

**POPULATION AND URBAN SPRAWL IN LUCKNOW CITY: PROBLEMS & PROSPECTS****Upendra Bhai Patel and B.L. Teli**

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**Abstract:** *An unprecedented population growth and migration, and increased urban population and urbanization are inadvertent. These urban ecosystems are a consequence of urbanization through rapid industrial centers and blooming up of residential colonies, also became hub of economic, social, cultural, and political activities. Urbanization, as such, is not seen as a threat to the environment and development, but it is the unplanned urbanization and subsequent urban growth, or the sprawl that affects the land-use of any region prone to extensive urbanization with loss of prime agricultural lands. Therefore there are certain demographic, physical, economic, social and environmental and lastly governance factors which contribute to this phenomenon of sprawl. Ideally, the growth that takes place around urban areas should be channeled in an orderly manner that will produce an economically efficient, socially and personally satisfying living environment. In practice, ideal growth can hardly be achieved due to many practical reasons. But, it can be said that growth is a phenomenon, it can be guided to prevent it from becoming sprawl.*

**Key words:** Urban sprawl, Urban-rural fringe, Migration trend, LU/LC change, GIS

**Introduction**

In industrial countries the future growth of urban populations will be comparatively modest since their population growth rates are low and over 80 percent of their population already live in urban areas. Conversely, developing countries are in the middle of the transition process, when growth rates are highest. The transition drifts from agricultural employment, high overall population growth and increasing urbanization rates. In the initial stages, development in the form of service centers such as shops, cafeteria etc. is seen on the roadside, which eventually become the hub of economic activities leading to sprawl. This type of upsurge caused by a road network between urban / semi-urban / rural centers is very much prevalent and persistent in most places in India. Biggest challenge is to ensure adequate housing, sanitation and health, and transportation services in a habitable urban environment in developing countries. Sprawl is seen as one of the potential threats for such developing and for better management of resources in developing country. Hence, it is very essential to understand the phenomenon of urban sprawl.

**Literature Review**

There are so many studies done by Geographers, Planners, and Scientists & Researchers in the concerned study area. Er. Rajeev Shekhar et al. prepared a land use land cover map of the concerned area. Swadesh Kumar et al. (2013) also described the assessment of land use around highly populous business centre. Another study done by Pathak et al. (2009) he described that the issues arising from unplanned and rapid urban growth, developing countries could significantly gain from the information generated using advanced technologies such as satellite Remote Sensing, Geographical Information System (GIS), Global Positioning System

(GPS) and LiDAR etc. for generating appropriate plans and strategies for sustainable development of urban environment. Venkatesh Dutta et al. (2010) described that migration lead to large-scale urban sprawl and the inherent distinctiveness of hydrological environment is being neglected in urban planning. With the expansion of the urban sprawl and the increasing population, there has been a surmounting pressure on a) natural and built drainage systems b) surface/subsurface hydrological storage units, of Lucknow. The anthropogenic factors have also contributed to the presence of heavy metals in the hydrological units of the city. Up to now the regeneration of water by nature kept the surface and subsurface water ecosystem pure, satisfying the urban and peri-urban requirements.

