

Population growth and changing land use land cover in Nagaon town and its fringe areas

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Abstract

Most of the urban areas often experience migration from adjoining rural areas and outside along with the diversification of functions and land use transformation. When an urban settlement of multi-functional character starts growing both horizontally and vertically along with lots of future potentialities, it has to bear immense pressure of population and diverse activities within a limited space. Such phenomena have also been observed in Nagaon town, the headquarters of Nagaon district, with an area of 11.91 km² and a population of 1,21,628 as per the 2011 Census. The growing population in the town, multiplying urban functions and scarcity of land have been exerting tremendous pressure on the land and environment of the fringe areas. In consideration of this, the present paper attempts to examine the extent of growth of Nagaon town in terms of population and land use change and its impact on its fringe areas during the last few decades. The study is primarily based on secondary data obtained from various Census of India volumes including the District Census Handbook for the period 1971-2011 and remote sensing data of Landsat MSS, Landsat TM and Landsat OLI for 1980, 2000 and 2018. The impact of urbanization on the fringe areas has been assessed through population growth rate, components of population growth and land use land cover change in varying spatial contexts during the last four decades. Broadly, the study reveals that the impact of Nagaon town on its fringe areas has been quite significant. The impact has been such that the fringe areas have experienced rapid growth of the population largely contributed by migration and considerable expansion of the built-up area, which have been even much faster than the town.

Keywords: *Population growth, land use land cover change, Nagaon town, fringe areas.*

Introduction

Urbanisation, a demographic phenomenon, is characterised by the large concentration of population in the form of towns and cities and transformation of land use and economic activities from agricultural to non-agricultural ones. Although the level of urbanisation still remains somewhat low in most developing countries, the absolute growth of the urban population has been quite alarming (Preston, 1979). India is one

of such glaring examples where the degree of urbanisation is only 31.16 percent, while in absolute terms its total urban population is 377.11 million, the second largest in the world after China (Census of India, 2011). The primate cities, which constitute the largest cities of each country, are found to draw a disproportionate influx of population from other areas (Preston, 1979). In fact, urbanisation is a process in which resources

are reallocated from agricultural to industrial activities, and people move from rural to urban areas (Sarkar, 2019). Besides industrialization and various other associated factors, the rapid increase of population in the urban areas also contributes to the improvement in infrastructural, educational and healthcare facilities. Moreover, the prevalence of better income opportunities often attracts people from neighbouring and far off places to the urban areas. Thus, the growth of the population of an urban area during a particular period of time involves the varying contribution of natural increase, migration and expansion of urban area boundary. In the absence of desirable planning exercises, such phenomenon often results in a haphazard growth of cities and towns, and as such sometimes it becomes unsuitable for living in such urban areas due to increased congestion and lack of adequate space. This is no less true in many urban settlements of different parts of the world, where unplanned rapid growth of population and urban functions, and associated environmental degradations in recent times has exerted tremendous pressure on the fringe areas (Ukoje, 2016). The pressure of such fast growing urban areas is reflected in the marked increase of population and somewhat visible transformation of land use and economic activities in the urban fringe within a short period of time.

So far Nagaon town of Assam, located on the bank of Kolong river and lying in the heart of Brahmaputra valley, is concerned, it has experienced a marked increase in population and transformation in land use within its municipal boundary during the last few decades. In fact, the impact of its rapidly growing population and urban functions during the last few decades is visible in

the considerable change in demographic character and land use pattern in the fringe areas. The increase in the population of the town from 56,537 to 1,21,628 during 1971-2011 has turned the urban environment congested for comfortable living. On the other hand, the fast-rising cost of land due to the growing scarcity of land in the town area has compelled many people to start settling in the more spacious and environmentally healthy fringe areas. However, in due course, besides the gradual transformation of land use pattern, these fringe areas have also started experiencing rapid population growth, which has even been higher than the corresponding growth rate in the town.

Objectives

The main objectives of this study are:

- i) to assess the Spatio-temporal pattern of population growth in Nagaon town and its fringe areas during 1971-2011; and
- ii) to examine the land use and land cover change in the study area during 1980-2018.

