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Application of Geospatial Technology in Change Detection Analysis of Land Cover/Land Use of Dhule City 2009-2019

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Abstract

The present study has shown that remote sensing techniques have tremendous potential for mapping and monitoring of land use. The geographic information system and remote sensing tools are very useful for the urban land use classification and change detection of LULC. The study of land use / land cover changes is an essential feature of urban geography. The process of urbanization is a universal phenomenon taking place all over world and has increasingly become a major issue facing many metropolitan areas. The land use/land cover pattern of a city or region is an outcome of natural and socio–economic factors and its utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural activity, urban sprawl and demographic pressure. Hence, information on land use / land cover and possibilities for its optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. The information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population. It is also useful to the different departments and government agencies like revenue, agriculture, irrigation, forest, environment, urban development & urban planners for land use planning and decision making. For betterment of human beings well planning of city is needed. In this regard there is need to study urban growth and land use /land cover.

Introduction:

Urbanization has become a dominant trend all over the world. It is responsible for extraordinary growth of cities and towns, particularly in the economically developed and developing areas. India has also shown a considerable level of urbanization mainly after independence. However, urban growth is not same everywhere and every time. Few urban centers show faster pace of growth, while other witnesses slow growth or stagnation. In fastly growing urban areas, due to over concentration of population certain problem arises such as inadequate housing, drinking water, sanitation, health, employment and education facilities.

The study of land use / land cover changes is an essential feature of urban geography. The process of urbanization is a universal phenomenon taking place all over world and has increasingly become a major issue facing many metropolitan areas. The land use/land cover pattern of a city or region is an outcome of natural and socio–economic factors and its utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural activity, urban sprawl and demographic pressure. Hence, information on land use / land cover and possibilities for its optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. The information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population. It is also useful to the different departments and government agencies like revenue, agriculture, irrigation, forest, environment, urban development & urban planners for land use planning and decision making. For betterment of human beings well planning of city is needed. In this regard there is need to study urban growth and land use /land cover.

The rapid development of multi-spatial and multi-temporal remote sensing data has now made it possible to monitor urban land-use / land-cover

changes in a very efficient manner. Remote sensing techniques have proven very useful in urban mapping (M. Batty 2008). Keeping this view in mind it was decided to study the land use/land cover in Dhule city of Maharashtra State (India) using applications like remote sensing and geographical information system.

Study Area:

In this research paper Dhule Municipal Corporation limits have been selected as the study area. Dhule city is the middle urban centre of Khandesh region of Maharashtra state. It is the headquarters of Dhule district. It is situated on the bank of river Panzara, a tributary of Tapi.Dhule city is located at the latitudes of 20050'55" North to 20056'28" North and longitudes of 74044'22" East to 74048'59" East (Figure 2.1). It sits in a strategic position on the northwest corner of Deccan plateau. The city is located at about 241 meters above the mean sea level. To the north of the Dhule city Nagaon hills (Nagaon Bari) are located. East side is bounded by Mumbai-Agra bypass highway. Towards the south of Dhule city Mohadi sub-urban, Avadhan MIDC area and Laling Fort are located. South-west side is bounded by Surat bypass highway and towards west Jawahar Sutgirani, Morane, Nakane, Walwadi area and Gondur airport are located.

The river Panzara flows through the city, dividing it into two parts i.e.southern and northern parts namely Dhule and Deopur respectively. Dhule Municipal Corporation covers an area about 46.46 sq km. It comprises areas of Dhule, Deopur, Mohadi sub-urban, Walwadi village (partly) and Mahindale village (part).

More recently, in 2018 surrounding 12 villages are merged into Dhule Municipal Corporation. Therefore, area of the city is extended up to 137sq km. Of course, newly merged area is not taken into consideration for the present study.

