Land Transformation Around Chandigarh: A Study of Eastern Periphery Using Remote Sensing And GIS Technology

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Abstract- *Chandigarh being the capital of two states of Punjab and Haryana is developing as an Educational, Industrial and Administrative hub in the region. Chandigarh being planned of approximately five lack persons initially has attracted large scale in migration from the surrounding areas. At present more than million people live within the administrative boundaries of the city. This continuous increasing pressure of population and demands for infrastructure and services has transformed the rural areas in the periphery of the city. In the last one and a half decade the periphery of Chandigarh is under constant attack from the illegal construction and slum population. All these activities have transformed the land use and land cover of the periphery of the city, transforming the rural and vacant lands into the urban and built-up land. The present study is an attempt to trance the changes in the land use and land cover of the periphery and to understand the process of land transformation around the planned city of Chandigarh using remote sensing and GIS technologies.*

Keywords- Land Transformation, Remote Sensing, GIS.

I. INTRODUCTION

Since the Neolithic times, the alteration of the earth by anthropological action mainly involved influences on the soil and biotic resources (Fazal, 2005). Land transformation did not decline but, rather, enhanced and diversified with the beginning of the Industrial Revolution, the globalization of the world economy and the expansion of population and technological capacity (Turner an Meyer, 1994). Forests were cleared, grasslands tilled or grazed, wetlands exhausted and crop lands and settlements expanded, yet never as rapidly as in the last few years (Fazal, 2000). Almost all of the world's lands are now used and managed, although in widely varying degrees of intensity (Lakshmi and Fazal, 2002).

Land use and land cover are always defined as two separate terminologies which are often used interchangeably (Dimyati et al., 1996).Land cover on the one side refers to the physical characteristics of the earth's surface in the form of vegetation cover, water bodies, land area, settlements, etc. In simple words land cover is anything which is covering a portion of the surface of the earth. On the other side Land use refers to the manner in which the humans use the land for their personal benefits. In other words the land use is the functional use of the resources of the land for economic activities (Rawat and Kumar, 2015).

Both the land use and land cover affect each other at the same time. Changes in land cover due to land use not always results in the form of degradation of the land cover. However many time continuous change in the land use under the social, political, economic factors results in large scale transformation of the land cover of the region Riebsame et. al., 1994).

This use of land has never been stagnant as the demand and use of land keeps on changing with the time. Due to the continuous changing nature of the land use the areas under non anthropogenic land cover are brought under human land use with the time. Detection of land use and land cover change is very essential for managing the limited resources of the land in a better and organised manner for achieving the goal of sustainable management.

The development of remote sensing and Geographical Information System (GIS) techniques have enabled the researchers to precisely and accurately map and analyse the land use and land cover patterns at both global and local levels (Selcuk et al., 2003). Using remote sensing and GIS technologies have enabled to study the land use and land cover in less time and in cost effective way Kachhwala, 1985). Geographical Information System has made possible the capabilities of handling large data sets, editing and updating of the data and provides suitable platform for data analysis, update and retrieval (Chilar, 2000). As the technologies developed and high spatial resolution satellite images were obtained along with the quick and accurate image processing and GIS Technologies researcher are now able to perform

continuous and routine monitoring and mapping of land use and land cover of the surface of the earth (Lo and Choi, 2004). In the light of the present discussion the present study is aimed at accessing the land transformation process in the Eastern periphery of the planned city of Chandigarh.

