

Analysis of Land transformation of Panipat Municipal Corporation and city Outgrowth

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ABSTRACT

Urbanization is an integral part of economic growth; urbanization leads to changes in the environment, in particular the conversion of concrete and impermeable surfaces, and the displacement of agriculture and forests recognizing these connections between human activities and their environmental consequences. This is especially relevant in area of the world which are experiencing rapid change, where cumulative development impacts can be recognized too late to cause mitigation measures. The present analysis of land transformation in the city of Panipat aims to demonstrate the usefulness of existing maps with satellite data relevant geographic information to dynamically map characteristics of urban land transformation. This study gives a clear representation of development and transformation pattern, and shows how the growth of modern urbanization results in landscape changes. The analysis revealed that during the study period of 27 years (1991 to 2017) a large scale land use/land cover change and transformation occurred in Panipat city. Such changes were confirmed by carrying out the city's estimate of the time of study 1991 to 2017 on the fertile agricultural fields in its fringe area.

Keywords : Land Transformation, Geographical Information System, Urban Growth pattern.

1 Introduction : Land transformation is a process in the geographic information system, used to calculate the differences between two or more attributes over the various periods of time in a given area. Land transformation has been widely used to quantify population growth, deforestation, agricultural pattern, crop change, land use/land cover change and natural disaster such as earthquake, floods, tsunamis etc. Land transformation often includes comparing satellite imagery and aerial photographs taken at various times of the area. Land transformation is also useful for understanding ice sheets and forest growth, one can use land transformation to calculate four different types of changes.

- Change in feature identification and their characteristics over time.
- Land transformation could be used to monitor a feature's movement.

- Changing of shape and form of a feature over time. Land transformation may be used to explain shrinkage over time or the shift in the shape of a river or lake.
- The extent of a feature can also be calculated by land transformation. Grows or shrinks urban area within two time periods.
- Shifts in the size of a feature over time.

So, the present study describes that the change between different attributes of given area using land transformation technique. Land transformation of Panipat Municipal Corporation has been found sixteen types of changed land categories such as:

1. Built-up to Vegetation cover
2. Built-up to Water Bodies
3. Built-up to Built-up
4. Built-up to Other area

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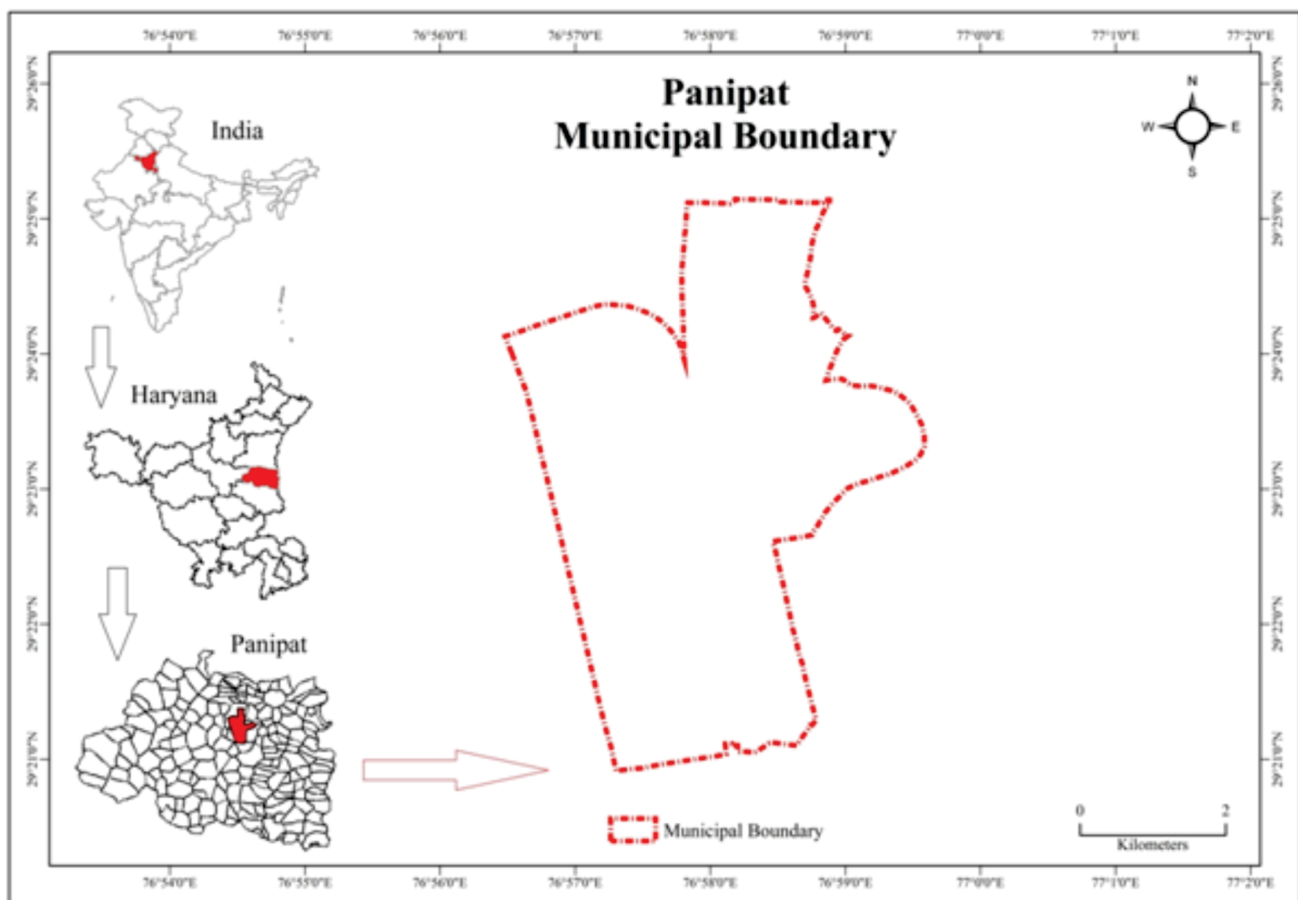
5. Vegetation cover to Vegetation cover
6. Vegetation cover to Water bodies
7. Vegetation cover to Built-up
8. Vegetation cover to Other area
9. Other area to Vegetation cover
10. Other area to Water bodies
11. Other area to Built-up area
12. Other area to other area
13. Water bodies to Vegetation cover
14. Water bodies to Water body
15. Water bodies to Built-up
16. Water bodies to other body

