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Spatio-temporal Assessment of Land Use Land Cover Changes and population dynamics Using Geoinformatics: a case study of Mardan, Khyber Pakhtunkhwa, Pakistan

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Content of Presentation

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01-Introduction

1

Global land use has changed by one-third over the last decades once or multiple times.

(K. Winkler et al., 2021)

2

According to a United Nations report in 1950, only 30% of the global population was residing in urban areas which increased to 55% in 2018 and are projected to be 68% by 2050

(Nations, 2018)

3

The dynamic conditions of land use land cover changes (LULC) have given birth to various socio and environmental issues like degradation of the ecosystem, food security, water, and climatic variation.

(Song et al., 2018; Karina Winkler et al., 2021; Wolde et al., 2021)

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01-Introduction

4

A developing country like Pakistan is urbanizing with an annual growth rate of 3%, which is the highest in South Asia

(Kotkin & Cox, 2013)

5

According to the Pakistan Bureau Statistics, and World Bank 2017 reports, Pakistan ranked 6th in the list of most populous countries in the world.

(PBS-2017 Census Report)

6

The accelerated rate of unplanned urbanization in Pakistan has not only influenced demographic conditions in cities but also gear up the conversion of rural areas, and decreased urban sustainability

(Dubovyk et al., 2011; Patra, Sahoo, et al., 2018)

01-Introduction

7

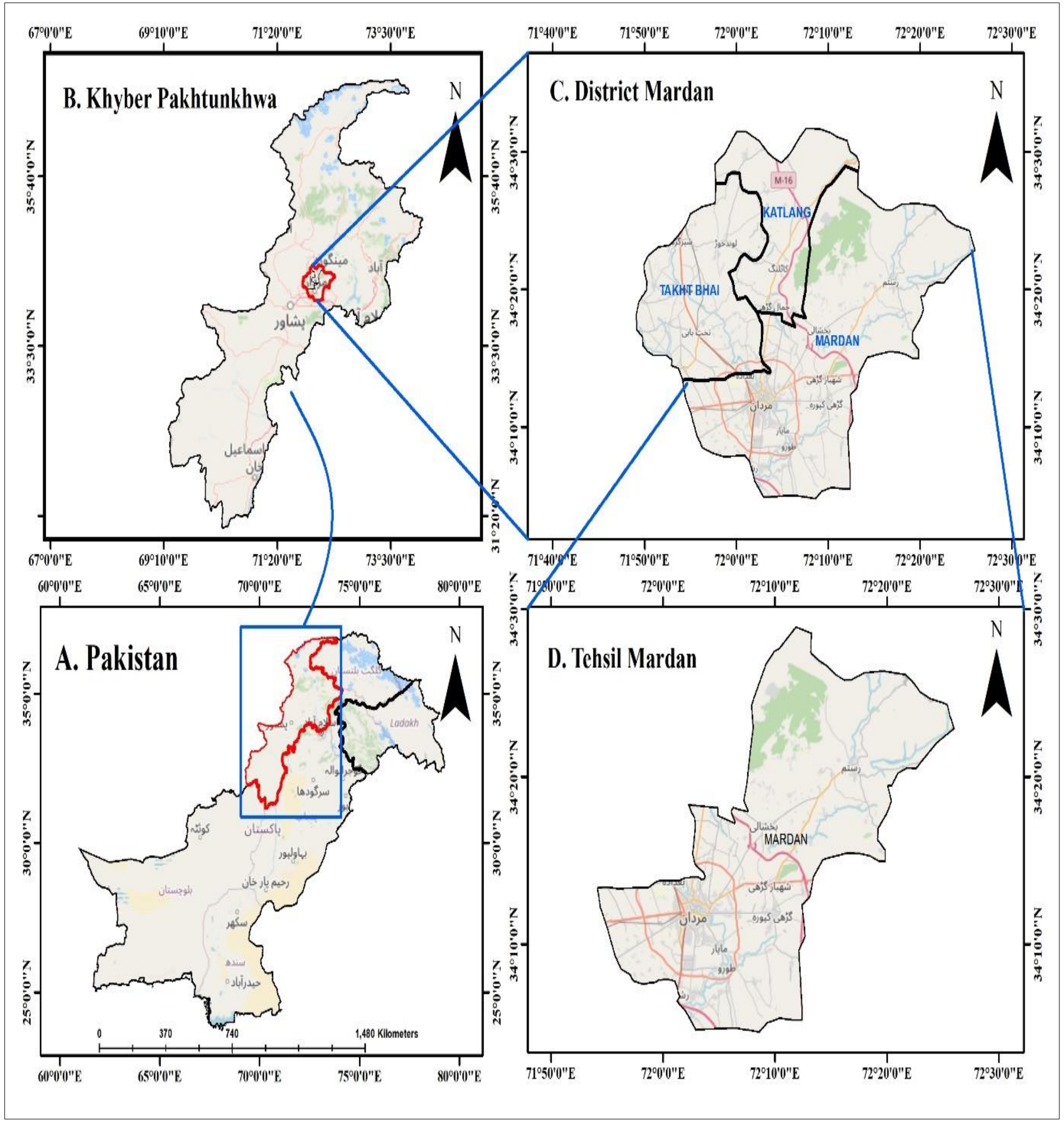
Information System (GIS) and Remote Sensing (RS) applications/techniques are widely used to assess and quantify land use land cover changes over a long-term spatio-temporal range measurement, change detection, and analysis.

(Rimal et al., 2018; Coppin et al., 2004; Lu et al., 2013)

8

Satellite imagery data was successfully used for the assessment of LULC change analysis for the last 30 years.

