# Land Transformation in the Western Periphery of Chandigarh: A Case Study Using Remote Sensing and GIS

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**Abstract**

Land is the basic natural resource that provides habitat and sustenance for living organisms, and a major source of economic activities (UNEP, 2001). The growing pressure of population coupled with an increasing variety of demands being made on land resource have brought extra pressure on the available resources all over the country (Kumar and Radhakrishnan, 2010). Hence it is a necessary and a pre- requisite to know the present or existing use of land in order to plan for its optimal use. Timely and reliable information base is essential for effective land use management. The present study is taken to study the land use and land cover patterns and change, land transformation, and to find out the drivers of the land transformation in the western periphery of Chandigarh over last one decade (2005-2015). The present study is conducted using high resolution satellite data collected from different sources such as IRS, LandSAT, and Google Earth. Data is collected, geo-referenced and brought to same scale. On screen digitization process was followed to identify the LULC classes in the study area. LULC patters, change in the pattern and transformation maps was prepared. Govt. records, published reports and interview with govt officials and local residents were conducted to find the underlying drivers of the change.

**Key words:** LULC, Land Transformation, LULC Change, GIS.

## INTRODUCTION

Land is the basic natural resource that provides habitat and sustenance for living organisms, and a major source of economic activities (UNEP, 2001).  The growing pressure of population coupled with an increasing variety  of demands being made on land resource have brought extra pressure on the available resources all over the country (Kumar and Radhakrishnan, 2010). Hence it is a necessary and a pre-requisite to know the present or existing use of land in order to plan for its optimal use. Timely and reliable information base is essential for effective land use management.

Studies have shown that there are only few landscapes on the earth, which are still in their natural or virgin state (Zubair,2006). Zubair noted that due to anthropogenic activities, the earth surface is being significantly altered in some manner and man's presence on the earth and his use of land has had a profound effect upon the natural environment thus resulting into an observable pattern in the land use/land cover over time.

Satellite remote sensing plays an important role in generating information about the latest land use and land cover pattern in an area and its temporal changes through times. The information being in digital form can be brought under Geographical Information System (GIS) to provide a suitable platform for data analysis, update and retrieval.

The present study analyses the land use/land cover change and land transformation in the western periphery of Chandigarh. The aim of this study is to see the existing land use pattern, change as well as land transformation and  also

tries to find the underlying drivers of land transformation in the periphery of the city.

**Defining the concepts:**

*Land Use*: This is the manner in which human beings employ the land and its resources**. "**Land use describes how land is used" (NRSC, 2010). Land use examples include: wildlife management area, agriculture land, urban, recreational area, etc.

"Land use refers to the human activities which are directly related to land, making use of its resources and having an impact upon it. Land use includes settlement, cultivation, pasture, rangeland, recreation and so on." (Meyer and Turner, 1992). Hence, Land use is a synthesis of physical, chemical, and biological systems and processes on the one hand and human/societal processes and behavior on the other.

*Land Cover:* On the other hand is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, water and elements of natural environment etc.

"Land cover describes as the assemblage of biotic and abiotic components on the earth's surface, is one of the most crucial properties of the earth system" (NRSC, 2010). "The term land cover relates to the type of features present on the surface of the earth" (Lillesand & Kiefer, 1979). In other words it described as ground blanket of natural and cultural landscape. "The vegetation (natural or planted) or man-made constructions that occur on the surface" (Campbell, 1987). So land cover refers to the observed physical surface of the earth,  including various

combinations of vegetation types, soils, exposed rocks, water bodies.

***Land Use and Land Cover Change:*** Land use - land cover change (LULCC) also known as land change is a general term for the human modification of the Earth's terrestrial surface. Though humans have been modifying land to obtain food and other essentials for thousands of years, current rates, extents and intensities of LULCC are far greater than ever in history, driving unprecedented changes in ecosystems and environmental concerns of human populations today, including climate change, biodiversity loss and the pollution of water, soils and air, monitoring and mediating the negative consequences of LULCC while sustaining the production of essential resources has therefore become a major priority of researchers and policymakers around the world.

Historically, humans have been modifying land to obtain the essentials for their survival, but the accelerated rate of exploitation has brought unprecedented changes in ecosystems and environmental processes at local, regional and global scales. The prime aim of these land use/land cover changes including land conversion from one type to another and land-use management is to satisfy mankind's immediate demands i.e., the need to provide food, fiber, water, and shelter.

## OBJECTIVES

The present study is taken to achieve the following objectives: (a) to study the land use and land cover patterns and change in land use and land cover patterns of the western periphery of Chandigarh during 2005-2015. (b) To study the land transformation of the western periphery of Chandigarh over last one decade and (c) To find out the drivers of the land transformation.

## RESEARCH QUESTIONS

In the light of the above objectives, the present study intends to find out the answers to the following research questions: (a) what is the land use and land cover pattern of the western periphery of Chandigarh and what are the major changes that have been introduced over last one decade in the area? (b) How has this pattern transformed over the last one decade? (c)What have been the major drivers of land transformation?

