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Modelling and Analyzing Land-Use Pattern Using GIS

Asst. Prof. Prof. Kalyani.N.Kulkarni, Sanket Anil Bhame, Akshay Gaware, Kunal Ghule, Adhiraj Kotwal
Department of Civil Engineering,
AISSMS COE,
Savitribai Phule University,
Pune

Abstract- This paper delivers the modelling of the region under Pune Metropolitan Region Development Area (PMRDA) to evaluate the area on Geographic Information System. Later on analysing the various projects that are making an enormous change in a significant area causing ecological, social, and physical changes in the same area under study. This takes place because of urbanization which is a physical and socio-economic spatiotemporal approach that transforms the rural terrain into urban form. It is attaining pace worldwide and is the most elemental cause of global land change. The rate of growth poses a great challenge for urban planners, as the development of cities often outpaces the planning cycle. This leads to additional challenges for metropolitan planners, namely: i) the database for the planning is usually obsolete and ii) methods and patterns of arbitrary urban growth are not accounted for properly. This study presents an approach to address these challenges by using commonly open and affordable remote sensing data to study: i) land use and land cover transformation and ii) by examining the extent of urban areas to explore the patterns and methods of urban development. There is a need for land use cover change to be studied on spatial and temporal scales to understand its possible impacts on the environment. We assessed land-use/land-cover data from 1991 to 2021 using multi-temporal Landsat datasets. The dynamics of urban growth were quantified using various metrics of metropolitan development. Urban land has increased significantly at the cost of grasslands, barren and agricultural lands, and our study confines in predicting and mapping this and giving us a fair percentage change in the tabular form by conversion and processing accordingly.

Keywords- Spatiotemporal process, Remote Sensing, Landsat datasets.

I. INTRODUCTION

Today, urban areas occupy only five percent of the earth's terrestrial surface but they are home to almost half of the global inhabitants, who consume seventy-five percent of the world's natural resources and generate an equal proportion of pollution and waste. Thus, unless addressed properly it often leads to serious ecological and environmental degradation such as reduced green spaces, expanded land fragmentation, decreased air and water quality, loss of productive agricultural land, and alteration of natural drainage. Besides land-use transformation, terrain patterns and urbanization are linked to each other. Therefore, data on land-use change is crucial for the efficient use of resources and for setting policy priorities for equitable development for urban and rural.

An accurate assessment of the state of current urbanization and the formal & informal processes leading to urban expansion is thus necessary to ensure sustainable urban expansion and mitigate adverse ecological and environmental impacts. India, being the leading country in South Asia has shown an unusual increase in the urban population in the previous few decades and its urban population has grown about 14 fold from 1901 to 2011. This development is mainly uneven but not skewed and not concentrated in a single city in the country. The population residing in urban areas in India, according to the 1901 census, was 11.4%, increasing to 28.53% by the 2001 census, and is currently 34% in 2017 according to The World Bank. According to a survey by the UN, in 2030 40.76% of the country's population is expected to settle in urban areas. Remote sensing provides both spatially and temporally uniform data to map and observe the spatiotemporal dynamics of urban development.

1. Nature of problem:

The first task in modelling the area was to get the satellite images of the previous years as we have our Indian satellite (Bhuvan) data from 2014 onwards. So, most of the data has been obtained from the USGS Earth Explorer. Secondly, the reliability and accuracy of the data used from the Landsat satellites are also susceptible to due to technical errors in the satellite.

II. METHODOLOGY

Selecting aspects to be analysed namely Built-up area, Forest, agricultural land, Shrub land, barren land, and water bodies. We selected the new Pune metropolis as our

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central area for analysis and we also covered the neighbouring major areas. Data is collected from the USGS website for raster processing. USGS server provides data from the year 1991 therefore we have selected 1991 as our start point or base point. Different bandwidth combinations are used for different types of data. We will be using Landsat 8 images. After procuring the data, we will then generate a data set of the discovered land use and use it for analysis of the pattern.

III. ANALYSIS

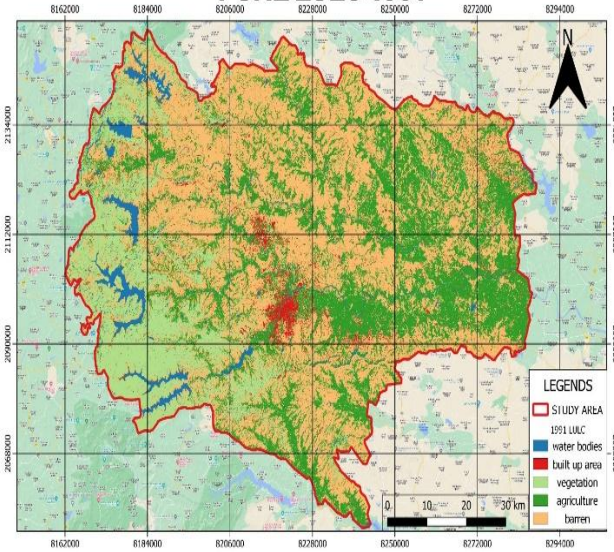
The analysis of the given research is done concerning the given points:

- Firstly, using semi-automatic classification tool in QGIS data is pre-processed to get rid of potential remote sensing errors. This process does not eradicate all the errors but limits it up to some extent.
- This data is then combined with the bands to form a band composite. This composite is the combination of various wavelengths of bands. These bands can be assigned a three-colour system (red, green, blue) to create an image of the combination.
- Whole satellite image is clipped to study area to isolate the required area from the image.
- This image is further classified according to maximum likelihood classification to create a land-use pattern.
- The program is trained by providing it with training samples of known attribute (i.e., waterbody, built-up, vegetation, agriculture and barren) to help it identify the pixels by colour.
- After running the band composite with different band combinations through the program we get a classified image of the area we processed.
- The TIFF format file thus obtained is then processed in ArcGIS to extract statistics, by converting the image to a polygon, and then adding a field for area and calculating area based on number of pixels. This table is exported to excel to get data in tabular form and percentages are calculated to understand the data.

Trials for Land Use Land Classification patterns using GIS:

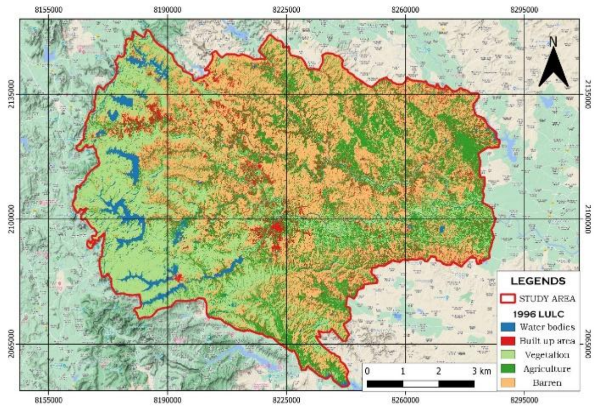
Row Labels	Sum of Area (km2)	%
Water body	218.84	3.17
Built up	190.53	2.76
Vegetation	1046.55	15.16
Agriculture	2164.19	31.35
Barren	3283.91	47.57
Grand Total	6903.33	100.00

PUNE LULC 1991



Row Labels	Sum of Area (km2)	%
Water body	189.15	2.74
Built up	334.12	4.84
Vegetation	1246.74	18.06
Agriculture	2291.90	33.20
Barren	2840.72	41.15
Grand Total	6903.33	100.00

PUNE LULC- 1996



Row Labels	Sum of Area (km2)	%
Water body	170.51	2.47
Built up	463.90	6.72
Vegetation	1596.74	23.13
Agriculture	2155.22	31.22
Barren	2516.95	36.46
Grand Total	6903.33	100.00

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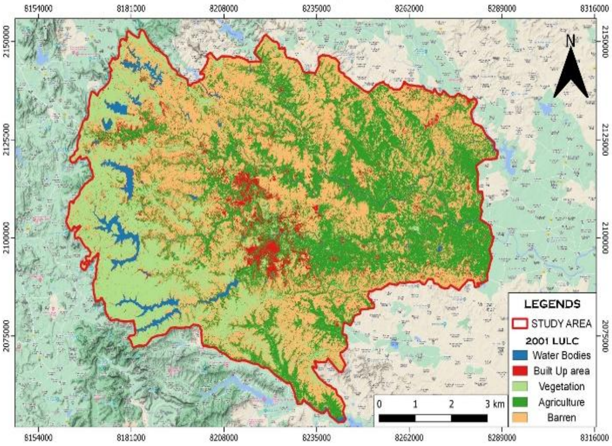
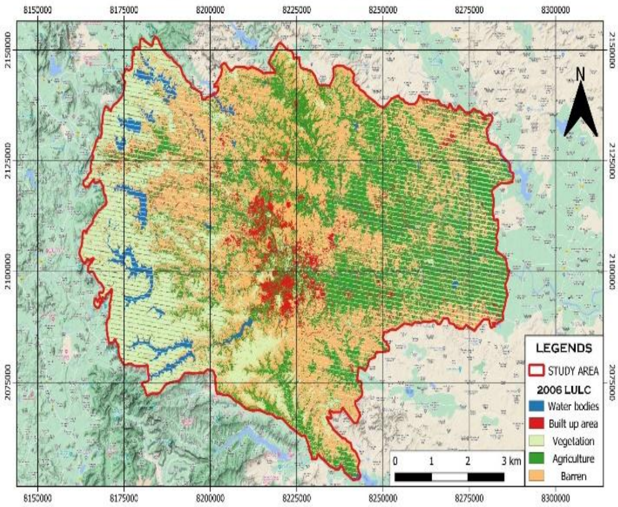
PUNE LULC- 2001