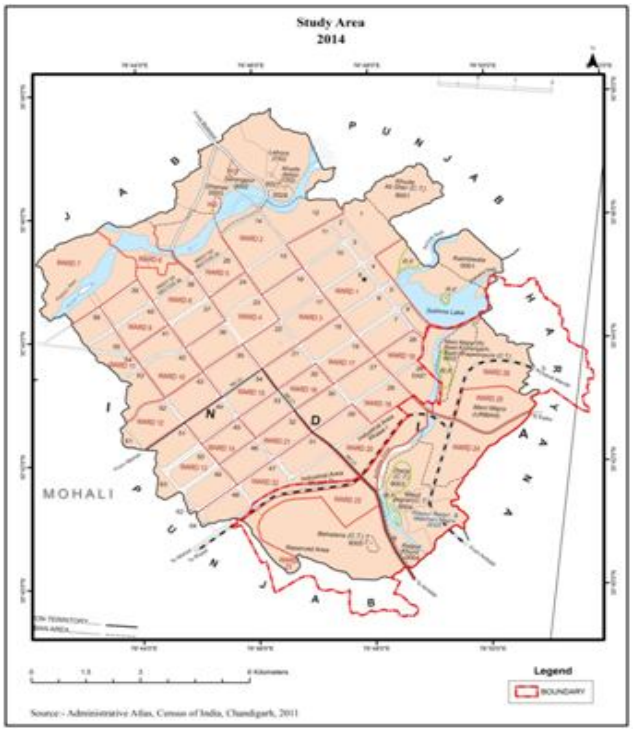
II. OBJECTIVES

The primary objective of the present study is to study and map the patterns of Land Use and Land Cover of the study area for the year 2002, 2009 and 2014. Secondly, it will attempt to study the patterns of land transformation in the study area between the years 2002 to 2014. And lastly it will also try to identify and investigate the factors responsible for the land transformation in the Chandigarh periphery region.

In the light of the above objectives following research questions have been raised; (i)what have been the Land Use Land Cover patterns in the study area during last decade? (ii) How land transformation varies in time and space in terms of its extent and intensity? (iii)What factors are governing the land transformation process in the Chandigarh periphery area?

Study Area

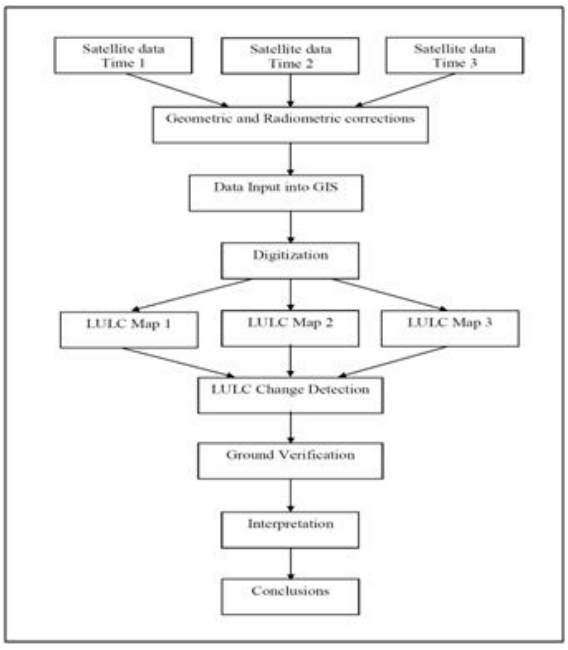
Chandigarh 'the City beautiful' designed by famous French Architect, Le Corbusier is known for its unique architecture and well planned landscaping. It derives its name from a temple 'ChandiMandir' located in the vicinity of the site selected for the city. It is a modern city housing the Capital of two States Punjab and Haryana and the seat of 'Union Territory' Administration. Bounded on two sides by two seasonal rivulets, the northern edge of the city is the Capital Complex against the panoramic backdrop of the Shavlik hills.The study area is located in the Eastern side of the city. The area was predominantly agricultural to begin with.The total geographic area is approx. 36 square kilometers (Map 1).The study area is bounded in north by Shavlik hills, in west by Panchkula city, from east by the planned urban area, in from south by the Chandigarh Airport.



Map 1 Location of Study Area

Data sources and Methodology

The present study is based on the satellite data obtained from the United States Geological Survey's official web portal (Glovis). Remotely sensed satellite images of Landsat satellite were acquired and corrected for any atmospheric and geometric errors. The satellite images were then subset into study area boundary using administrative maps obtained from the Census of India's Administrative Atlas of 2011 for the Chandigarh city. The subset images were than input into the GIS to classify the images into various land use and land cover classes using on screen digitisation process.



Flow Chart of Methodology adopted for the study

Land use and land cover maps were prepared using the ArcGIS software. After creating the land use and land cover maps for the time period 2005, 2009 and 2014 ground verification was performed and accuracy assessment of the classification system was carried out. After suitable modifications and rectification of the land use land cover maps land transformation was calculated using the GIS. It was followed by the interpretation of the maps and identification of factors responsible for the land transformation in the eastern periphery of Chandigarh.

Results and Discussion

Land Use and Land cover, 2002

In 2002, majority of the land was under agricultural land use. Almost twenty eight percent (10.19 square kilometers) of the land area was under it. Area under tree cover was measured to be slightly less than nineteen percent (6.79 square kilometers) (Table 1). The tree cover was distributed along the Sukhnachoe and along the green belt kept as the cover between Chandigarh and its periphery.

