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Assessing The Land Use / Land Cover Changes Due To Urbanization In Mangalore, Karnataka, India

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Abstract
Urbanization is the process by which cities expand and an increasing proportion of the population moves into urban areas, together with the corresponding decline in the number of people living in rural areas and the methods in which societies adjust to this shift. Over the past few centuries, there has been a considerable increase in the global population and industrialization of our economies. Consequently, a large number of people have relocated to cities. The present study aimed at monitoring the land use land cover changes in Mangalore region during the period 2009 to 2024. Remote sensing and Geographical Information System (Arc GIS 10.7) techniques were used to determine the land use and land cover changes, satellite images were downloaded from USGS based on the analysis of temporal Landsat-8 satellite imagery. Netravathi and Gurupur River are two major rivers flows in Mangalore, Because of this, the change in land use and land cover was varying from day to day around the river mouth. The present study shows that classes like agricultural land built up area; water bodies, river basin and mixed vegetation have also experienced changes. Built-up lands (settlements) have increased from 117.0078 Km^2 in year 2009 to 698.7640 Km^2 in the year 2024. Because of rapid urbanization, increase in industries and increase in population has increased built up area. Mangalore city is one of the fastest developing cities in India. Proper land use planning is essential for a sustainable development of Mangalore.

Keywords: *Land use; Land cover, Change analysis, GIS, Mangalore, Remote sensing, Satellite images.*

1. Introduction

Changes in land use and land cover have an impact on a wide range of environmental and landscape attributes, including the quality of water, land and air resources, ecosystem processes and function, and ecosystem quality. These changes are central to the debate on sustainable development because they are one of the main drivers of global environmental change. The land use/land cover pattern of any region is influenced by natural and socio-economic factors and their utilization by human in time and Degradation of land is mainly due to population pressure that leads to intense land use without proper management practices. Over population makes people to relocate themselves towards sensitive areas like highlands. Land is becoming a scarce resource due to immense agricultural and demographic pressure The change in land cover occurs even in the absence of human activities through natural processes where as land use change is the manipulation of land cover by human being for multiple purposes- food, fuel wood, timber, fodder, leaf, litter, medicine, raw materials and recreation. . However, changing land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere. Remote sensing and GIS can be effectively used as a source or tool for rational planning of any area or region. With the invent of these techniques, land use/cover mapping has given a useful, economical and detailed way to improve the selection of areas designed to agricultural, urban and/or industrial areas of a region. Remote Sensing tool has been used to classify and map land use and land cover changes with different techniques and data sets. In this study an attempt is made to assess the changes in LU/LC of Mangalore district

of the Karnataka State, by using remote sensing datas. The objective of the study is to assess the Land Use/ Land Cover (LU/LC) changes in the Mangalore City of Dakshina Kannada district using Remote Sensing data.

2.0 Materials and Methodology

Six Indian Remote Sensing (IRS) cloud free and post-monsoon satellite images were used in this study. The satellite images are downloaded from the help of USGS web portal, the four numbers of satellite images of following years are downloaded, 2009, 2014, 2019, and 2024.The flow chart shown in Figure 2.

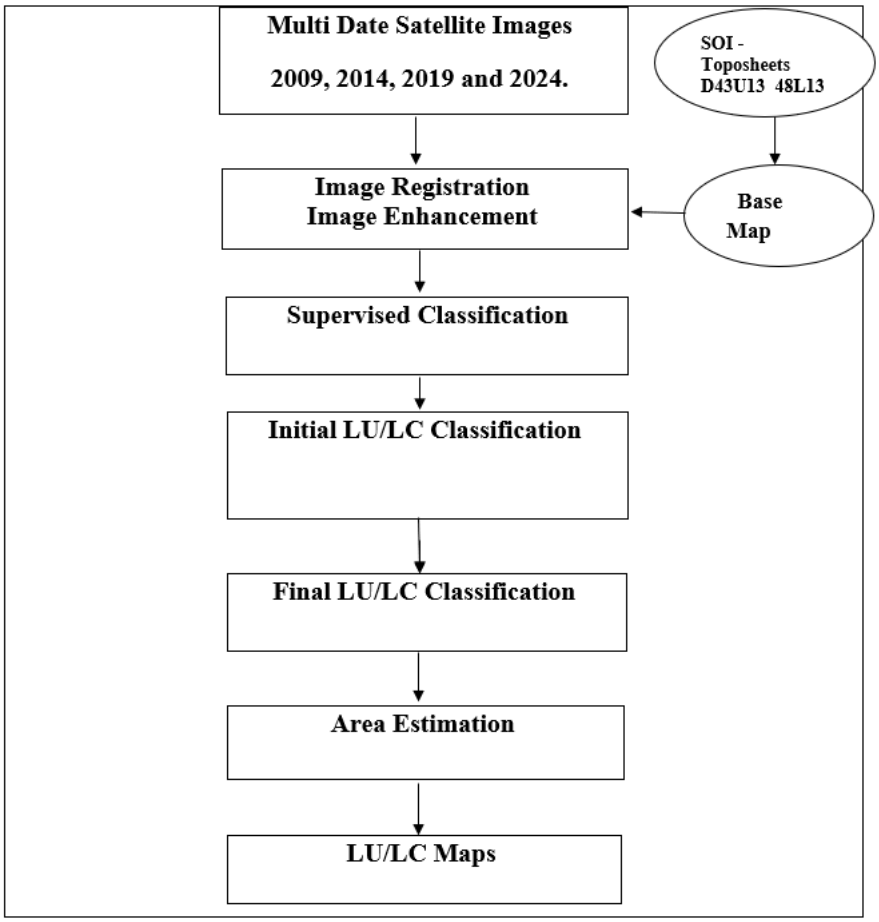

Figure 2: Methodology flow chart

Figure 2 illustrates the flow chart used to create maps of land use and land cover. The digital image processing program Arc GIS 10.7 offers standard image processing methods. In the analysis, techniques such picture extraction, rectification, restoration, and classification were applied.

