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Spatiotemporal Land use/Land cover Changes in Bangalore Rural District, Karnataka

K. Gajalakshmi[1], Anantharama. V[2]

[1]Assistant Professor, [2]Associate Professor and Deputy COE,
Department of Civil Engineering, R.V College of Engineering, Bangalore, Karnataka

Corresponding Author: K. Gajalakshmi

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ABSTRACT

Determining land-use/land-cover (LULC) changes provides valuable insights into the dynamics of the Earth's surface and is crucial for a variety of purposes. To monitor changes in agricultural land to optimize land use, manage crop rotations, and enhance sustainable agricultural practices LULC used. LISS III and LISS IV satellite images for 2010 and 2020 were used to generate the LULC map and compared to analyse the changes. Landforms in five categories Agriculture land, Built-up, Wasteland and Water bodies were analysed in the four taluks of Bangalore rural District. In Nelamangala and Hosekote built-up increased by 3 % of total area, where as in Devanahalli built-up area increased by 7 % of total area. Agricultural land has reduced 2 % of total area in Devanahalli but whereas 2 % of agricultural land reduced in Devanahali in a decade time reflecting the Kempegowda international airport in Devanahalli. Provide recommendations for sustainable land use planning and development based on the study's findings. Analysis involves a combination of remote sensing, GIS, and fieldwork to comprehensively understand and manage spatiotemporal land use changes in a specific region. Future scope of this study is Use models to project future land use changes based on different scenarios and Provide recommendations for sustainable land use planning and development based on the study's findings.

Keywords: *Agricultural Land, Landuse/Landcover, Satellite Image, Spatio-temporal, Sustainable planning*

INTRODUCTION

Analyzing spatiotemporal land use/land cover changes in Bangalore Rural requires a comprehensive study involving remote sensing and GIS (Geographic Information System) techniques. Acquire satellite imagery covering multiple time periods and perform Hybrid classification on the satellite imagery to identify different land cover classes. Classified images are Validate and refine the classification results using ground truth data. Employ change detection algorithms to identify areas of significant change.

Temporal Analysis were to analyze the temporal trends in land use/land cover changes and Identify periods of rapid change and stability [1,2]. Examine seasonal variations and long-term trends. Spatial Analysis were to identify hotspots of change and areas with persistent land cover characteristics [3]. Future Scope of the study to evaluate the proximity of changes to urban centers, transportation networks, and other relevant features.

LU/LC map visualizations to effectively communicate the spatiotemporal land use/land cover changes using GIS tools to generate maps showing different classes and change patterns [4]. Analyzing spatiotemporal land use/land cover changes in a specific region, such as Bangalore Rural District in Karnataka, involves the study of how the physical and functional characteristics of the land have evolved over time. This type of analysis is crucial for urban and regional planning, environmental monitoring, and sustainable development.

STUDY AREA

Bangalore Rural district is situated in the south-eastern corner of Karnataka. The district lies between the latitudes 12°98'11'' to 13°28'00'' N and longitudes 77°57'46'' to 77°60'00'' E. It consists of four taluks viz. Devanahalli, Doddballapura, Hoskote and Nelamangala. The district is bounded by Tamil Nadu State on the East, Tumkur and Mandya districts on the West, Chamarajanagar on the South and Kolar and Tumkur districts on the North. The district has 1061 village 185 Panchyat 22 hoblies covering area of 8388 sq km. According to 2011 census, Bangalore Rural population was 990,923 were 509,172 male and 481,751 female [5].

The central, northern and eastern portion of the district consists of vast stretches of undulating plains. The uplands are bare or covered with scrub jungles, whereas low lands are covered with a series of irrigation tanks [6]. A range of hills from Kanakapura in the South to Nijagal in the North is formed of coarse grain granite, which is a prominent physiographic feature. Shivaganga, Savanadurga, Nijagal, Muduvani Betta and Narashima Devara Betta are some of the notable hills in the district.

