An Analysis Of Urban Expansion In And Around The Imphal City, Manipur

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Abstract

Understanding of urban sprawl analysis at the regional scale is of utmost importance in a wide range of application such as land-use planning and land management. Thus, in this study different prospects of time in a decadal manner such as 1988, 1998, 2008 and 2018 along with Landsat 5 and 8 images have been used. Prior to use, image enhancement procedures, for example, histogram equalisation, radiometric correction are done keeping in mind the end goal to enhance the perceivability and interpretability of the images. Thus, the images are being put as subset and classified into 5 land-use and land cover classes. Furthermore, Shannon Heterogeneity Diversity Indices (SHDI) and Landscape Shape Indices (LSI) in like manner helps in understanding the example and checke the arranged and impromptu nature of the examination region. Thus, the study area is been characterised by a large increase in the built-up land on the southern side as compared to the remaining sides.

Keyword: LULC, SHDI, LSI, Imphal city, Urban Sprawl.

Introduction

Without precedent for humankind's set of experiences, half of the populace keep an eye to live in metropolitan regions, which has lead to the urbanization on the planet. As urbanization is the way in to the advancement on the planet, urban communities and towns have been extending wherever all throughout the earth. Villages being changed quickly into towns and towns are again being changed into cities, which expanded metropolitan development (Jain et

al, 2016). Populace pressing factor and industrialization are the vital components behind a particularly remarkable change in spatial design. Populace contrasted with the inward piece of the urban communities compresses periphery or suburbia regions more (Hasnine,2020). Notwithstanding, in ongoing many years have seen fast urbanization and metropolitan populace developing bringing about never-ending suburbia of urban areas. Urban sprawl, also called sprawl or suburban sprawl, the rapid expansion of the geographic extent of cities and towns, often characterized by low-density residential housing, single-use zoning, and increased reliance on the private automobile for transportation. (Rahman et al, 2007). Urban sprawl is caused in part by the need to accommodate a rising urban population. However, in many metropolitan areas it results from a desire for increased living space and other residential amenities. (Garouani, et al 2017,. Liu,et al. ,2020, Ahmad, et al. 2016).

Never-ending suburbia have been related with expanded energy use, contamination, and gridlock and a decrease in local area peculiarity and cohesiveness. Moreover, by expanding the physical and ecological "impressions" of metropolitan regions, the wonder prompts the obliteration of untamed life territory and to the fracture of staying normal regions.(Rafferty, 2020).

In India, extraordinary populace development combined with spontaneous formative exercises and gigantic relocation has prompted the urbanization which needs foundation offices. This additionally has passed genuine ramifications on the asset base of the district. The urbanization happens either revolutionary way around a grounded city or directly along the interstates (Tewolde et al, 2011). This scattered settlement prompts never-ending suburbia. This has straightforwardly ramifications of such spread is the change in the landuse and landcover of a framework which eventually influences the accessible useful land (Dadras, et al, 2014).

This has likewise straightforwardly affected on the urban spaces of Manipur. Imphal city, the biggest urban place in Manipur with the populace more than 1 lakh has been

described by the fast pace of endless suburbia because of its power over different towns. The improvement per capita income of everybody just as the change in the interconnectivity of street in like way expects a gigantic work in the fast differentiation in LULC classes in the assessment zone. Along these lines dissecting at the local scale will be incredible assistance in the metropolitan arranging too. Besides, comprehension of endless suburbia at the territorial scale is fragmented without the utilization of transient information throughout some undefined time frame.

Thus, remote sensing offers a couple of focal points. It is a tolerably practical and speedy method for making sure about in the current style of information over a tremendous land and area inferable from its succinct incorporation and dreary assessments commonly picked up in cutting edge outline are more straightforward to control and analyze; they can be acquired from evident just as from ridiculous reaches that are imperceptible to natural eyes; they can be gotten from far off locales where receptiveness is a concern; and they give an unprejudiced viewpoint of land use/landcover classes.

Above all, the diversity indices, for instance, Shannon Heterogeneity Diversity Indices (SHDI) and Landscape Shape Indices (LSI) help in deciphering the model and organizing an unconstrained nature of present LULC components over some vague time period. Thus, when analyse the study area, there has been a large increase in the built-up land on the southern side as compared to the remaining sides.