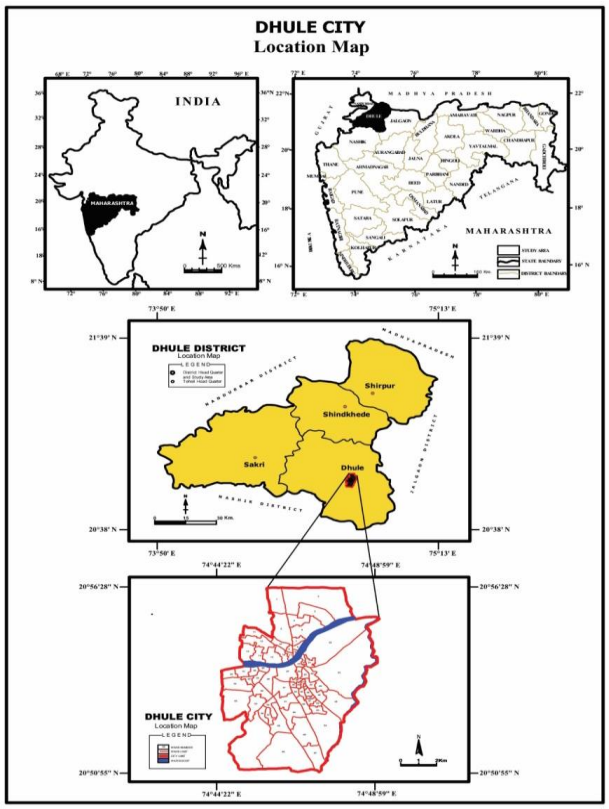

Figure 1: Location of Dhule City

Origin of the research problem:

The rapid development of multi-spatial and multi-temporal remote sensing data has now made it possible to monitor urban land use / land cover changes in a very efficient manner. Remote sensing techniques have proven very useful in urban mapping (M. Batty, 2008). Keeping this view in mind it was decided to study the land use/land cover using applications like remote sensing and geographical information system.

Objectives:

The main objective of the present research work is to use the modern technologies like Remote Sensing, Geographic Information System and Global Positioning System. As well as analyze the land use / land cover changes in study area over period of time of the Dhule city for the sustainable urban planning.

- To study classify the urban land use of Dhule city for the year 2009 and 2019.
- To study the changing land use pattern using satellite data for the year 2009 and 2019.

Parameters for Land Use/ Land Cover

In this study the selection of parameters for land use/ land cover classification system in order to

arrange it under suitable framework to facilitated systematic land use inventory, mapping and change detection study. The important features used for analysis are built up, barren land, Vegetation and Water Bodies.

Source of Data Base and Research Methodology:

To study the land use/land cover changes in Dhule city from 2000 to 2019 the satellite imageries have been obtained from United States Geological Survey's (USGS) Earth Resources Observation & Science (EROS) The base map of the city and Dhule guide map obtained from Survey of India (SOI). The subsets for LANDSAT TM image were taken for further interpretation and classification process. Supervised classification for the LANDSAT 8 (OLI) has been performed with parametric rule as maximum likelihood in Erdas 14 software. The classified images showing area under different land use categories in 2000 and 2019 are given in figure 2 and 3. The resulted data have been used for land use / land cove change detection analysis.

For the present study initially the SOI toposheets were scanned and geo-referenced to use as base layer for image registration. The digital remote sensing data LANDSAT TM (May 2009) and LANDSAT 8 (OLI) (May 2019) having spatial resolution 30m, were processed and geo-referenced using Ground Control Points (GCP) from Survey of India map. The satellite images and toposheets were projected into WGS 1984 Complex UTM Zone 43N projection system. The Dhule city boundary AOI layer was overlaid upon so that study area could be extracted from the whole image. The collected data has been processed and analyzed by using different quantitative, statistical technique. MS-Excel and QGIS software has been used.

Ground Truth Verification

For this study, ground truth verification is done for land use/land cover analysis for unclassified areas. Spatial locations of all land use/land cover taken using Garmin GPS instrument. Due to ground truth verification the accuracy of interpretation has been enhanced. The doubtful areas were physically verified in the field work and observation for modification of thematic details.

Result and Discussion

Landuse / Land Cover Change Detection Analysis based on Remote Sensing Data

The rapid development of multi-spatial and multi-temporal remote sensing data has now made it possible to monitor urban landuse / land cover changes in a very efficient manner. Remote sensing techniques have proven very useful in urban mapping (M. Batty, 2008). Keeping this view in mind, it was decided to study the landuse/land cover of study region using applications like remote sensing and geographical information system.