MATERIALS & METHODS

DATA USED

Spatial data and Non-spatial or attribute data were utilized for preparing the LU/LC map. The spatial data consists of Survey of India topo sheets on 1:50000 scale and Remote sensing satellite imagery and Non-spatial data such as rainfall data, ground water fluctuation data.

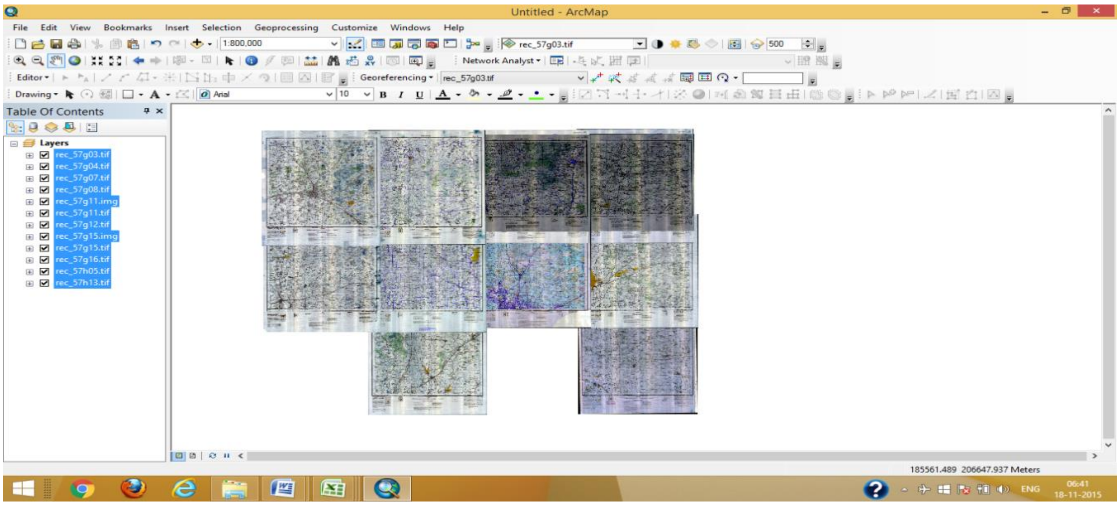


Figure 1 Toposheets Georeferenced

The toposheets collected from survey of India is numbered as 57g03,57g04,57g07,57g08,57g11,57g12,57g13,57g16,57h05 and 57h13 which is geo referenced and mosaiced using ARC-GIS 10.1. as shown in the figure 1.

QGIS is used for digitization of water bodies like tanks, reservoirs, lakes etc, drainages and preparation of land use land cover maps of Bangalore rural.

The satellite imagery LISS III (Linear Imaging Self Scanning Sensor) with spatial resolution 23m has a multi-spectral camera (optical sensor) and consists of 4-bands. 3 – bands in the visible and near infra-red (NIR) and 1- band in the short-wave infrared region (SWIR). It covers 141 km swath with a resolution of 23 m in all spectral bands.

The table 1 shows the characteristics of LISS III and LISS IV images

Table 1 SPECIFICATIONS OF LISS III and LISS IV images

Satellite	Band	Spectral Value (µm)
LISS III image	2	0.52-0.59
	3	0.62-0.68
	4	0.77-0.86
	5	1.55-1.70
LISS IV image	1	0.50-0.75
	2	0.52-0.59
	3	0.62-0.68
	4	0.77-0.86

The figure 2 shows the LISS III satellite imagery with band combination of 3, 2 and 1 that is Red, Green and Blue respectively.

