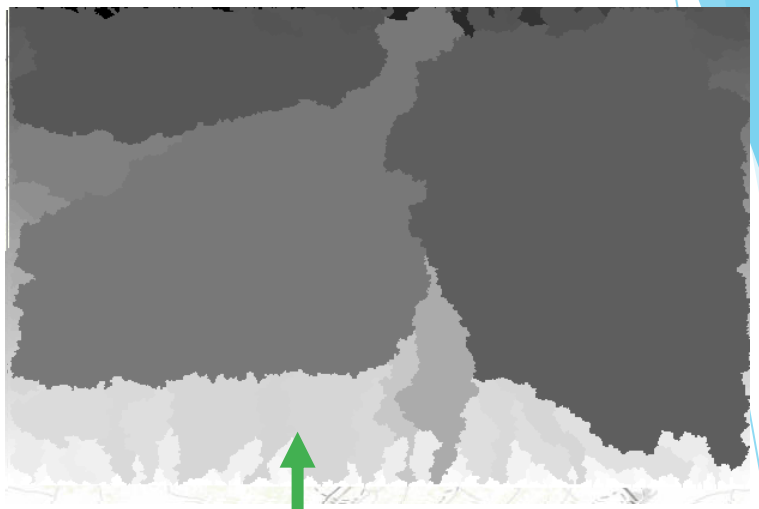
Resampling of Classified Maps

Land Change Intensity Analysis

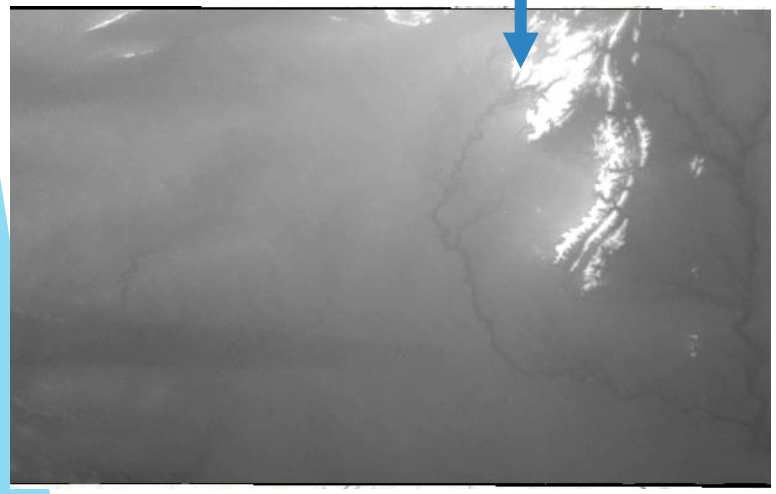
PROCEDURE

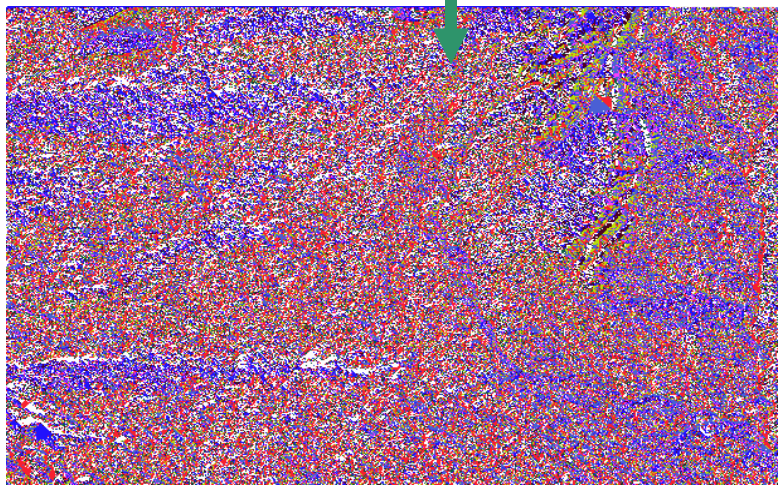


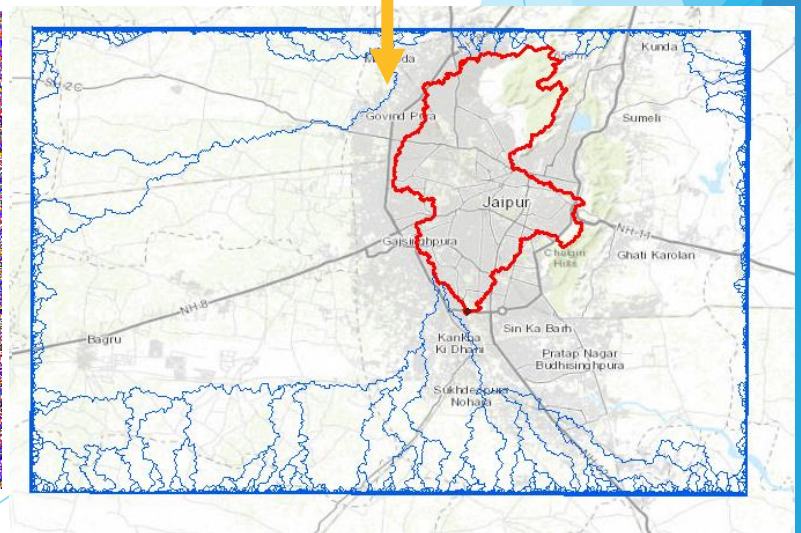




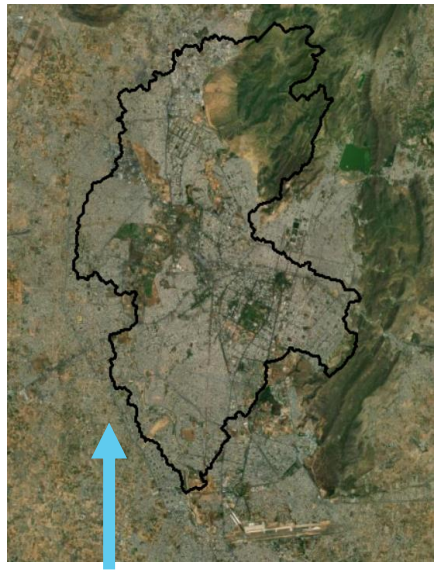
DEM TILES → MOSAIC → FILL → FLOW DIRECTION → FLOW BASIN → RASTER BASIN TO VECTOR POLYGON → WATERSHED