Data Base and Research Methodology

The digital remote sensing data LANDSAT 5 TM (March 2000), LANDSAT 5 TM (April 2009), LANDSAT 8 TM (April 2019) have spatial resolution 30m were processed and geo-referenced using Ground Control Points (GCP) from Survey of India map. The technical information about satellite images taken in March 2000, April 2009 and April 2019 is given in Appendix II, III and IV respectively. The satellite images and toposheets were projected into WGS 1984 Complex UTM Zone 43N projection system. The data used for this study is mentioned in Table 3. The Dhule boundary layer was overlaid upon the merged layer, so that study area could be extracted from the whole image through the subset method in Erdas 14.

Table 1: Remote Sensing Data Source.

Sr. No.	Used Data	Spatial Reference	Data Source
01	LANDSAT 5 TM WRS_PATH = 147 WRS_ROW = 045	30 m	Earth Explorer, USGS (http://earthexplorer.usga.gov)
02	LANDSAT 5 TM	30 m	
03	LANDSAT 8 TM	30 m	
04	Toposheet: 46L/13	1:50000	

To study the landuse / land cover changes in Dhule city from 2000 to 2009 and from 2009 to 2019 the satellite imageries have been obtained from United

States Geological Survey's (USGS) Earth Explorer (FCC Fig. 2, 3, and 4). The base map of the city and Dhule guide map is obtained from Survey of India (SOI). The subset for LANDSAT TM image was taken for further interpretation and classification process. Supervised classification for LANDSAT TM has been performed with parametric rule as maximum likelihood in Erdas 14 software. The classified images showing area under different landuse categories in 2000, 2009 and 2019 are given in figure 10, 11 and 12 respectively. The resulted data have been used for landuse / land cove change detection analysis.

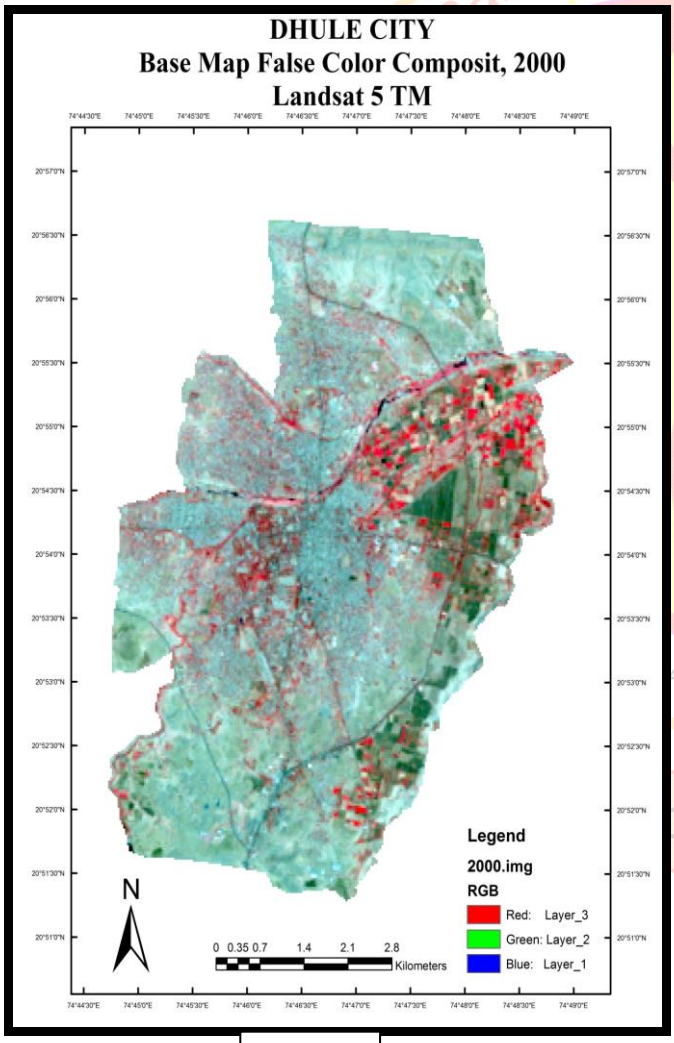

FIG 2

Source: Earth Explorer, USGS (http://earthexplorer.usga.gov)