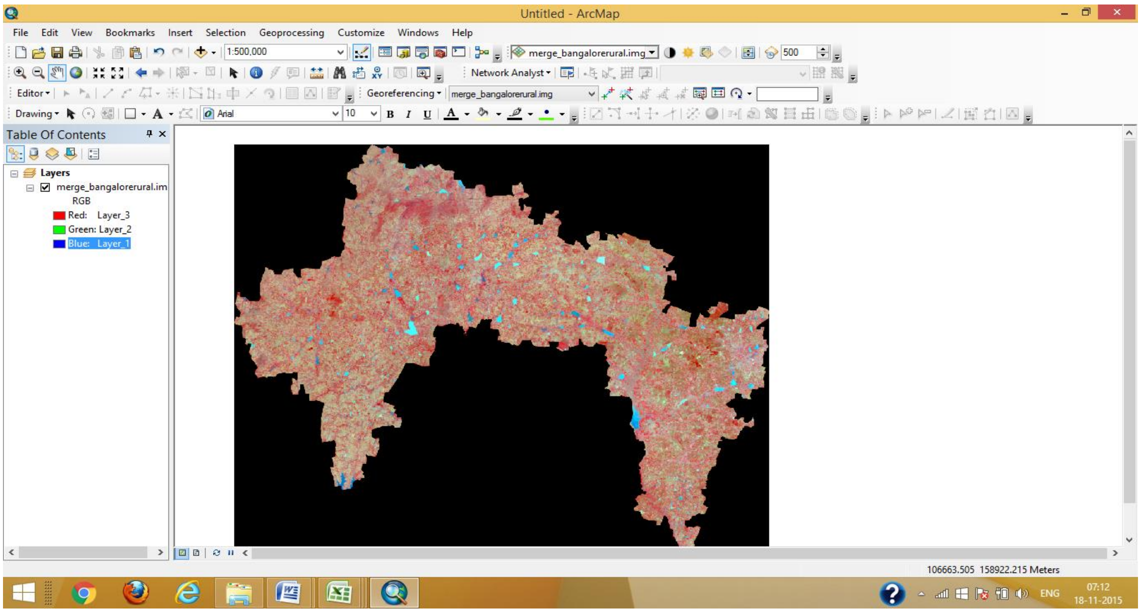


Figure 2: LISS III SATELLITE IMAGERY

LISS IV Satellite imagery can work either in panchromatic or in multispectral mode with the same bands as LISS III (expect SWIR). However, the resolution is much better than LISS III of 5.8m. Band 1 Panchromatic mode of spectral band 0.50 – 0.75. Band 2 in Multispectral mode. The figure 3 shows the LISS IV Satellite imagery with band combination of 3, 2 and 1 that corresponds to red, blue and green.