Database and Methodology

The present study is primarily based on secondary data obtained from government publications, such as District Census Handbook and Primary Census Abstract (PCA) for data relating to demographic characteristics like population size for the Census year 1971, 1991 and 2011. On the other hand, data regarding land use land cover change almost for the last four decades have been taken and downloaded from the United States Geological Survey (USGS) website (<http://glovis.usgs.gov/>). Accordingly, Landsat MSS data for February 1, 1980, Landsat TM data for January 12, 2000, and Landsat OLI data for January 29, 2018, have

been used. Necessary atmospheric correction, geometric registration, supervised image classification (using the maximum technique) and accuracy assessment of all such images have been performed. The accuracy of each class of the three classified images (1980, 2000 and 2018) has been checked with a stratified random sampling method, and an accuracy assessment is performed for each data error matrix for the classifications.

As the study area comprises Nagaon town (Area: 11.91km²) and its fringe areas (Area: 72.74 km²), it is delineated by including the municipal boundary of the town as per the 2011 Census and villages immediately surrounding it having been characterised by a mix of both urban and rural landscape (Fig.1). The entire Nagaon town fringe area so delineated up to a distance of around 6km from the municipal boundary comprises an inner fringe zone consisting of eleven villages immediately surrounding the municipal boundary and an outer fringe zone consisting of twenty-four villages surrounding the inner fringe zone. In fact, it has been selected as the study area to understand how the rising population, increasing urban functions, growing urban problems and scarcity of land, etc. in the town have brought about changes in the demographic and land use characteristics in the fringe areas.

Analysis and Discussion

Spatio-Temporal Pattern of Population Growth

The urban areas are characterized by the high concentration of population with accelerated growth, expansion of area and functions (Long, H., et. al, 2008). An urban settlement is a dynamic area that grows in its spatial extent with time along with population growth and

multiplicity of urban functions. So far, the Nagaon town is concerned; its population has increased from 4.43 thousand to 1.21 lakh by experiencing a growth of more than 27 times during 1901-2011 (Table 1) along with the gradual expansion of municipal area and associated urban functions. However, in recent times during 1971-2011, it experienced a growth rate of 1.93 percent which has been higher than the corresponding growth rate of a comparable town Tinsukia (1.89 percent).

Table 1: Trend of Population Growth in Nagaon Town, 1901-2011

Years	Total Population	Annual Growth Rate (in percent)
1901	4,430	-
1911	5,433	2.06
1921	6,885	2.39
1931	10,413	4.22
1941	12,972	2.22
1951	28,257	8.09
1961	38,600	3.16
1971	56,537	3.89
1981*	No Census held	No Census held
1991	93,350	5.14
2001	1,08,786	1.54
2011	1,21,628	1.12

**No Census was conducted in Assam due to disturbing situation.*

Source: Census of India, 1971-2001, District Census Handbook, Nagaon District, Assam

It may be mentioned here that, had there been no migration into the town and no municipal area expansion, the population of the town would have experienced an annual growth rate of 1.4 percent during 1971-2011 as indicated by SRS data of urban areas of Assam for the same period. It thus indicates

Table 2: Nagaon Town and the Fringe Area: Components of Population Growth, 1971-2011

Census Period	Total Population Increase	Contribution of different components of population growth and corresponding proportional share to total increase		
		Natural Increase ¹	Areal Expansion ²	Migration ³
1971-1991	36,813	20,212 (54.90%)	904 (2.45%)	15,697 (42.65%)
1991-2011	28,278	26,092 (92.27%)	2,257 (7.98%)	-71 (-0.25%)
1971-2011	65,091	46,304 (71.14%)	3,161 (4.86%)	15,626 (24.00%)

1. Based on SRS data of urban areas of Assam, Census of India, 1971-2011.
2. Based on the rural population density of Nagaon District, Census of India, 1991 and 2011.
3. Contribution of migration to a total increase of town population during a particular period = Total increase of population - (Natural increase + Increase due to area expansion).