The Landsat-I launch in 1972 marked the beginning of satellite remote sensing for applications of natural resources. Because of their ability to acquire synoptic and repetitive data, satellite based sensors hold

the potential to identify, classify and map modification which is important for urban planners.

2 Objective : Main objective of the study is to evaluate land transformation pattern of Panipat city between 1991-2001, 2001-2011 and 2011-2017.

3 Study area : The word Panipat comes from prasthas or patas, in Mahabharata. It lies at 29° 36'N, 76° 97'E. Over the past few years, Panipat has attracted people from outer parts of India due to its over dimensional industrialization. It is historic city and a large industrial and residential area. The main city located at national highway no. 1. It is connected by road network with its surrounding area i.e. Delhi, Sonipat, Jind, Karnal etc. When Panipat become the headquarter of the district it was the center of industrial and educational activities. Because of great industrial status of Panipat, it is known as the city of weavers and the city of textile.



Map 1 Study area

Source: Municipal Corporation of Panipat, 2017

4 Data base and Methodology : The study is based on satellite imagery of the year 1991, 2001, 2011 and 2017 downloaded from earth explorer's website. Demographic information was derived from census of

India in the form of secondary data for the year 1991, 2001 and 2011. Municipal boundary map related to study area was obtained from official website of Panipat Municipal Corporation.