## CONTEXTUALIZING THE STUDY

Chandigarh was planned as a standalone city and the villages on its periphery were meant for agrarian functions of poultry farming and dairy farming and agriculture so that a city could get a regular supply of food grain, milk, vegetables, eggs, and meat from its periphery.

Corbusier marked the importance of the periphery by pointing out that "the functions of the city and the periphery must not be interchanged, otherwise confusion and anarchy are sure to follow" (Punjab periphery control act. 1952).

Chandigarh periphery is a controlled area with a radius of 16 km enacted by the Punjab New Periphery control Act of 1952 around its city. Out of this Punjab shares maximum (73%) followed by Haryana (24%) the remaining 3 percent is with the Chandigarh U.T. Somehow, land use of the controlled periphery even within the U.T. of Chandigarh has been completely transformed. Over a period of time, large number of developments has been taken up in the periphery; these developments are both of planned and unplanned nature. With these developments, the city has been extended towards the East, South and West to accommodate new requirements without any comprehensive plan. New residential, institutional and other uses have been added both within and outside the sectorial grid. The establishment of the I.T. park, rehabilitation colonies for unauthorized settlements, Sarangpur Institutional area, Botanical Garden, Milkmen Colony-Dhanas, Dumping Ground for solid waste etc towards the east and west has entailed overstepping of the natural boundaries of the Patiali Ki Rao and the SukhnaChoe.

This study is a small and humble step towards understanding the overall LULC change process around the city. Its significance is both for planners and for the local people. The study would enable us to comprehend the nature of land transformation, its determinants and implications for the city and its periphery.

## DATA SOURCE

The present study is based on both primary as well as secondary data sources. The land use and land cover change have been studied with the help of satellite data acquired for different time periods and from different agencies. Satellite data from LandSat sensors and IRS satellites was obtained from online sources such as Glovis and Bhuvan. High accuracy and high spatial resolution data from Google Earth Pro was also downloaded in order to generate the precise LULC data. Primary data about the drivers and present land use and land cover was acquired from the field. Secondary data sources such as revenue records and land use data from government agencies was also utilized.

## METHODOLOGY

Data for this study is acquired from both the sources primary and secondary. GIS was the main tool to store, analyze and represent the collected data to draw meaningful results. Images that were used for preparation of land use

land cover maps were first downloaded as rectified images from Google Earth Pro, through El- Shayal Smart GIS and then re-georeferenced in Arc GIS environment. Study area was extracted from 2011 Administrative map of Chandigarh.

*Fig. 1, Methodology flow chart*
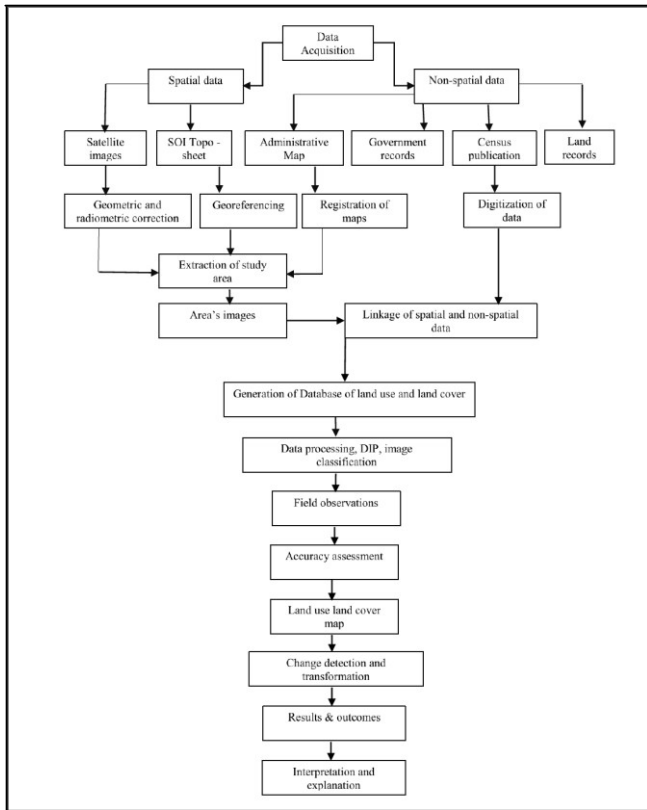


After the extraction of the study area linkage of the spatial and non-spatial data was done and the generation of geodatabase for LULC has also been done in Arc GIS.

The images were digitized in GIS environment using Arc GIS 10.3 in the form of polygons representing different land use land cover categories. The data were classified into 6 broad land use land cover classes spread over a total area of 18 sq. km. of the western periphery of Chandigarh.

After classifying the images, accuracy of classification was measured by field visit. The land use /land cover change were than calculated and every polygon representing the particular class was quantified and displayed in respective maps. It was followed by superimposing of two time period land use and land cover maps to carry out land transformation analysis. And at the end the causes or drivers of land transformation were identified. (See Fig. 1)

### STUDY AREA

Chandigarh is a union territory that serves as the capital of the states of Punjab and Haryana. It is located near the foothills of the Shivalik range of the Himalayas in North-West India.  It covers an area of approximately 114 sq. km.