(Lu et al., 2013; Maity et al., 2020; Mallick et al., 2021)



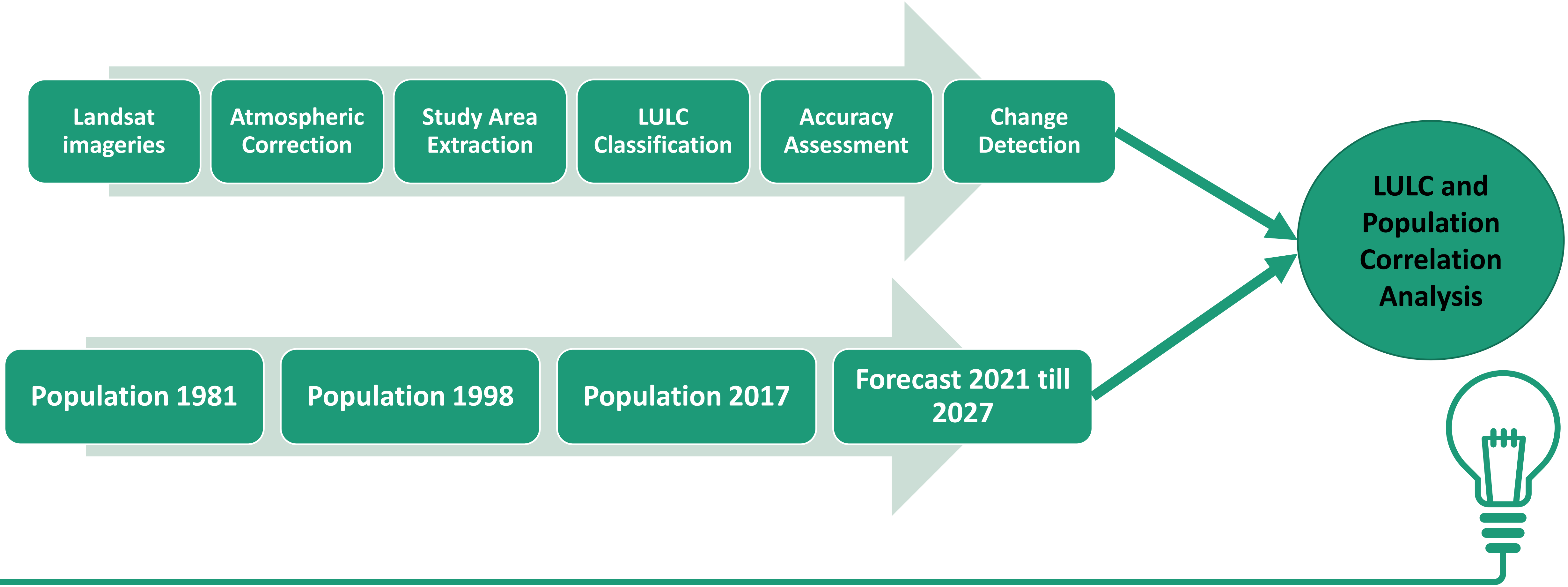
2. Study Area-Mardan

- ☑ Tehsil Mardan was chosen based on its rapid urban expansion and population growth over the last three decades.
- ☑ Mardan is the 2^{nd} big city after the provincial capital Peshawar of Khyber Pakhtunkhwa and 23^{rd} on the list of the biggest cities in the country.
- ☑ It is about 32 km and 148 km away from Peshawar and Islamabad respectively.
- ☑ The average annual temperature remained 22^{0}C with June being the hottest month and total annual rainfall of 560 mm, with August having the highest rainfall of 122 mm.

3. Methodology and Data Set

Both primary and secondary data sets (literature and published reports) were accessed and analyzed during the current study