Study area

The present research will be carried out at Imphal city and its fringe areas which lies between 24^{o} 51'N and 24^{o} 52'N latitude 93^{o} 53'E and 94^{o} 3'E longitude (Figure 1). Being the only large city in the state, Imphal enjoys a pre-eminent position in terms of economic activities, administrative services and even social influences on the lifestyle of people that inhabit the state. An important consequence of this primacy is the intense pull force that the city exerts, attracting activities from in and around the city leading to intensification of landuse within and around the city. The

city is now become the centre of gravity of the settlement system of Manipur by possessing all the premier functions of the State such as administration, economic, educational, cultural, political and judicial works. Trance Asian highway connects the city with Myanmar in the East and Nagaland in the North. Imphal city is rapidly expanding along the fringe areas and getting urbanized. There are also various built-up categories along the fringe areas.

Imphal city, the major urban centre in Manipur and the only city where the population as well as facilities are being concentrated is characterised with the increased in population mainly because of urbanization as well as well as migration of rural areas mainly results from the search of job opportunities. This creates a great pressure in the infrastructure of Imphal city.

The ongoing population growth and urbanization impacts the heavy land use change in and around the urban fringe which leads to the conversion of agricultural land to non agricultural land for its diversified use. Besides this, the increased in traffic congestion, lack of parking facility, flooding during rainy season due to lack of good drainage system, lack of water supply, improper maintenance of sewage system, urban heat island effect and environmental degradation also affects the urban area.

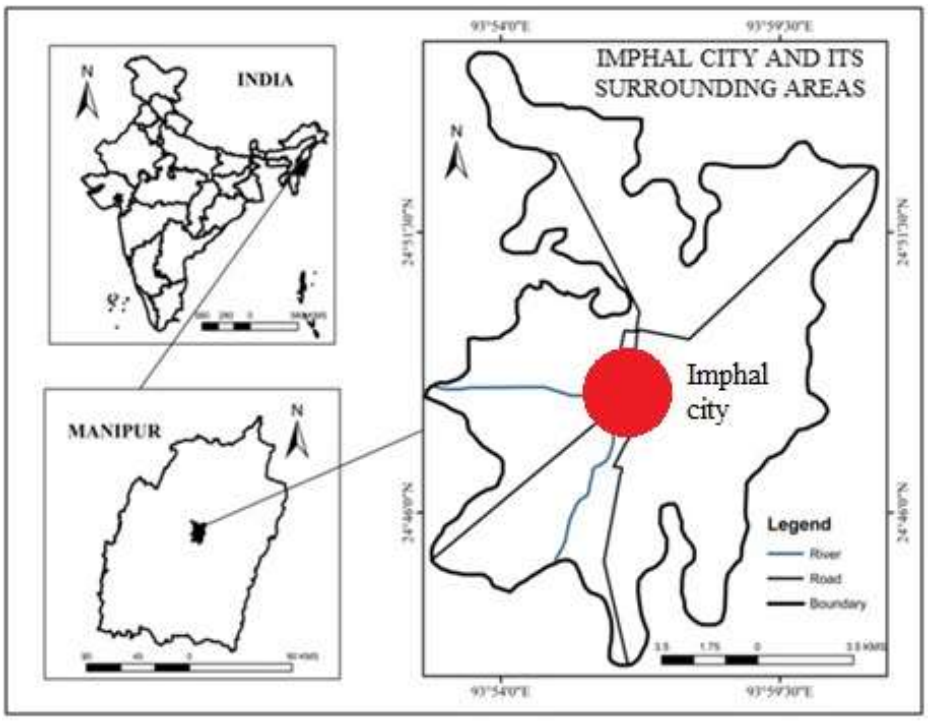

Figure 1: Study Area

Objectives:

To study the decadal change in urban sprawl in and around the Imphal city.

Data used and Methods

Being downloaded the geo -reference Landsat 5 TM and Landsat 8 TIRS/OLI images of 1988, 1998, 2008 and 2018 are from USGS site, they are being stack in Erdas 9.1 to get a composite image expect panchromatic image(for 2018) and thermal images. The dates of both the images are being as about as conceivable in a similar vegetation season. The subsets of the study area are being reckoned from the composite images. Before the image classification, image enhancement procedures, for example, histogram equalisation, radiometric correction are done keeping in mind the end goal to enhance the perceivability and interpretability of the images. The accessible auxiliary wellspring of information including research articles, government publication, books is being gathered.