Source: Census of India, 1971-2011, District Census Hand-Book, Nagaon District and Compendium of India's Fertility and Mortality Indicators, 1971-2013, Census of India

Table 3: Population Growth and Annual Growth Rate in Fringe Areas of Nagaon Town, 1971-2011

Town & Fringe Zones	Total Population			Annual Growth Rate in (%)		
	1971	1991	2011	1971-1991	1991-2011	1971-2011
Inner Fringe Zone	16,746	28,383	52,733	2.67	3.14	2.90
Outer Fringe Zone	23,668	35,268	56,212	2.01	2.35	2.18
Fringe Areas	40,414	63,651	1,08,945	2.29	2.72	2.51
Nagaon Town	56,537	93,350	1,21,628	2.53	1.33	1.93

Source: 1. Census of India, 1971, District Census Handbook, Nagaon District, Assam.
2. Census of India, 1991 & 2011, Primary Census Abstract, Nagaon District, Assam.

that besides the usual natural increase, the prevailing higher growth rate of the population of Nagaon town is attributed to migration and inclusion of new areas through the expansion of municipal boundary (Table 2). The component analysis of population growth also makes it further clear that the town experienced its population growth by 24 percent due to migration and 4.86 percent due to municipal area expansion during 1971-2011. However, between migration and area expansion, the contribution of migration had been more during 1971-1991 and area expansion during 1991-2011 (Table 2).

With the growing population pressure combined with increased urban functions and urban environmental problems, the Nagaon town has been exerting tremendous pressure on its fringe areas, which has contributed to the marked transformation of the rural landscape along with the rapid increase in population in the fringe areas. This phenomenon is reflected in its population size, which has increased from 40.41 thousand in 1971 to 1.08 lakh in 2011 by experiencing a growth rate of 2.51 percent as against 1.93 percent in the town (Table 3). Consequently, the population density (persons/km²) of the fringe areas has

Table 4: Components of Population Growth in the Fringe Areas of Nagaon Town, 1971-2011

Fringe Zones and Area Coverage	Census Period	Total population increase	Contribution of different components of population growth and corresponding proportional share to the total increase	
			Natural Increase ¹	Migration ²
Inner Fringe Zone (20.86 km ²)	1971-1991	11,637	6,853 (58.89%)	4,784 (41.11%)
	1991-2011	24,350	5,570 (22.87%)	18,780 (77.13%)
	1971-2011	35,987	12,423 (34.52%)	23,564 (65.48%)
Outer Fringe Zone (51.88 km ²)	1971-1991	11,600	9,686 (83.5%)	1,914 (16.5%)
	1991-2011	20,944	6,922 (33.05%)	14,022 (66.95%)
	1971-2011	32,544	16,608 (51.03%)	15,936 (48.97%)
Total Fringe (72.74 km ²)	1971-1991	23,237	16,539 (71.18%)	6,698 (28.82%)
	1991-2011	45,294	12,492 (27.58%)	32,802 (72.42%)
	1971-2011	68,531	29,031 (42.36%)	39,500 (57.64%)

1. Based on SRS data of rural areas of Assam, Census of India, 1971-2011.

2. Contribution of migration to a total increase of rural population during a particular period
= Total increase of population - Natural increase

Source: Census of India, 1971-2011, District Census Hand-Book, Nagaon District and Compendium of India's Fertility and Mortality Indicators, 1971-2013, Census of India

also increased from 555 per km² to 1498 per km² during 1971-2011. However, between the inner fringe zone and outer fringe zone, the prevalence of a higher growth rate of population in the inner zone (2.90 percent) is indicative of its more urban impact. This is a reflection of the fact that increasing pressure of population in the town has contributed immediately to the growth of population in the inner fringe areas, and this, in turn, has further exerted pressure in the inner fringe with consequent growth of population in the outer fringe zone. It may be mentioned here that the annual growth rate of the population of the outer fringe zone (2.18 percent) has also been higher than that of the town (1.93 percent) during the same period (Table 3).