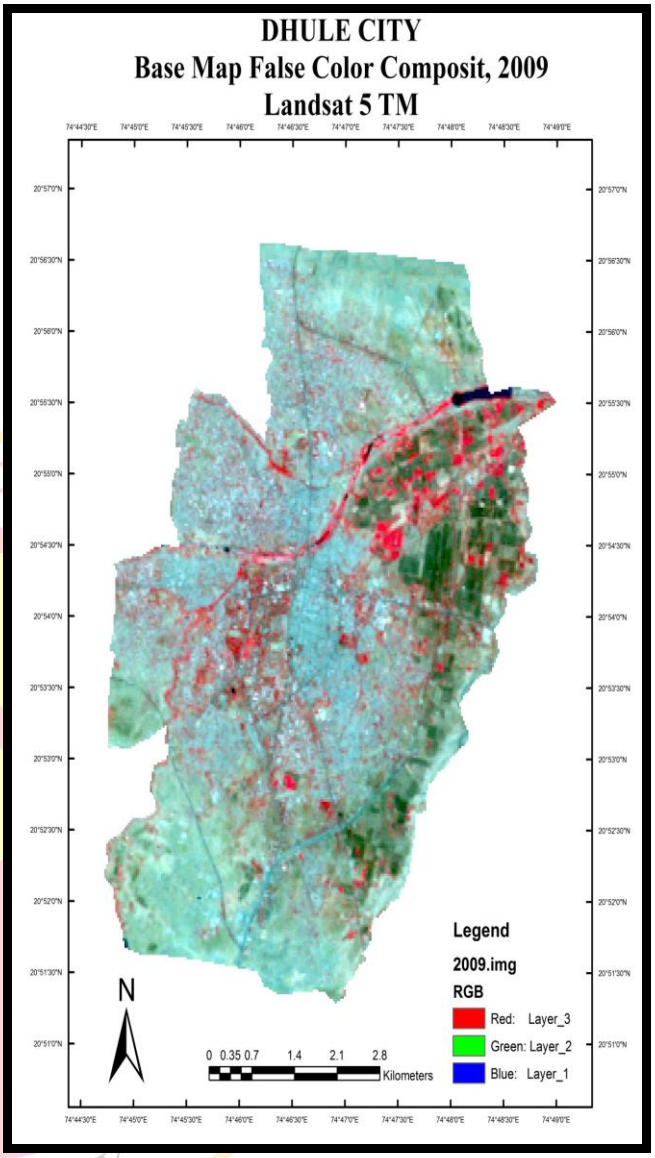

Fig.3

Source: Earth Explorer, USGS (http://earthexplorer.usga.gov)

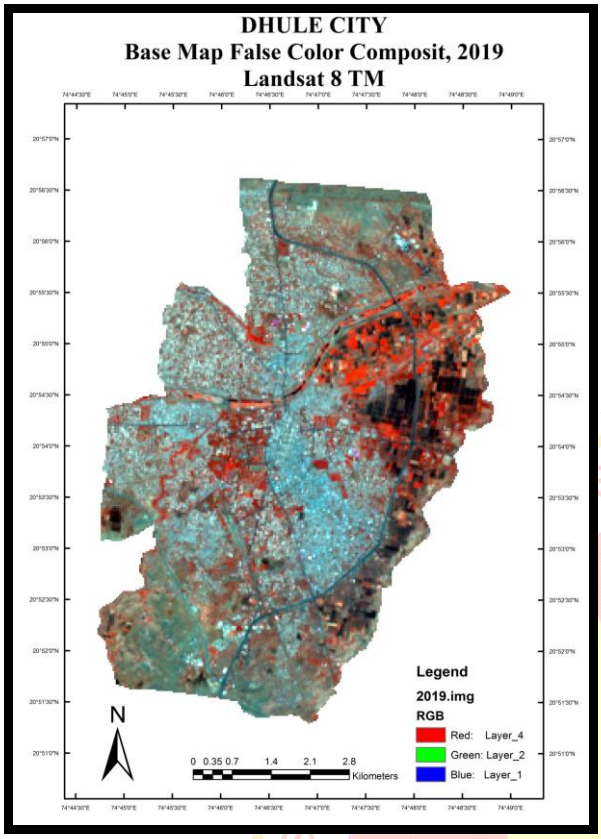

Fig.4

Source: Earth Explorer, USGS (http://earthexplorer.usga.gov)

Results and Discussion

The present study reveals the changes in the land use/land cover pattern of Dhule city between the years 2000 to 2019. Table 4 shows change detection in the year 2000 to 2019. During this twenty years of period, the maximum changes observed in built-up land.