3.0 Study Area.

Mangaluru, officially known as Mangalore, is a major industrial port city in the Indian state of Karnataka and on the west coast of India. It is located between the Laccadive Sea and the Western Ghats about 352 km (219 mi) west of Bangalore, the state capital, 14 km north of Karnataka–Kerala border and 297 km south of Goa. Mangalore is the state's only city to have all four modes of transport- air, road, rail and sea. It is known for being one of the locations of the Indian strategic petroleum reserves. The research area (Figure 1) is the coastal area of the DK district in the Indian state of Karnataka. It is located between latitudes 12°45' N and 13°7'30" N and longitudes 74°45' E and 75° E. Nethravati and Gurpur are the study area's two principal rivers. We only looked at the Central and Southern regions of the city for our analysis.

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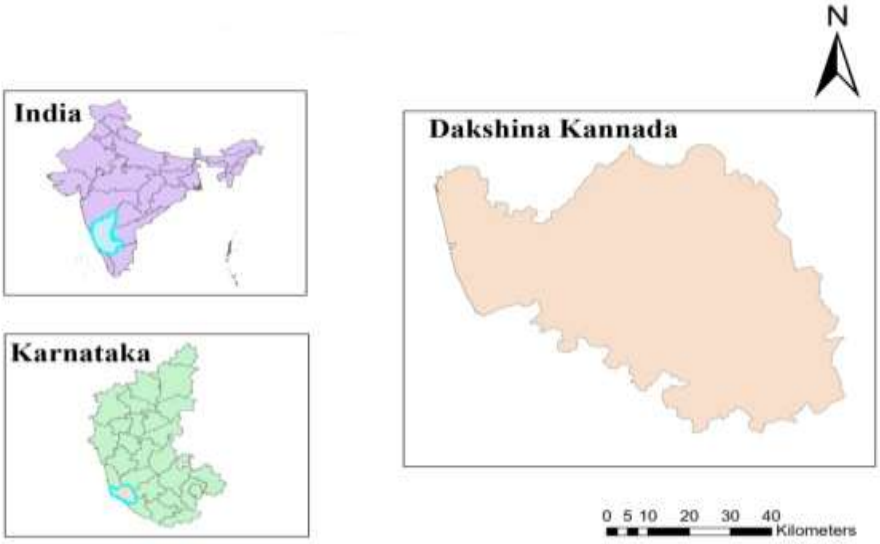

Figure 1: Study Area of Dakshina Kannada.

4.1 Preparation of base map

After being traced, scanned, and integrated into the ERDAS Imagine environment, two 1:25,000 scale Survey of India toposheets were created. Then, using Lat/Long spheroid and geometric projection, they were georeferenced. Sub-setting and mosaicing were used to create the base map from the toposheets.

4.2 Pre-processing of satellite imagery

Base map was used for image to map registration. Subsets of the photographs that matched the size and form of the research area were then created. Given that the research area is located in zone 43 N; these images were reprojected using the Universal Transverse Mercator (UTM) projection. The histogram stretch approach was used for radiometric enhancement while the edge enhancement technique was used for spatial enhancement.

4.3 Image classification

Using the spectral characteristics gleaned from training samples, supervised classification categorizes images. It has been simple to generate training examples that represent the classes we wish to extract with the help of the Image Classification toolbar. In order to classify the image, the Spatial Analyst multivariate classification tools employ the signature file that it can readily construct from the training samples. The classification scheme employed in the preparation of the decadal land covers and use data presented in Table 1.

Table 1: Details of Data Used

Description of the data and Source	Remote Sensing data and Source
Toposheet -D43U13_48L13 Toposheet - D43V1_48P1	2009 2014 2019 2024
Source- Survey of India Government of India, New Delhi.	Source - USGS web portal.

Changes in how a particular region of land is utilized or managed by humans are referred to as land-useandland-coverchanges.

This has to do with how urbanization has changed the natural landscape. It is interesting to note that this change

is the cause of many local and global repercussions, such as the loss of habitat and ecosystem services, as well as the loss of biodiversity and the health effects that go along with it for humans. It is mostly caused by urbanization and is crucial right now for developing and impoverished nations. Figures 3, 4, 5, and 6 exhibit how the study area's land usage and land cover have changed over time. The land use land cover classification scheme, and area covered by different land use land cover classes in different years are shown in Table 2,3,4,5,6 and 7.