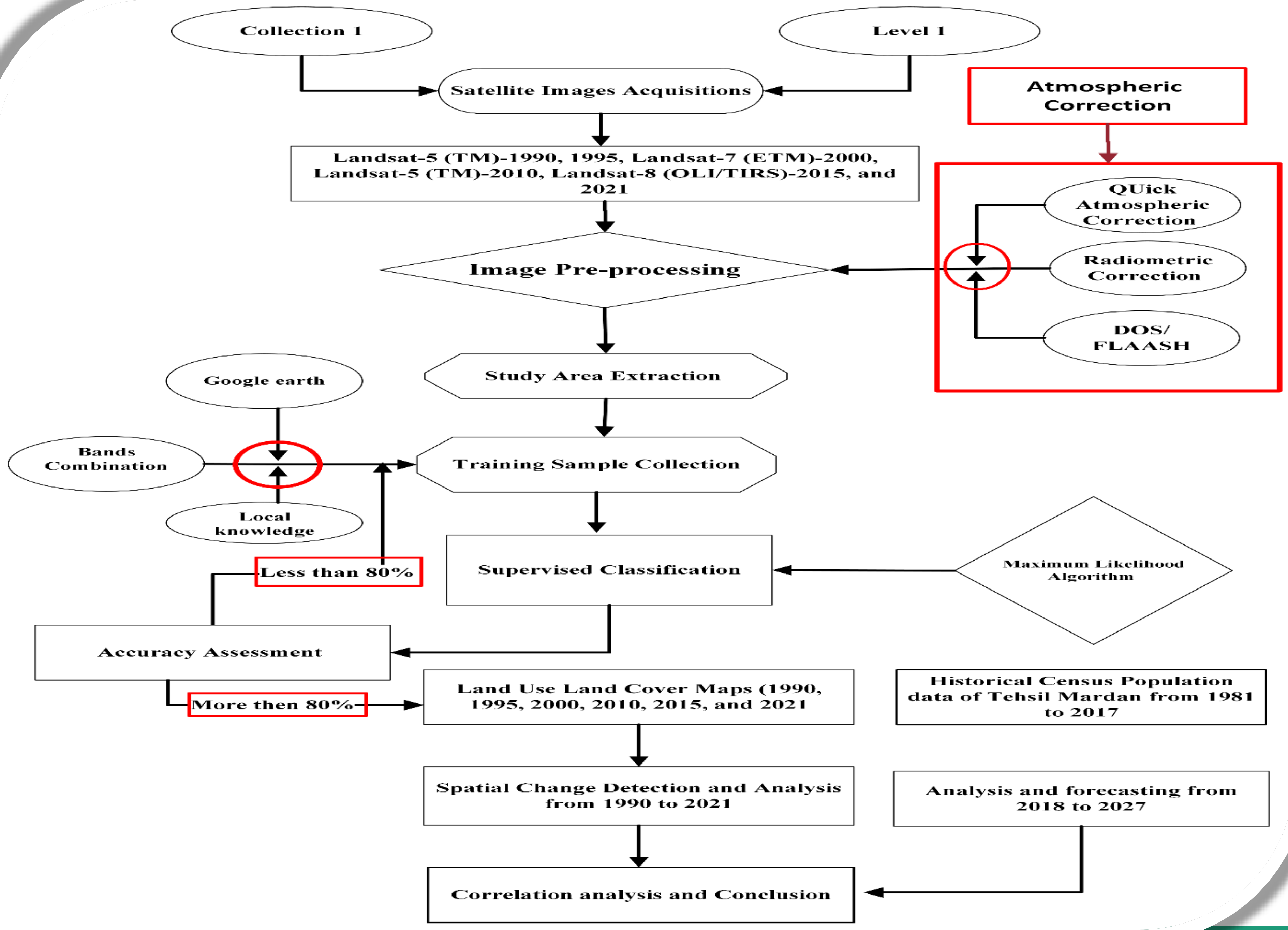
To know the extent and space of urbanization, Landsat satellite imageries were downloaded from the USGS website (https://earthexplorer.usgs.gov/).



S.No.	Year	Satellite	Sensor	Acquisition date	Cloud Cover (%)	Remarks
1	1990	Landsat 5	TM	14th March 1990	2	-Targeted Months -Minimum Cloud Coverage -Clear Study Area -Free from Scan-Line Error -Resolution =30x30 meters
2	1995	Landsat 5	TM	13th April 1995	1	
3	2000	Landsat 7	ETM+	18th April 2000	3	
4	2010	Landsat 5	TM	6th April 2010	1	
5	2015	Landsat 8	OLI/TIRS	19th March 2015	1.7	
6	2021	Landsat 8	OLI/TIRS	19th March 2021	2.4	

S.No.	LULC Class	Description
1	Built-up	This class includes buildings, roads, concrete, and asphalt structures that are covered with impervious surfaces and anthropogenic.
2	Vegetation	This class includes forest, grasslands, green belts, and cropland
3	Water bodies	This class includes lakes, reservoirs and streams, and inundated area
4	Bare land	This class includes areas where no permanent built-up, vegetation, or water bodies exist.