Western periphery of Chandigarh covers approximately an area of 18 sq. km. and the total population of the area is approximately fifteen thousand having five villages viz. KhudaLahora/Jassu, Sarangpur, Dhanas, Dadumajra and Maloy (See map 1). The study area is located at 30°45'N latitude and 76°43'E longitude. It has an average elevation of 321 meters (1053 ft.).
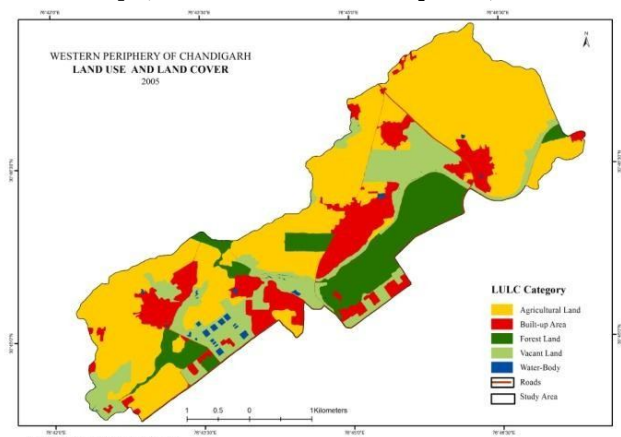
*Map 1, Location of Study Area*
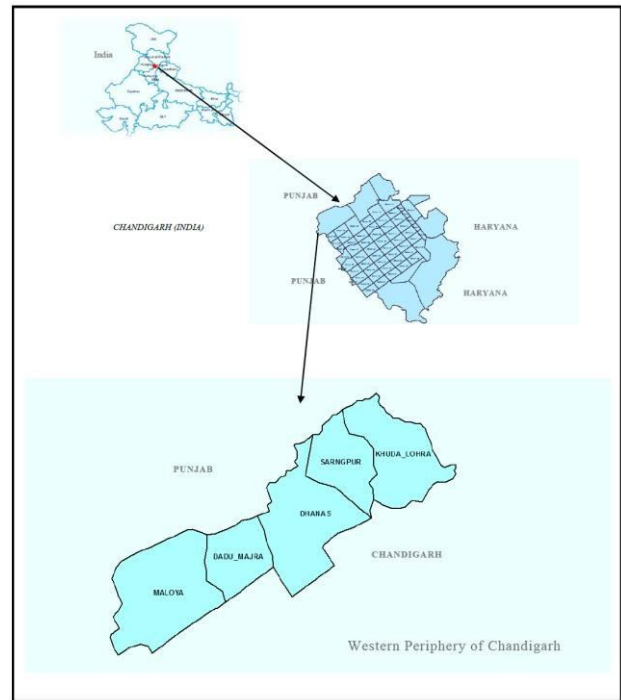


### RESULTS AND FINDINGS

*Land use and Land cover pattern:* The study area or western periphery of Chandigarh has five villages (KhudaLahora/ Jassu, Sarangpur, Dhanas, Dadumajra and Maloya). In 2005 more than half of the area of the western periphery of Chandigarh was covered by the agricultural land (52%).

*Map 2, Land use and Land cover pattern, 2005*



Map 2 shows the land use land cover pattern of 2005. Area from each land use class was calculated in km$^2$ and percentage is presented in Table 1. The total area of the

western periphery of Chandigarh is 18.12 km$^2$, in which the agricultural land covers almost half (9.54 km$^2$) of the total area. Northern and western part of the study area is mainly dominated by the agricultural land. There are reserved/protected forest cover in the area at the east of the village Dhanas and other forests which include the area near water works Dadumajra and the south-west part of the Dhanas which covers the total part of 2.43 km$^2$ (13.5%). The total area under built-up land is 2.6 km$^2$ (14%) which is even less than the vacant land (3.07 km$^2$) covering almost 16% of the land in the study area. The vacant land cover the part of Sarangpur, Dhanas, Khuda Lahora, part of water works near Dadumajra and the part along Patiali ki Rao choe.

**Table 1, Land use and land cover, 2005**

|  | Agricultural Land | Built-up Land | Forest | Water-Body | Vacant Land | Roads | Total area |
|---|---|---|---|---|---|---|---|
| Area | 9.54 | 2.6 | 2.43 | 0.18 | 3.07 | 0.28 | 18.12 |
| % | 52.7 | 14.37 | 13.46 | 1.01 | 16.97 | 1.49 | 100 |

*Source: Satellite data analysis using GIS*

**Fig. 2, Land use and Land cover, 2005**
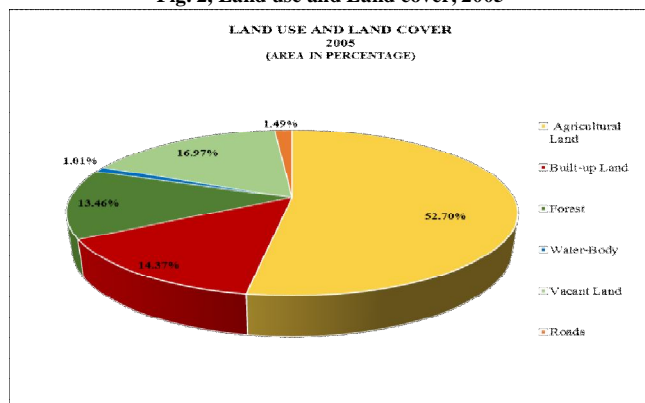


*Source: Satellite data analysis using GIS*

Water-body covers the area of 0.18 km$^2$ which includes the water works near Dadumajra village, small village ponds in Dhanas, KhudaLahora, Dadumajra and Maloya and the Patiali Ki Rao choe. The Major roads in the area are Kurali Chandigarh Road, DLF Mullanpur Road and the road along the sectorial grid which cover the part of 0.28 of the total area.