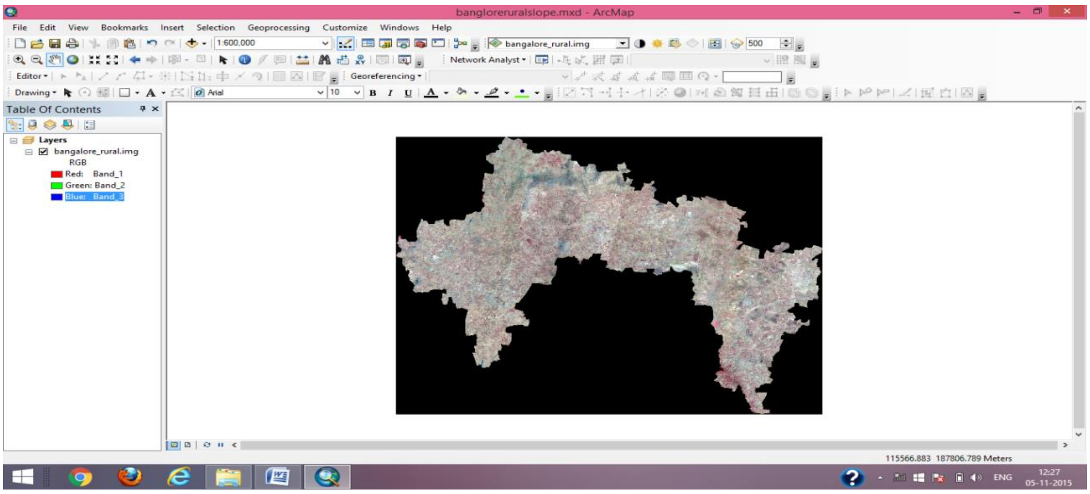


Figure 3: LISS IV satellite image

The characteristic specifications of Cartosat1 DEM image as shown in table 2. The Digital Elevation Model (DEM) image is downloaded from the website Bhvvan.nrsc.in for deriving the slope map showing the elevation information for study area.

Table 2: Specifications of Cartosat1 DEM image

CARTOSAT 1	Specifications
Resolution	2.5m
Launch date	may 5,2005
Location	sriharikota, India
Nominal Altitude	617.99km
Orbit/day	15
orbital repeat cycle	116days
Nominal wait time to	11days
Acquire adj.path	
Maximum wait time for revisit	5days
Mode for P/L operations	Descending node
Local time for equatorial crossing	10.30AM

The figure 4 shows the cartosat1 DEM image which as 2.5m resolution

METHODOLOGY

Generating a land-use/land-cover (LULC) map in QGIS involves several steps, including data preparation, classification, and mapping. satellite imagery with suitable resolution for the study area is obtained. Relevant vector data were download for reference (roads, administrative boundaries, etc.). As a preprocess step it's ensured that all data layers are in the same coordinate reference system (CRS). Clip or subset the imagery to cover the area of interest and remove any clouds or artifacts from the satellite imagery. In **Supervised Classification r**equires training samples of known classes. training samples representing different land cover types were collected and use a classification algorithm (e.g., Maximum Likelihood, Support Vector Machines) to classify the entire image. In **Unsupervised Classification** Groups pixels based on spectral characteristics are used with an unsupervised classification algorithm (e.g., K-Means, ISODATA) and Assign land cover types to the resulting clusters.

Accuracy Assessment carried out to validate the accuracy of your classification by comparing the classified image with reference data. As a post-processing step Remove small, isolated pixels or features that may be noise and smoothen the boundaries and refine the classified image. Vectorization process was carried out to Convert the raster classification result into vector polygons representing different land cover classes. Assign different colors to each land cover class for better visualization. Overlay the classified map with reference vector data to refine and validate the results. Create a map layout with a legend, scale bar, and other necessary elements. Export the final map as an image or PDF for sharing or further analysis. Document the data sources, processing steps, and any assumptions made during the classification. In this study Hybrid classification method was used as shown in figure 5, including both Supervised and UnSupervised concepts to improve accuracy. Consider using ancillary data (e.g., NDVI, texture) to enhance classification results.