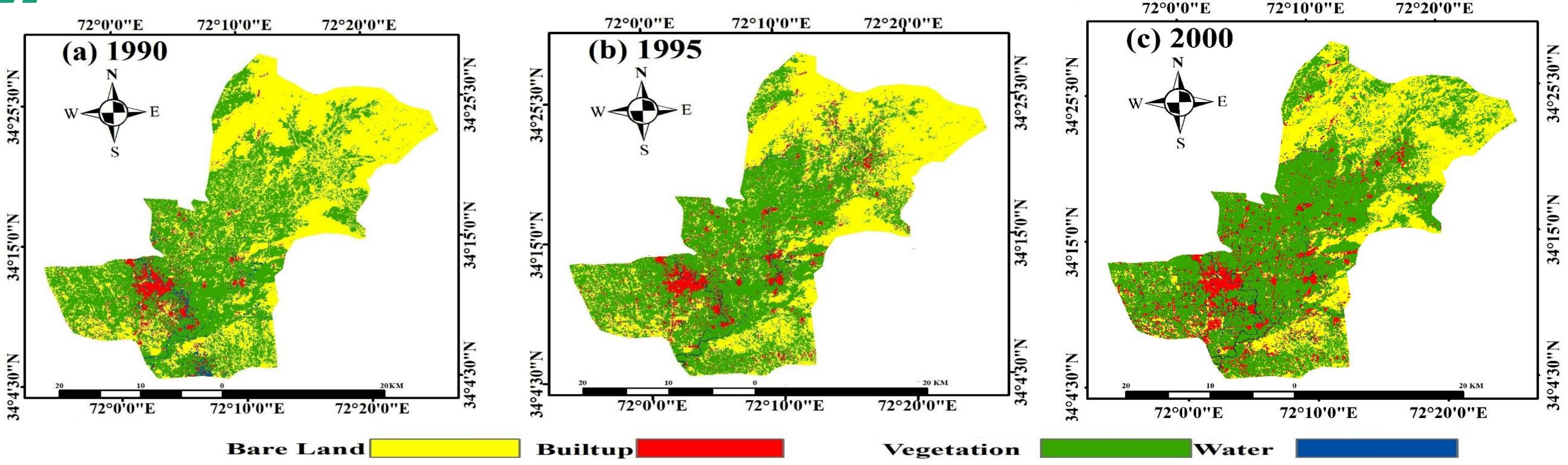
3. Methodology and Data Set

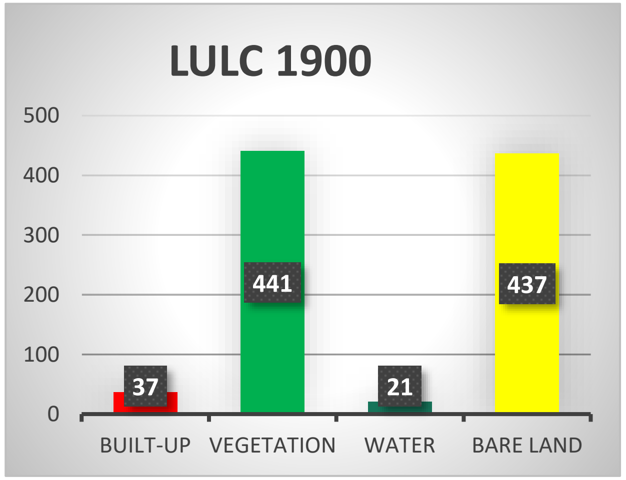


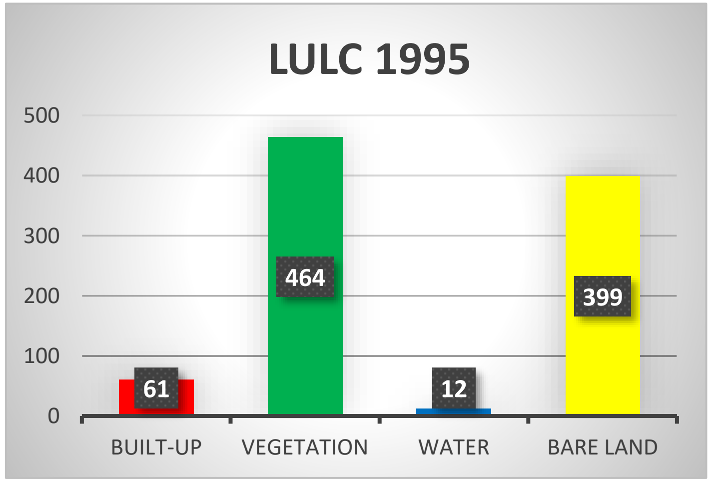
4. Results and Discussions

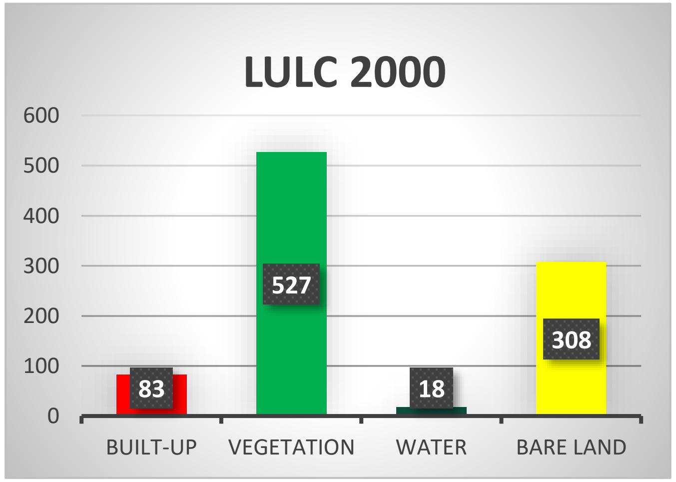
- LULC Classification Maps (19990, 1995, 2000, 2010, 2015, and 2021)
- Accuracy Assessment
- Change Detection (1990-2021)
- Population dynamics
- Correlation Matrix