In the span of one decade the land use and land cover in the periphery has undergone a rapid transformation. In 2015, the area under built-up land covered approximately 5.21 km$^2$. Built-up area has increased in village Dhanas, Sarangpur, Dadumajra, Khuda Lahora/Jassu and Maloya. The maximum increase in the study area have been witnessed in the village Dhanas, Maloya and Dadumajra as the new construction have been taken place of the agricultural land in the area, rehabilitation colonies have been constructed at a very large scale in the area. Increase of built-up in the Sarangpur (along DhanasSarangpur road) and KhudaLahora/Jassu have also been witnessed at a very large scale as the increase in commercialization has

replaced the agriculture in the area. The agricultural land covered 5.11 km$^2$ of land area in the periphery. Area under forest was recorded to be 2.44 km$^2$. Forest cover has also witnessed increase along the Patiali Ki Rao choe as it is a seasonal stream and at present have very less water and the sides of the stream have forests (shrubs).

Water bodies spread over one forth of a kilometer. Water-body has also increased (0.25 km$^2$) because of the creation of new water-bodies e.g. Dhanas Lake and the addition of the water tanks in water works near Dadumajra. The vacant land in the area was mapped over 4.62 km$^2$ of total geographical area. In the North of Sarangpur 30 acres of land have been shifted to vacant land from agricultural land for the new developing projects of the area.

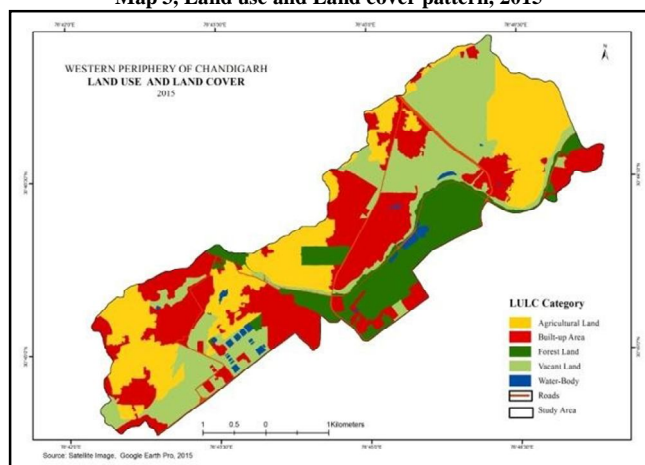**Map 3, Land use and Land cover pattern, 2015**



**Table 2, Land use and land cover, 2015**

|  | Agricultural Land | Built-up Land | Forest | Water-Body | Vacant Land | Roads | Total area |
|---|---|---|---|---|---|---|---|
| Area in sq. km. | 5.11 | 5.21 | 2.44 | 0.25 | 4.68 | 0.42 | 18.12 |
| Area in percentage % | 28.21 | 28.76 | 13.49 | 1.38 | 25.84 | 2.31 | 100 |

*Source: Satellite data analysis using GIS*

**Fig. 3, Land use and Land cover in 2015**
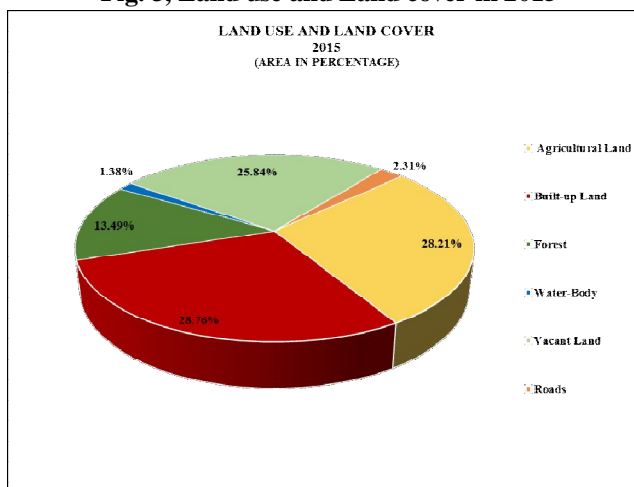


*Source: Satellite data analysis using GIS*

***Land use and Land cover change in the western periphery of Chandigarh (2005-2015)***

The analysis of Satellite imagery of 2005 and 2015 has shown that the land use and land cover pattern of the western periphery has undergone a tremendous change in last one decade. The area under built-up land has increased tremendously. The maximum increase in the study area have been witnessed in the village Dhanas, Maloya and Dadumajra as the new construction have been taken place of the agricultural land in the area, rehabilitation colonies have been constructed at a very large scale in the area.