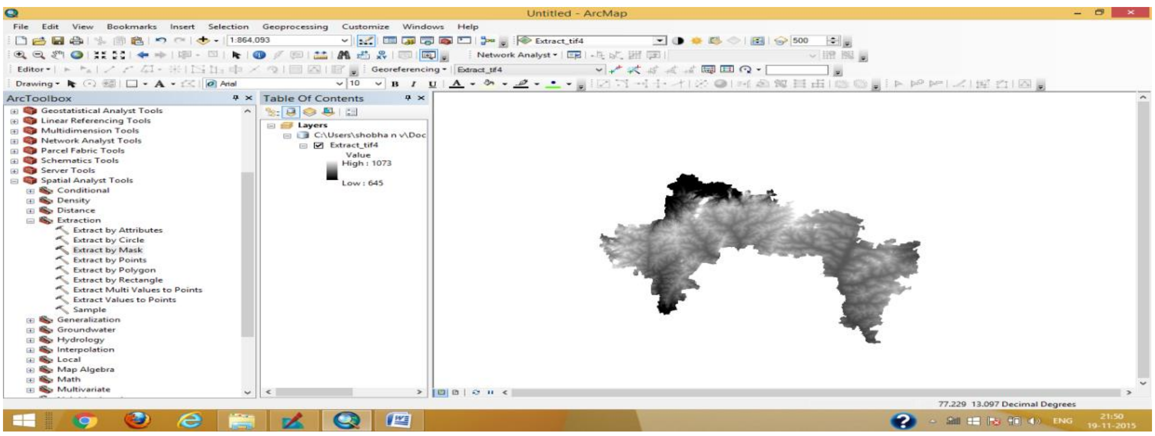
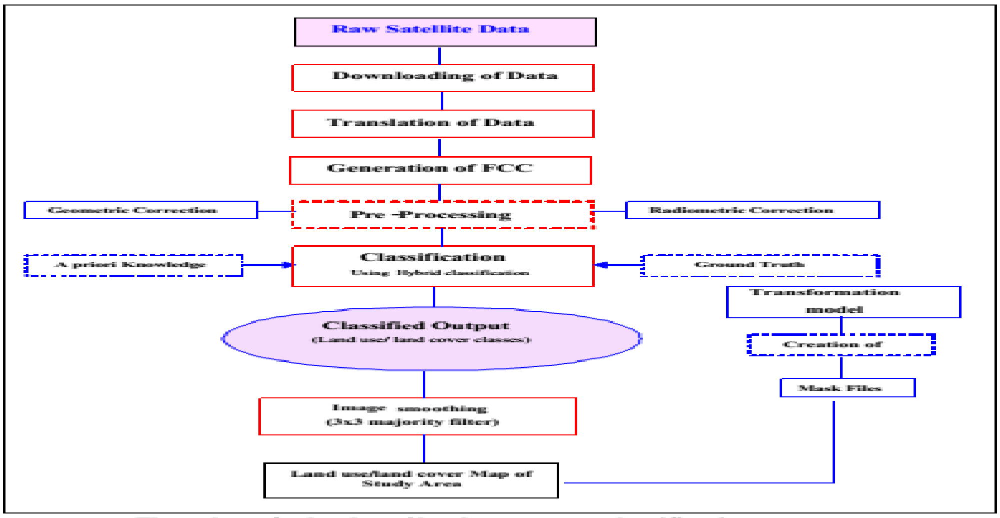


Figure 4: Cartosat1 Dem Image



Flow chart for land use/ land cover map classification

Figure 5: FLOW CHART OF LAND USE AND LAND COVER

The figure 6 shows the classification of lulc for the year 2010 using LISS IV. The classified features consist of Agricultural land, built up land, forest, waste lands and water bodies.

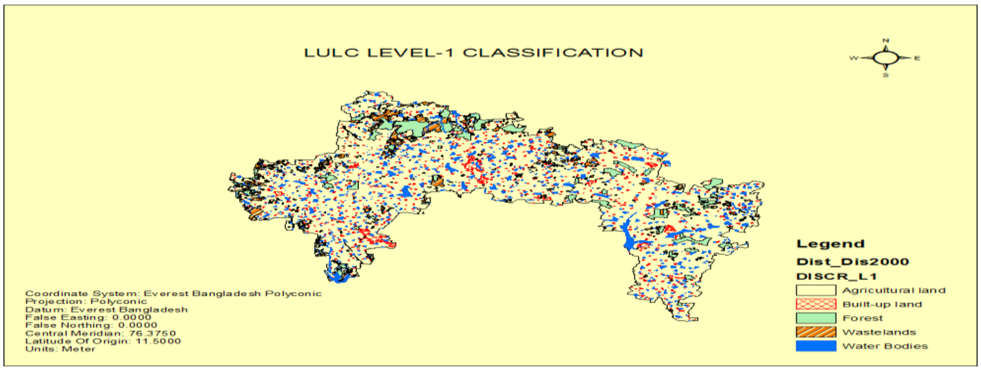


Figure 6: LEVEL-1 CLASSIFICATION FOR THE YEAR 2010

The figure 7 shows the classification of lulc for the year 2020 using LISS III image