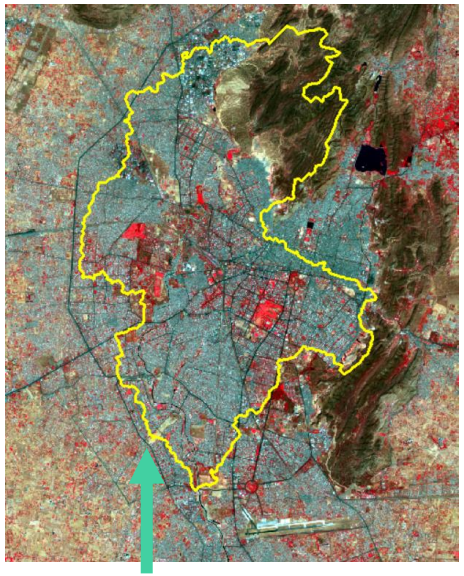


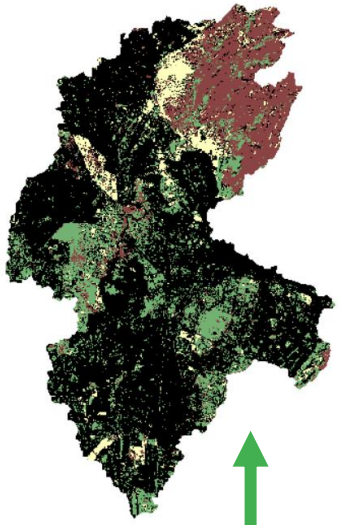


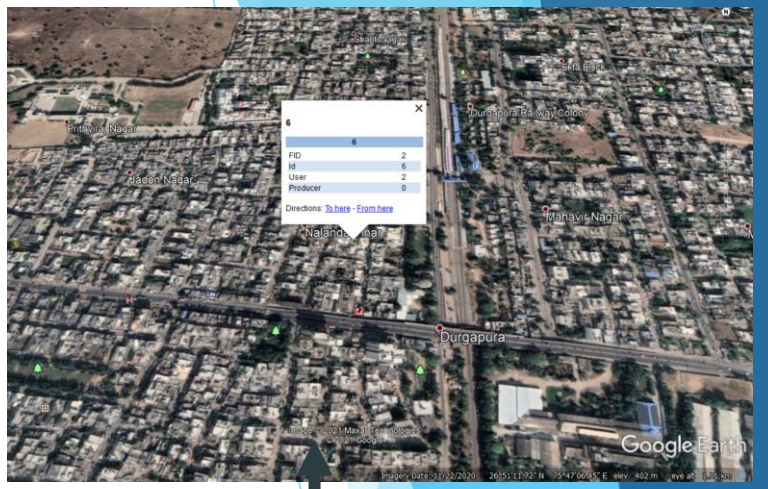


PROCEDURE

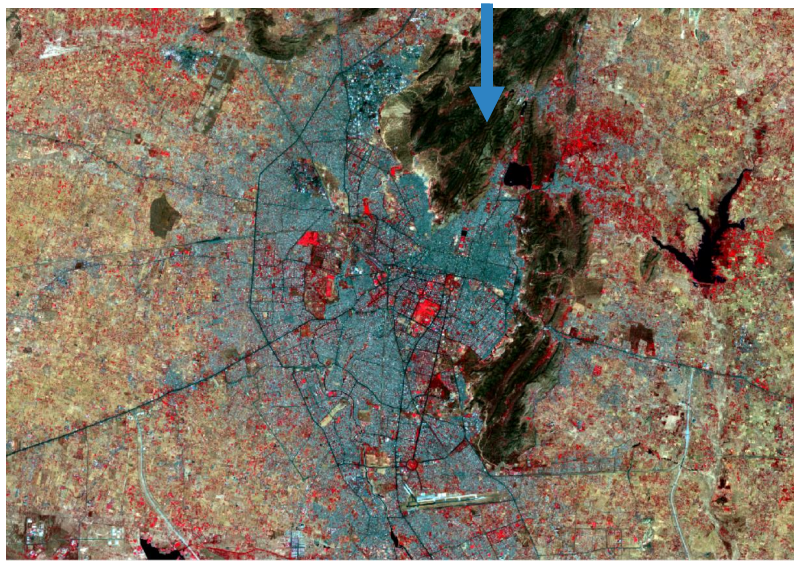


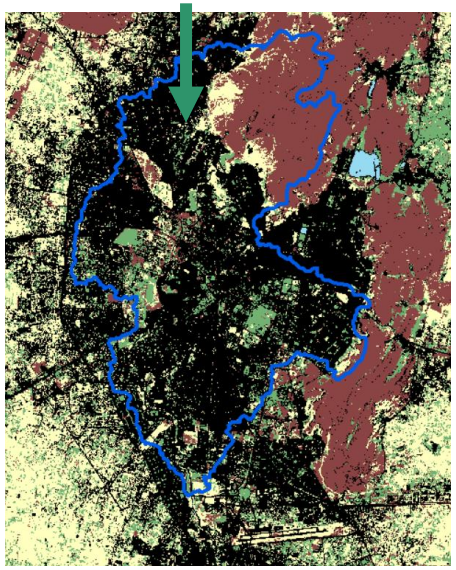


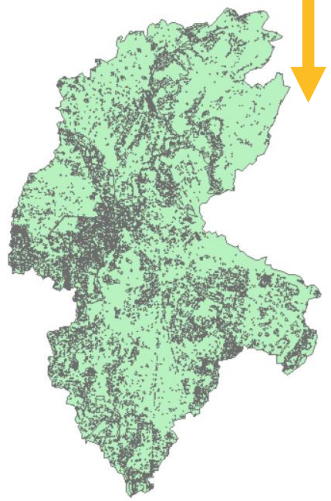




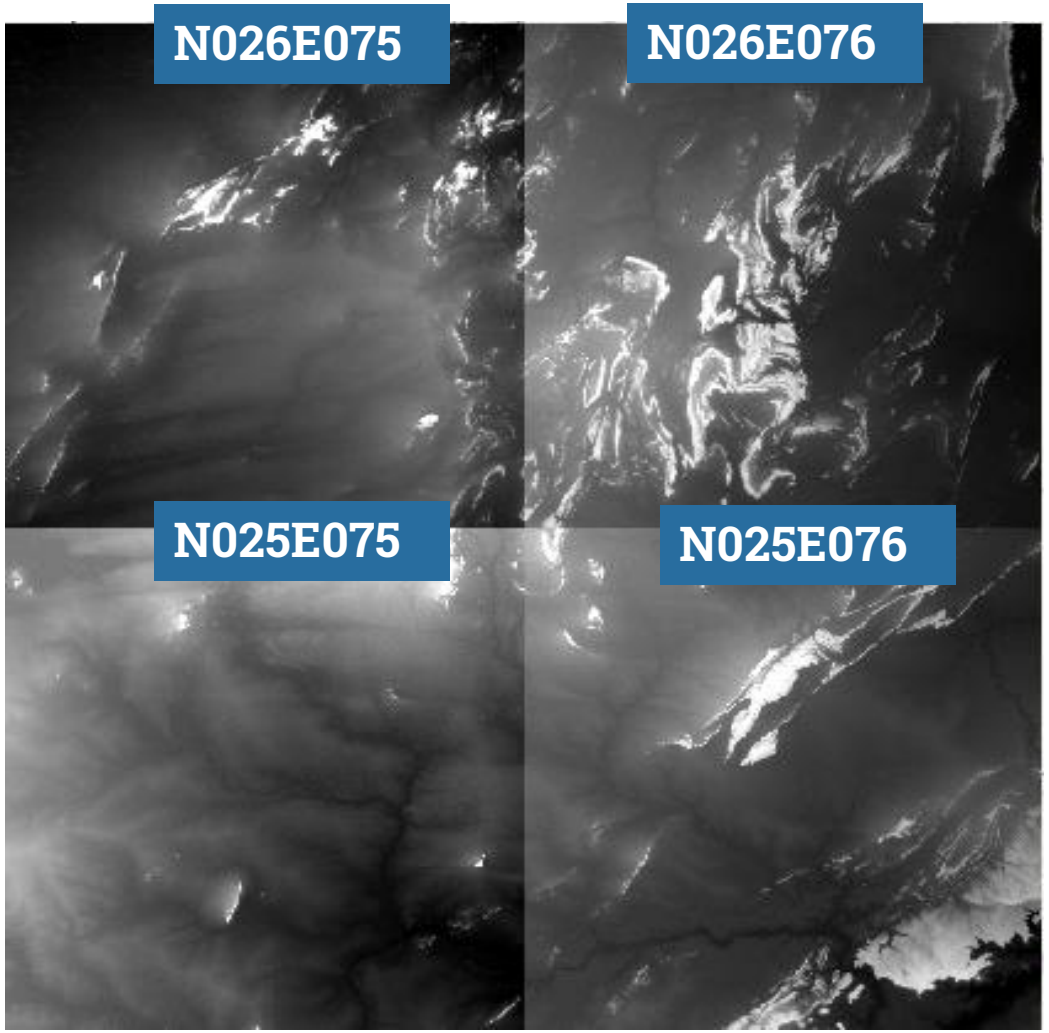
LANDSAT & SENTINAL IMAGES → FALSE COLOR COMPOSITE → EXTRACTION OF STUDY AREA → MAXIMUM LIKELIHOOD CLASSIFICATION → RESAMPLING → CLASSIFIED MAP TO VECTOR(AREA CALCULALTION) → ACCURACY ASSESSMENT & CHANGE DETECTION