Built-up land increased (14%) rapidly in last one decade. The development process was very fast to meet the housing, commercial, industrial, etc. demands. Due to the proximity and good linkage with the planned city of Chandigarh, the area of the periphery is to achieve faster growth of development.

In 2005 most of the study area was dominated by the agricultural land which was 9.54 sq.km (52%) and in 2015 it has been decreased to 5.11 sq.km (28%). Built-up area has been increased from 2.06 (14%) to 5.21 sq.km (28%) and vacant land has increased from 3.07 (16%) to 4.68 sq.km (25%). Forest area (13.5%) and Water Bodies (1%) has remained almost same during the last one decade. Total length and area under the roads have increased almost double in just the span of one decade.

Most of the area in North, West and Southern part has covered by the agricultural land (9.54 km$^2$). Middle-East part has covered by the forest, vacant land and built-up land. Built-up area has covered 2.06 km$^2$ of the total area. There are only few water bodies in the area which covere0.18 km$^2$ and include water works near Dadumajra, village ponds and the Patiali Ki RaoChoe. As compare to the 2005, 2015 study area has witnessed a tremendous change in last one decade. Agricultural land has been reduced to a great extent and is replaced by the built-up land, vacant land, roads and so on. In the map (Map 3) we can see that the built-up land has increased almost in every part of the study area. Village Dhanas, Maloya, Dadumajra have witnessed a tremendous change as the rehabilitation colonies have been constructed in these villages. Increase in built-up in Sarangpur (along SarangpurDhanas Road) and KhudaLahora/Jassu also have witnessed in last one decade. New and large water-bodies e.g. Dhanas Lake, water tanks etc. have also taken place in the area in year 2015. Table 3 below shows the land use and land cover change in last ten years form 2005- 2015. Agricultural land has decreased 24.49 percent in last one decade and built-up land have increased 14.39 percent followed by vacant land    8.87

percent, roads 0.82 percent, water-bodies 0.37 and     forest 0.03 percent in the study area. In the Fig. 4we can see through the following comparison chart the maximum area of the study were covered by the agricultural land in 2005 but it is completely changed in the year 2015. Most of the agricultural land has been shifted to built-up area and vacant land.

**Table 3, Land use and land cover change (2005 -2015)**

| Sr. No. | Categories | 2005 | | 2015 | | % Change |
|---|---|---|---|---|---|---|
| | | Area (In sq.km.) | Percentage % | Area (In Sq.km.) | Percentage % | |
| 1 | Agricultural Land | 9.54 | 52.7 | 5.11 | 28.21 | 24.49% |
| 2 | Built-up | 2.06 | 14.37 | 5.21 | 28.76 | 14.39% |
| 3 | Forest | 2.43 | 13.46 | 2.44 | 13.49 | 0.03% |
| 4 | Water Bodies | 0.18 | 1.01 | 0.25 | 1.38 | 0.37% |
| 5 | Vacant Land | 3.07 | 16.97 | 4.68 | 25.84 | 8.87% |
| 6 | Roads | 0.28 | 1.49 | 0.42 | 2.31 | 0.82% |
| | **Total** | **18.12** | **100** | **18.12** | **100** | |

*Source: Satellite data analysis using GIS*

**Fig. 4, Land use and land cover change (2005 -2015)**
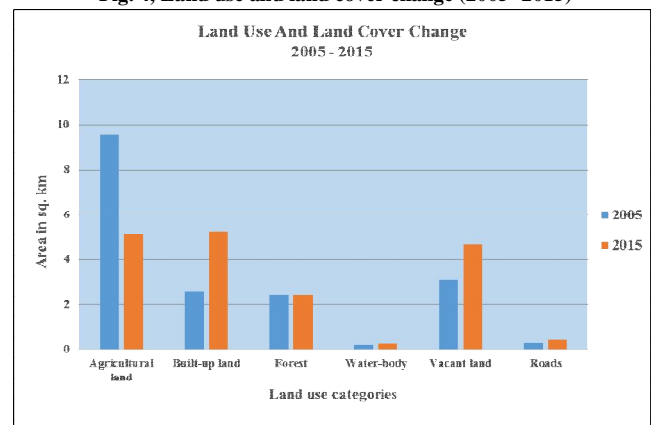


*Source: Satellite data analysis using GIS*

*Agriculture land: A*rea under the agriculture in 2005 comprised of 2357.39 acres (9.54 sq.km.) of land. This is 52.70 % of total area of the study. The area under agricultural land decreased from 2357.39 acres in the year 2005 to 1262.78 acres in the year 2015. There is almost a decrease of 1094.68 acres of land in last one decade. The agricultural land is decreased 24.49 percent over the time period of ten years. This was mainly due to population increase agricultural land converting into the built-up land. In the North-western part of the area this change is very apparent.