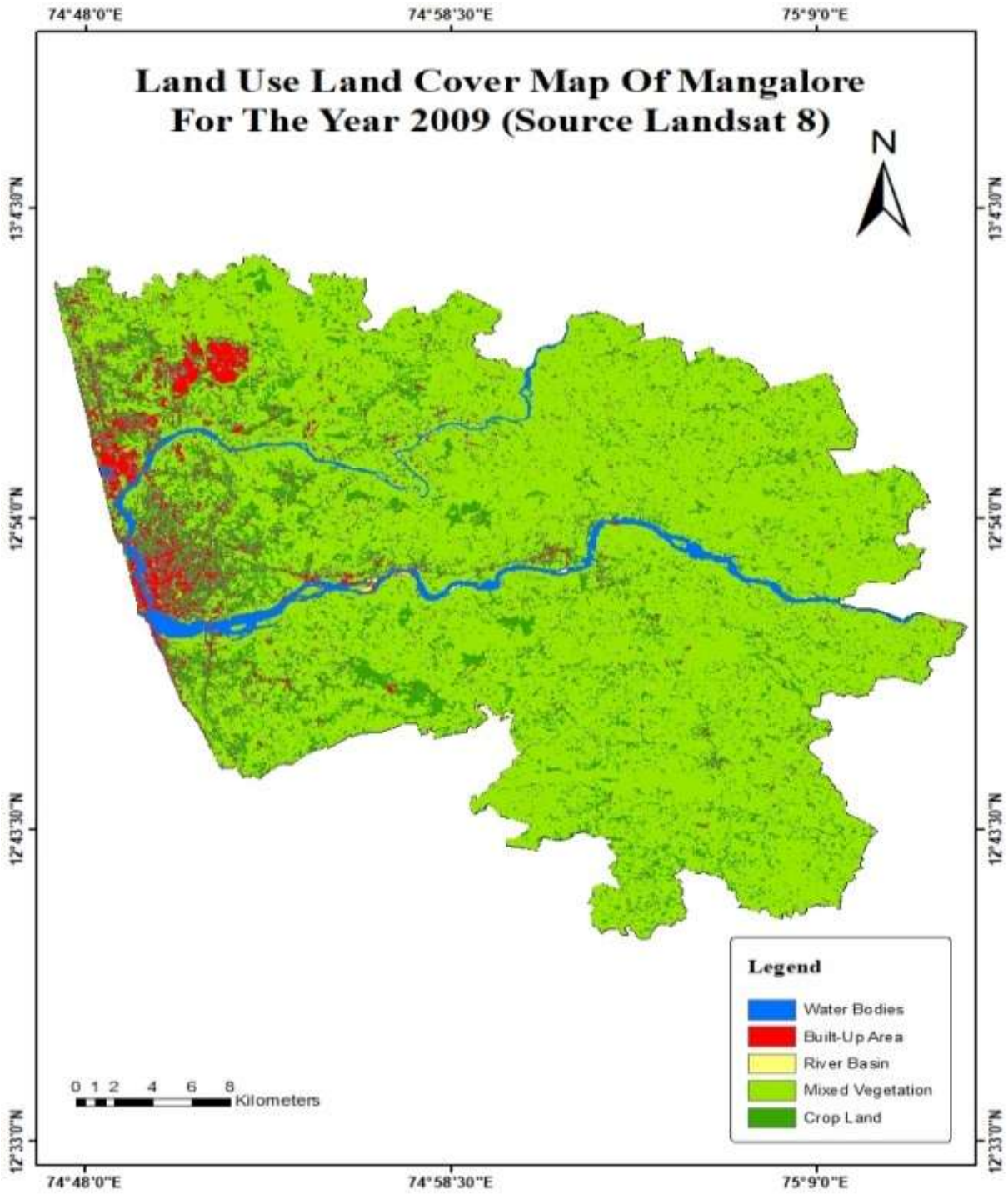

Figure 3: LU/LC map of the Mangalore for the year 2009

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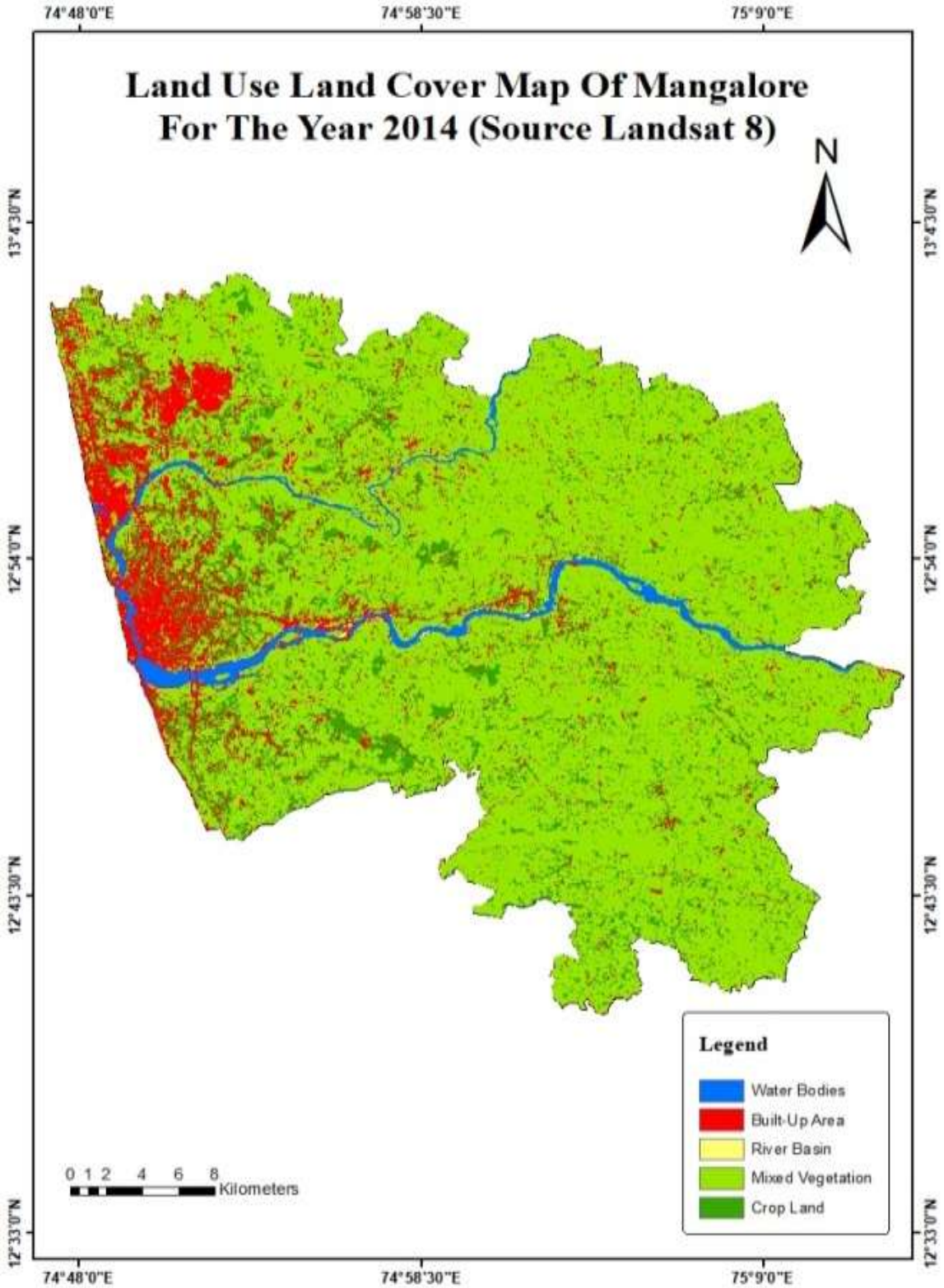