Table 4: Area under different Landuse / Land cover from 2000 to 2019.

Landuse	2000	%	2009	%	2019	%
Agriculture	667.35	14.21	362.52	7.72	858.87	18.29
Vegetation	1733.13	36.90	1603.89	34.15	1314.54	27.99
Fallow Land	401.58	8.55	621.09	13.23	39 37	8.42
Barren Land	1257.57	26.78	1423.35	30.31	1078.83	22.97
Built-up	636.57	13.555	6835	14.59	1048.59	22.33
	4696.2	100	4696.2	100	4696.2	100

Landuse change from 2000 to 2009 (Landsat 5 TM Image)

Landuse / land cover layers represent the digital image of city is classified into five classes as Agriculture, Vegetation, Fallow Land, Berren Land, and Built up. To get the clear scenario of landuse and land cover, the area was measured and presented in tabular form (Table 5). The same is represented by bar graph in figure

Table 5: Landuse / Land cover Change Detection (2000 to 2009)

Sr.No.	Class	2000 (%)	2009 (%)	Change (%)
1	Agriculture	14.21	7.72	-6.49
2	Vegetation	36.90	34.15	-2.75
3	Fallow Land	8.55	13.23	4.67
4	Barren Land	26.78	30.31	3.53
5	Built-up	13.555	14.59	1.04

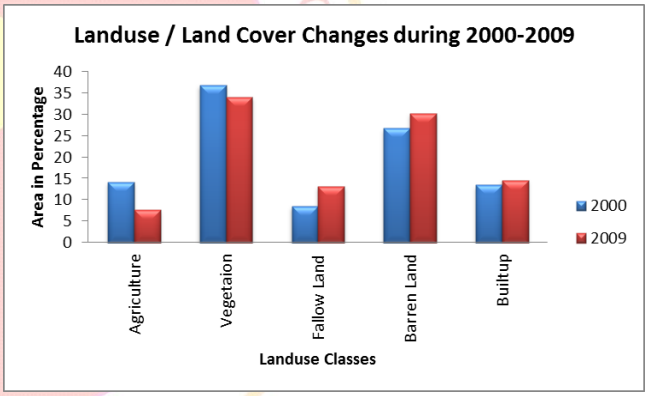

Figure: 5

From 2000 to 2009, the highest change is observed in fallow land, which is a 4.67 percent. However, the overall change under barren land and built-up landuse. Percentage share of other categories like agriculture and vegetation decreased considerably during the investigation period. In 2000, landuse / land cover map of Dhule city, fallow land was 8.55 percent of the total geographical area of the city. By the year 2009, area under this category increased up to 13.23 percent of the total geographical area. Due to migration of industries towards the out of city limits. The area under barren land was 26.78 percent in the year 2000 and it was 30.31 percent in 2009. It changed by 3.53 percent of total geographical area of the city. Built up area in 2000 was 13.55 percent and increased up to 14.59 percent in the year 2009. As per 2000 data, area covered by agriculture was 14.21 percent. It's declined up to 7.72 percent in 2009.

Vegetation land area also declined from 2000 to 2009. Which was 36.90 percent in 2000 and decreased up to 34.15 percent in 2009. Its change was -2.75 percent.

Landuse Change From 2009-2019 (Landsat 5 TM & 8 TM Images)

During the period 2009 to 2019, most of the changes in landuse is detected in the built up land and agricultural landuse categories. During this period built up area increased by 8.77 percent. On the other hand, percentage shares of vegetation, barren land and fallow land declined by 8.91, 3.81 and 0.13 percent respectively.