To access and check the uncontrolled and impromptu elements of LULC classes in scantily or inflexibly and demonstrate scientifically a few lists, viz. Shannon Heterogeneity Diversity Indices (SHDI) and Landscape Shape Indices (LSI) are being ascertained at class level in Fragstats 4.2.1. SHDI provides more information about area composition than simply area richness (i.e the number of types of land cover present). It takes into consideration both the number of different land cover types (m) observed on the point and their relative abundances (Frerebeau, 2021).

In this proportion of species "i" relative to the total number of species (Pi) is calculated and then multiplied by the natural logarithm, of their proportion. The resultant product is summed across species and multiplied by -1.

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

LSI measures the perimeter to area for the landscape as a whole. The index quantifies as a whole. The index quantifies the amount of edges present in a landscape relative to what would be the present in the landscape of the same size but with a simple geometric shape and no internal edges. It is very identical to the shape index at the patch level except that is treated the entire landscape as if it were 1 patch and any patch edges as they belong to the perimeter. The landscape boundary must be included as edges in the calculation in order to use a circle or square standard for comparision. LSI is the total length of the edge involving corresponding class divided by the minimum length of class edges for a maximally aggregated class, a measure of class aggregation or clumpiness (Frerebeau, 2021). Higher the value of LSI, the less in the planned manner of the areas. Thus it is given by

$$LSI = \frac{0.25E}{\sqrt{A}}$$

Where, E= Total length of edges in landscape between class types including the entire landscape boundary.
A= Total area

Image classification and accuracy assessment

Each distinctive feature is identified by using different band combination methods among which the Standard False Colour Composite (Std. FCC) is the most efficient. Out of which, 5 features for 1988, 1998, 2008 and 2018 image are identified and classified such as Agricultural land, Built-up land, Forest land, Water and Wetlands (Figure 2). The subset images are compared and classified using Interactive supervised classification on Erdas 9.1 independently. Accuracy assessment such as the error matrix of both the classified images is used to prove the accuracy assessment. Overall, user's and producer's accuracies are also derived from the error matrices

Review of Literature

Angel (2007) define and present a comprehensive set of metrics for five dynamic attributes of urban spatial structure commonly associated with 'sprawl': (a) the extension of the area of cities beyond the walkable range and the emergence of 'endless' cities; (b) the persistent decline in urban densities and the increasing consumption of land resources by urban dwellers; (c) ongoing suburbanization and the decreasing share of the population living and working in metropolitan centers; (d) the diminished contiguity of the built-up areas of cities and the increased fragmentation of open space in and around them; and (e) the increased compactness of cities as the areas between their fingerlike extensions are filled in.

Polidoro et al (2012) aims to analyze the phenomenon of urban sprawl in the city of Londrina by means of geotechnologies and to identify the impacts that the form of land occupation the city has employed may cause on the current and future scenario of the municipality in general.

Rahnama et al (2013) aims in improving urban environmental quality and creating relation between natural structure and spatial –physical structures .

Goswami et al (2013) studies Land use/land cover pattern of Bhopal using LANDSAT ETM+ data. The land use/land cover patterns were visually interpreted and digitized using Arc GIS software. The study observed that agriculture area (67.51%) is dominant in Bhopal and its surroundings followed by forest area (13.77), settlement area (6.97%), wasteland area (8.74%) and surface water body area (3.02%) The study also recommends the use of open source satellite imageries for future environmental monitoring studies.

Mishra et al (2014) based their study carried out on solid waste management practiced by Yavatmal municipal corporation. This study was also designed to study the composition of solid waste in Yavatmal city.

Tan Yigitcanlar et al (2015) offers a critical review of the key literature on the issues relating to planning, development and management of sustainable cities, introduces the contributions from the Special Issue, and speculates on the prospective research directions to place necessary mechanisms to secure a sustainable urban future for all.

Manglem Singh et al (2016) analysed the decadal expansion of the Imphal city towards its fringe and ensuing land use /land cover changes in two different time periods (1989 and 2010). It is found out that that built up areas have grown into the fringe areas of the city at the expense of other landuse categories with serious implications for socio-economy and environment of the region

Joseph Zamchinlian Tungnung et al (2017) focused on monitoring urban landuse change over a period of 45 years (1970-2015), and to assess its impact on agriculture in Imphal city and its surroundings. The growing population was the main driving force of landuse change.