Figure 4: LU/LC map of the Mangalore for the year 2014

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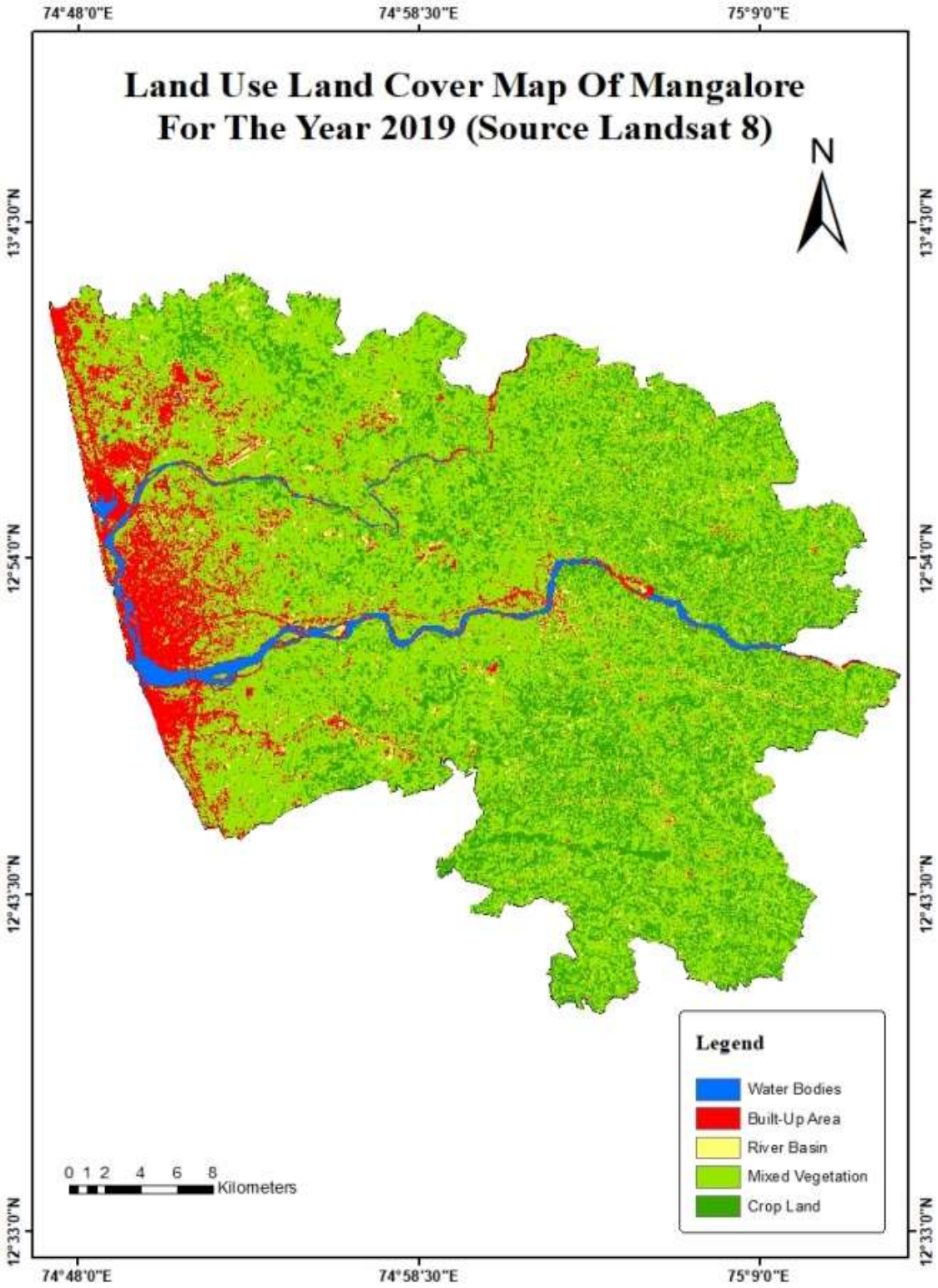