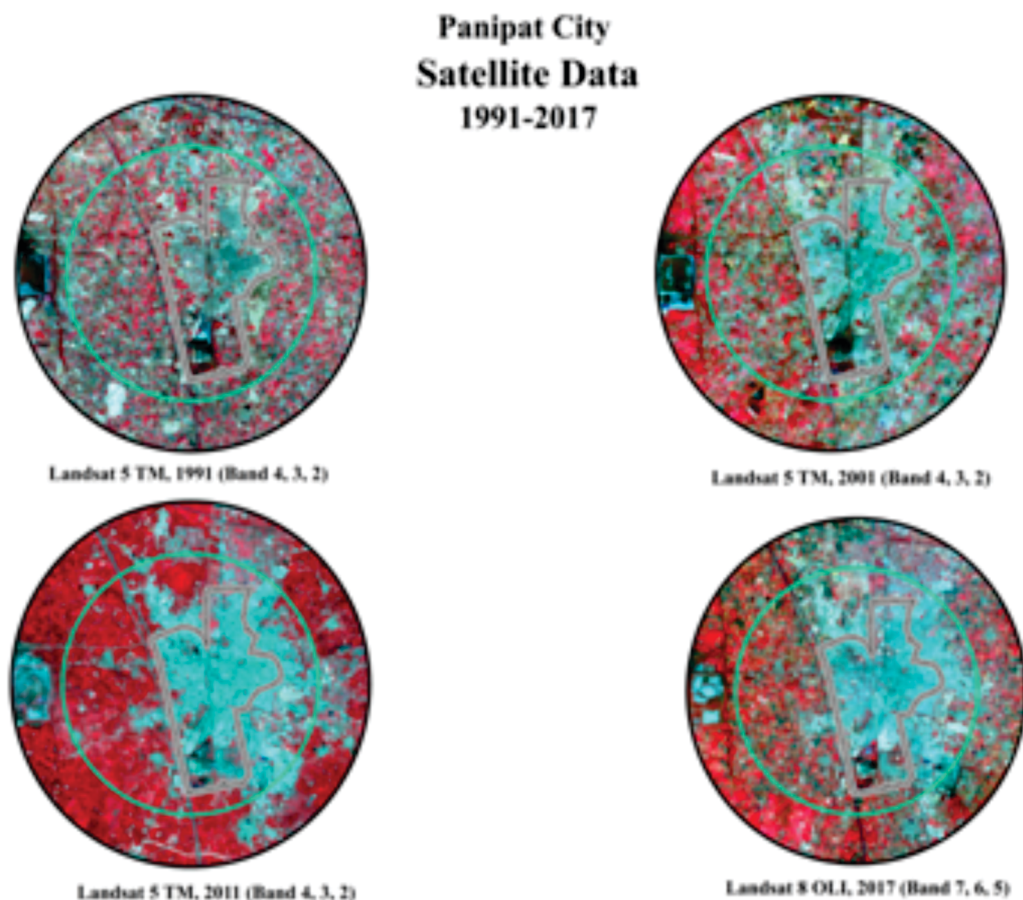


Figure 1 Landsat data of the study area with demarcation

In present research work “Analysis of Land transformation of Panipat Municipal Corporation and city Outgrowth.”

Different features of urban landscape were studied using both experiential and interdisciplinary approaches. Specific statistical analysis was made to identify accurately the different aspects of Land use/Land cover. Statistical techniques have been used to attain main objective of the study.

Good efforts to avoid mistake different kind of charts, tables, graphs and statistical diagrams were prepare to make the study more cartographically accurate. Landsat TM (Thematic Mapper) and ETM

(Enhanced Thematic Mapper) satellite will be used to create the land use and land cover map. Image analysis and ground truthing were initially used for the land use/land cover pattern classification. In the present work the image processing technique such as image extraction, clip and analysis, area identification, classification (maximum likelihood classification) of features were used.

To calculate the land transformation firstly use image classification process then reclassify the identified area of Panipat city to create proper shape conversion of each year.

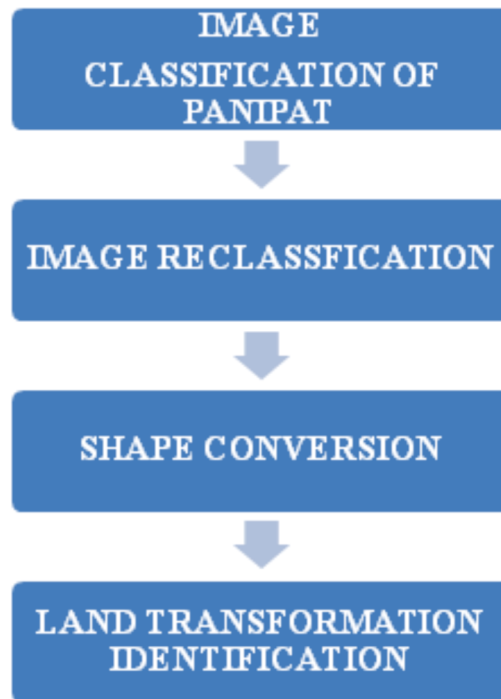


Figure 2 Process for land transformation of Panipat city

5 Result and Discussion : The history of land transformation in Panipat is long enough to study. It has been studied in four categorical transformations from 1991 to 2017. There has a significant cause of land transformations in Panipat throughout the time. The land transformation in Panipat is discussed in upcoming paragraphs.