*Built-up land:* In the present study the Built up land has witnessed an increase over a time span of 10 years. Earlier in 2005, it occupied only 14.37 percent of the total area but in the year 2015, it has increased to 28.76 percent. Hence, there was increase of 14.39 percent in the built up land. At present the total area under the built-up land is 1287.42 acres, which is 5.21sq.km.of the total area of the study. The built-up land is showing increase due to the fast development policies of the town and planning  schemes and the illegal land use for commercial and residents by the village people. Study showed increase in built-up land around the villages. Rehabilitation colonies are being constructed in the area at very large scale in    Dhanas,

Maloya and Dadumajra. Besides, the marble market which has come up along the Dhanas Sarangpur road has also change the land use from agriculture to built-up. Such a change is visible in the entire study area excluding the North-western part where an area of 30 acres reserved for the proposed project on "Multimedia center or Film city Center**.**

*Forest:* Forest area mainly protected or reserved type can be seen in the study area. Other category under the forest cover is shrubs or scrub forest which have been grown along the Patiali Ki Rao (Seasonal river). Dense forest can be seen at the middle-east part of the study area. Total area under the Forest comprised of 2.43 sq.km in 2005 which increased slightly to 2.44 sq.km in 2015.

*Vacant land:* In the present study all the area under developing projects where land has been acquired for construction are included in vacant land category. In 2005 the area under the vacant land was 3.07 sq. km that have increased to 4.68 sq. km in 2015. The area under vacant land can be seen around water works, Dadumajra, North of the village Dhanas which is the area under Botanical garden and the land along Patiali Ki Rao. This area has witnessed increase towards north of the Sarangpur village which is a reserved area of 30 acres of land for the upcoming developing projects.

*Water body:* In the study area one of the major water – body of the Chandigarh Patiali ki Rao choe Flows, which is a seasonal river originating from the Shivalik hills. Other water-bodies of the area are ponds, Water Tanks and lakes etc. The water bodies have increased from 0.18 sq. km. to 0.25 sq. km in last one decade. The increase in water-body is because of Dhanas Lake which was created in 2006.

*Roads:* In the present study the roads also have increased to 0.28 sq. km. to 0.42 sq. km it is because of the road widening in the area. In 2005 most of the roads were un-metaled and single lane but with the passage of time roads have been widened. Kurali Chandigarh road and the DLF Mullanpur road are the example of the widened roads.

In comparison with the two periods of 2005 and 2015 only the area under the Agriculture had decreased, rest of all the area under built-up, forest, vacant water bodies and roads have been increased. Most of the agricultural land that has been changed in the present study is shifted to built-up land vacant land and roads. Built-up land has increased almost in every part of the study area. This clearly indicates that the population expansion and development processes have led to such changes. The agriculture land, decreased considerably getting converted into settlements, commercial and industrial uses.

## LAND TRANSFORMATION

Land transformation refers to (quantitative) change in the areal extent (increase or decrease) of a given type of land use or land cover, respectively. However land transformation may result either from the land conversion (a change from one cover type to another), or land modification (alterations of structure or function without a wholesale change from one type to another), or even maintenance of land in its current condition against agents of change.

Land transformation is a complex phenomenon. It is the outcome of the interrelationship of different social, economic, natural, cultural and even political situations (Fazal, 2012). It is a process where changes in land use/cover are observed at different time periods and it is one of the important fields of human induced environmental transformation. Land is in a continuous state of transformation as a result of various natural and man-made processes. The two basic features of land transformation are land use alteration and intensification. Compared to other areas the first process lies mainly in the study area because most alterations of land use drastically reduce the agricultural area. Intensification consequently is the common type of land transformation in all sections of areas development. Types and pattern of land use in the study are controlled both by the economic development and the strong influences of technological, social and political alterations during the last one decade.

***Land transformation in study area:*** Apart from land use/land cover change, the study area experienced significant interchange of land between different classes during the study period which is because of economic and social transformation leading to the land transformations.
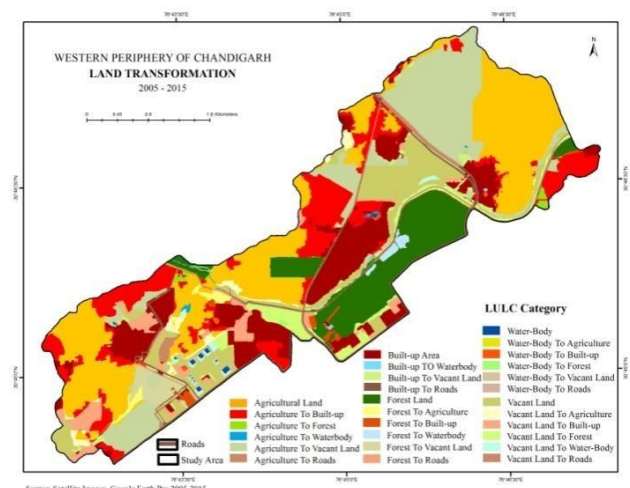
**Map 4, Land Transformation, 2005-2015**



Table 4 shows the transformation of various land use classes of the area. The development and expansion of the area has led to increase in demand for various built up land e.g., residential, commercial, industrial etc., purposes.