Figure 5: LU/LC map of the Mangalore for the year 2019

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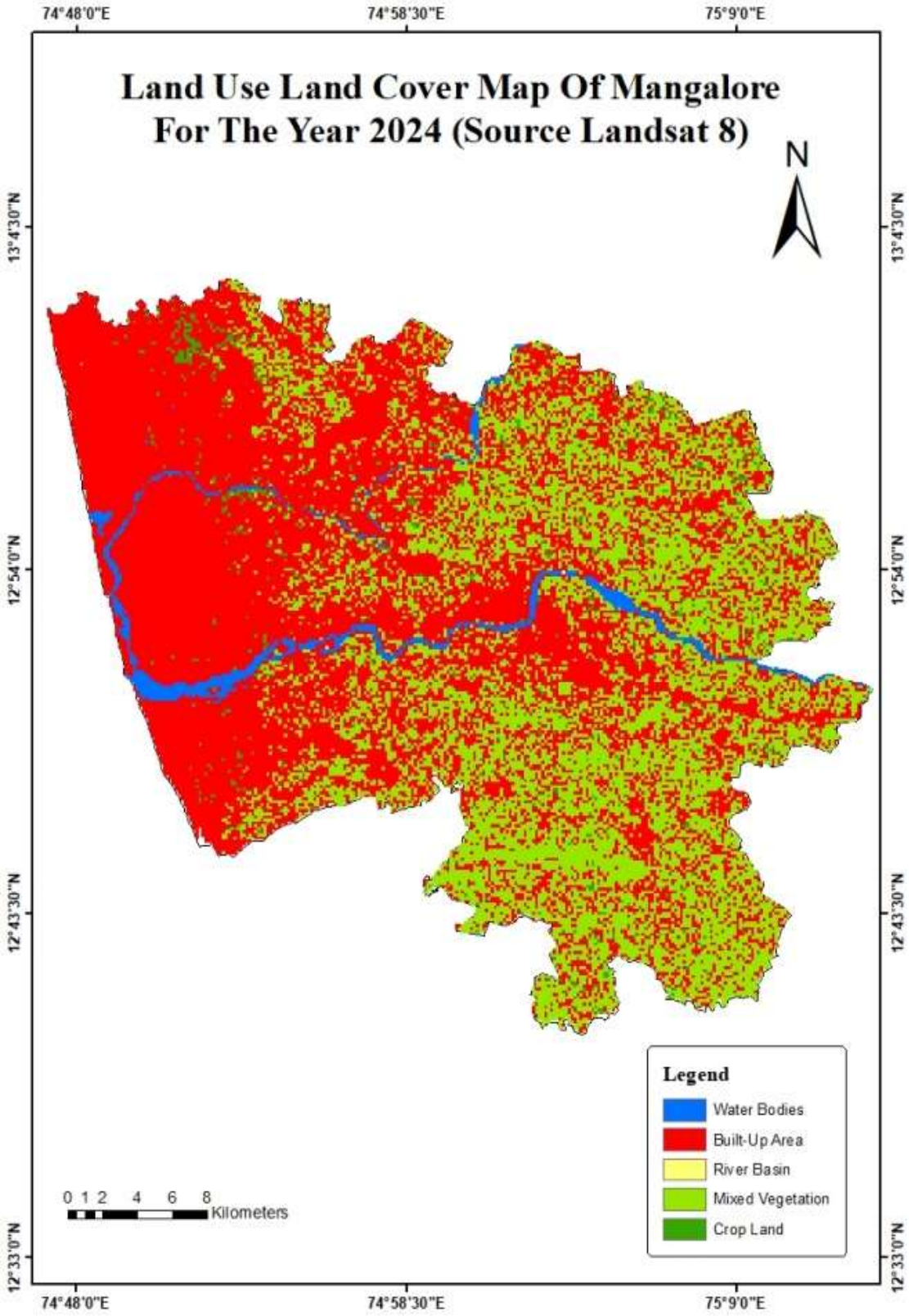

Figure 6: LU/LC map of the Mangalore for the year 2024

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Table 2: Land use Land cover classification scheme.

SL.NO	LULC Classes	Description
1	Water Bodies	River, Pond, Sea.
2	Built up Areas	Housing, Industries, commercial, Transport Systems.
3	River Basin	River sand.
4	Mixed Vegetation	Forest, Natural vegetation, plantation, shrub, grass.
5	Crop Land.	Crop land, pre-sow, post-sow.

Table 3: Area of land use and land cover classes for the year 2009

SL.NO	Class Name	Area in km^2
1	Water Bodies	30.4715
2	Built up Areas	117.0078
3	River Basin	0.2052
4	Mixed Vegetation	876.5460
5	Crop Land.	174.0086
Total Area		**1198.2391**

Table 4: Area of land use and land cover classes for the year 2014.

SL.NO	Class Name	Area in km^2
1	Water Bodies	29.4714
2	Built up Areas	117.6978
3	River Basin	0.5152
4	Mixed Vegetation	876.5459
5	Crop Land.	174.0088
Total Area		**1198.2391**

Table 5: Area of land use and land cover classes for the year 2019

SL.NO	Class Name	Area in km^2
1	Water Bodies	106.1384
2	Built up Areas	263.1031
3	River Basin	28.0584
4	Mixed Vegetation	768.2654
5	Crop Land.	32.6738
Total Area		**1198.2391**

Table 6: Area of land use and land cover classes for the year 2024

SL.NO	Class Name	Area in km^2
1	Water Bodies	32.2471
2	Built up Areas	698.7640
3	River Basin	0.2205
4	Mixed Vegetation	446.7785
5	Crop Land.	20.2289
Total Area		**1198.2391**

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Table 7: Area of land use and land cover classes and Change Statistics from 2009–2024

Class Name	Area in sq. km in each class in Year				Change of Area from 2009 to 2024 in Km^2
	2009	2014	2019	2024	
Water Bodies	30.4715	29.4714	106.1384	32.2471	+1.7756
Built up Areas	117.0078	117.6978	263.1031	698.7640	+581.7562
River Basin	0.2052	0.5152	28.0584	0.2205	+0.0155
Mixed Vegetation	876.5460	876.5459	768.2654	446.7785	-429.7675
Crop Land.	174.0086	174.0088	32.6738	20.2289	-153.7797
Total Area in Km^2	**1198.2391**	**1198.2391**	**1198.2391**	**1198.2391**	