5.1 Land transformation in Panipat Municipal Corporation (MC) 1991-2001

The beginning of change in land categories in Panipat (MC) was found during the establishment of industrial as well as residential set up in 1991 to 2001, so the changing pattern in land categories in Panipat (MC) during 1991 to 2001 bring into being in following statistics –

Table 1 Category wise land transformation in Panipat (1991-2001)

Land Classes in 2001 Area (sq. km)	Land Classes in 1991 Area (sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	5.43	0.81	0.28	0.22	6.74
Vegetation	3.41	5.37	2.69	0.33	10.8
Other area	3.19	0.31	0.18	0.00	3.68
Water bodies	0.03	0.06	0.01	0.46	0.56
Total	12.06	6.55	3.16	0.01	21.78

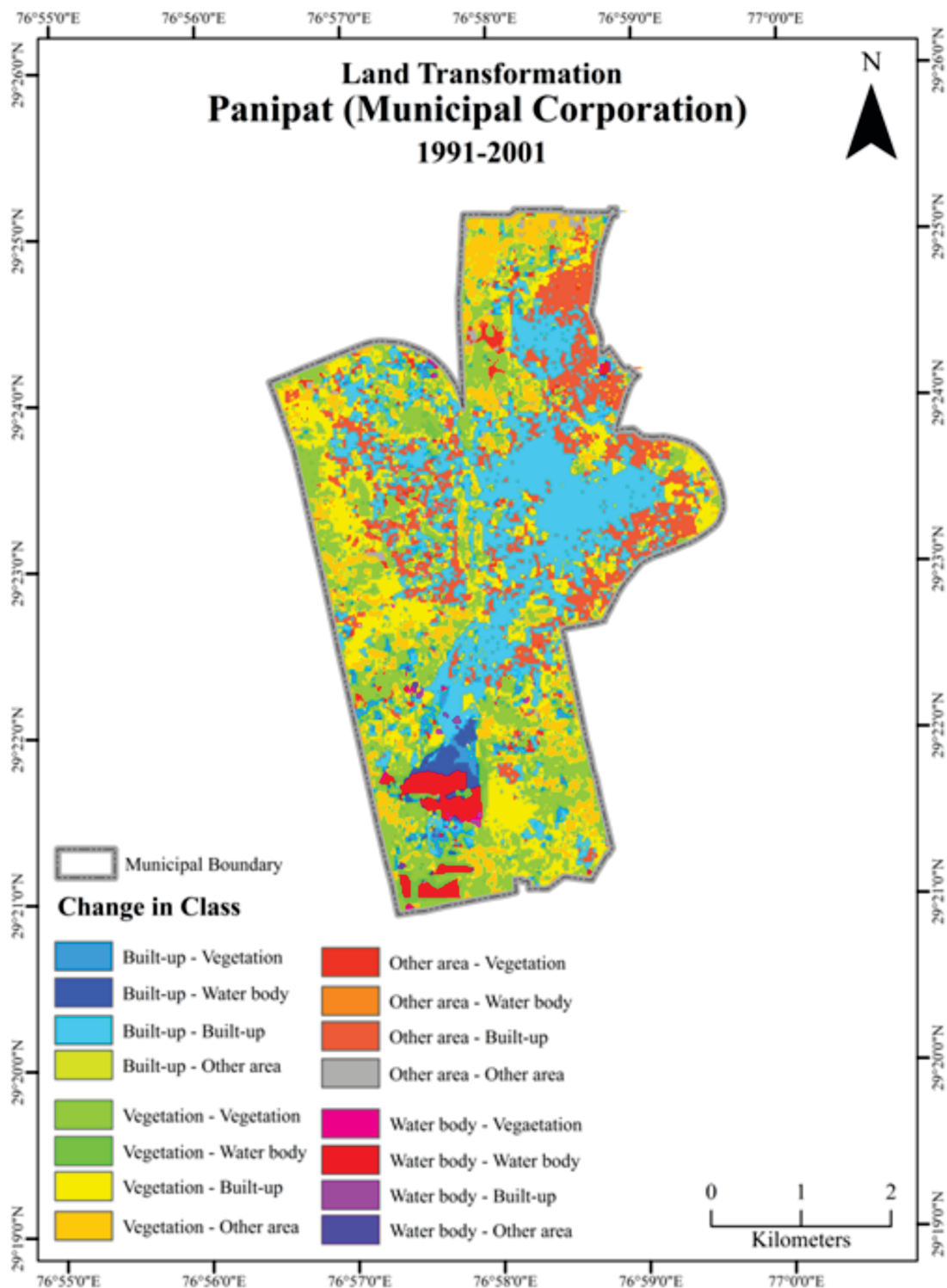
Source: classified and computed by author