Table 6: Landuse / Land cover Change Detection (2009 to 2019)

Sr. No.	Class	2009 (%)	2019 (%)	Change (%)
1	Agriculture	14.21	18.29	4.08
2	Vegetation	36.90	27.99	-8.91
3	Fallow Land	8.55	8.42	-0.13
4	Barren Land	26.78	22.97	-3.81
5	Built-up	13.56	22.33	8.77

In the year 2009 landuse / land cover map of Dhule city, built up landuse was 13.56 percent of the total geographical area of the city. By the year 2019, area under this category increased up to 22.33 percent of the total geographical area. It happened mainly due to educational facilities, medical facilities, and service sector and employment opportunities in the city.

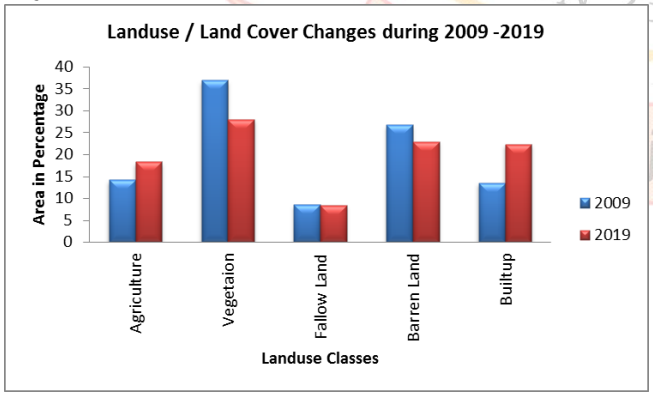

Figure 6

Agricultural landuse in 2009 was 14.21 percent and increased up to 18.29 percent in the year 2019. The area under fallow land was 8.55 percent in the year 2009 landuse map whereas it was 8.42 percent in 2019. Barren land also declined from 2009. It was 26.78 percent in 2009 and decreased up to 22.97 percent in 2019. From the study of satellite imagery it is seen that barren land declined by 3.81 percent because of development of government projects and real estate projects on barren land area within the city limits. In 2009, area occupied by vegetation landuse was 36.90 percent and was declined by the year 2019 with 27.99 percent of total geographical area. It was highly declined by 8.91 percent of total geographical area of the city.

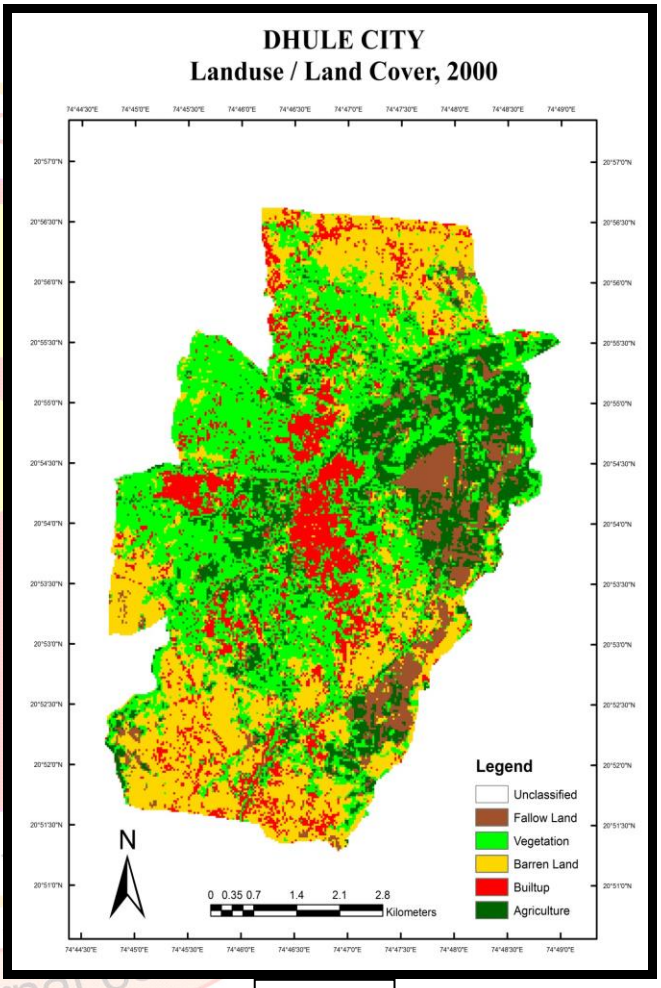

FIG 7

Source: Earth Explorer, USGS (http://earthexplorer.usga.gov)