Table 8: Increase and decrease in land use and land cover class of Water Bodies

Year	Area in sq. km	Water Bodies	
		Increase	Decrease
2009	30.4715	-	-
2014	29.4714	-	-1.0001
2019	106.1384	+76.667	-
2024	32.2471	-	-73.8913

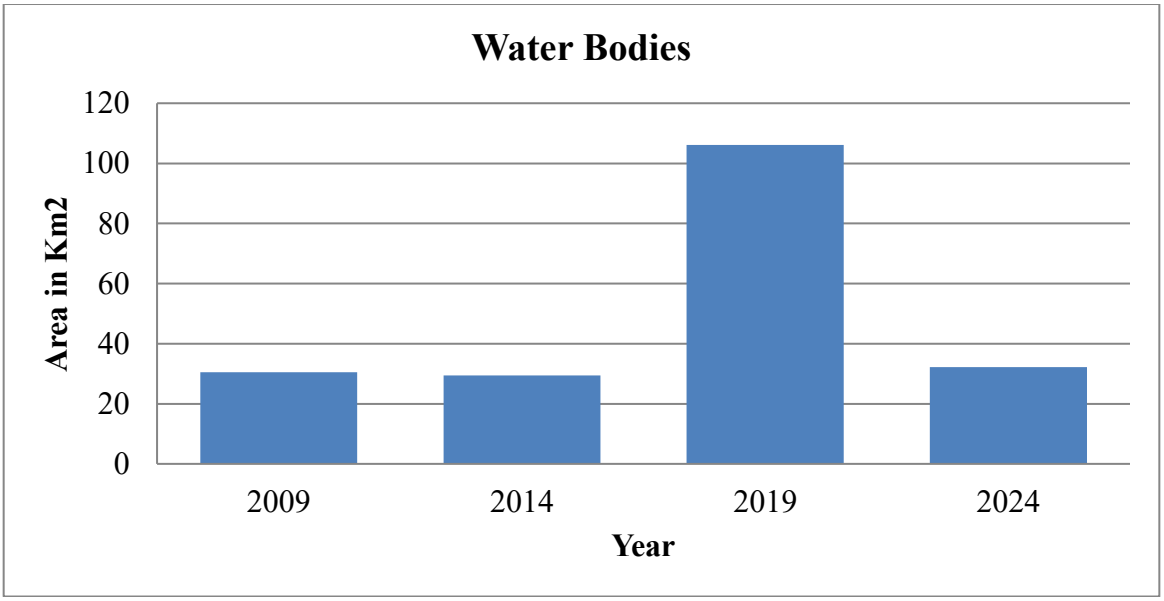

Figure 7: Areal extent (km^2) of land use and land cover of Water bodies during period of 2009 to 2024.

5.0 Changes in Water Bodies

This class consists of mainly Gurpur river and Nethravathi river and some lakes. The total area of water bodies in the year 2009 is 30.4715 Km^2, which is increased to 106.1384 Km^2 in the year 2019. This is because of recreational activity taken up near the Pilikula water park, where a check dam has been constructed for ponding for recreation purposes like boating etc, again the water bodies decreased to 32.2471 Km^2 in the year 2024. This is because of increase in population and unplanned urbanization. The details shown in Figure 7 and Table 8.

Table 9: Increase and decrease in land use and land cover class of Built up Areas.

Year	Area in sq. km	Built up Areas	
		Increase	Decrease
2009	117.0078	-	-
2014	117.6978	+0.69	-
2019	263.1031	+145.4053	-
2024	698.7640	+435.6609	-

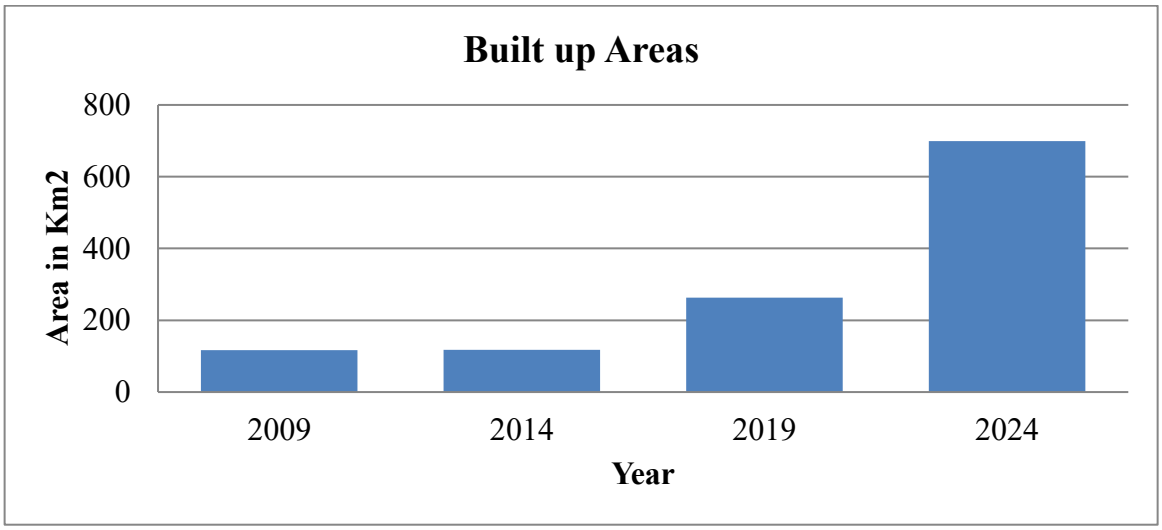

Figure 8: Areal extent (km^2) of land use and land cover of Built up Areas during period of 2009 to 2024.