Significant land transformation was witnessed among built-up area, vacant, agriculture, water bodies and forests. Built-up area increased by 14.39 %, capturing land mainly from agriculture, vacant, forest and water-bodies. Vacant land also increased by 8.87 %, gaining area from agricultural land, water-bodies and forest area. Agricultural land lost 24.49 %, this loss was gain for built-up, roads and vacant area. Vacant shifted its 0.62 km$^2$ to built-up area for residential and commercial development and 0.26 km$^2$ to agriculture area expansion. Agriculture lost 4.18 km$^2$ for built-up land for residential, commercial, industrial, recreational (parks and gardens) and 5.22 km$^2$ for vacant land for future developments.

Spatially, the Change can be observed in the area around Dhanas, Dadumajra and Maloyavillage, Most of the increase in built-up land has been witnessed in these areas because of the construction of the new rehabilitation colonies at a large scale. Besides, Sarangpur (along SarangpurDhanas road) and KhudaLahorahave also witnessed the increase in built-up area because of the development of commercialization at a very large scale in these areas. Vacant land in the North of the Sarangpur and forest along the Patiali Ki Rao has also been increased in the last one decade. This vacant land has already been acquired for developmental project and is awaiting the commencement of construction.

### Table 4, Land Transformation, 2005–2015

(Area in sq. km.)

| | | 2015 | | | | | |
|---|---|---|---|---|---|---|---|
| | **Categories** | **Agricultural Land** | **Built-up Land** | **Forest** | **Water-Body** | **Vacant Land** | **Roads** |
| **2005** | **Agricultural Land** | 9.28 | 4.18 | 0.15 | 0.03 | 5.22 | 0.22 |
| | **Built-up Land** | 0 | 2.37 | 0 | 0.01 | 0.17 | 0.06 |
| | **Forest** | 0.13 | 0.14 | 1.81 | 0.07 | 0.25 | 0.03 |
| | **Water-Body** | 0.01 | 0.03 | 0.03 | 0.04 | 0.07 | 0 |
| | **Vacant Land** | 0.26 | 0.62 | 0.47 | 0.11 | 1.53 | 0.08 |
| | **Roads** | 0 | 0 | 0 | 0 | 0 | 0.28 |

*Source: Satellite data analysis using GIS*

The study area witnessed rapid land transformation during the study period (2005- 2015). Major transformation has been occurred mainly in three categories. The major portion of the agricultural land have transformed to built-up and vacant land. Residential, commercial, industrial and recreational (parks and gardens) have led to these transformation, vacant land have also played the major role in land transformation as the 5.22 km$^2$ of agricultural land have been transformed to vacant land, for the developing projects in the area. Some part of the vacant land also shifted to agricultural land, built-up area, forest, roads and water-bodies. As land transformation is the inter category change of the area the study reveals that every category in the area have been converted or transformed from to one type to another except roads. This situation has accelerated the rate of rural expansion and land transformation and the process is still continuing.

### Drivers of Land Transformation

Identifying the causes of land transformation requires understanding both how people make land-use decisions, (decision-making processes) and how specific environmental and social factors interact to influence these decisions (Lambin et.al. 2001). It is also critical to understand that land use decisions are made and influenced by environmental and social factors across a wide range of spatial scales, from household level decisions that influence local land use practices, to policies and economic forces that can alter land use regionally and even globally.

Land-use change is always caused by multiple interacting factors. The mix of driving forces of land-use change varies in time and space according to specific human-environment conditions. Biophysical drivers of land use change, such as droughts induced by climate change or loss of soil fertility by erosion may be as important as human drivers, which include economics and policy.

Land use change occurs initially at the level of individual land parcels when land managers decide that a change towards land use / land utilization is desirable. Another factor that influence land use land cover change are Natural variability, highly variable ecosystem conditions driven by climatic variations amplify the pressures arising from high demands on land resources, especially under resource-limiting conditions, such as dry to sub-humid climatic conditions.

Besides this increase and decrease in local populations have large impacts on land use change. Demographic changes include not only shifts in fertility and mortality (e.g. the demographic transition), but also changes in household structure and dynamics, including labor availability, migration, urbanization, and the breakdown of extended families into multiple nuclear families. Institutional and cultural factors also influence the land use change, the motivations, collective memories, personal histories, attitudes, values, beliefs, and individual perceptions of land managers influence land-use decisions, sometimes profoundly.

The intended and unintended ecological consequences of land-use decisions all depend on the knowledge, information, and management skills available to land managers, and these in turn are often linked to political and economic conditions.

Therefore, land-use changes tend to be driven by a combination of factors that work gradually and factors that happen intermittently.

***Factors influencing land use transformation in the Study area:*** The driving forces or the causes that are responsible for land transformation in the area are many. The agricultural land has been changed because of the increase in built-up area, vacant land and the road widening etc. The following flow diagram will make land transformation more clean in the study area.

*Factors responsible for change in Agricultural land: Area* under agricultural land has gone under major changes since 2005. In 2005 the area under agricultural land was 9.54 sq. km. which remains only 5.11 sq. km in 2015. The main reason for the change in agricultural land were the increase in built-up land due to increasing commercial activities, built-up of rehabilitation colonies, unauthorized construction in the area and the land shifted to vacant land for further development and road widening.