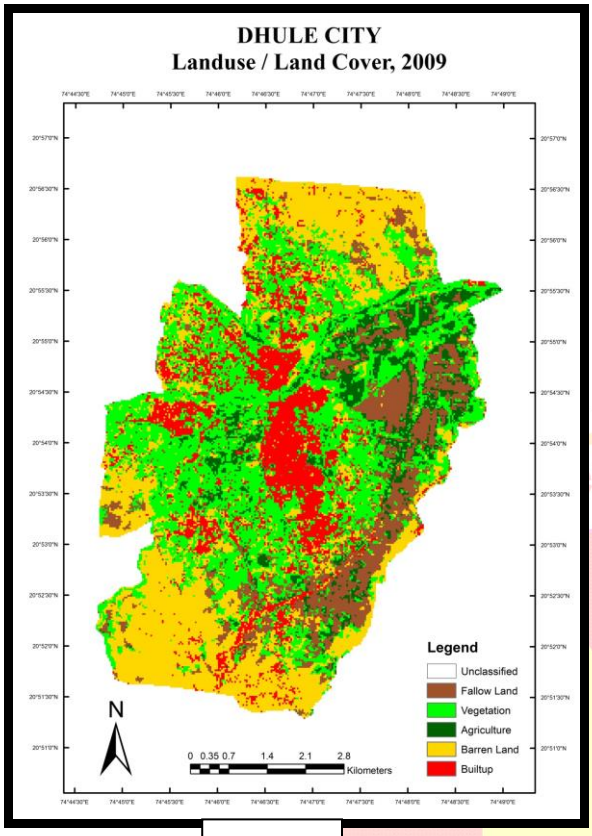

FIG 8

Source: Earth Explorer, USGS (http://earthexplorer.usga.gov)

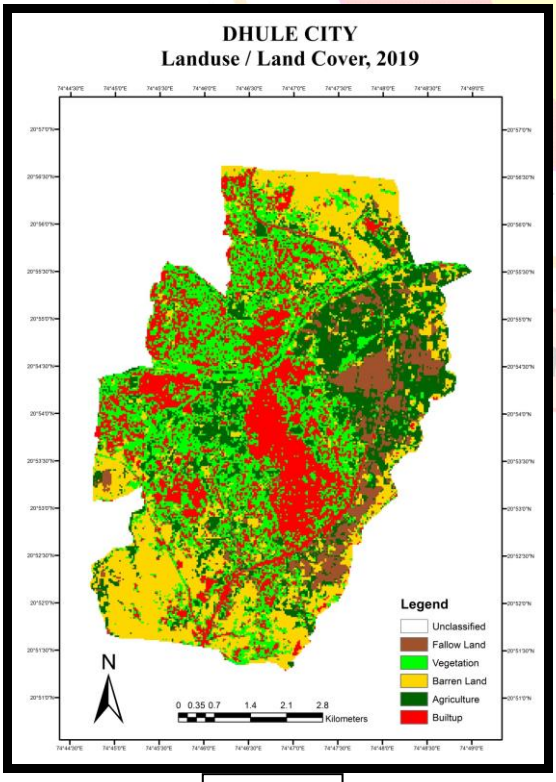

FIG 9

Source: Earth Explorer, USGS (http://earthexplorer.usga.gov)

Conclusion:

The present study has shown that remote sensing techniques have tremendous potential for mapping and monitoring of land use. The geographic information system and remote sensing tools are very useful for the urban land use classification and change detection of LULC. The rapid urban growth has been transformed barren land in industrial establishment and other settlements. The land use/land cover assessment using satellite imagery provides reliable and accurate information, which cost and time effective. It also offers a holistic view of large areas for better monitoring of land use/land cover. Hence, the satellite remote sensing is useful for assessing the land use/land cover. From the above discussion, it is concluded that analysis of land use/land cover of the area can be effectively determined and can be used for future planning.

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