The land transformation method revealed that there was almost 6.74 sq.km area lies under built-up class in 1991 to 2001. The built-up area can be distinguished in the imagery of Panipat MC was the second highest proportionate. During 1991 to 2001 the conversion of

vegetation Cover into built-up area or other area was 3.41 sq.km and 2.69 sq.km.

The transformation of other area into built-up area was 3.19 sq.km which is highest proportionate.. The area under water bodies was change in vegetation cover was

0.06 sq.km and built-up area was 0.03 sq.km during 1991 to 2001 (See Table 1).



Map 2 Land transformation in Panipat (1991-2001)

5.2 Land transformation within Panipat Municipal Corporation (MC) 2001-2011

The changing pattern in land categories in Panipat (MC) during 2001 to 2011 bring into the following statistics –

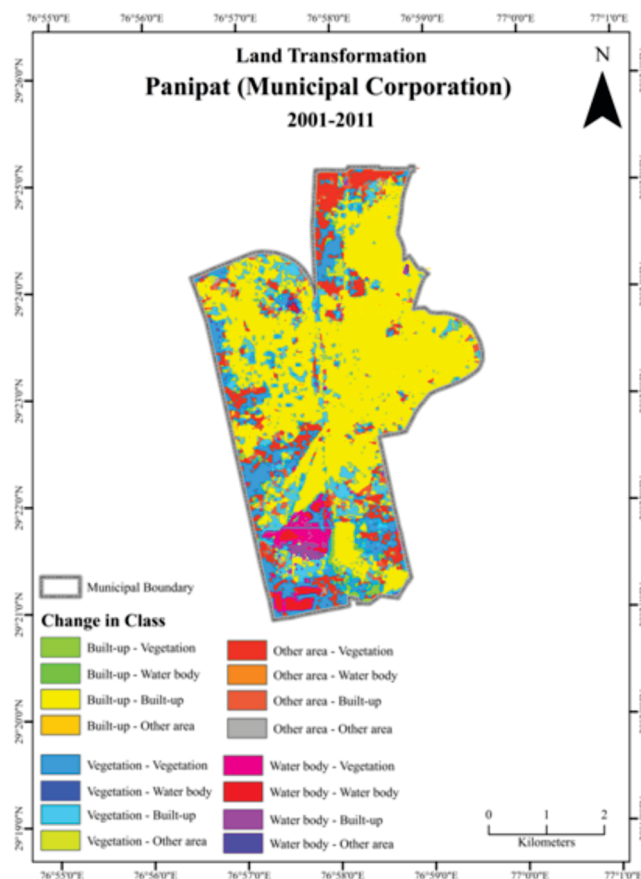
Table 2: Category wise land transformation in Panipat (2001-2011)

Land Classes in 2011 Area(sq. km)	Land Classes in 2001 Area(sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	11.27	0.49	0.30	0.00	12.06
Vegetation	2.22	3.06	1.25	0.02	6.55
Other area	0.88	2.18	0.10	0.00	3.16
Water bodies	0.22	0.55	0.01	0.23	0.01
Total	14.59	6.28	0.66	0.25	21.78

Source: classified and computed by author

The figure shows that the area under built-up class was found in highest i.e. 12.06 sq.km proportionate out of total area (21.78sq.km) of Panipat Municipal Corporation in 2001 to 2011. The conversion of built-up area into other area and vegetation cover was 0.30 sq.km and 0.49 sq.km.

The area under vegetation cover has been converted into vegetation cover (3.06sq.km), built-up area (2.22sq.km) and other area was (1.25sq.km). The maximum portion of other area converted into vegetated area was 2.18 sq.km in 2001-2011. According to figure other area regularly changed into built-up area (0.88sq.km) see table 2.