*Factors responsible for increase in Built-up land:* Built-up land has been increased tremendously in last ten years. The increase in the built-up area is due to the rapid development in the study area. In last one decade many rehabilitation colonies have been built-up in the area and there is also a rapid growth in the commercialization in the area. Due to the lack of space within the sectorial grid the people are shifting towards the periphery of the city and it led to the unauthorized construction in the area. As per the information made available by the Department of Rural Development and Panchayats, the area under unauthorized development beyond the abadi areas is nearly three times the abadi area in some of the villages.

Due to the slum rehabilitation colonies in the study area major changes in built-up land have took place. These colonies are; rehabilitation colony of Dhanas that were basically built-up for the slum population of the City that were resides within the city. Sector 25 west slums also have been shifted to Dadumajra new housing board colonies. Unlike the Dhanas rehabilitation colony Maloya also have the same for the slum population of the south part of the city.

*Other factors:* Other factors that are responsible for land use change and land transformation are the vacant land which has been acquired for the upcoming developing projects in the area. 30 acres of the land in the Sarangpur village come in this category that has been acquired for the proposed project entitled "Multimedia-center/ film city or the E-Sampark Project". Besides this unauthorized constructions have led to the increase in built-up land, and dryness of the water-bodies changes into forest cover and vacant land. The variations in the water bodies are due to the seasonal variation over the time period.

Land use and land cover change are influenced by the variety of factors. The present study have discussed about the land use and land cover pattern, change and the transformation of the area which reveals that the drivers of the land use change and land transformation are dependent on one another. From the year 2005 to 2015 the major changes have been occurred in agricultural land, built-up area, vacant land and roads. Most of the agricultural land has been transformed into built-up area due to the increase in commercial area, unauthorized construction, construction of rehabilitation colonies and the lack of space in the sectorial grid within the city. Most of the people near the periphery area have been shifted towards the periphery villages as there is the cheap accommodation available as compare to the city and thus it leads to the pressure on the village land. New developing projects have also taken place in the area and as results the agricultural land has been acquired for the future use. In the last one decade roads have also been developed and agricultural land has been shifted to roads. Apart from this drying of the water-bodies have led to change of land cover into forest (shrubs or scrub land) and vacant land. The variation in the water bodies is due to the seasonal variation over the time period.

**CONCLUSION**

Land transformation is a complex phenomenon, resulting either from the land conversion (a change from one cover type to another), or land modification. It is a process where changes in land use/cover are observed at different time periods and it is one of the important fields of human induced environmental transformation. Land is in a continuous state of transformation as a result of various natural and man-made processes. While working on this project many changes were observed in the study area. The change in land use - land cover brings change in life style of that area. This in return brings change in social, political, economic, demographic and environmental aspects.

Information on land use - land cover in the form of maps and statistical data is very vital for spatial planning, management and utilization of land. In the study, Remote Sensing and geographical information system (GIS) were used in order to study land use and land cover pattern, changes and land transformation. In the study area the changes are highly noticeable, land use is changing very rapidly due to various human activities, natural conditions and development activities.

The study shows that the development and expansion of the area has led to increase in demand for various built up land e.g., residential, commercial, industrial etc., purposes. Significant land transformation was witnessed among built-up area, vacant, agriculture, water bodies and forests. Built-up area increased by 14.39 percent, capturing land mainly from agriculture, vacant, forest and water-bodies. Vacant land also increased by 8.87 percent, gaining area from agricultural land, water-bodies and forest area. Agricultural land lost 24.49 percent, this loss was gain for built-up, roads and vacant area. Vacant shifted its 0.62 km$^2$ to built-up area for residential and commercial development and 0.26 km$^2$ to agriculture area expansion. Agriculture lost 4.18 km$^2$ for built-up land for residential, commercial, industrial, recreational (parks and gardens) and 5.22 km$^2$ for vacant land for future developments.

The present study shows rapid growth of built-up land in the area and decreased agriculture land to the great extent. The built-up land is being increased rapidly due to the fast development policies of the town and planning schemes. Rehabilitation colonies are being constructed in the area at very large scale. The legal and illegal constructions or land use are shaping the present day landscape.

The study revealed many factors that are responsible for the land transformation in the area. Construction of new rehabilitation colonies, commercialization, illegal land encroachment, unauthorized construction at a very large scale has completely changed the area. The land use - land cover pattern in 2005 was basically almost agricultural in nature where it covered the largest area among all but in 2015 it has been decreased at a very large scale. The built-up land has replaced almost half of the agricultural land since 2005 it was only 2.06 km$^2$ in 2005 but increased to 5.21 km$^2$ in 2015. According to the Department of Rural Development and Panchayats, the area under unauthorized development beyond the abadi areas (Lal Dora) is nearly three times the abadi area in some of the villages. All these have far reaching implications not only for the periphery but also the city as well. Where will the city gets supply of vegetables, milk, poultry and grains in times to come and would these periphery areas be able to with stand the pressure of increasing population? These question need to be looked into to make the city and the periphery complimentary to each other.

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