The component analysis of population growth reveals that the increasing trend of population growth in the fringe areas of the

town during the last forty years (1971-2011) has been largely due to migration (57.64 percent). It means that the contribution of migration towards such a high growth rate of population in the fringe areas has been quite significant as compared to the town (Table 2 and Table 4). As a matter of fact, the development of various urban facilities, increasing educational institutions and diversity in occupations in the fringe areas have attracted a large number of people from neighbouring and other areas for various activities and functions. Consequently, in the course of time, many of such people started settling down in the fringe areas due to the prevalence of comparatively less cost of land and more open space unlike the costly and congested urban environment in the town. This phenomenon of migration has been found to be more intense during recent

times (1991-2011). Again, when compared between the inner and outer fringe zones, as expected the impact of migration has been more visible in the inner zone compared to the outer zone both in absolute and relative terms (Table 4). It is indicative of the fact that the fringe areas of Nagaon town have been growing quite fast in respect of population and associated economic activities, and thus it has great potential for urban development in near future.

So far spatial pattern of population growth in the entire fringe areas is concerned, it is found to vary significantly from one part of the fringe to another depending on the nature and extent of the urban impact. Accordingly, in the case of the inner fringe zone, the population growth rate has been quite high in the southern part during 1971-1991 and the eastern part during 1991-2011 due to the prevalence of better accessibility (Table 5 and Fig. 2). On the other hand, in the case of the outer fringe zone, the growth rate

has been considerably high in the northern part during the entire period of 1971-2011 and the western part during 1991-2011 due to a gradual increase of non-agricultural activities (Table 5 and Fig. 2).

Land use/land cover change

Land use and land cover change (LU/LC) has been recognized as an important force of environmental change on all spatial and temporal scales (Turner et. al., 1994). The monitoring of land use change is essential for assessing urban growth and development trends (Mundhe and Jaybhaye, 2014). The rapid growth of population, urbanization and industrialization exert substantial pressure on land, where human activities are performed, and often bring about environmental degradation. Urban growth and development also result in the decline of landscape diversity, amplification of urban dominance, and making overall landscape mosaics more continuous, homogenous and clumped (Dewan et. al., 2012). The land use pattern

Table 5: Nagaon Town: Population Growth in the Inner and Outer Fringe Zones, 1971-2011

Fringe	Total Population			Annual Growth Rate (%)		
	1971	1991	2011	1971-1991	1991-2011	1971-2011
Inner Northern Fringe	4,227	6,830	11,514	2.42	2.64	2.53
Inner Eastern Fringe	-	4,383	11,224	-	4.81	-
Inner Southern Fringe	5,075	11,342	19,550	4.10	2.75	3.42
Inner Western Fringe	7,444	5,828	10,445	-1.21	2.96	0.85
Inner Fringe Areas	16,746	28,383	52,733	2.67	3.14	2.90
Outer Northern Fringe	4,975	9,983	19,549	3.54	3.41	3.48
Outer Eastern Fringe	4,806	7,250	8,428	2.07	0.75	1.41
Outer Southern Fringe	8,856	11,871	16,726	1.47	1.72	1.60
Outer Western Fringe	5,031	6,164	11,509	1.02	3.17	2.09
Outer Fringe Areas	23,668	35,268	56,212	2.01	2.35	2.18

Source: 1. Census of India, 1971, District Census Handbook, Nagaon District, Assam.
 2. Census of India, 1991 and 2011, Primary Census Abstract, Nagaon District, Assam.