5.1 Changes in Built up Area.

The total area occupied by this class in the year 2009 was only 117.0078 Km^2. This has been increased to 698.7640 Km2, in the year 2024. This change is due to rapid growth in population and number of residential buildings has been reported in the study area. This is also due to the major commercial and residential initiatives taken by the real estate companies. The major area of Mangalore was occupied by Banking sector, and also industries like Kudremukh Iron Ore Company Limited or KIOCL, Mangalore Chemicals and Fertilizers or MCF, Mangalore Refinery And Petrochemicals Limited or MRPL, BASF and ELF Gas. The change in Built up area shown in Figure 8 and Table 9.

Table 10: Increase and decrease in land use and land cover class of River Basin

Year	Area in sq. km	River Basin	
		Increase	Decrease
2009	0.2052	-	-
2014	0.5152	+0.31	-
2019	28.0584	+27.5432	-
2024	0.2205	-	-27.8379

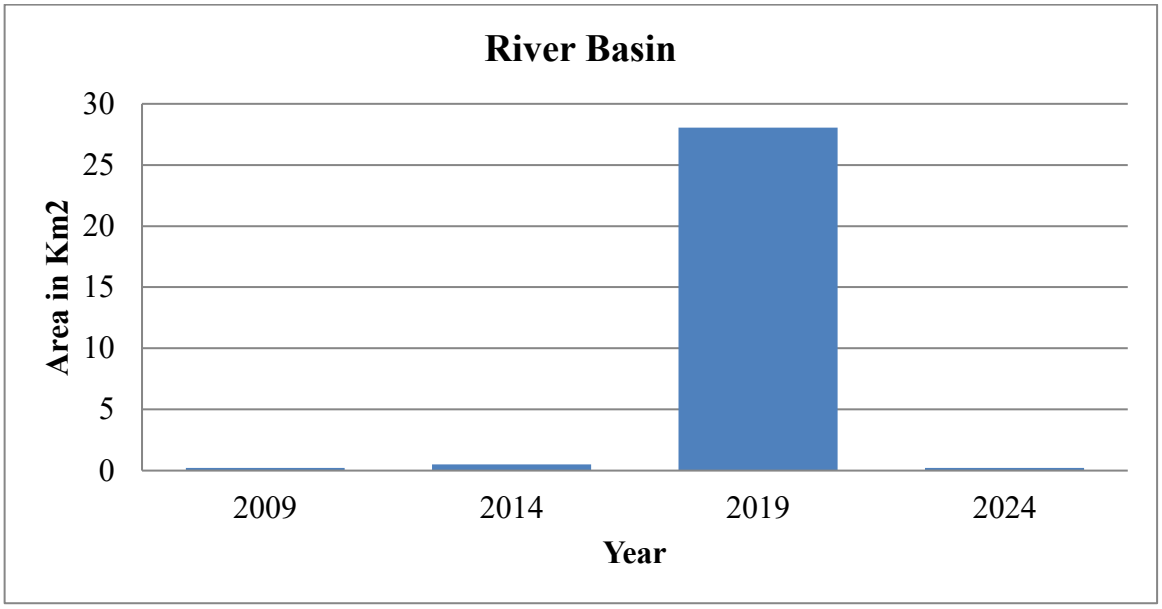

Figure 9: Areal extent (km^2) of land use and land cover of River Basin during period of 2009 to 2024.

5.2 Changes in River Basin.

The Netravathi River is a west flowing river in the southern part of the Karnataka state. The river flows for about 125 km before joining the Arabian Sea and has a catchment area of 3351 km^2. The Gurupura River which is also known as the **Phalguni River, Pachamagaru River or the Kulur River** is a river of Karnataka which originates in the Western Ghats and is a tributary of the **river Netravati.** The river basin of study area in the year 2009 was 0.2052 Km^2, was increased to 28.0584 Km^2, in the year 2019, this is due to the climate change in study area caused by urbanization. Again the river basin decreased from 28.0584 Km^2, in the year 2019 to 0.2205 Km^2, in the year 2024, this Changes is due to seasonality and amount of water flows from river systems occur due to climate change.The changes shown in Figure 9 and Table 10.

Table 11: Increase and decrease in land use and land cover class of Mixed Vegetation.

Year	Area in sq. km	Mixed Vegetation	
		Increase	Decrease
2009	876.5460	-	-
2014	876.5459	-	-0.0001
2019	768.2654	-	-108.2805
2024	446.7785	-	-321.4869