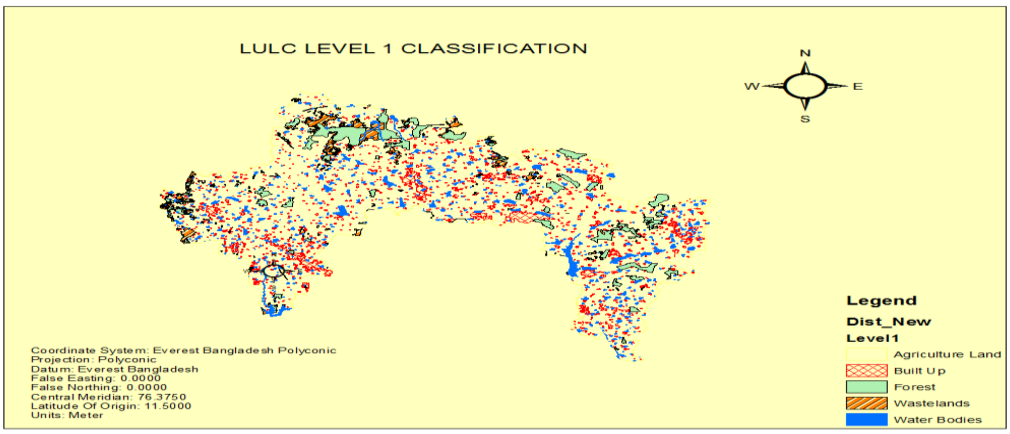


Figure 7: LEVEL-1 CLASSIFICATION FOR THE YEAR 2020

RESULT

The table 3 shows the percentage of Landuse/Land cover (Lu/Lc) for Bangalore rural for four taluks in the year 2010 and 2020 obtained from attribute table of Lu/Lc classification system.

Table 3: AVERAGE OF LEVEL-1 CLASIFICATION FOR THE YEAR 2010

TALUK	CATEGORY	2010		2020	
		AREA COVERED	PERCENTAGE	AREA COVERED	PERCENTAGE
NELAMANGALA	Agriculture land	409305567.9	81.11	415528084.8	82.5
	Built-up	17720830.81	3.5	33063837.22	6.5
	Forest	17790914.94	3.5	17708730.08	3.5
	Wasteland	35829824.96	7.1	15691872.49	3.1
	Water bodies	23943604.24	4.7	21292169.42	4.2
	TOTAL AREA	504590742.9		642266685	
HOSKOTE	Agriculture land	44891.5	81.79	691750049.7	81.3
	Built-up	1401.974142	2.55	29938556.94	5.3
	Forest	1561.561152	6.4	39589731.73	6.52
	Wasteland	1287.537954	2.34	3174057.65	0.57
	Water bodies	3741.249368	6.81	38660071.47	6.28
	TOTAL AREA	544882.916		53787.83	
DEVANAHALLI	Agriculture land	3833303186	84.45	477813271.2	82.13
	Built-up	11895948.09	2	38502817	7.8
	Forest	22392219.98	4.9	29269223.63	4.4
	Wasteland	13767101.03	3	7760724.63	1.1
	Water bodies	22513039.32	4	26647928.96	4.3
	TOTAL AREA	453871495		449429660.3	
DODDABALLAPURA	Agriculture land	618057849.6	78.07	756242564.9	80.2
	Built-up	20810397.14	2.6	27724071.09	3.4
	Forest	56801647.66	7.1	106478734.9	7.6
	Wasteland	58140293.95	7.3	44117471.39	5.1
	Water bodies	37763317.36	4.7	29912421.43	3.4
	TOTAL AREA	791573505.7		792257269.9	