Results and discussion

Land use and land cover change analysis

The study area in the earlier days was characterised by the larger spatial extend of the agricultural land. It signifies the importance of agro-based economy at the local economy which was the perfect example of land utilization. It was sure that the study area was in the embrayonic stage of development in the earlier times

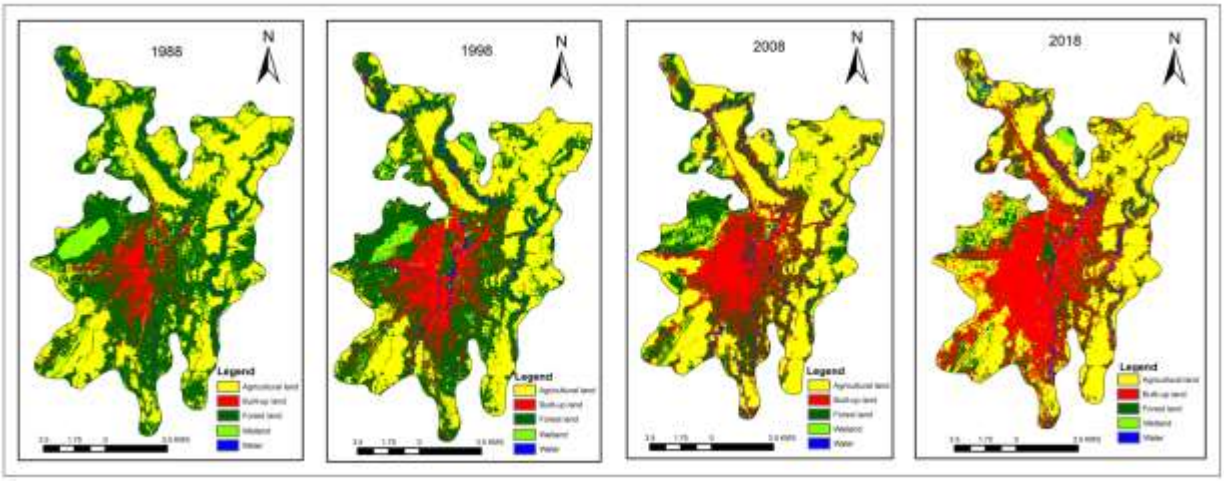

Figure2: Decadal Landuse and landcover

Table 1: Accuracy assessment for 1988, 1998, 2008, 2018

1988					
Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Wetland	2	1	1	50.00%	100.00%
Water	1	0	0	---	---
Agricultural land	12	12	12	100.00%	100.00%
Built-up land	2	2	2	100.00%	100.00%
Forest land	13	15	13	100.00%	86.67%
Totals	30	30	28		
Overall Classification Accuracy = 93.33%					
Overall Kappa Statistics = 0.8919					

1998					
Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Wetland	5	1	1	20.00%	100.00%
Water	1	1	1	100.00%	100.00%

Forest	9	13	9	100.00%	69.23%
Built-up land	6	4	4	66.67%	100.00%
Agricultural land	9	11	9	100.00%	81.82%
Totals	30	30	24		
Overall Classification Accuracy = 80.00%					
Overall Kappa Statistics = 0.7248					

2008					
Class	Reference	Classified	Number	Producers	Users
Name	Totals	Totals	Correct	Accuracy	Accuracy
Forest	7	4	4	57.14%	100.00%
Wetland	1	1	1	100.00%	100.00%
Water	0	0	0	---	---
Built-up land	5	5	3	60.00%	60.00%
Agricultural land	16	20	16	100.00%	80.00%
Totals	30	30	24		
Overall Classification Accuracy = 80.00%					
Overall Kappa Statistics = 0.6578					

2018					
Class	Reference	Classified	Number	Producers	Users
Name	Totals	Totals	Correct	Accuracy	Accuracy
Wetland	4	1	1	25.00%	100.00%
Forest land	3	5	3	100.00%	60.00%
Water	1	1	1	100.00%	100.00%
Agricultural la	12	13	11	91.67%	84.62%
Built-up land	10	10	8	80.00%	80.00%
Totals	30	30	24		
Overall Classification Accuracy = 80.00%					
Overall Kappa Statistics = 0.7115					