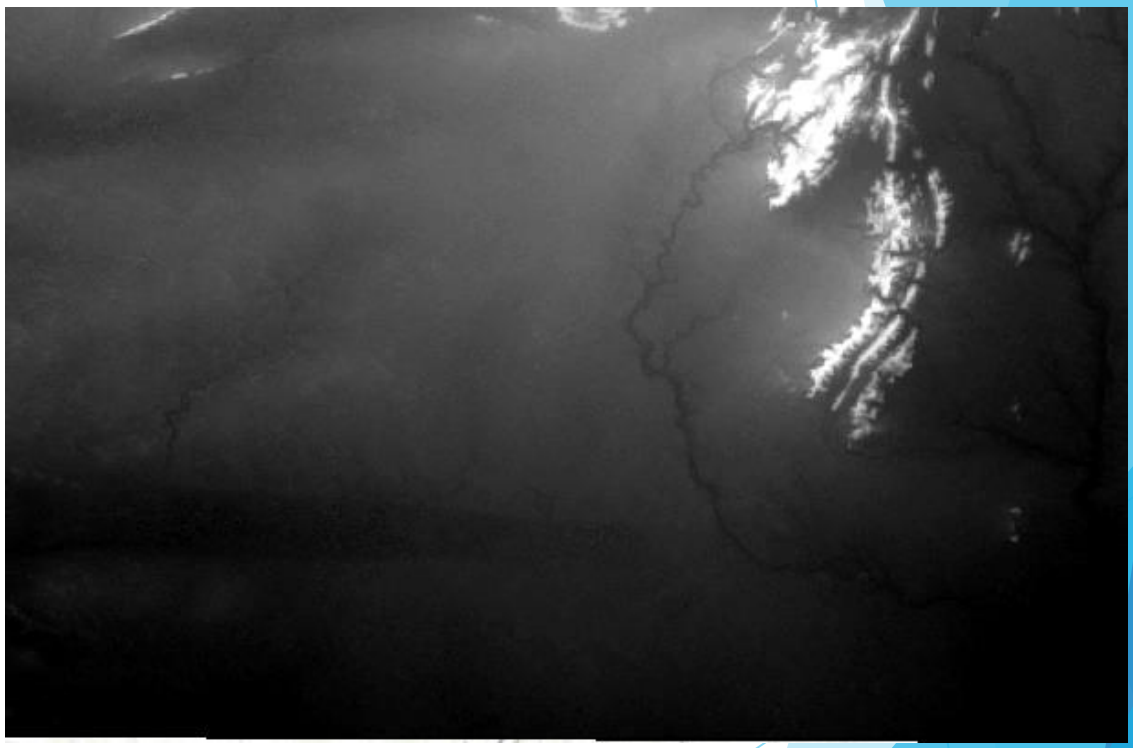


DEM TILES

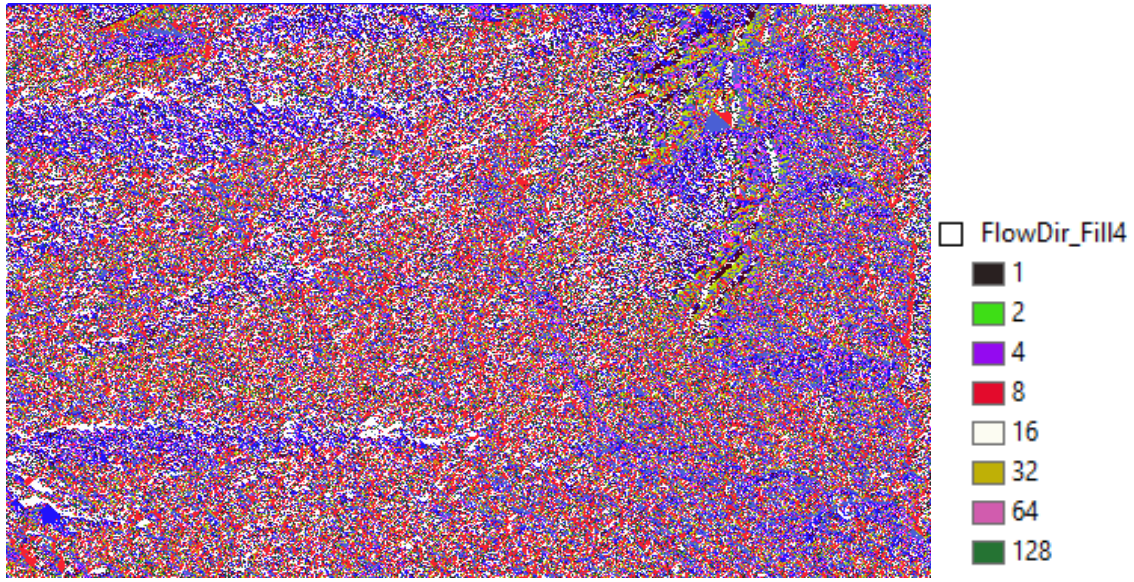


MOSAIC

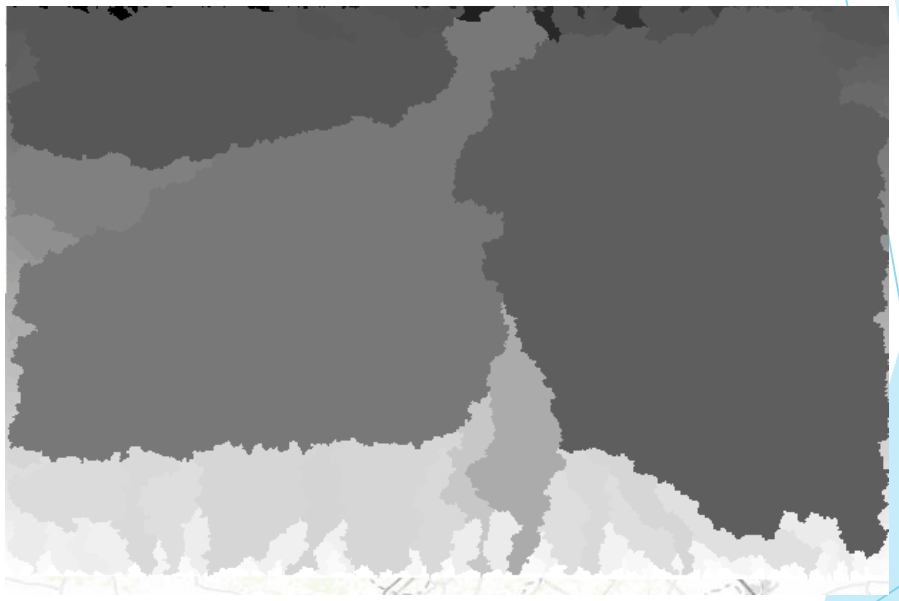
FILL



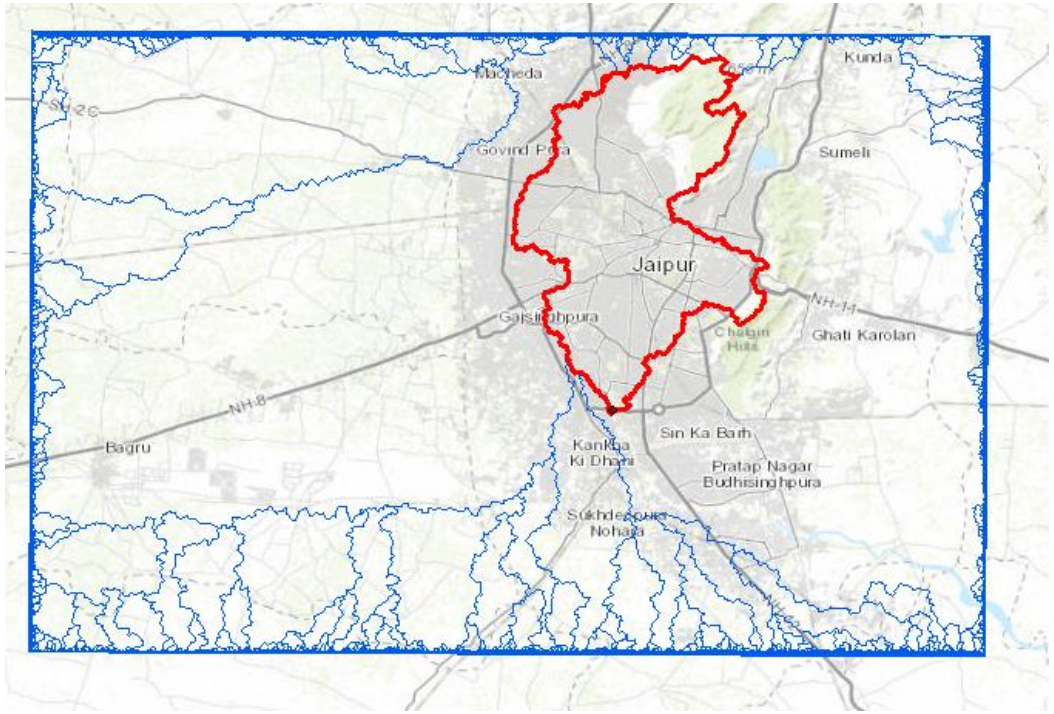
FLOW DIRECTION



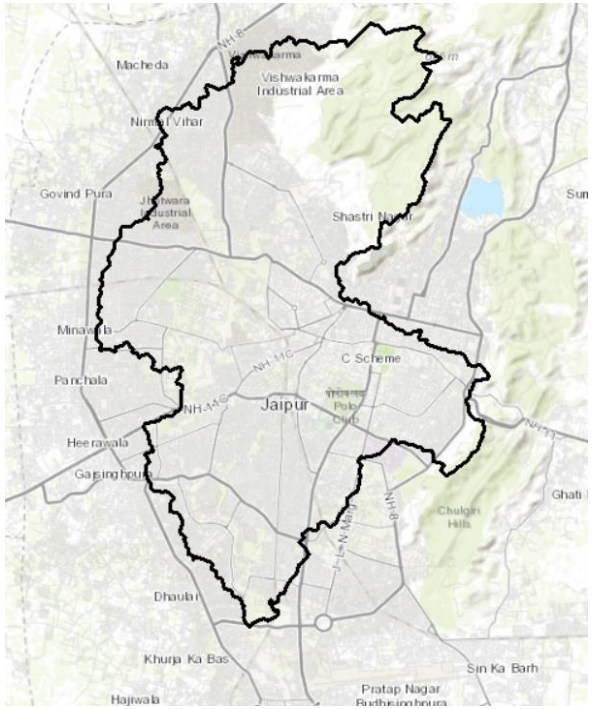
FLOW BASIN



RASTER DATA OF BASIN TO VECTOR POLYGON

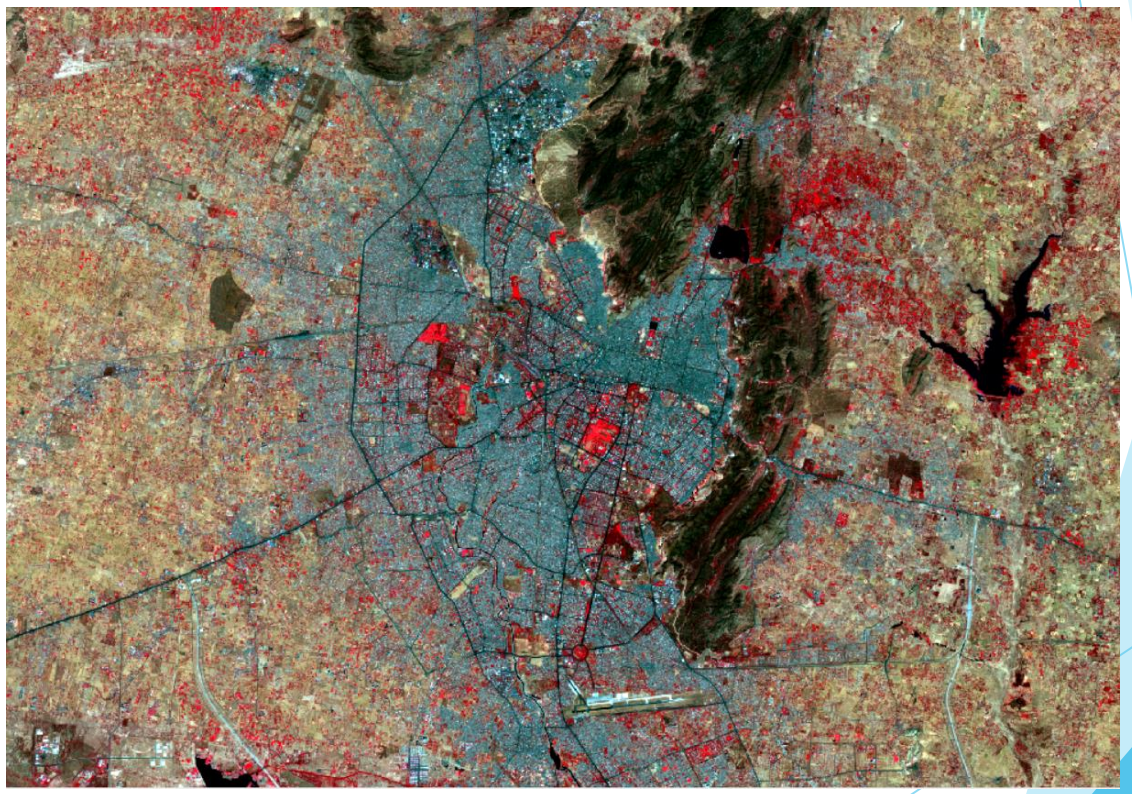


CLIPPED WATERSHED

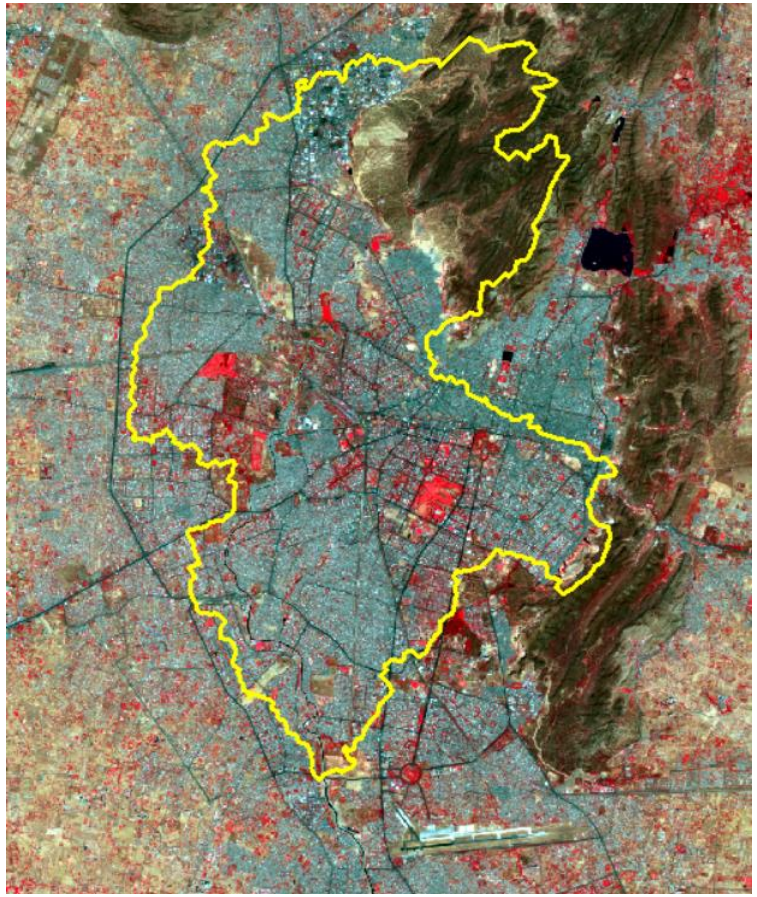


EXTRACTION OF LANDSAT AND SENTINEL DATA

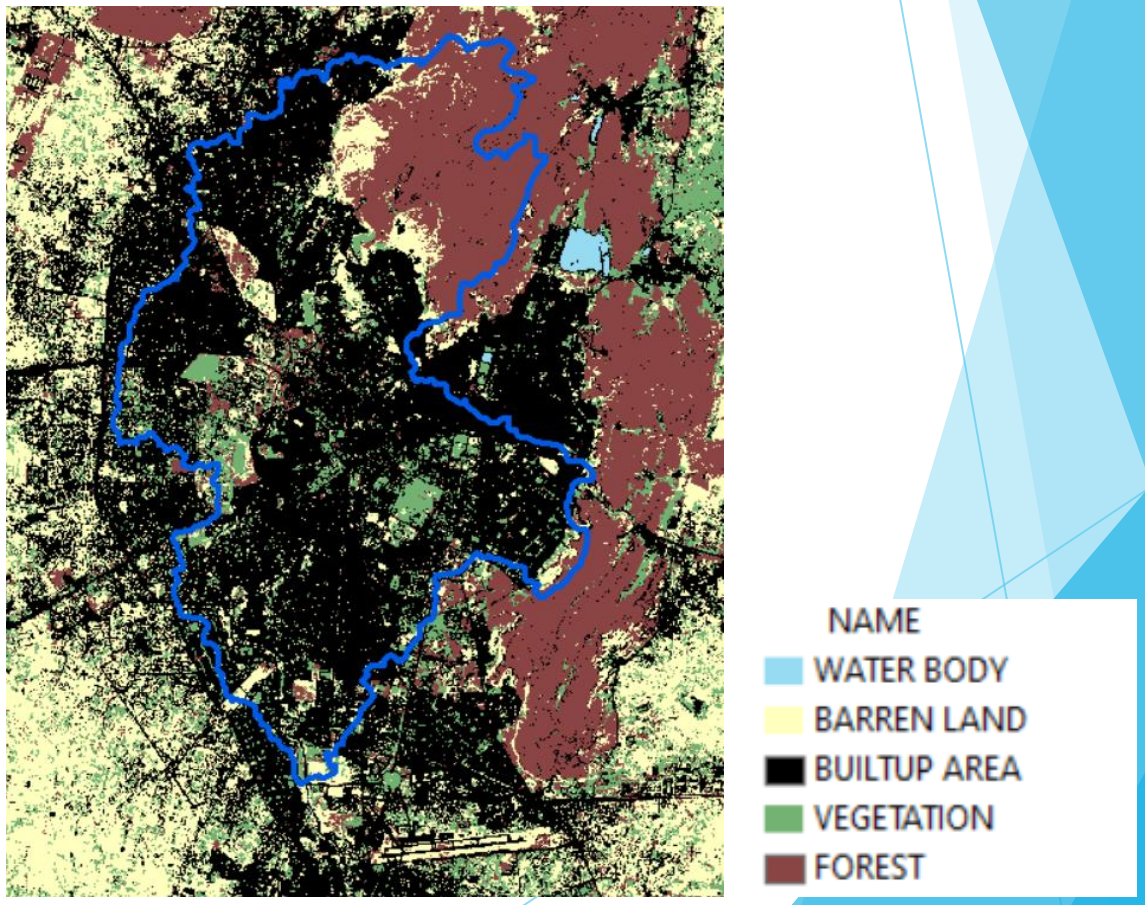
FALSE COLOR COMPOSITE



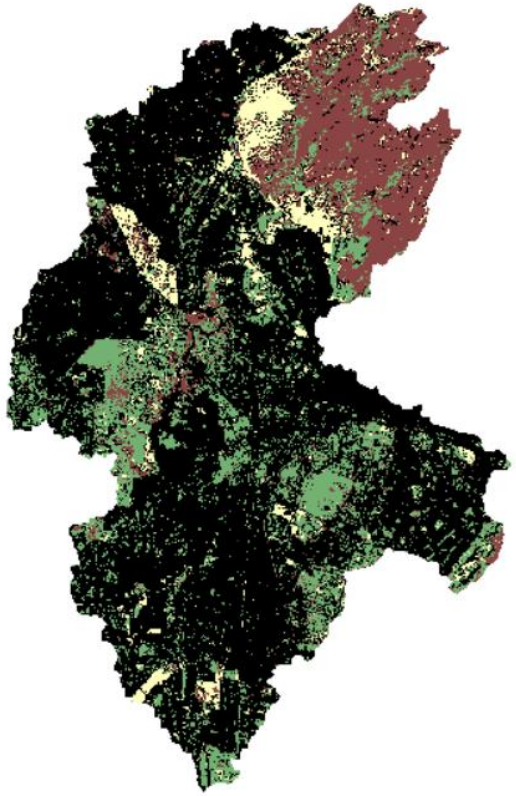
EXTRACTION OF STUDY AREA



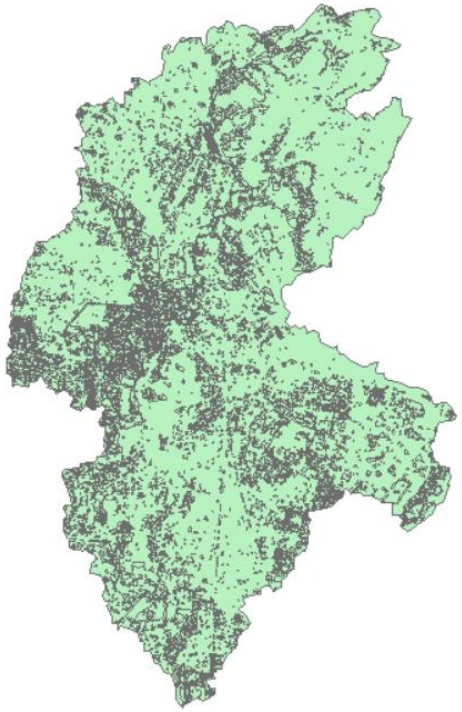
MAXIMUM LIKELIHOOD CLASSIFICATION



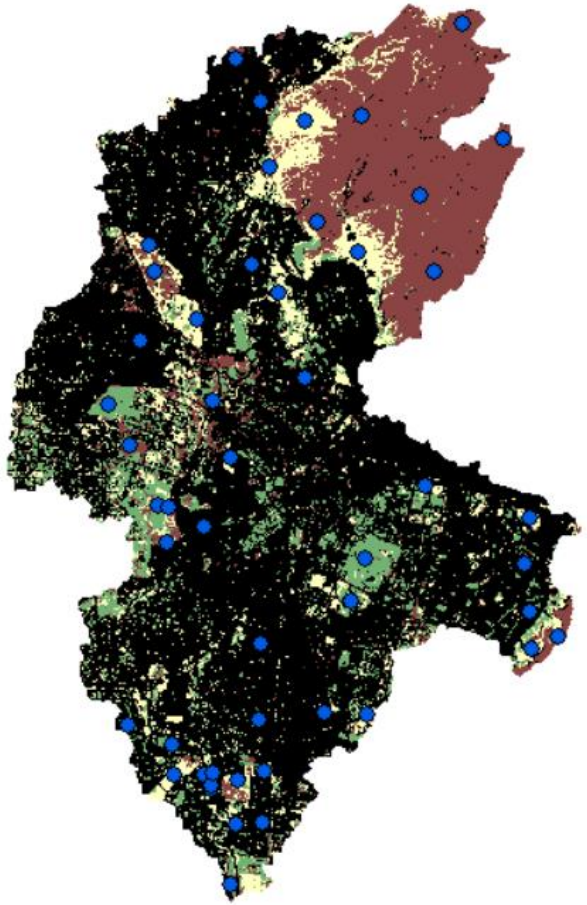
RESAMPLING

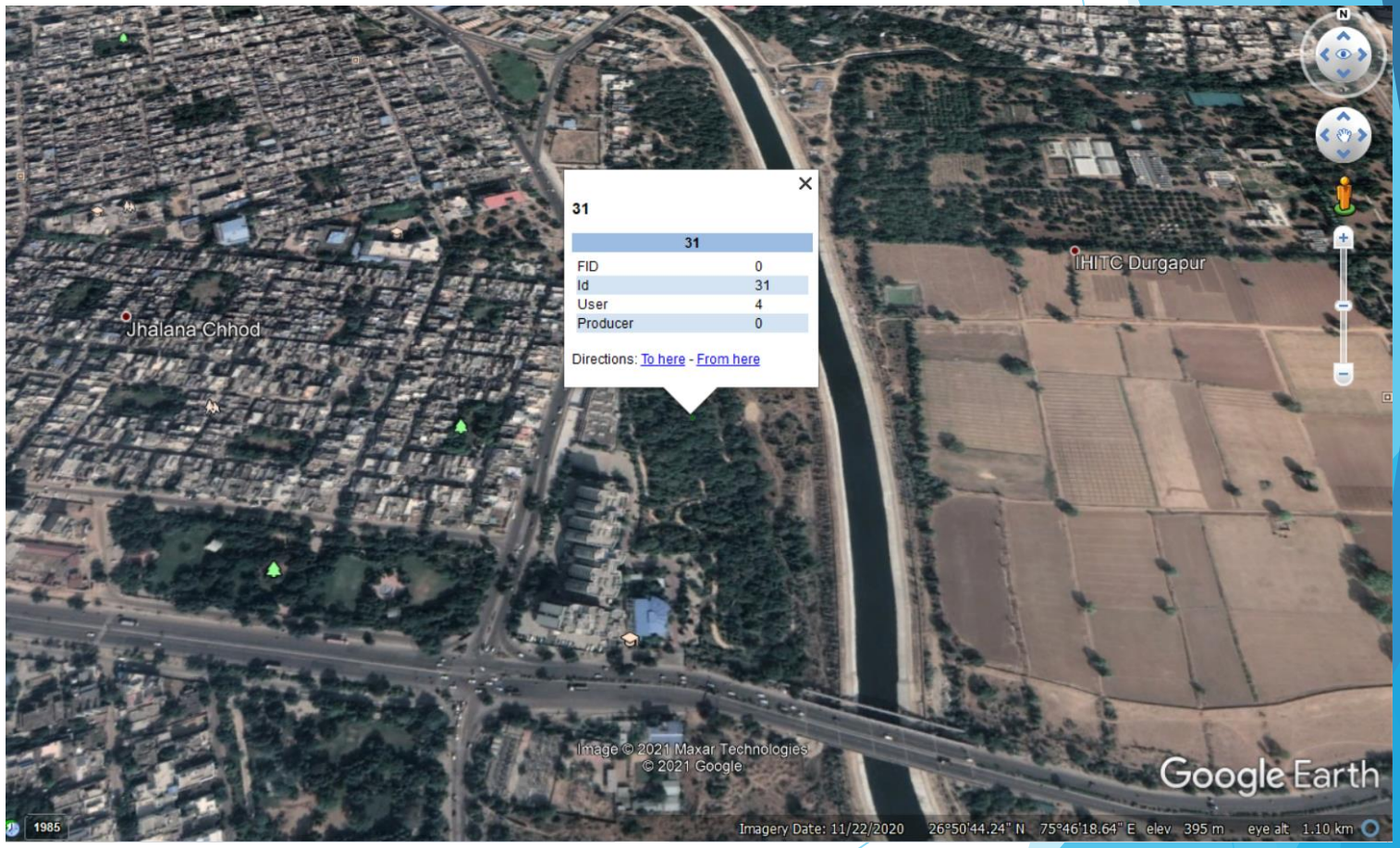


CLASSIFIED MAP TO VECTOR POLYGON



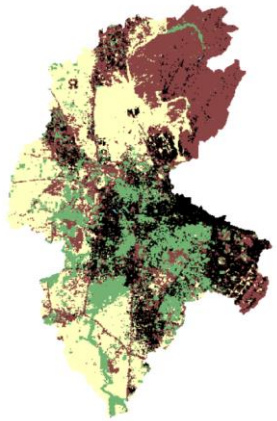
ACCURACY ASSESSMENT & LAND COVER CHANGE DETECTION



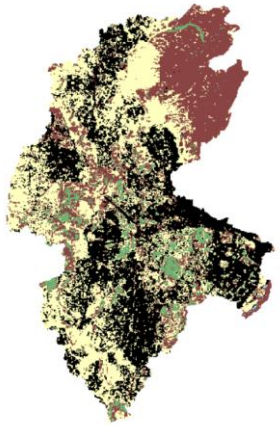


RESULTS : CLASSIFIED MAPS(1990-2021)

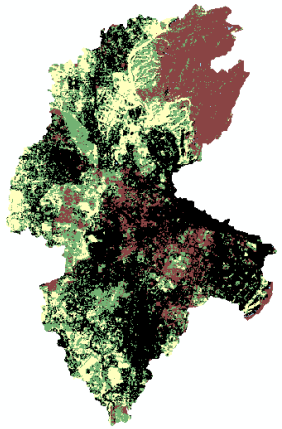
1990



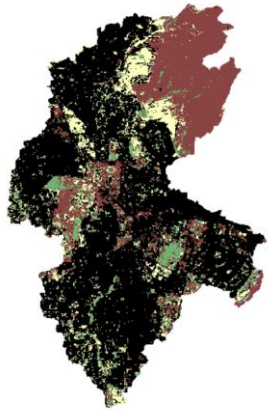
1995



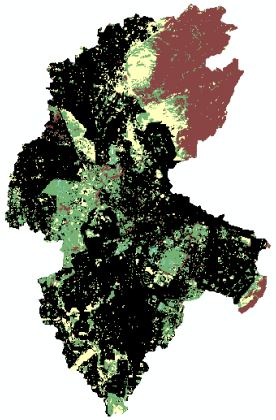
2000



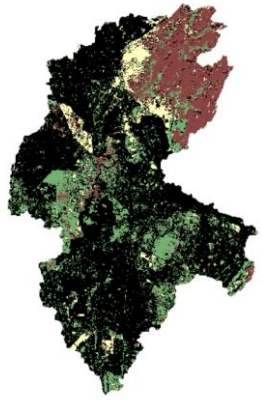
2010



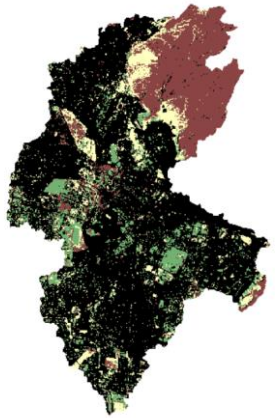
2015



2020



2021



NAME
WATER BODY
BARREN LAND
BUILTUP AREA
VEGETATION
FOREST

ACCURACY ASSESSMENT FOR CLASSIFIED MAPS

- **Overall Accuracy**

$$\frac{\text{Number of correctly classified pixels}}{\text{Total number of reference pixels}} \times 100$$

- **User Accuracy**

$$\frac{\text{Number of correctly classified pixels in each category}}{\text{Total number of classified pixels in that category}} \times 100$$

- **Producer Accuracy**