Table 1
Land use and land cover, 2002

Category	Area in Sq.Kms.
Built-up Land	5.25
Agricultural Land	10.19
Area Under Tree Cover	6.79
Vacant/Open Area	7.51
Chandigarh Airport	4.21
Area Under Conversion into Built-up	2.09

Source: Derived from the analysis of Satellite Images in GIS environment, 2002.

Almost one fifth (7.15 square kilometres) of the total area was under vacant category as large stretches of the land were acquired by the government agencies to develop as a built-up

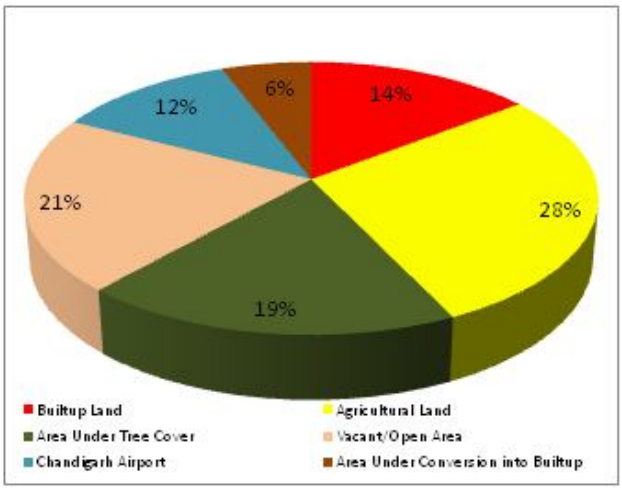
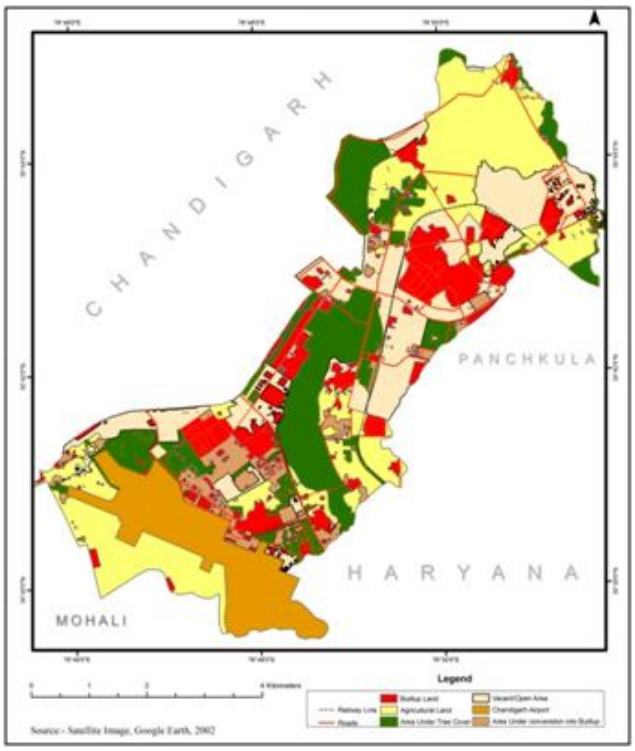


Figure 1Land use and land cover, 2002

Source: Derived from the analysis of Satellite Images in GIS environment, 2002-2014.

area. Majority of the vacant land was located around the already built-up areas as these areas were under agricultural land use and were cleared for future expansion of the settlements.



Map 2 Land use and land cover, 2002

The area under the already developed Chandigarh airport accounts for nearly twelve percent i.e. 4.21 square kilometers. Airport of Chandigarh was further expanded and developed after 2010. Almost two square kilometers (5.8

percent) of land is under construction where large scale residential complexes were being constructed.

Land Use and Land Cover, 2009

In 2009, the share of agricultural land decreased drastically to 6.28 square kilometers that accounted nearly 17.43 percent of the total land area (Table 2). The area under tree cover on the other hand increased to almost one forth (9.19 square kilometers) of the total area.

Table 2
Land use and land cover, 2009

Category	Area in Sq. Kms.
Built-up Land	6.57
Agricultural Land	6.28
Area Under Tree Cover	9.19
Vacant/Open Area	7.00
Chandigarh Airport	4.06
Area Under Conversion into Built-up	2.94

Source: Derived from the analysis of Satellite Images in GIS environment, 2009.