Map 3: Land transformation in Panipat (2001-2011)

5.3 Land transformation within Municipal Corporation (MC) 2011-2017

The changing pattern in land categories in Panipat (MC) during 2011 to 2017 bring into the following statistics –

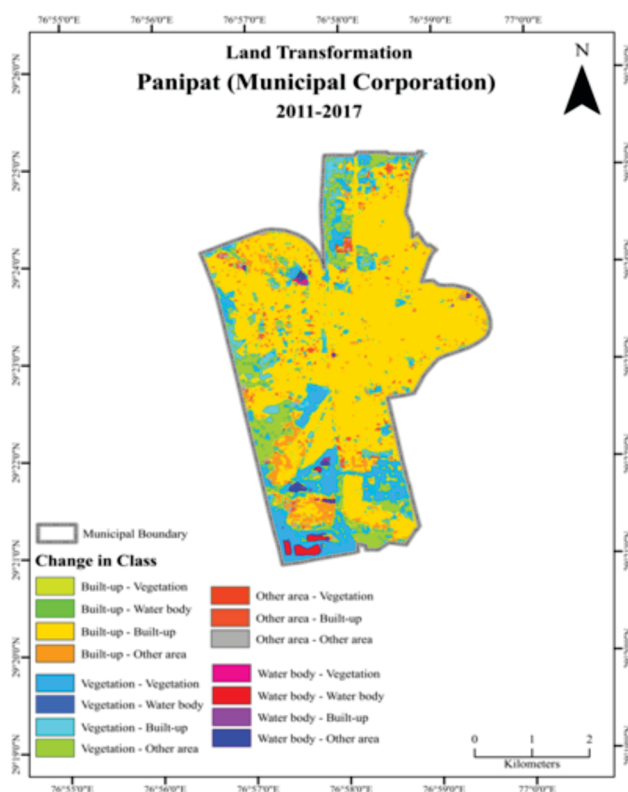
Table 3: Category wise land transformation in Panipat (2011-2017)

Land Classes in 2017 Area (sq. km)	Land Classes in 2011 Area (sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	12.95	0.46	1.18	0.00	14.59
Vegetation	1.03	3.20	2.02	0.03	6.28
Other area	0.47	0.04	0.15	0.00	0.66
Water bodies	0.01	0.03	0.09	0.12	0.25
Total	14.46	3.73	3.44	0.15	21.78

Source: classified and computed by author

The land transformation method revealed that there is almost 14.59 sq.km area was lies under built-up class in 2011 to 2017. The conversion of built-up area into other area was 1.18 sq.km and built up area converted into vegetation cover (0.46sq.km) and water bodies (0.00sq.km) was very least proportionate.

During 2011 to 2017 the conversion of vegetation cover into built-up area and other area was 1.03 sq.km and 2.02 sq.km. This map shows that the total area under other area was 0.66 sq.km in 2011 to 2017. The transformation of other area into built-up area was 0.47 sq.km, which is highest proportionate (See Table 3).



Map 4: Land transformation in Panipat (2011-2017)

5.4 Land transformation in Panipat city Outgrowth (1991-2001)

The changing pattern of land categories in 7 km zone of outgrowth of Panipat (MC) during 1991 to 2001 bring into being in following statistics –

Table 4: Category wise land transformation up to 5 km & 7 km buffer zone of Panipat (1991-2001)

Land Transformation up to 5 km					
Land Classes in 2001 Area(sq. km)	Land Classes in 1991 Area(sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	13.47	5.76	0.87	0.81	20.91
Vegetation	13.48	30.82	4.72	2.15	51.17
Other area	1.79	0.54	1.58	0.03	3.94
Water bodies	0.57	0.48	0.05	1.24	2.34
Total	29.31	37.6	7.22	4.23	78.36
Land Transformation up to 7 km					
Land Classes in 2001 Area(sq. km)	Land Classes in 1991 Area (sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	15.96	12.92	3.04	1.34	33.26
Vegetation	20.43	68.05	8.58	3.73	100.79
Other area	4.10	6.34	3.35	0.77	14.56
Water bodies	0.72	1.24	0.11	3.07	5.14
Total	41.21	88.55	15.08	8.91	153.75