$$\frac{\text{Number of correctly classified pixels in each category}}{\text{Total number of classified pixels in that category}} \times 100$$

- **Kappa Coefficient**

$$\frac{TS \times TCS - \sum \text{Column Total} \times \text{Row Total}}{TS^2 - \sum \text{Column Total} \times \text{Row Total}}$$

Here, TS=Total Sample, TCS= Total Corrected Sample

Errox Matrix(1990)

Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total(User)	User's Accuracy(%)
Barren Land	18	0	0	2	0	20	90.00
Built Up Area	1	29	0	0	0	30	96.67
Forest	3	1	15	1	0	20	75.00
Vegetation	0	0	1	19	0	20	95.00
Water Body	0	0	1	2	7	10	70.00
Total (Producer)	22	30	17	24	7	100	
Producer's Accuracy(%)	81.82	96.67	88.24	79.17	100.00		

Overall Accuracy(%)	Kappa Coefficient(T)
88.00	0.85

Errox Matrix(1995)

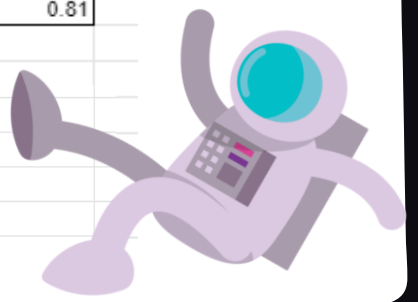
Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total	User's Accuracy(%)
Barren Land	15	2	0	3	0	20	75.00
Built Up Area	0	30	0	0	0	30	100.00
Forest	1	0	18	1	0	20	90.00
Vegetation	0	0	2	17	1	20	85.00
Water Body	0	0	2	1	7	10	70.00
Total (Producer)	16	32	22	22	8	100	
Producer's Accuracy(%)	93.75	93.75	81.82	77.27	87.50		

Overall Accuracy(%)	Kappa Coefficient(T)
87.00	0.83

Errox Matrix (2000)

Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total	User's Accuracy(%)
Barren Land	16	1	0	3	0	20	80.00
Built Up Area	0	28	2	0	0	30	93.33
Forest	1	0	17	2	0	20	85.00
Vegetation	0	0	3	17	0	20	85.00
Water Body	0	0	2	1	7	10	70.00
Total (Producer)	17	29	24	23	7	100	
Producer's Accuracy(%)	94.12	96.55	70.83	73.91	100.00		

Overall Accuracy(%)	Kappa Coefficient(T)
85.00	0.81



Errox Matrix (2010)

Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total	User's Accuracy(%)
Barren Land	19	0	0	1	0	20	95.00
Built Up Area	0	30	0	0	0	30	100.00
Forest	0	0	16	4	0	20	80.00
Vegetation	0	0	2	18	0	20	90.00
Water Body	0	0	1	0	9	10	90.00
Total (Producer)	19	30	19	23	9	100	
Producer's Accuracy(%)	100.00	100.00	84.21	78.26	100.00		

Overall Accuracy(%)	Kappa Coefficient(T)
92.00	0.90

Errox Matrix (2015)

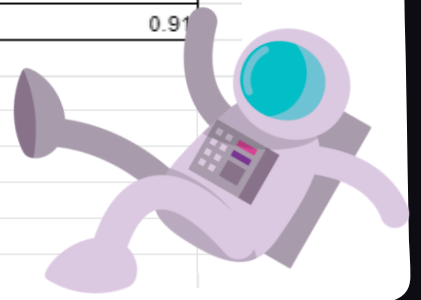
Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total	User's Accuracy(%)
Barren Land	18	0	1	1	0	20	90.00
Built Up Area	0	29	0	1	0	30	96.67
Forest	0	0	18	2	0	20	90.00
Vegetation	0	0	3	17	0	20	85.00
Water Body	0	0	2	0	8	10	80.00
Total (Producer)	18	29	24	21	8	100	
Producer's Accuracy(%)	100.00	100.00	75.00	80.95	100.00		

Overall Accuracy(%)	Kappa Coefficient(T)
90.00	0.87

Error Matrix(2018)

Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total	User's Accuracy(%)
Barren Land	19	0	0	1	0	20	95.00
Built Up Area	0	28	0	2	0	30	93.33
Forest	0	0	17	3	0	20	85.00
Vegetation	1	0	0	19	0	20	95.00
Water Body	0	0	0	0	10	10	100.00
Total (Producer)	20	28	17	25	10	100	
Producer's Accuracy(%)	95.00	100.00	100.00	76.00	100.00		

Overall Accuracy(%)	Kappa Coefficient(T)
93.00	0.91



Errox Matrix (2020)

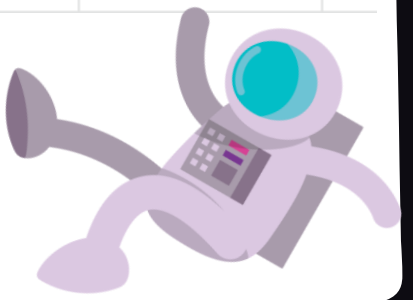
Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total	User's Accuracy(%)
Barren Land	18	0	0	2	0	20	90.00
Built Up Area	0	30	0	0	0	30	100.00
Forest	0	0	19	1	0	20	95.00
Vegetation	1	0	0	19	0	20	95.00
Water Body	0	0	0	0	10	10	100.00
Total (Producer)	19	30	19	22	10	100	
Producer's Accuracy(%)	94.74	100.00	100.00	86.36	100.00		

Overall Accuracy(%)	Kappa Coefficient(T)
96.00	0.95

Errox Matrix (2021)