4. Results and Discussions (A. LULC Maps)



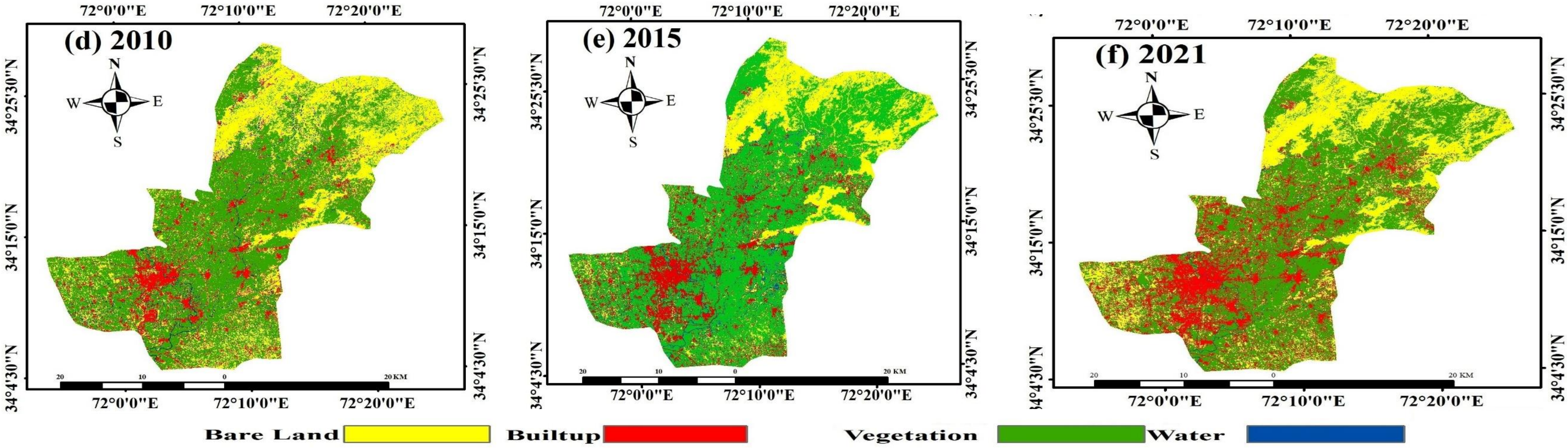


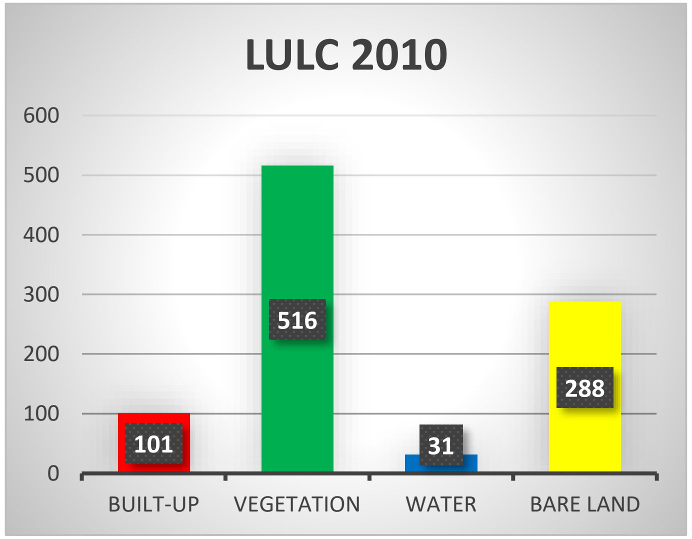


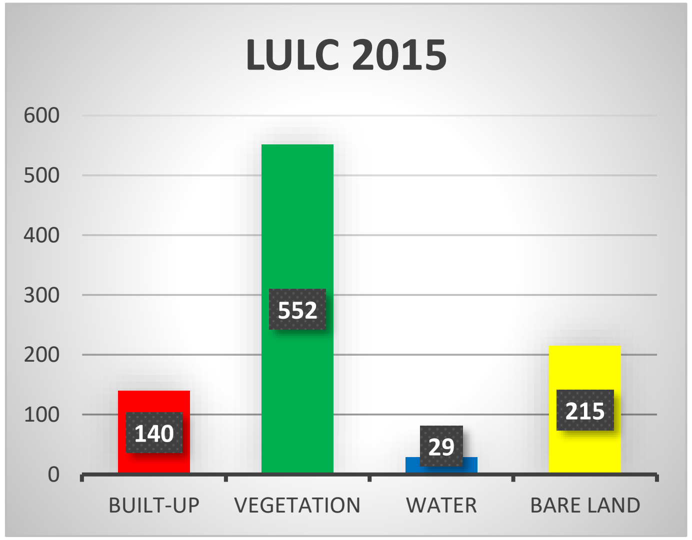


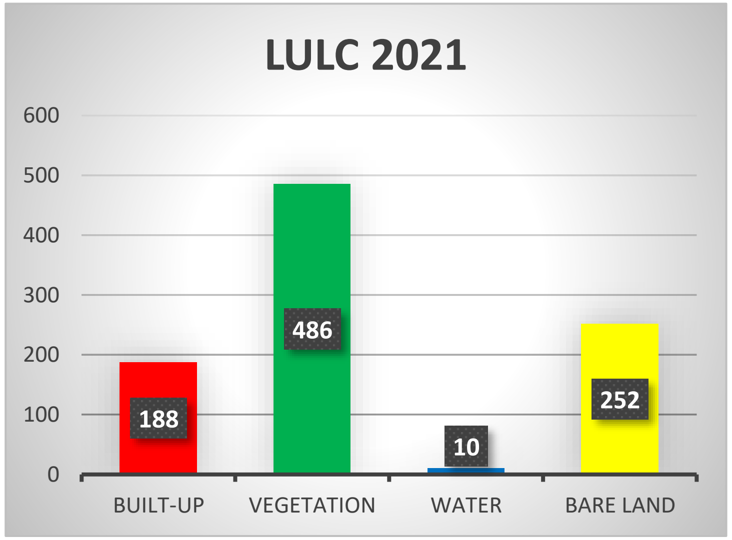