The Chandigarh airport was further extended and developed and occupied almost four square kilometres that is 11.27 percent (Figure 2). Vacant land remained approximately the same to seven square kilometres i.e. 19.42 percent of the entire land area.

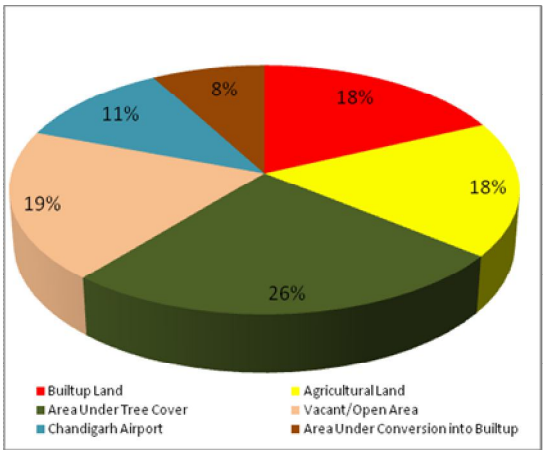
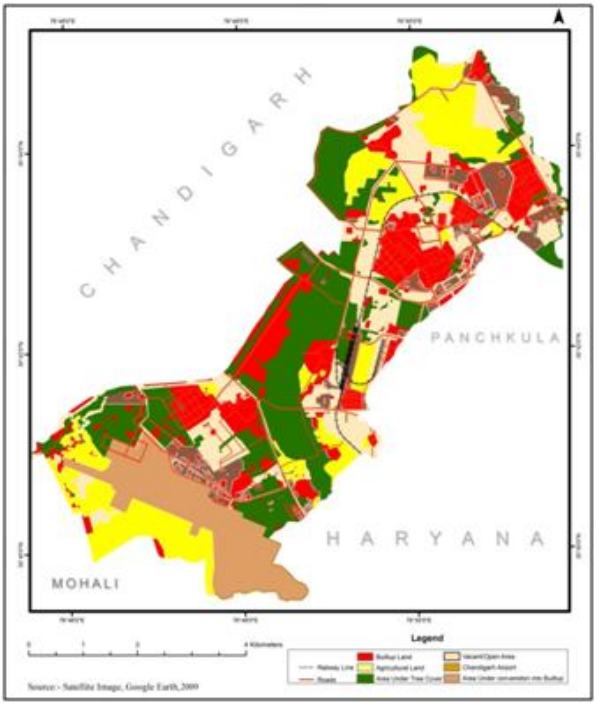


Figure 2 Land use and land cover, 2009

Source: Derived from the analysis of Satellite Images in GIS environment, 2002-2014.

The area under conversion into built-up land increased to almost three square kilometres i.e. occupying nearly 8 percent of land. Area under built-up land increased to 18.23 percent (6.57 square kilometres) as major residential projects and industrial development was taking place in the region. The pattern of land use and land cover in the study area during the year 2009 can be seen in the map 3.



Map 3Land use and land cover, 2009

Land Use and Land Cover, 2014

Recently in 2014 the eastern periphery was dominated by the built-up land which occupied nearly one fourth (8.33 square kilometers) of the land area. The area under tree cover remained almost same to one fourth (9.05 square kilometers) of the area. Agricultural land was further reduced to 10.5 per cent i.e. 3.78 square kilometers (Table 3). As the area under Chandigarh airport was further increased to 5.05 square kilometers its share increased to almost 14 per cent.

Table 3
Land use and land cover, 2014

Category	Area in Sq. Kms.
Built-up Land	8.33
Agricultural Land	3.78
Area Under Tree Cover	9.05
Vacant/Open Area	6.24
Chandigarh Airport	5.05
Area Under Conversion into Built-up	3.55

Source: Derived from the analysis of Satellite Images in GIS environment, 2014.

At the same time the area under conversion from non-built-up to built-up increased to 3.55 square kilometres i.e. nearly 10 percent of the total area (Figure 3). Further 6.24 square kilometres (17.33 per cent) of land were cleared for further extension of urban areas.