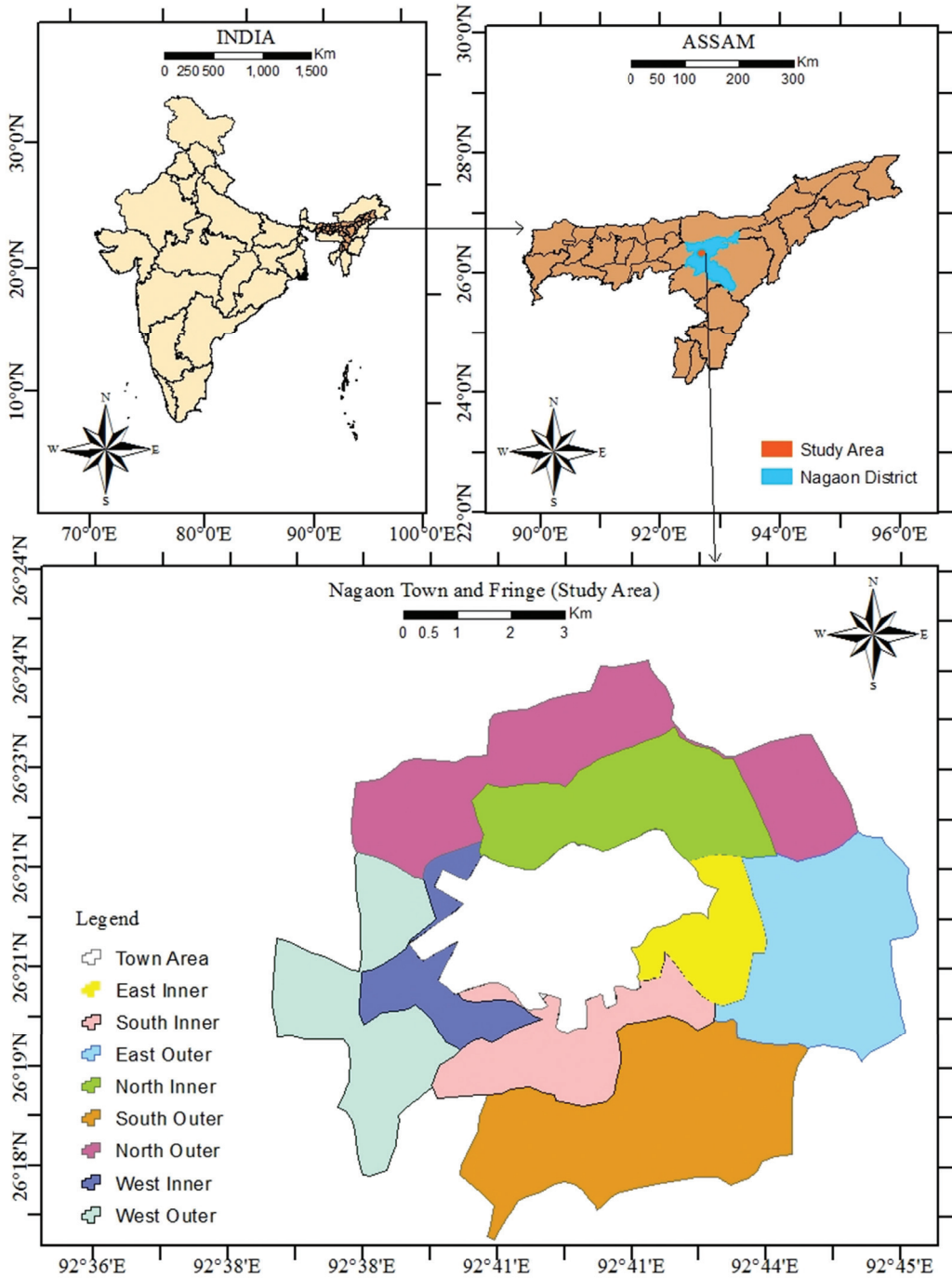


Fig 1: Location of the study area

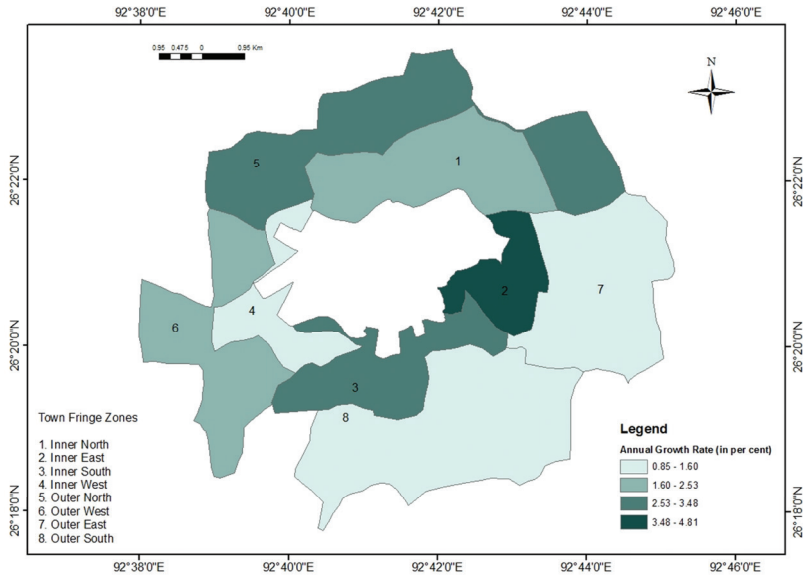


Fig. 2: Pattern of Population Growth in Nagaon Town and the Fringe Areas, 1971-2011

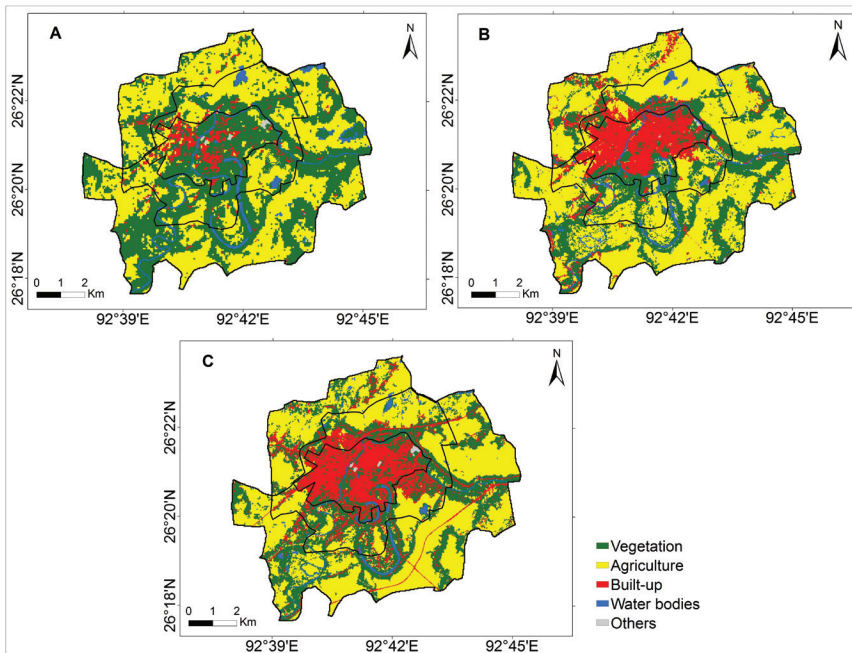


Fig. 3: Land use/cover of Nagaon town and its fringe areas;
(A) 1980 (B) 2000 (C) in 2018

of any urban area basically depends on the population growth and increasing diversity in economic activities. The land use change in an urban area and beyond is a common phenomenon more particularly in developing countries due to fast growing population and multiplicity of urban activities. The Nagaon town in this respect is also no exception. The fast-growing population and urban functions in the town, which has exerted considerable pressure on its land, environment and urban services, has brought about a marked change in land use in the town and its fringe areas during the last few decades. Thus, in order to understand the nature and extent of spatio-temporal change of land use in Nagaon town and its fringe areas, the land use land cover

(LULC) data have been broadly classified into five categories, viz. water bodies, built-up, vegetation, agriculture and others (Table 6).