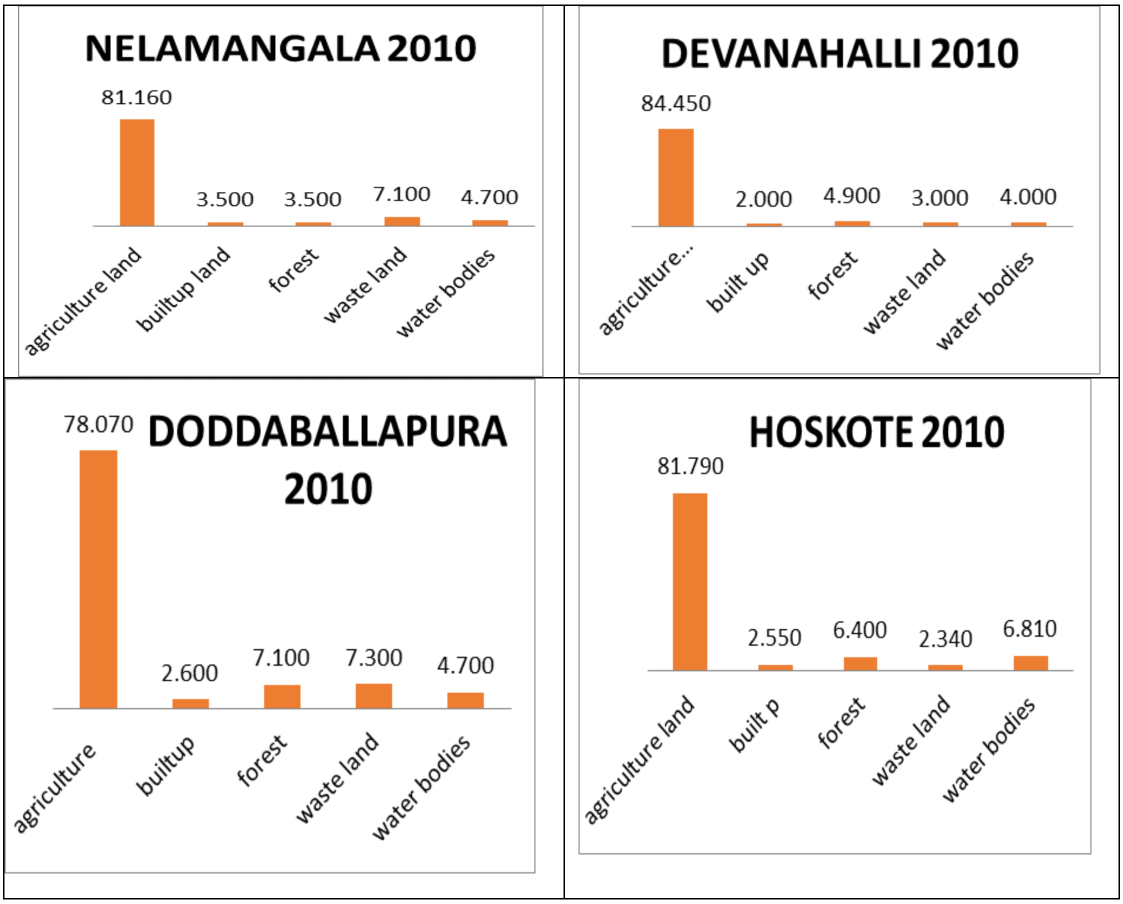


Figure 8: GRAPHS FOR LEVEL-1 CLASSIFICATION FOR THE YEAR 2010

Overall, in year 2010 it shows that the agricultural area is more compared to other land use such as built up, waste land, water bodies and forest as shown in the figure 8.