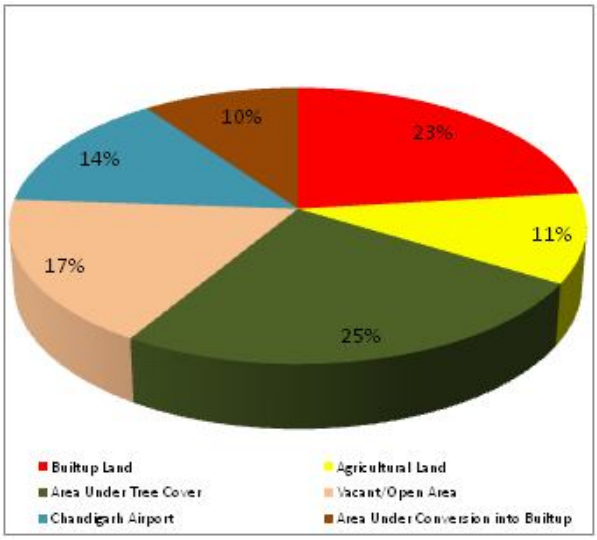
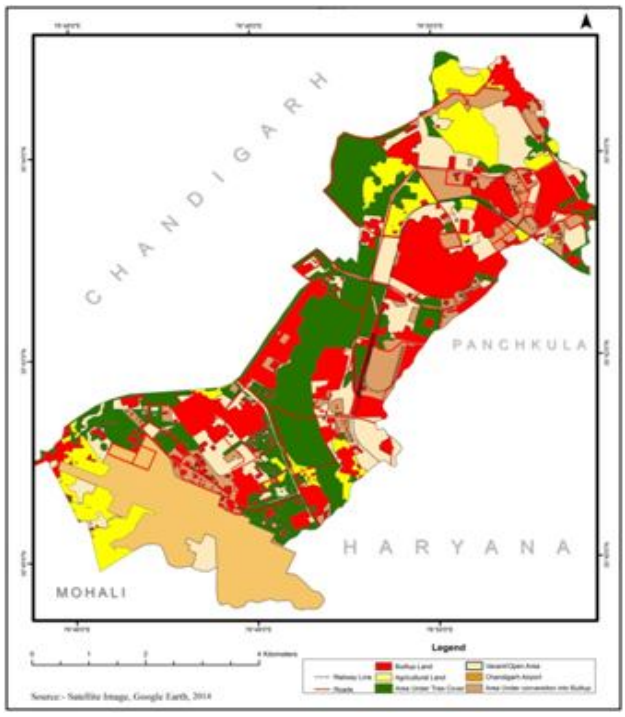


Figure 3 Land use and land cover, 2014

The patterns of land use and land cover in the eastern periphery of Chandigarh are shown in the map 4. It is clearly evident from the map that areas which are closer to the urban areas or already built-up areas are brought under vacant land which get further transformed into area under conversion and finally end up into the built-up areas. The area under tree cover is only present along the sukhnachoe and areas designated as sukhnachoe reserved forest. The forest area along the sukhnachoe is a reserved forest and Chandigarh administration have spent huge amounts of money in order to restore the degrading forest cover in the Chandigarh periphery.



Map 4Land use and land cover, 2014

Change in Land Use and Land Cover, 2002-2014

Chandigarh being the capital of two states (Punjab and Haryana) has always been a preferred choice for the people living in the neighbouring states. It has been developed as an administrative town to serve as a capital of the states. It has been viewed as a growth pole after the new economic policy of the Indian government in 1991. Chandigarh have witnessed a large scale land transformation from basically rural characteristics of the periphery to semi- urban and then from semi- urban to urban in the last one and a half decade. After 2000, the population of the periphery have increased many folds due to the employment opportunities within and around the city.

The area under Agriculture decreased from 10.2 square kilometres in 2002 to 3.8 square kilometres in the span of less than one and a half decade. On the other side the government's efforts to preserve the forest cover of the periphery resulted in increasing the area under tree cover from 6.7 to 9.03 square kilometres. It was possible due to efforts of the various government and private agencies to restore the land lost to development activities in the periphery. Area under tree cover increased due to the efforts of the Chandigarh Administration to restore the Sukhnachoe reserve forest to strengthen the green belt around the city.Vacant land declined in the area as development of residential and industrial hubs started to take place in the periphery. Majority of the vacant land was located around the existing settlements and built-up

areas. The vacant land slightly declined from 7.5 square kilometres to 6.2 square kilometres during the same period (figure 4). The area under Conversion is the area where at that time land was acquired by the government agencies and construction of residential as well as industrial buildings was being carried out.