So far land use land cover changes in Nagaon town and its fringe areas together during 1980-2018 is concerned, while it witnesses a considerable increase in built-up area at the expense of vegetation cover, the agricultural land has experienced slight increase due to conversion of large area under vegetation into agricultural land in the fringe areas, where mainstay of many people still continues to be agriculture (Table 8; Fig. 3). In the case of the municipal area alone, the growth of built-up area has been so fast that the vegetation cover has been on the marked decline and agricultural land

Table 6: Description of Land Use Land Cover Types

LULC type	Description
Vegetation	Herbaceous plants, shrubs and bushes, trees.
Agriculture	Cropland, orchards, pastures, plantation, fallow land.
Built-up	Residential, commercial, industrial, and transportation facilities areas.
Water bodies	River, lake, streams, wetlands, fishing ponds.
Others	Parks, garden, playground, stadium.

Source: Based on the general scheme of first level classification of land use and land cover.

Table 7: Land use/Land cover change of Nagaon town and its fringe areas, 1980-2018

LULC categories	Area in hectare			Area in Percent			Percentage of relative change		
	1980	2000	2018	1980	2000	2018	1980-2000	2000-2018	1980-2018
Vegetation	3789.79	2354.94	2615.49	45.82	28.47	31.62	-17.04	3.15	-13.89
Agriculture	3799.41	4435.74	3960.99	46.28	53.64	47.89	7.33	-5.75	1.58
Built-up	340.33	1152.81	1444.41	4.11	13.95	17.48	9.86	3.53	13.39
Waterbodies	313.89	303.84	234	3.79	3.67	2.83	-0.1	-0.84	-0.94
Others	26.89	22.68	15.12	0.32	0.27	0.18	-0.05	-0.09	-0.14
Total	8270.01	8270.01	8270.01	100.00	100.00	100.00			

Source: Based on Remote Sensing Data (Landsat TM, MSS, OLI) for 1980-2018.

Table 8: Land use/cover change of Nagaon town, 1980-2018

LULC Categories	Area in hectare			Area in percentage			Relative change of area in percentage		
	1980	2000	2018	1980	2000	2018	1980-2000	2000-2018	1980-2018
Vegetation	714.93	301.53	316.44	62.52	26.36	27.67	-36.16	1.31	-34.85
Agriculture	126.17	55.45	5.63	11.03	4.85	0.49	-6.18	-4.36	-10.54
Built-up	223.31	730.56	773.6	19.54	63.89	67.66	44.35	3.77	48.12
Waterbodies	61.88	49.73	33.22	5.41	4.35	2.90	-1.06	-1.45	-2.51
Others	17.23	6.25	14.64	1.50	0.55	1.28	-0.95	0.73	-0.22
Total	1143.52	1143.52	1143.53	100.00	100.00	100.00			

Source: Based on Remote Sensing Data (Landsat TM, MSS, OLI) for 1980-2018.

Table 9: Land use/cover change of Inner fringe of Nagaon town, 1980-2018

LULC categories	Area in hectare			Area in percentage			Percentage of relative change		
	1980	2000	2018	1980	2000	2018	1980-2000	2000-2018	1980-2018
Vegetation	978.00	642.37	786.57	44.81	29.43	36.04	-15.38	6.61	-8.77
Agriculture	1041.33	1212.34	925.29	47.71	55.55	42.39	7.84	-13.16	-5.32
Built-up	63.24	210.69	387.41	2.90	9.66	17.77	6.76	8.11	14.87
Waterbodies	95.27	114.44	82.81	4.36	5.24	3.79	0.88	-1.45	-0.57
Others	4.77	2.6	0.36	0.22	0.12	0.01	-0.1	-0.11	-0.21
Total	2182.61	2182.44	2182.44	100.00	100.00	100.00			

Source: Based on Remote Sensing Data (Landsat TM, MSS, OLI) for 1980-2018.

on the disappearance (Table 8). It is, in fact, indicative of lack of further possibility of growth of the built-up area in the town. Moreover, the Kolong river passing through the town has become a solid waste dumping site for the urban dwellers, and thus been polluting the river bank and making it unfit for human habitation (Bora and Goswami, 2016).