Table 2: Spatial extend over time

Features	1988	1998	2008	2018
Agricultural land	6447.12	6154.79	7786.47	7192.57
Built-up land	1103.77	2306.43	3353.13	5610.97
Forest land	8349.69	7145.46	4605.78	3054.43
Water	141.98	302.94	296.62	377.03

Wetland	387.44	520.38	388	195
Total	16430	16430	16430	16430

When compared 1988 with 1998, there has been the highest increased in the built-up land which the agricultural land and forest land shows a decreasing trend. It can be reasoned for the clearence of forest land for agricultural activities as well for the increase in the construction of new building to accommodate the increase in population (Figure 3). It is also seen (Figure 2) that the increased in the built-up land is highest to the south as compared to others and conversion from forest land to agricultural land has the highest spatial extend in the northern and eastern part of the study area.

However in 2008, there has highest increased in agricultural land and the great decrease in the forest land. It is due to the fact that there were mass clearance of forest for timber and expansion of agricultural land in order to support the vast agri-bussiness economy

But there has been a great change in the agricultural land and highly increased in the built-up land in 2018. It may be reason due to the urban primacy of the Imphal city that there has been the shift of economic activities. Another can be reason to the process of urban sprawl near the fringes as the number of satellite towns emerge around the Imphal city to accommodate the ongoing expansion of Imphal city.

When overally compared there has been highest increased in the built-up land towards the south. Amongst many reason one can be noted due to hilly terrin on the eastern and northern part hinders in the expansion of urban growth which there is less to the south as compared to the rest.

It can aslo be added as the loss in the wetlands over the period of time. The conversion of Heingang lake to the fish farm, Lamphel lake in Langol areas to agricultural land and the built-up land for the construction of various administrative building and hospital is the main reason behind the LULC change. Another major reason for the change in Lamphel lake is the contruction of building for the accomdation of athletes of National Games which Manipur hosted in 1997 (Manglem et al, 2016). It is also likewise seen on the eastern part of the study area for the conversion of wetland to built-up land near the Soibam Leikai areas on the errection of JNIMS in 1989.

Diversity indices

Amongst different features, the agricultural land and built-up land shows the singnificant increase over 30 years. Since the diversity indices only show the pattern of change over time where 0 indicates the complete clumpiness or the nucleated pattern and 1 shows the complete disperseness or the randomness of LULC, so the higher the value of the SHDI, tendency to the disperse increased in the with its value. So, it can be derived that the agricultural land has decreased upto an extend when compared from 1988-2018. It also suggested that a number of features have been changed from Agricultural land within this limit.

However, the built-up land shows the alternation as compared to the Agricultural land. The increased in SHDI (0.15 in 1988 to 0.35 in 2018) for built-up land coupled with the increased in LULC over period of time suggest the increased in haphazard way thereby. In other words, it is the strong suggestion of urban sprawl. Wetlands and water bodies doesn't show much alteration over the vast period. It singnifies that if there is change in LULC sepcially for those of low SHDI (table 3), it suggests that the changes are present but concentrated to few.

In the case of LSI, almost all the features except Water and Wetland shows the increasing trend in the later periods of time. However, in the beginging of study, all the features shows the increasing trend. The steady increased in the LSI shows the plannned manner in decreasing and increasing of a respective features. It can be pointed out from the steady increased in the population of the study area. However in 2018, all the features except, water and wetland show the uncontrolled increased in LSI. The increased in LSI for built-up land confirms the unplanned manner in the increase of built-up land. The likewise is seen in the Forestland and Agricultural land. It can be pointed out that the increased in the built-up land corresponds to the decreased in the agricultural and forest land. One can be pointed from the change in way of livelihood results in the construction of many buildings for the mass expansion of city area.

Table 3: Diversity Indices Dynamics over times

	SHDI	LSI

FEATURES	1988	1998	2008	2018`	1988	1998	2008	2018
Agricultural land	0.18	0.2	0.29	0.31	29.81	30.5	39	46
Built-up land	0.15	0.2	0.3	0.35	39.08	48.11	65	99
Forest land	0.11	0.12	0.13	0.22	48.21	55	68.9	89.36
Water	0.15	0.15	0.14	0.12	23.67	33.25	50.01	45
Wetland	0.31	0.33	0.14	0.12	12.7	26.33	22.89	27.96

Population Size

There has been a steady increased in the population of the study area. The study area does not folow the rank size rule which signifies high primacy over other towns. Thus, when compared with other years, 2011 has the least increased (Figure 3). But there has been highly change in LULC in 2018, which also tell that there has been a rise in many new functions in study area. This has resulted in the erection of many new buildings which of non residential types in the city areas but commute from the large distance as the cost of living is very high in the city region. It can also be added that there has been an increased in the number satellite towns over the study area also. This is also the main reason for the increases in the urban sprawl areas in the study region.