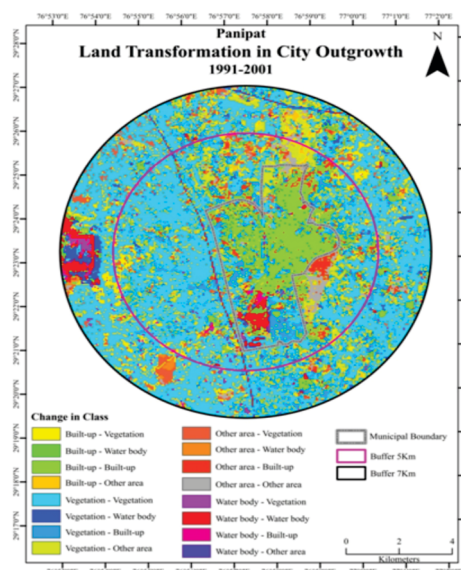
Source: classified and computed by author

The land transformation method revealed that there is almost 20.91 sq.km, 33.26 sq.km areas was lie under built-up class in 1991 to 2001 of Panipat city outgrowth (5 km & 7 km buffer zone). The conversion of built-up area into other area was 0.87 sq.km & 3.04 sq.km in 5 & 7 km zone, built up area converted into vegetation cover in 5 & 7 km zone was 5.76 sq.km and 12.92 sq.km.

The total area under vegetation cover in 5 & 7 km was 51.17 sq.km & 100.79 sq.km respectively. The conversion of vegetation cover into built-up area and other area was 13.48 sq.km, 20.43 sq.km and 4.72 sq. km, 8.58 sq.km respectively (See Table 4).

5.5 Land transformation in Panipat city Outgrowth (2001-2011)

The changing pattern in land categories in 5 km & 7 km zone of outgrowth of Panipat (MC) during 2001 to 2011 bring into being in following statistics –



Map 5: Land transformation in 5 km & 7 km buffer zone of Panipat (1991-2001)

Table 5: Category wise land transformation in 5 km & 7 km buffer zone of Panipat (2001-2011)

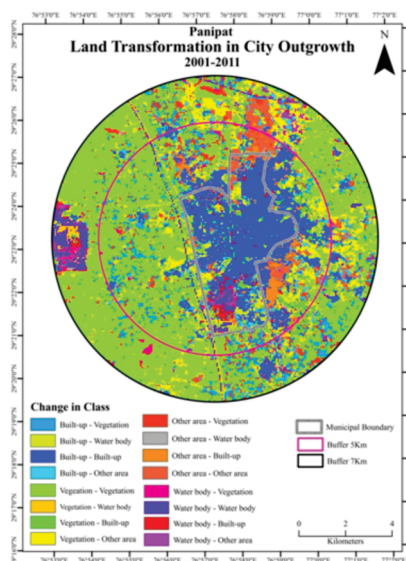
Land Transformation up to 5 km					
Land Classes in 2011 Area (sq. km)	Land Classes in 2001 Area(sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	24.30	3.27	1.35	0.40	29.32
Vegetation	11.48	23.43	1.71	0.99	37.61
Other area	5.28	1.05	0.66	0.21	7.20
Water bodies	2.15	0.83	0.17	1.08	4.23
Total	43.21	28.58	3.89	2.68	78.36
Land Transformation up to 7km					
Land Classes in 2011 Area(sq. km)	Land Classes in 2001 Area (sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	24.25	10.20	5.51	1.25	41.21
Vegetation	5.76	66.10	14.49	2.20	88.55
Other area	3.30	4.98	6.37	0.43	15.08
Water bodies	1.51	2.48	1.36	3.56	8.91
Total	34.82	83.76	27.73	7.44	153.75

Source: classified and computed by author

During this time period the maximum area under this land class (built-up area) was reformed in built-up class (24.30 sq.km in 5km zone, 24.25 sq.km in 7km zone). The conversion of built-up area into other area and vegetation cover was 1.35 sq.km (5 km buffer zone), 5.51 sq.km (7 km buffer zone) and 3.27 sq.km, 10.20 sq.km respectively. The area under vegetation cover has been

converted into built-up area (11.48 sq.km, 5.76 sq.km respectively), other area (1.71 sq.km 14.49 sq.km respectively).

The other area converted into built-up area (5.28 sq.km, 3.30 sq.km respectively), other area (0.66 sq.km, 6.37 sq.km respectively), vegetation cover (1.05 sq.km, 4.98 sq.km respectively) See Table 5.