The scenario of land use land cover change in the fringe areas of Nagaon town has been somewhat different from that of the town. Here, unlike the town area, there has been slow growth of the built-up area as a consequence of slow shrinkage of the area under vegetation cover. As many

people including some migrants initially settled in the fringe areas for habitation, they started clearing vegetation cover largely for expansion of area under agriculture and marginally for construction of houses, the area under agriculture has witnessed a slight increase during 1980-2018 (Table 9 and Table 10; Fig. 3). However, in view of the prevalence of higher urban impact on the inner fringe, unlike in the outer fringe, it has experienced a marked increase in a built-up area and a slight decrease in agricultural land. This particular phenomenon is reflected in the considerably higher relative increase of built-up area in the inner fringe (14.87 percent) as compared to

Table 10: Land use/cover change of Outer fringe of Nagaon town, 1980-2018

LULC categories	Area in hectare			Area in percentage			Percentage of relative change		
	1980	2000	2018	1980	2000	2018	1980-2000	2000-2018	1980-2018
Vegetation	2062.27	1504.35	1510.02	42.04	30.45	30.56	-11.59	0.02	-11.48
Agriculture	2632.77	3169.44	3031.92	53.68	64.15	61.36	10.47	-2.79	7.68
Built-up	50.44	115.74	281.97	1.02	2.35	5.71	1.33	3.36	4.69
Waterbodies	155.73	137.16	116.73	3.17	2.77	2.36	-0.4	-0.41	-1.41
Others	4.87	13.95	0.1	0.09	0.28	0.01	0.19	-0.27	-0.08
Total	4906.08	4940.64	4940.74	100.00	100.00	100.00			

Source: Based on Remote Sensing Data (Landsat TM, MSS, OLI) for 1980-2018.

Table 11: Change Matrix for each compared LULC type, 1980-2018 (Area in hectare)

LULC class	Waterbodies	Built-up	Vegetation	Agriculture	Others	Total (1980)
Waterbodies	126.30	23.40	89.49	74.61	0.09	313.89
Built-up	2.67	270.35	33.07	33.97	0.27	340.33
Vegetation	69.30	920.57	2114.20	684.1	1.62	3789.79
Agriculture	35.28	225.50	374.08	3110.52	1.08	3799.41
Others	0.45	4.59	4.65	2.07	15.25	26.89
Total (2018)	234	1444.41	2615.49	3960.99	15.12	8270.01
Image difference	-79.8	1104.08	-1174.3	104.53	-11.77	

Source: Based on Remote Sensing Data (Landsat TM, MSS, OLI), for 1980-2018.

that of the outer fringe (4.69 percent) during 1980-2018 (Table 9 and Table 10). Moreover, due to the construction of NH-37 bypass on the south and eastern parts of the town fringe, there has been the growth of built-up land in this area in recent times (Fig. 3).

From the overall land use land cover change analysis of the town and fringe areas together, it is found that there has been a marked increase of built-up area during the period 1980-2018 primarily at the expense of large vegetation cover in the fringe areas (Table 11). This is indicative of the growing pressure of population and expanding urban induced diverse economic activities in the fringe areas during the last few decades.

Conclusion

The foregoing discussion reveals that the high growth rate of the population as experienced by Nagaon town largely due to migration particularly during 1971-1991 has exerted tremendous pressure in the surrounding fringe areas. The impact has been observed in the fringe areas in terms of rapid population growth along with the marked increase in population density and consequent considerable change in land use and land cover. In view of the town reaching a kind of saturation with respect to population growth and multiplication of urban functions, the fringe areas have been witnessing an increased growth rate of the population over

time largely due to the growing volume of migration. This is very much reflected in the gradual shrinkage of vegetation cover and expansion of the built-up area. This phenomenon of transformation is, however, more pervasive in the inner fringe. On the other hand, although population size and built-up area of outer fringe have been growing even faster than the municipal area, the process of shrinkage of agricultural land has not been so visible as yet. Hence, all these developments call for urgent urban planning strategies for balanced and sustainable urban development in the area.

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