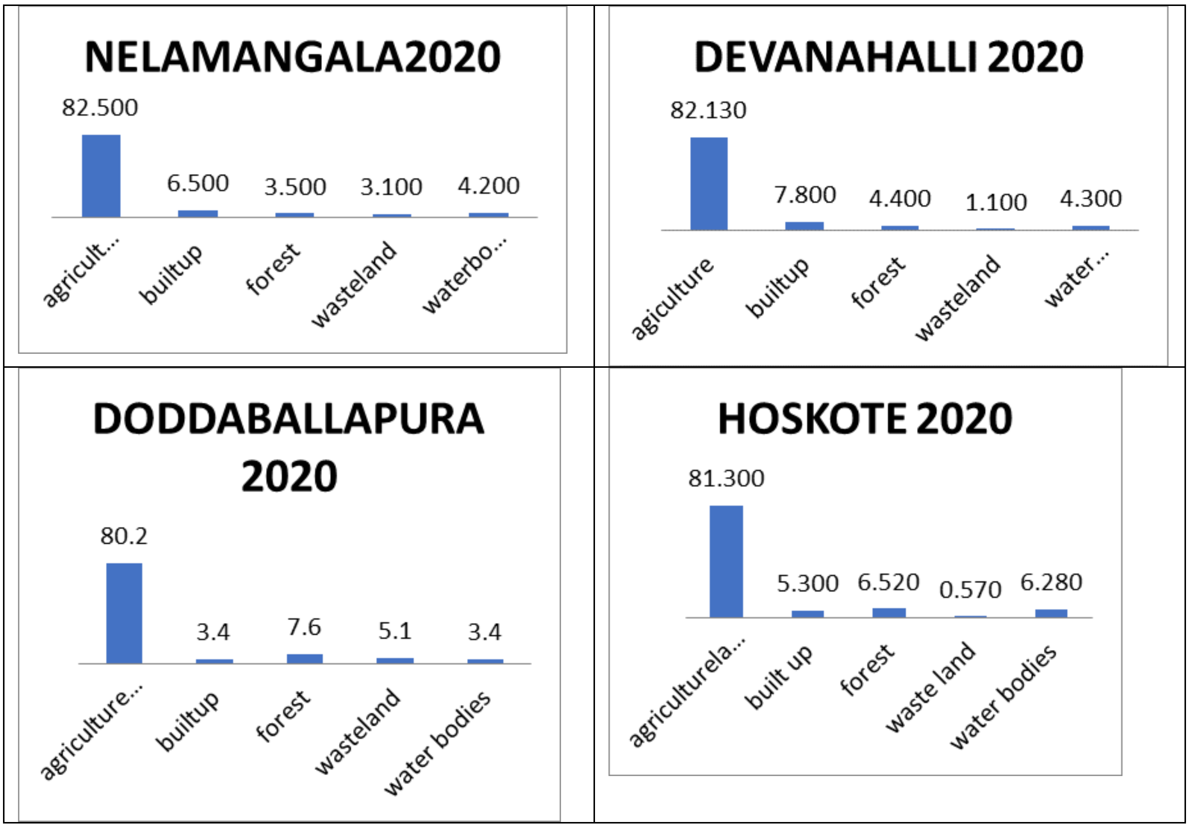


Figure 9: LEVEL-1 CLASSIFICATION FOR THE YEAR 2020

Similar to 2010 even in 2020 agricultural land is more compared to other land uses. But Built-up area as slightly increased and wasteland as decreased as shown in the figure 9.

CONCLUSION

The key benefits of studying LULC changes provides insight on Identify and monitor changes in natural ecosystems, deforestation, reforestation, and the conversion of natural habitats to urban or agricultural land. In Nelamangala and Hosekote built-up increased by 3 % of total area, where as in Devanahalli built-up area increased by 7 % of total area. Agricultural land has reduced 2 % of total area in Devanahalli but whereas 2 % of agricultural land reduced in Devanahali in a decade time reflecting the Kempegowda international airport in Devanahalli. In summary, understanding LULC changes is essential for holistic environmental management and sustainable development. It provides crucial information for a wide range of disciplines, supporting informed decision-making and policy development at local, regional, and global scales.

Declaration by Authors

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