Area= Km2

4. Results and Discussions (A. LULC Maps)









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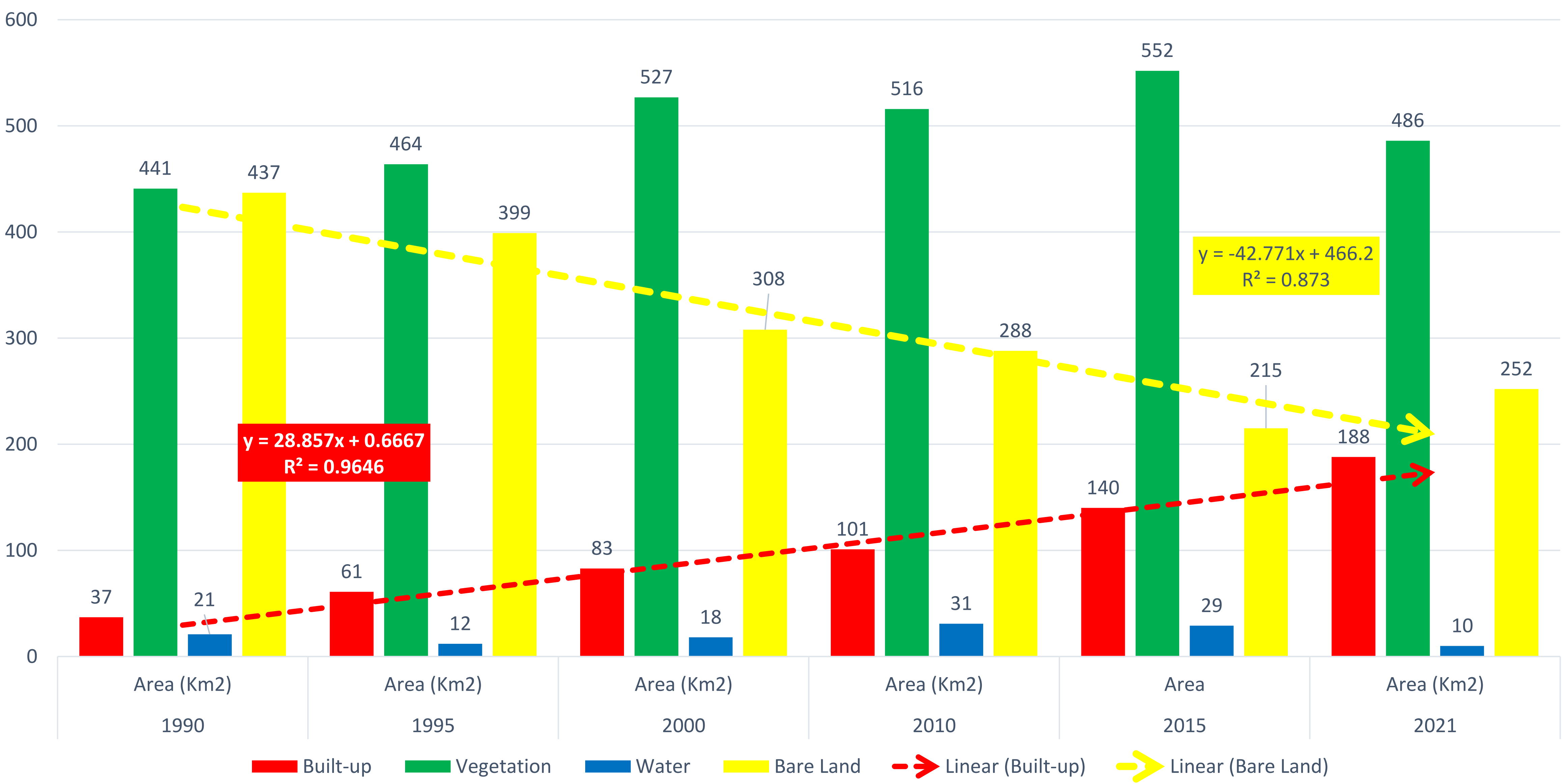
4. Results and Discussions (A. LULC Graph)