Map 6 Land transformation in 5 km & 7 km buffer zone of Panipat (2001-2011)

5.6 Land transformation in Panipat city Outgrowth (2011-2017)

The changing pattern in land categories in 5 km & 7 km zone of outgrowth of Panipat (MC) during 2011 to 2017 bring into being in following statistics –

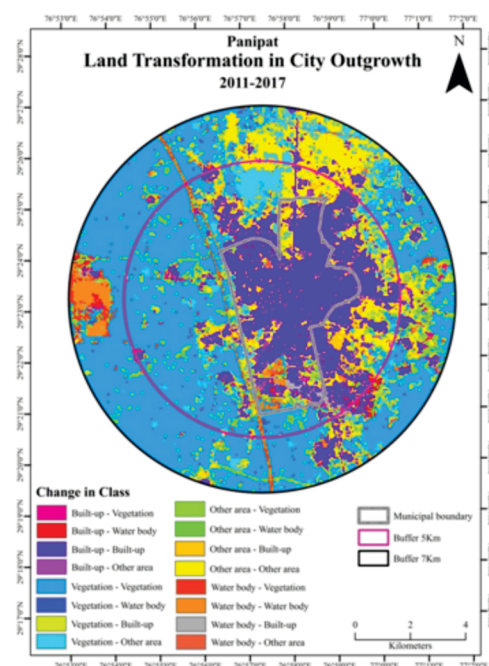
Table 6 Category wise land transformation in 5km & 7 km buffer zone of Panipat (2011-2017)

Land Transformation up to 5 km					
Land Classes in 2011 (sq.km)	Land Classes in 2001(Area in sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	36.39	4.77	1.51	0.56	43.23
Vegetation	2.66	23.88	1.49	0.55	28.58
Other area	2.60	0.47	0.69	0.12	3.88
Water body	0.57	0.95	0.09	1.06	2.67
Total	42.22	30.07	3.78	2.29	78.36
Land Transformation up to 7 km					
Land Classes in 2011(sq.km)	Land Classes in 2001(Area in sq. km)				
	Built-up area	Vegetation	Other area	Water bodies	Total
Built-up area	30.69	4.27	8.50	1.50	44.96
Vegetation	1.48	70.32	6.64	2.22	80.66
Other area	1.97	8.29	12.25	0.63	23.14
Water body	0.67	0.89	0.34	3.09	4.99
Total	34.81	83.77	27.73	7.44	153.75

Source: classified and computed by author

The built-up area can be distinguished in the imagery of Panipat city was the highest proportionate. The conversion of built-up area into other area was 1.51sq.km and 8.50sq.km respectively and built up area converted into vegetation cover 4.77 sq.km, 4.27 sq.km respectively (5km and 7km buffer zone). The conversion of vegetation covers into built-up area (2.66sq.km, 1.48 sq.km respectively) and in other area (1.49 sq.km, 6.64 sq.km respectively) see table 6.

We have seen major changes in the land transformation in every category of land from 1991-2017 in the city of Panipat. The transfer of land usage from one category to another is a notable observation of Panipat city, e.g. From 1991-2017 built up area has increased because of the cemented area of NFL (National Fertilizer Limited) as it is being counted in built up area category – reflected through satellite imagery. Also, other area and vegetated area has been converted in the built up area during aforementioned period.



Map 7 Land transformation in 5 & 7km buffer zone of Panipat (2011-2017)

Vegetation cover has been converted in other area and built up area continuously. Other area due to developmental activities e.g. Real estate projects it has been transferred into built up area over time. Few changes have been observed in water bodies at some places water bodies have been converted into vegetated or built up area. Hali Lake in the municipal corporation of Panipat city converted into other area as it is drying up (See Table 6).

6 Conclusion : Land transformation refers to change in the usage of land in a given period of time. In this study of land transformation in municipal corporation area and city outgrowth of Panipat city analysis of the land conversion of one category into other land usage is being done. For this study three periods have been earmarked i.e. – a) 1991-2001, b) 2001-2011, c) 2011-17

The study reveals the following findings :

- 1) Land transformation of water body has witnessed minor fluctuation.
- 2) Vegetation cover has been converted mainly into built-up area and other area. Later being formed especially in the last decade.
- 3) Built up area transformed into built-up area only viz- conglomerates, infiltration, etc.
- 4) Majority of other area transformed into built-up area.

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