Class	Barren Land	Built Up Area	Forest	Vegetation	Water Body	Total	User's Accuracy(%)
Barren Land	20	0	0	0	0	20	100.00
Built Up Area	0	30	0	0	0	30	100.00
Forest	0	0	18	2	0	20	90.00
Vegetation	0	0	2	17	0	19	89.47
Water Body	0	0	0	1	9	10	90.00
Total (Producer)	20	30	20	20	9	99	
Producer's Accuracy(%)	100.00	100.00	90.00	85.00	100.00		

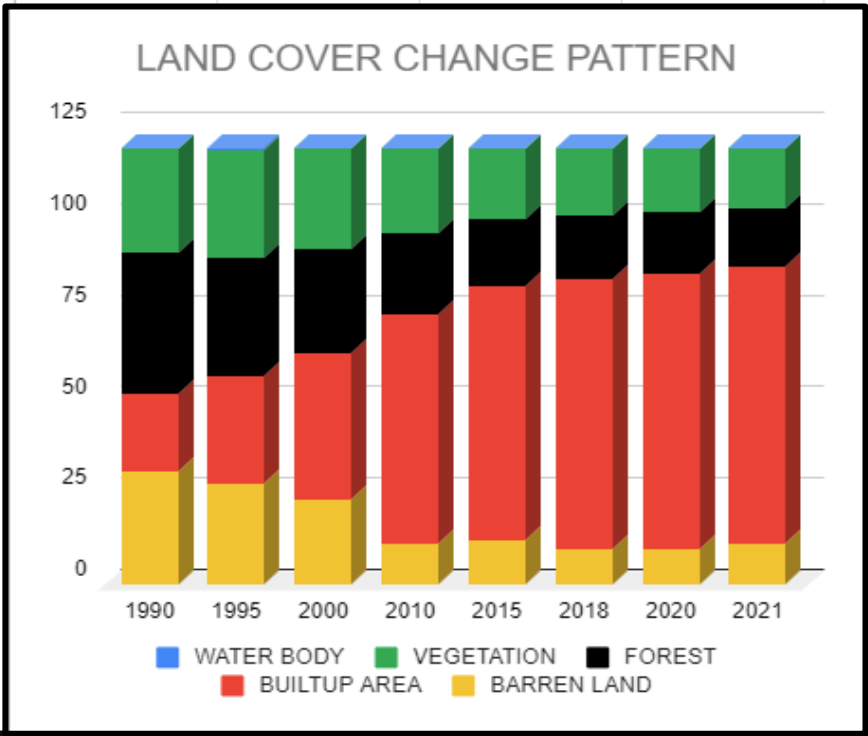
Overall Accuracy(%)	Kappa Coefficient(T)
94.95	0.92

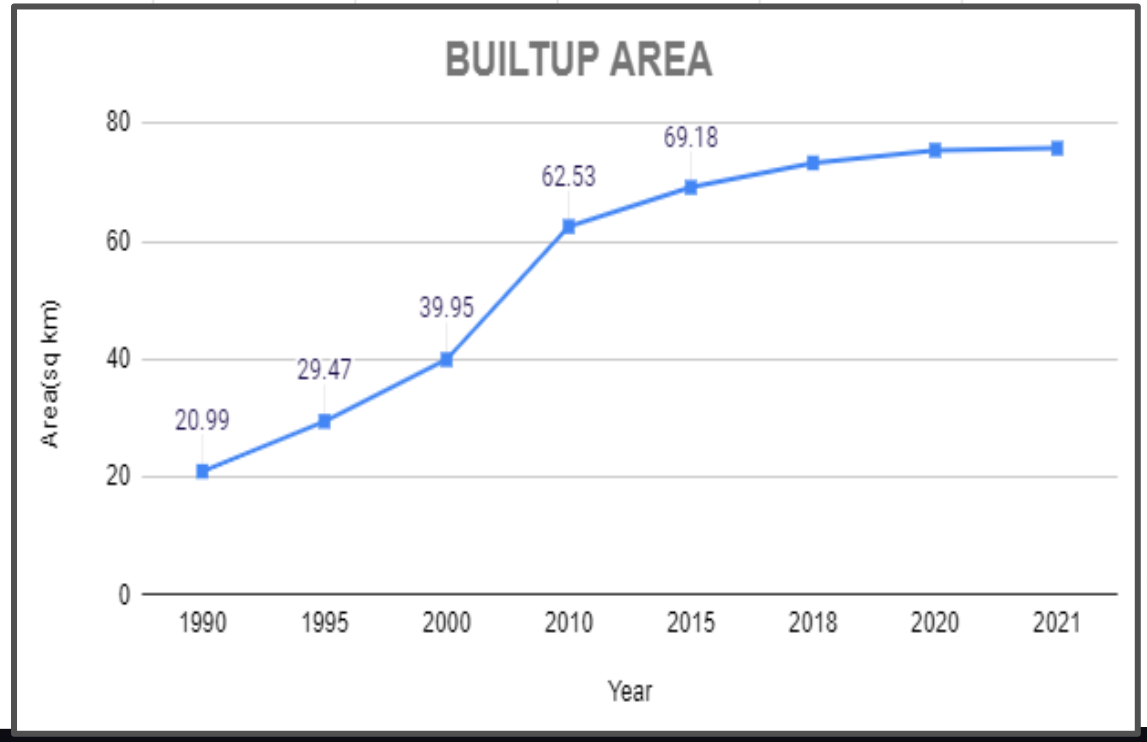


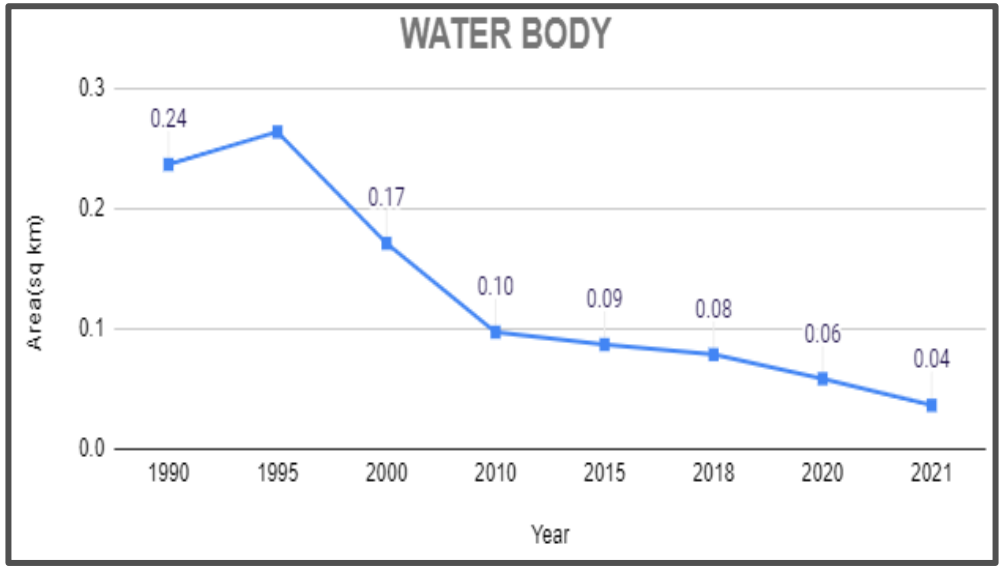
LAND COVER CHANGE DETECTION ANALYSIS

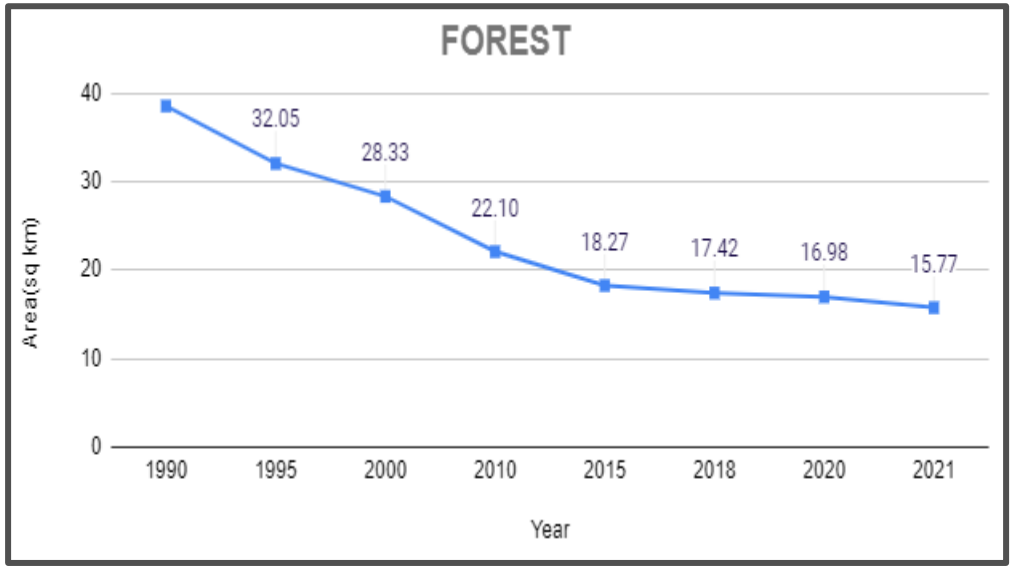
Land use/cover change for the studied area as extracted from the digital images