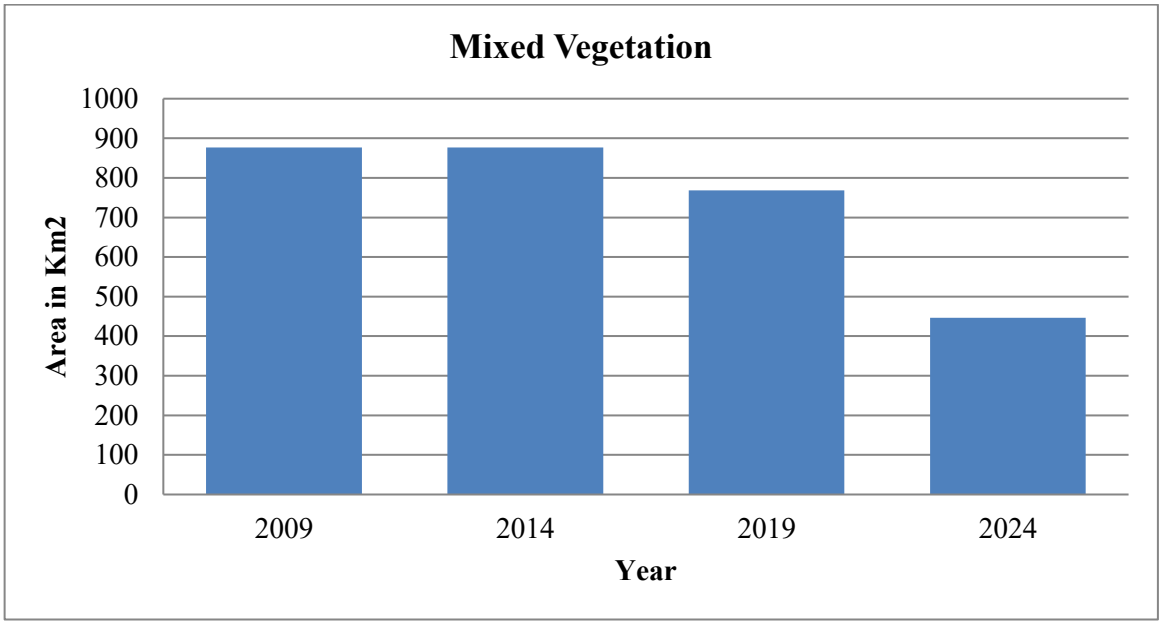

Figure 10: Areal extent (km^2) of land use and land cover of Mixed Vegetation during period of 2009 to 2024.

5.3 Changes in Mixed Vegetation.

The Mixed vegetation of Mangalore is of the evergreen, semi evergreen and moist deciduous type. The Area under this class in the year 2009 was 876.5460 Km^2, and decreased to 446.7785 Km^2 in the year 2024. This is due to the increase in population and increase in Construction activities in the study area. The year wise changes in Mixed Vegetation were shown in the Figure 10 and Table 11.

Table 12: Increase and decrease in land use and land cover class of Crop Land.

Year	Area in sq. km	Crop Land.	
		Increase	Decrease
2009	174.0086	-	-
2014	174.0088	+0.0002	-
2019	32.6738	-	-141.335
2024	20.2289	-	-12.4449

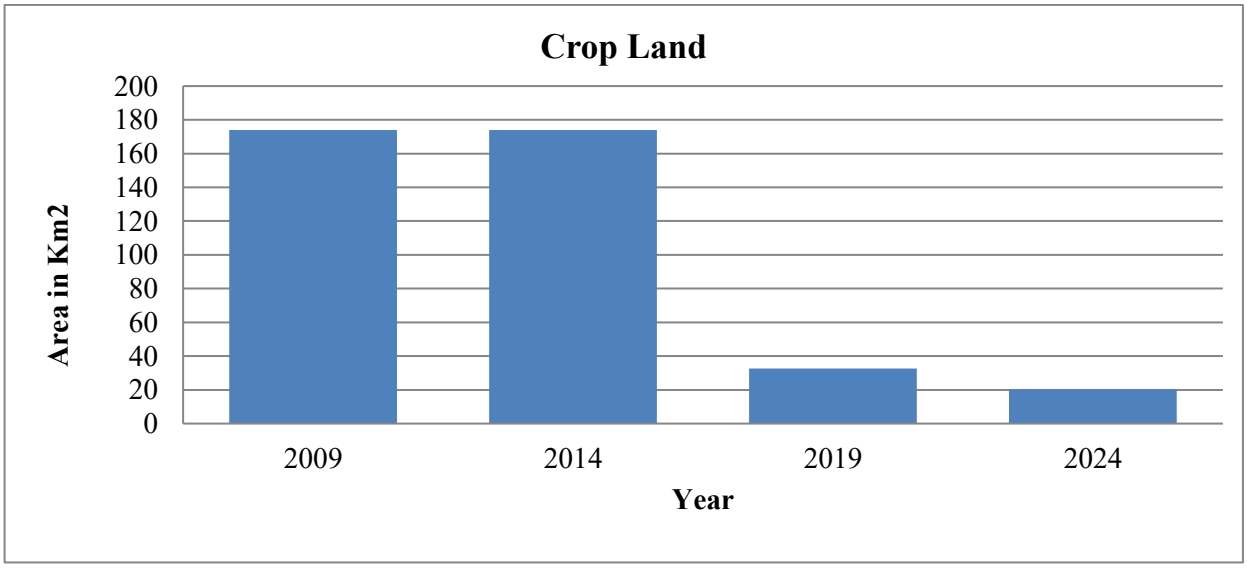

Figure 11: Areal extent (km^2) of land use and land cover of Crop land during period of 2009 to 2024.

5.4 Changes in Crop Land.

The cultivated land in the study area in the year 2009 was 174.0086 Km^2, and increased to 174.0088 Km^2, in the year 2014, Very small changes of 0.0002 Km^2 was observed in crop land respectively. The cultivated land decreased to 20.2289 Km^2, during the period from 2019 to 2024. In the year 2019, the cultivated land in the area is about 32.6738 Km^2, which is reduced to 20.2289 Km^2 in 2024. This change was mainly because of the conversion of agricultural land into residential area, commercial and Industrial area. The graphical area changes shown in Figure 11 and Table 12.

6. Conclusion

The study has revealed that Southern and Central zone of the study area has experienced drastic increase in built up area thereby decreasing the mixed vegetation and crop land. Necessary action has to be taken in order to restrict the rapid growth of built up area leading to the distraction of fertile Agriculture / Forest land. Based on the present study, the following conclusions have been drawn, there was a major change in built-up area, it was increased by 17 % and there was a decrease in mixed vegetation by 51 % and decrease in crop land by 12 % during the study period of 2009 to 2024. The results indicate that the urban/built-up area has increased largely by 17 % during the study period, due to the increase of population during the same period. It has been found that the urban development is taking place in faster rate in Mangalore city. Proper land use management strategies need to develop to solve the land related issue before it goes to extinction. In order to meet the growing demands for fundamental human needs and welfare, this land use and land cover data are crucial for the selection, planning, and implementation of land use programs.

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