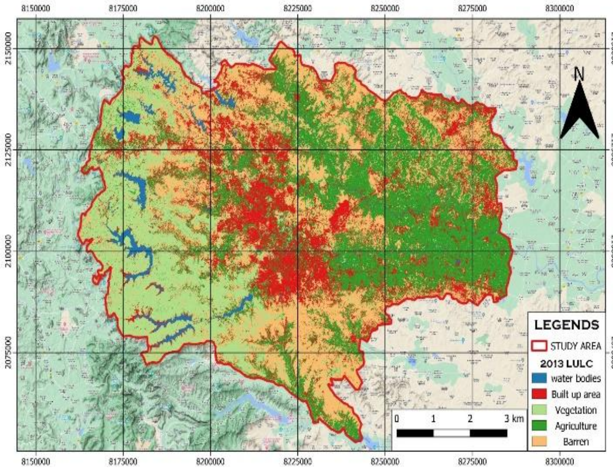
Row Labels	Sum of Area (km2)	%
Water body	276.13	4.00
Built up	520.51	7.54
Vegetation	1640.23	23.76
Agriculture	1884.61	27.30
Barren	2581.85	37.40
Grand Total	6903.33	100.00

PUNE LULC 2006



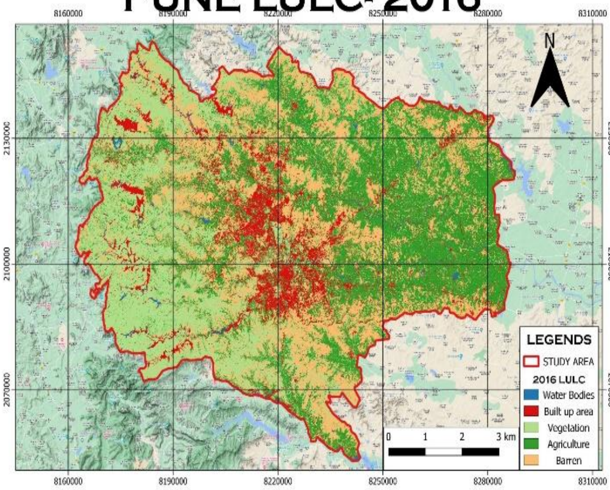
Row Labels	Sum of Area (km2)	%
Water body	155.49	2.25
Built up	1244.99	18.03
Vegetation	1439.18	20.85
Agriculture	2126.68	30.81
Barren	1936.98	28.06
Grand Total	6903.33	100.00

PUNE LULC - 2013



Row Labels	Sum of Area (km2)	%
Water body	133.92	1.94
Built up	1801.77	26.10
Vegetation	1215.68	17.61
Agriculture	2072.38	30.02
Barren	1680.27	24.34
Grand Total	6903.33	100.00

PUNE LULC- 2016



Row Labels	Sum of Area (km2)	%
Water body	220.90	3.20
Built up	2428.59	35.18
Vegetation	1966.76	28.49
Agriculture	1397.92	20.25
Barren	889.15	12.88
Grand Total	6903.33	100.00

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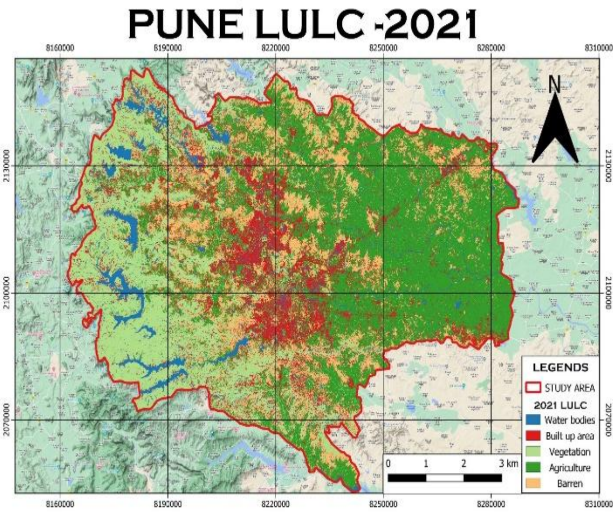

IV. LIMITATIONS

During the trials some of the limitations which were observed while processing the data are as follows:

- The study does not take into consideration the effect of different types of vegetation but considers a general vegetation cover.
- The concerned region of study selected is circumstantial.
- Factors considered for growth are limited.
- Can be very accurate over a larger period rather than for a short duration.
- The influence of local events might not get reflected in the data.
- USGS Landsat 7 data for the year 2011 had several discrepancies, which led us to model the dataset for 2013 instead.

V. CONCLUSION

Over the years as the development progresses the built-up area tends to increase. This growth is not random but directed along specific major roads and water bodies. We first see the formation of ribbons along the main road, which over the period grow large enough to be integrated into the core of development.

In the growth pattern, major changes were a drastic decrease in the barren land, significant growth in the built-up area, and a steady and very slow decline in water bodies. Agricultural land was not too affected till the end of the decade after which the ribbon development overtook agricultural land.

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