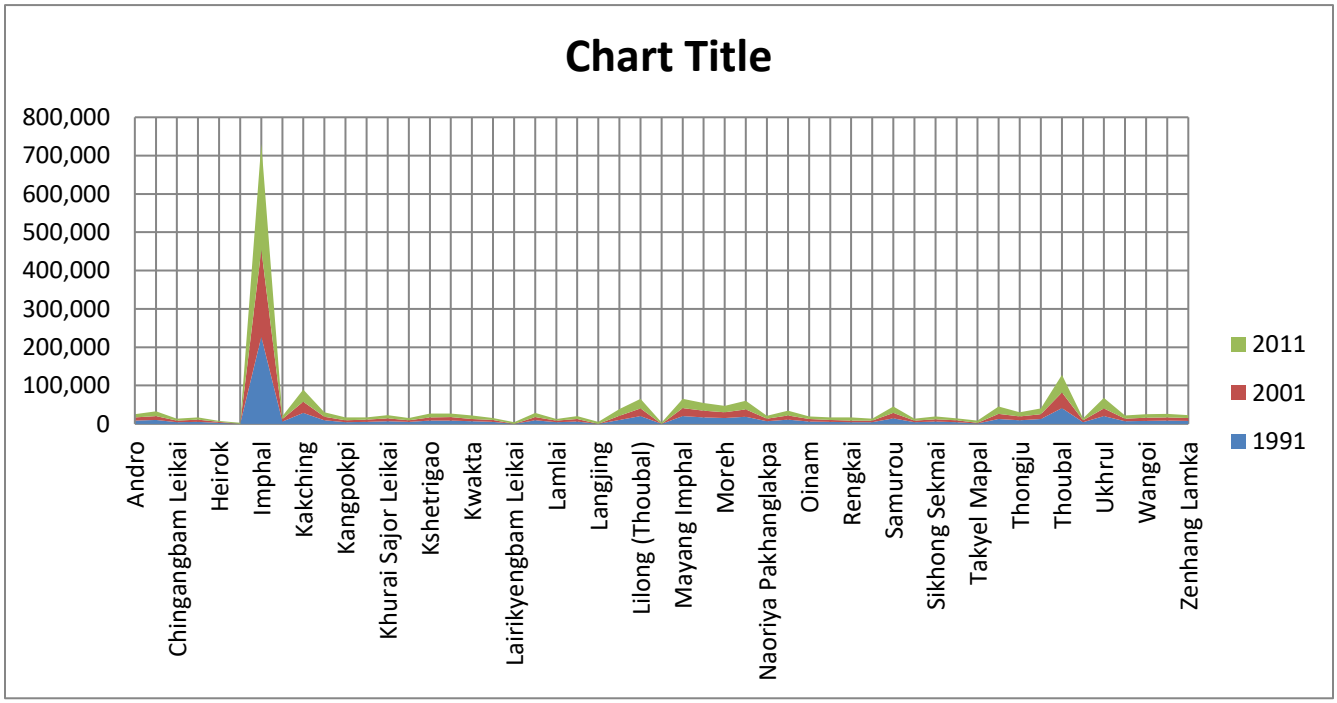

Figure 3: Population Size (1991-2011)

Source: Office of the Registrar General and Census Commissioner (web), Delimitation Commission of India (web), Rand McNally International Atlas 1994, School of Planning & Architecture (web).

Conclusion

It is cleared from the study that the quick increment of populace in study area is obtruding the agricultural land in the fringe of the urban focus too at the edge. The present spontaneous and uncontrolled change in present LULC classes will have a more noteworthy devastation in the study area. On the off chance that this present state wins later on, the city will lose the vicinity of the eco-friendly environment. Thus, a careful planning of land use is very much needed.Thus, the urgent planning of the satellite towns and the strict rules in buying and selling of land and heavy taxation on the alteration of productive land is a need in this hour.

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