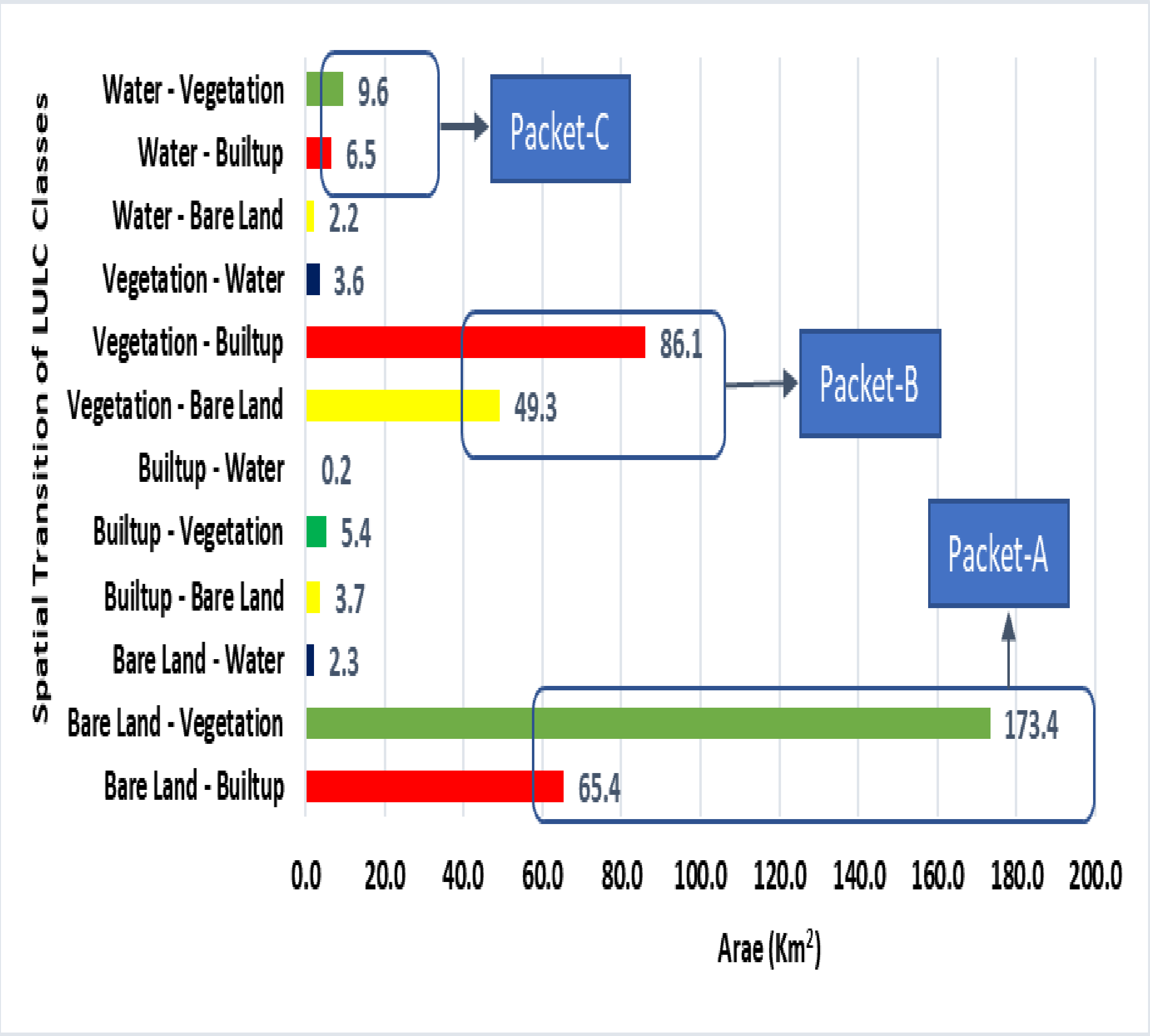
4. Results and Discussions

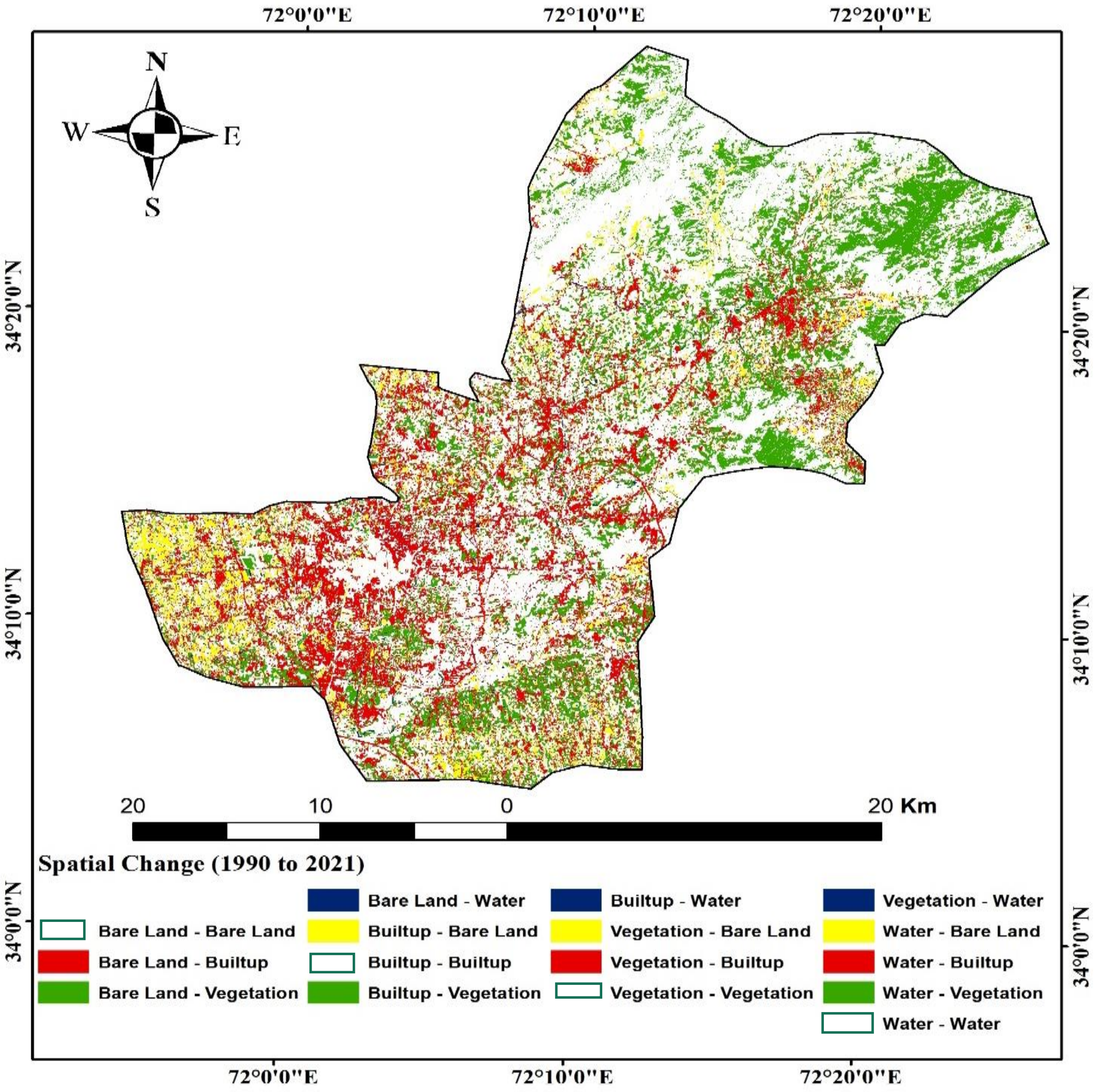
B. Accuracy Assessment

Overall classification accuracy for the years under study was more than 90 % except for 2010. Kappa Coefficient was also recorded above 0.80 for all the imageries.