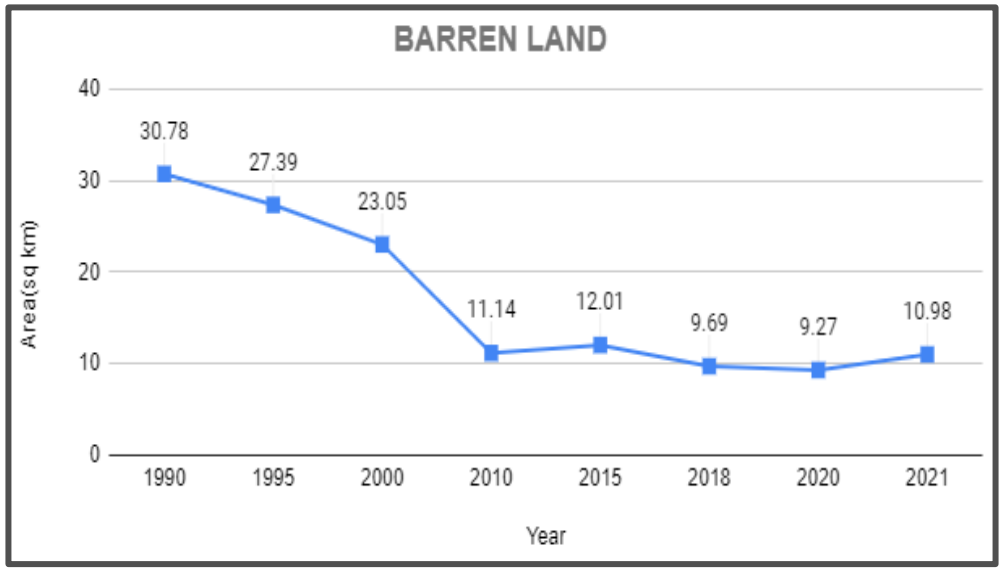
CLASS	1990	1995	2000	2010	2015	2018	2020	2021
BARREN LAND	30.783175	27.386795	23.046074	11.136684	12.011692	9.685637	9.267935	10.97881
BUILTUP AREA	20.991199	29.472777	39.954355	62.533988	69.177703	73.323973	75.470244	75.808372
FOREST	38.54979	32.049161	28.333142	22.09509	18.266318	17.415974	16.975669	15.765159
VEGETATION	28.368933	29.736813	27.397369	23.057926	19.387799	18.419822	17.141687	16.333658
WATER BODY	0.23747	0.264599	0.171814	0.097824	0.08747	0.079091	0.059004	0.03687

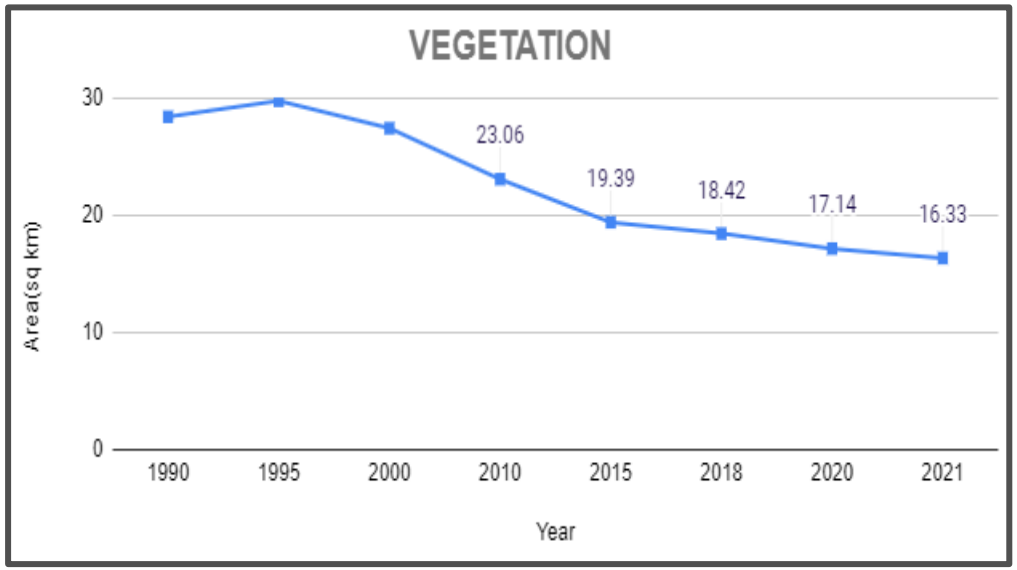





WATER BODY
Area(sq km)
0.3
0.2
0.1
0.0
0.24
0.17
0.10
0.09
0.08
0.06
0.04
1990
1995
2000
2010
2015
2018
2020
2021
Year


FOREST
Area(sq km)
40
30
20
10
0
32.05
28.33
22.10
18.27
17.42
16.98
15.77
1990
1995
2000
2010
2015
2018
2020
2021
Year


BARREN LAND
Area(sq km)
40
30
20
10
0
30.78
27.39
23.05
11.14
12.01
9.69
9.27
10.98
1990
1995
2000
2010
2015
2018
2020
2021
Year


VEGETATION
Area(sq km)
30
20
10
0
23.06
19.39
18.42
17.14
16.33
1990
1995
2000
2010
2015
2018
2020
2021
Year

LAND CHANGE INTENSITY ANALYSIS

- **Annual Change Intensity**

$$ACI(\%)=\frac{(LC/LA)}{TE}*100$$

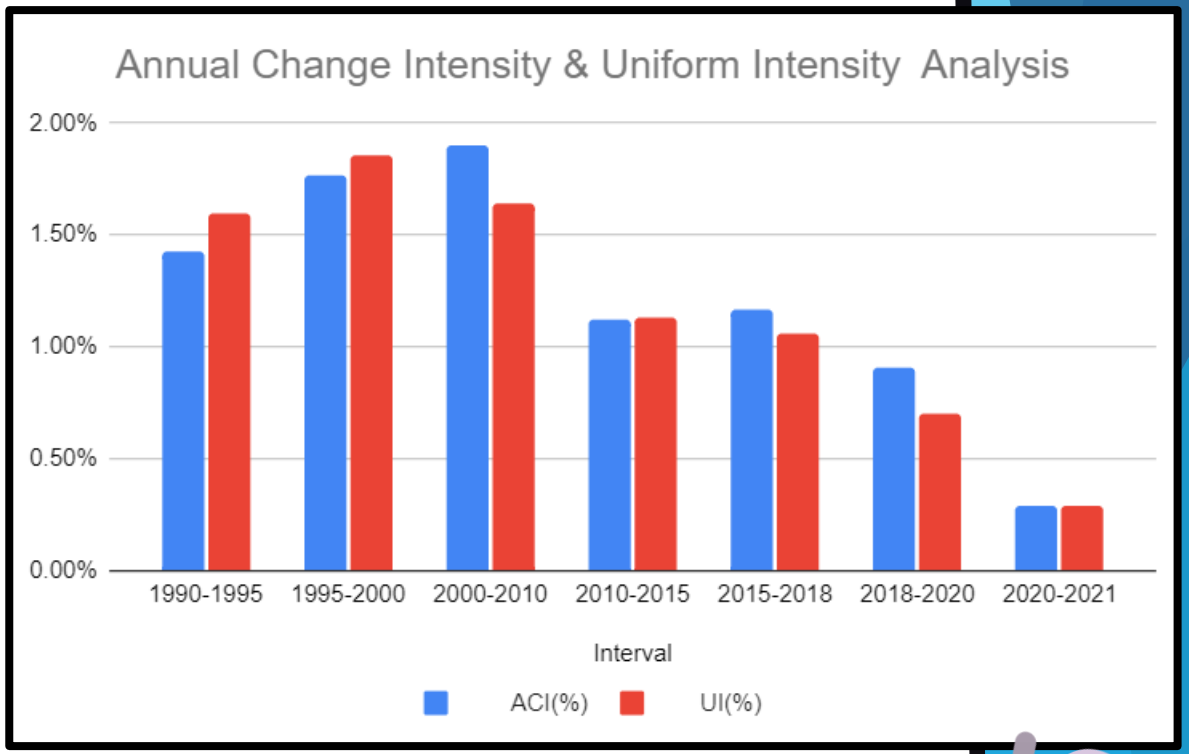
- **Uniform Intensity**

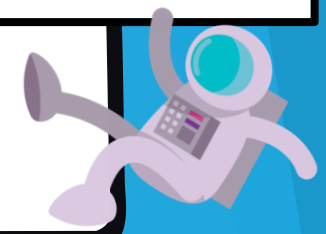
$$UI(\%)=\frac{[\{LCTI1+LCTI2\}/LA}{TETI1+TETI2}*100$$

LC- the area of land change from non-built to built
LA- the area of the entire landscape
TE- the duration of a given time interval

Interval	ACI(%)	UI(%)
1990-1995	1.43%	1.59%
1995-2000	1.76%	1.85%
2000-2010	1.90%	1.64%
2010-2015	1.12%	1.13%
2015-2018	1.16%	1.06%
2018-2020	0.90%	0.70%
2020-2021	0.28%	0.28%