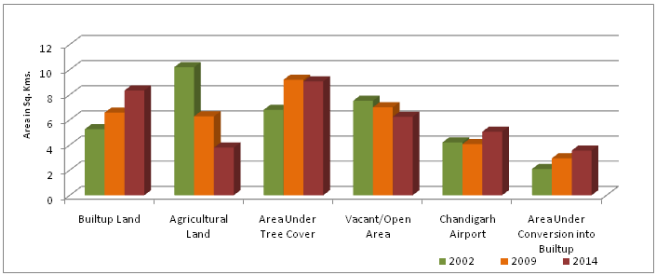


Figure 4 Land use and land cover Change, 2002-2014

Source: Derived from the analysis of Satellite Images in GIS environment, 2002-2014.

The area under conversion from non-built-up to built-up have grown from 2.09 square kilometres to 3.56 square kilometres in the given time period (Table 4). After 2000, many construction projects came into the periphery in order to fulfil the rising demands of local low income group. At the same time the area under the Chandigarh Airport increased from 4.21 square kilometres to 3.56 square kilometres (figure 5). The Chandigarh airport was extended and upgraded in its status and spatial extent from domestic to international during the same period.

Table 4
Land use and land cover Patterns, 2002 - 2014

Category	2002	2009	2014
Built-up Land	5.25	6.57	8.34
Agricultural Land	10.19	6.28	3.79
Area Under Tree Cover	6.79	9.19	9.05
Vacant/Open Area	7.51	7.00	6.25
Chandigarh Airport	4.21	4.06	5.06
Area Under Conversion into Built-up	2.09	2.94	3.56

Source: Derived from the analysis of Satellite Images in GIS environment, 2002-2014.

The vacant/open areas have been on constant move as the agricultural land get converted into the vacant land first before being converted into the built up land.The increasing pressure of population have its effect on the environment of Chandigarh periphery, many new residential colonies have come up in the past decade that have reduced the area under agricultural land.New settlements around the SukhnaChoe have increased the pollution in it. Industrial as well as the residential waste is dumped into it which have polluted the water and soil around the choe.According to CGWC(Central Ground Water Commission) in few well waters from very shallow zone, concentration of Fe more than 1.0 mg/l have been observed.Such waters are not suitable for domestic including drinking purposes.

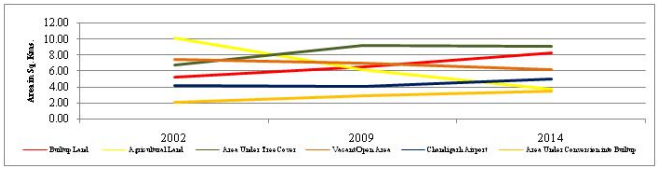


Figure 5 Land use and land cover Change, 2002-2014

Source: Derived from the analysis of Satellite Images in GIS environment, 2002-2014.

Drivers of Land Use and Land Cover Change

Chandigarh being the focal point of all the administrative a political power in the region has always been an attraction to the population searching for better standard of living and high income jobs. Chandigarh is emerged as the hub of educational facilities a number of educational institutes have emerged within the boundaries of the city as well as in the periphery. Large numbers of people come to Chandigarh in search of jobs and good source of income. Majority of the population coming from the surrounding areas tend to settle in the periphery of the city because of various factors such as high land rent in the city, high prices of property in the city, high density of population within the city, lack of vacant spaces within the city, less employment opportunities for lower class people and less education.

On the one side where it is difficult for the poor people to afford a house or rent a house within the city at the same time on the other side rich people move out of the city in order to construct better and bigger houses in the periphery. Along with the residential demands large scale industries basically assembly and distribution types have come up in the region which also require land to develop and grow.

This has led to the people settling in the nearby area such as in the periphery of the city and putting more pressure on the existing amenities and facilities. The demand for increased infrastructure has compelled the officials to take action and provide cheap housing complexes to the poor people. All this have transformed the periphery of the city beautiful from agricultural based to built-up.

III. CONCLUSIONS

To sum up, it can be inferred from the study that Chandigarh has emerged as an administrative, political and

educational hub in the region. It is seen as the perspective place to get good quality of life and to get better job opportunities. This has led to the large scale in migration to the city which city is unable to cope up with. This continuous pressure of population and demand for better housing and industrial infrastructure has forced the administrators to expand the limits of the city into the periphery and provide housing and industrial complexes. All this require proper planning and development administration or it will become another haphazard city in the world. So where on one side we are developing the urban areas and expanding into the periphery but at the same time it becomes important for us to preserve the agricultural and forest lands.

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