Year/Parameter	1990	1995	2000	2010	2015	2021
Overall Accuracy (%)	97.25	96.69	94.15	87.42	94.71	98.30
Kappa Coefficient	0.95	0.95	0.91	0.82	0.88	0.97

4. Results and Discussions (C. **Change Detection (1990-2021)**



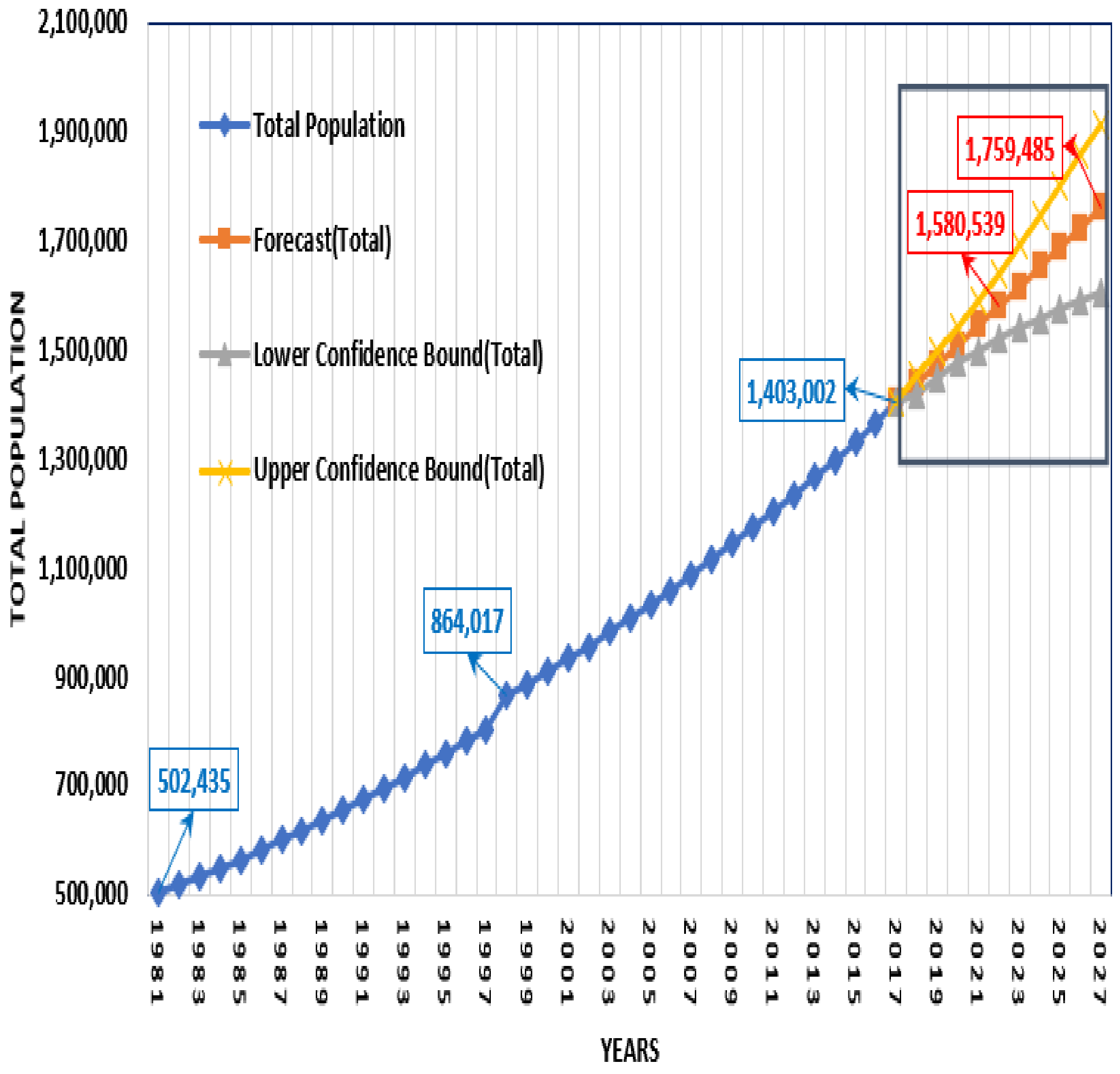


4. Results and Discussions (D. Population Dynamics)

1. According to the 6th population census in 2017, the total population of tehsil Mardan was 1,403,002.

2. Similarly, in 1998 and 1981, the total population was 864,017 and 502,435 respectively.

3. The forecasted population of tehsil Mardan for the years 2021 and 2027 was recorded as 1,580,539 and 1,759,485 respectively.



4. Results and Discussions (E. Correlation Matrix)

- Correlation analysis was performed to assess the correlation between the land use classes and total population data.
- The total population showed a strong positive correlation (0.98) with built-up and a strong negative correlation with bare land (-0.90).
- Built-up showed a significant negative correlation with bare land (-0.86).

	Total Population	*Built-up*	*Vegetation*	*Water*	*Bare Land*
Total Population	**1**				
Built-up	**0.982**	**1**			
Vegetation	**0.554**	**0.486**	**1**		
Water	**0.077**	**-0.096**	**0.537**	**1**	
Bare Land	**-0.907**	**-0.868**	**-0.851**	**-0.300**	**1**

5. Conclusion and Recommendations

1. The study showed that the built-up cover increased from 4% to 20% from 1990 to 2021. The built-up cover is increasing at the cost of bare land and vegetation cover conversion.
2. The main drivers behind the increase in the built-up cover are population growth, infrastructure development, and provision of basic amities of life in the city.
3. Bare land decreased from 46.7% to 27%.
4. The population of tehsil Mardan increased from 502,435 in 1981 to 1,544,750 in 2021.

1. It is recommended that further research should be carried out on the impact assessment of LULC changes on environmental parameters such as water quality and quantity, and climatic parameters like temperature and precipitation.
2. Government should formulate an approved and sustainable land use plan for current and future generations of the tehsil Mardan.
3. An awareness campaign should be launched to raise awareness among all stakeholders regarding the negative implication of the built-up layer and consequent ecosystem degradation.

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