Average ACI %	Average UI %
1.22	1.18





URBAN GROWTH RATE ANALYSIS

Annual urban growth percentage rate

$$K = \frac{(U_b - U_a)}{U_a} \times \frac{1}{T} \times 100$$

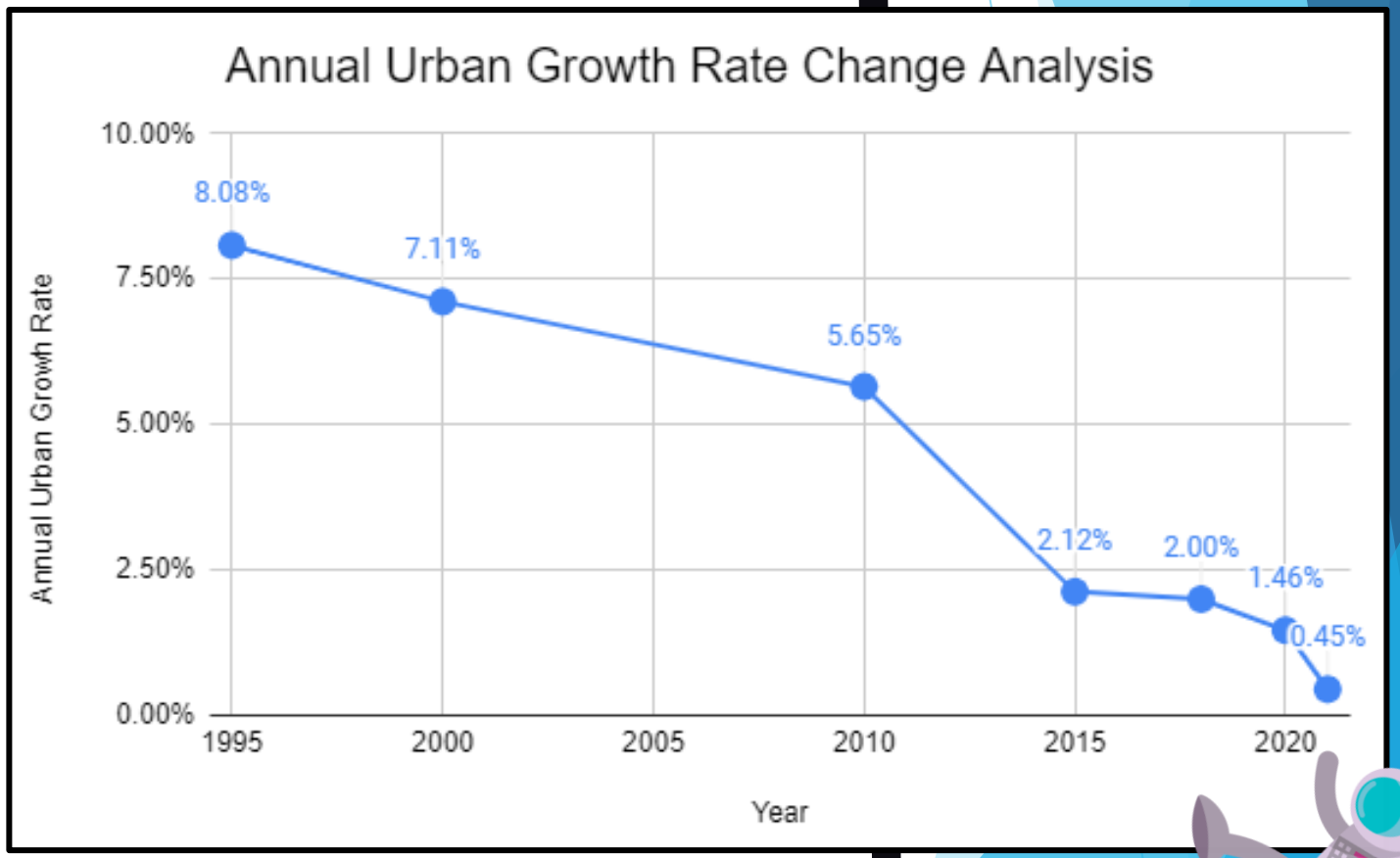
U_a = Urban area at the beginning

U_b= Urban area at the end

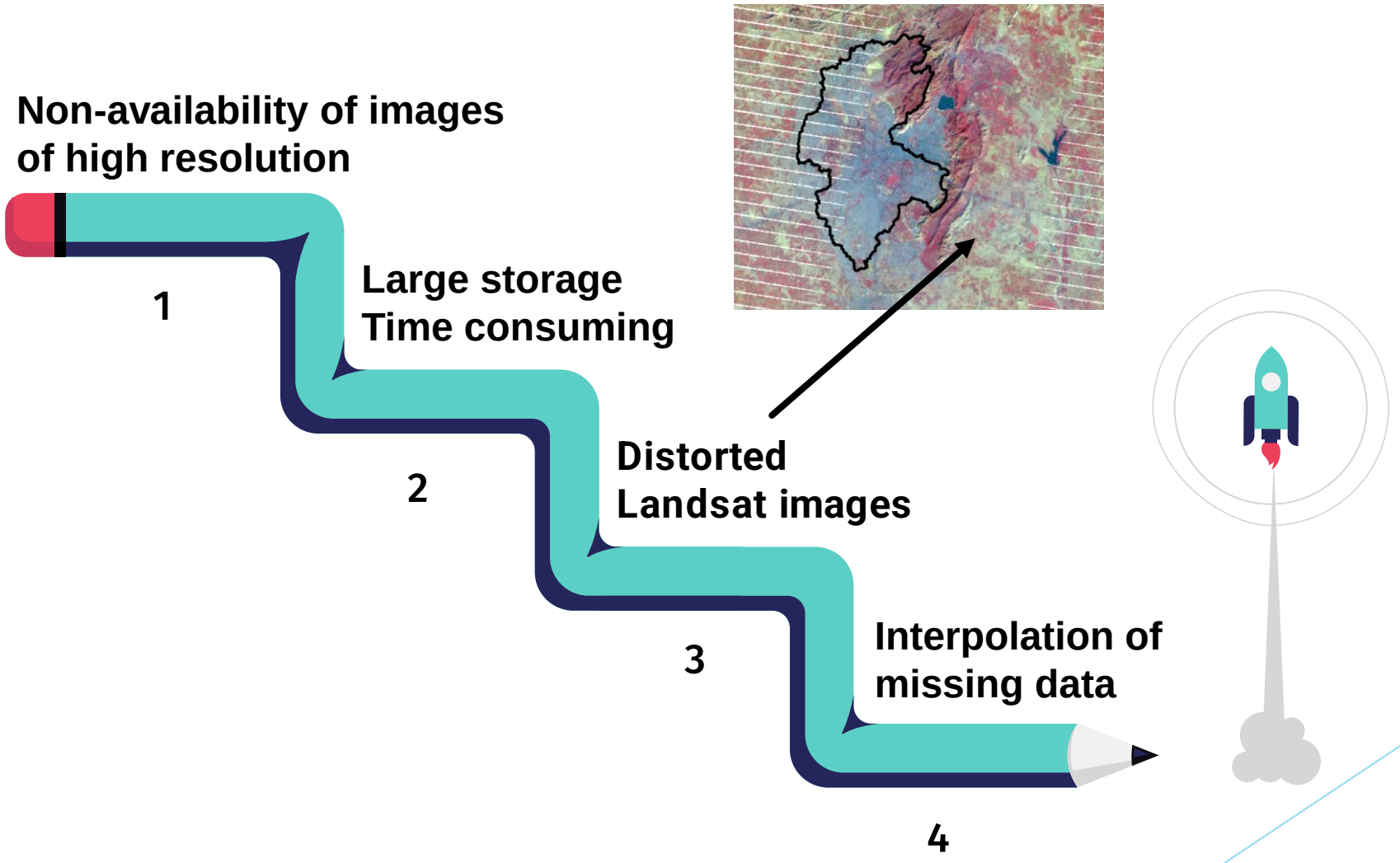
T= Time period

Annual urban growth percentage rate (1990-2021)

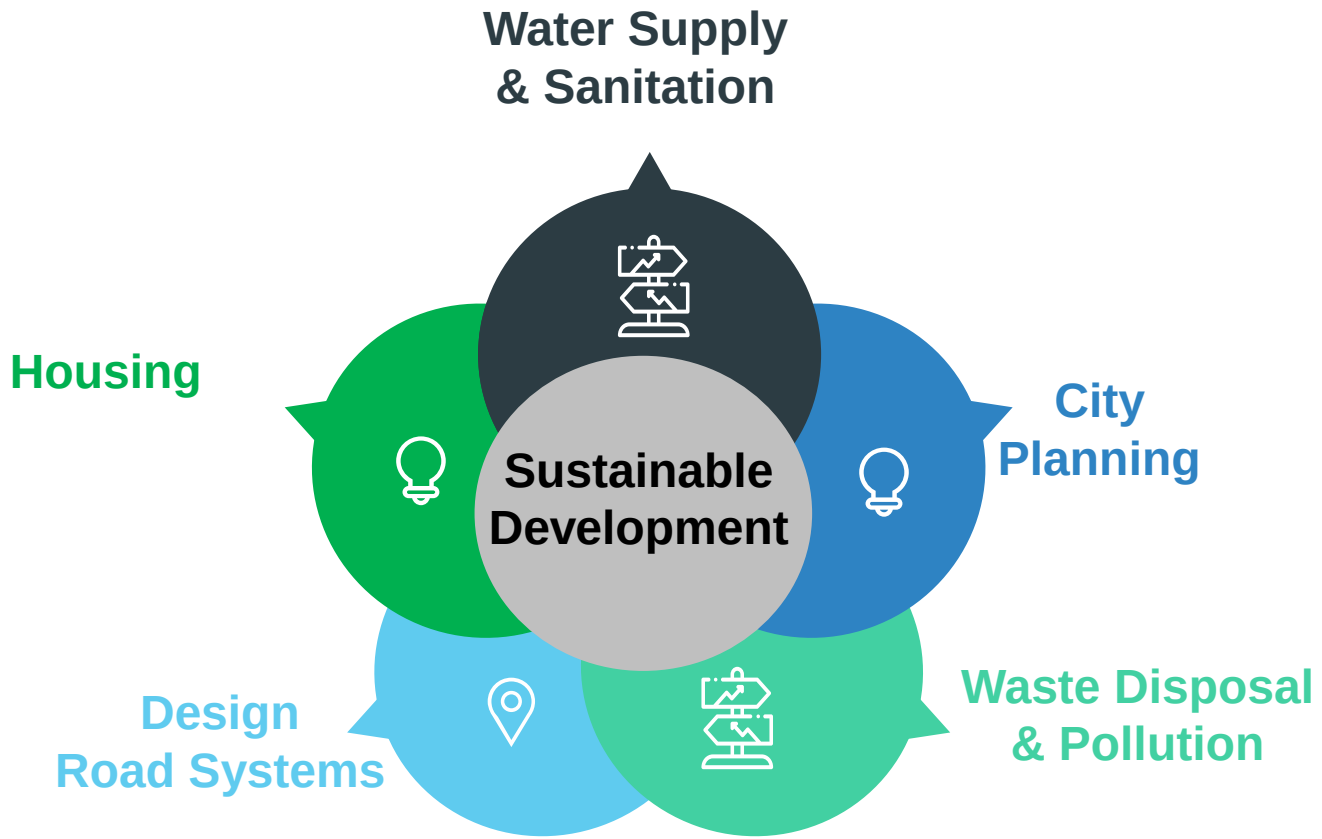
Year	Built Up Area(km2)	Annual Growth (%)
1990	20.991199	---
1995	29.472777	8.08%
2000	39.954355	7.11%
2010	62.533988	5.65%
2015	69.177703	2.12%
2018	73.323973	2.00%
2020	75.470244	1.46%
2021	75.808372	0.45%



CHALLENGES ASSOCIATED WITH PROJECT



PRACTICAL APPLICATION OF PROJECT IN CIVIL ENGINEERING PERSPECTIVE



REFERENCES

- Spatiotemporal Analysis of Urban Growth Using GIS and Remote Sensing: A Case Study of the Colombo Metropolitan Area, Sri Lanka - Shyamantha Subasinghe *, Ronald C. Estoque and Yuji Murayama https://www.mdpi.com/2220-9964/5/11/197

- Monitoring and analysis of urban growth process using Remote Sensing, GIS and Cellular Automata modeling: A case study of Xuzhou city, China By Cheng Li https://core.ac.uk/download/pdf/46915947.pdf

- 30-Meter SRTM Tile Downloader https://dwtkns.com/srtm30m/
- For Landsat and Sentinel Images : USGS Earth Explorer https://earthexplorer.usgs.gov/
- Copernicus Open Access Hub https://scihub.copernicus.eu/dhus/#/home
- Bhuvan ISRO Geoportal https://bhuvan-app3.nrsc.gov.in/data/download/index.php
- For Cross Verification: Google Earth Pro https://www.google.com/intl/en_in/earth/versions/

- Templates & Icons: https://slidesgo.com/