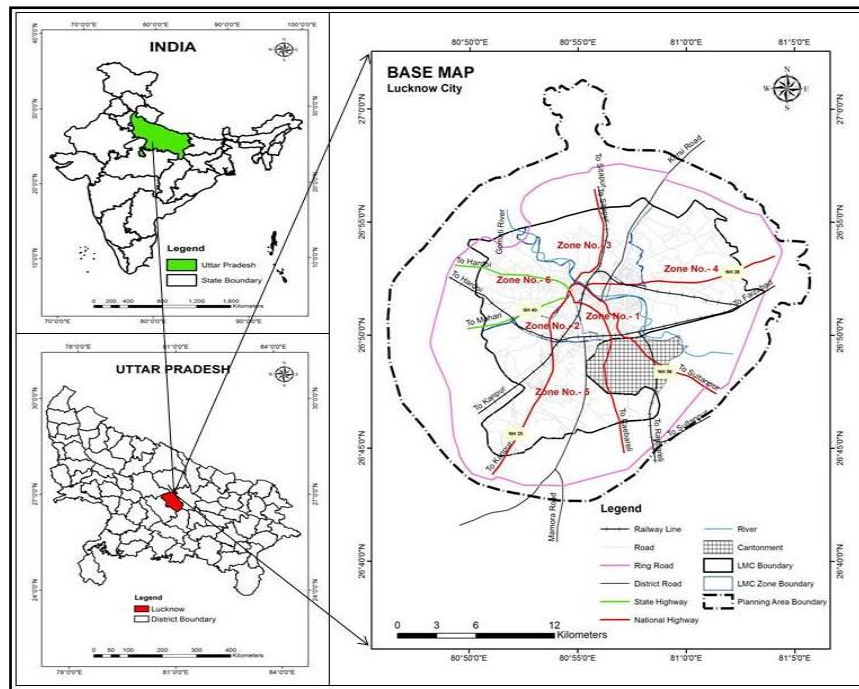
An assessment of the relative contributions of various factors that causes unregulated spatial expansion is very important to understanding the dynamics of urban population growth (Bhagat, 2011). The natural increase, net rural-urban classification and rural-to-urban migration are some of the important components of urban growth. Economists believe that three underlying forces—population growth, rising household incomes, and transportation improvements—are responsible for this spatial growth (Mieszkowski and Mills, 1993). Brueckner (2000) describes three types of market failures which may lead to excessive spatial growth of cities. The first arises during the process of urbanization, when economic agents fail to take into account the social value of open space and greenbelt. The second type of market failure arises due to failure on the part of urban dwellers to recognize the social costs of congestion created by their use of the transportation network, which leads to excessive commuting and congestion. Finally, the third market failure arises from the failure of public and private real estate developers to take into account all of the public infrastructure costs generated by their development projects. Thus, development appears artificially cheap from the developer's point of view, but encourages excessive urban growth making enabling infrastructure to function below standard.

### **Study Area**

Lucknow is the capital city of Uttar Pradesh in India, also the administrative headquarters of Lucknow District and Lucknow Division. Located in what was historically known as the Awadh region at an altitude of about 128 meters above the mean sea level and lies on 26.85°N latitude and 80.92°E longitude. Well Connected to all the four major regions and divisions of Uttar Pradesh like Pachimanchal, Purvanchal, Madhyanchal, Budelkhand and also to the major cities like Delhi, Kanpur, Jhansi, Varanasi and Gorakhpur towards the eastern side of Uttar Pradesh. The Gomti River, the chief geographical feature, meanders through the city, dividing it into the Trans-Gomti and Cisa-Gomti regions. Lucknow is situated about 500 km southeast of New Delhi, in the heart of the great Gangestic plain. Lucknow city is surrounded by its rural towns and villages like the orchard town of malihabad, historic Kakori, Mohanlal ganj, Gosainganj, Chinhat. Itaunja. While Lucknow city has an area of 310 sq. km in 2011, the Lucknow Agglomeration consists of the Cantonment as well. The Urban Agglomeration area is 340 sq. km. The population of the city is 28.15 lakhs (Census 2011) and 55.45 lakhs for the urban agglomeration.

It is imperative to understand that sprawl cannot be acknowledged by problems alone. Certain factors are responsible for sprawl which may provide it a positive connotation or a negative. This has to be decided by the study that it proves to be a problem or a potential. The two major problems with urbanization trend are its growing rate and the area it swallows to accommodate the urban.

**Figure 1: Location of the Study Area**



## Objective

The main objective of the research is to develop plan for urban growth forecasting and it's planning. The research is aimed at demonstration of planning for complex urban sprawl in this study. Research objectives in this broader scenario are as follows:

- To study the phenomenon and identify the causative factors for urban sprawl.
- To suggest planning strategies for and integrated and planned development.

## Database and Methodology

The data collection is done from both primary and secondary data sources. The primary data collected by field survey. The secondary data is from the office of Town & Country Planning Organization, Lucknow Development Authority, Office of Registrar General of India, Lucknow and also collected from Lucknow Municipal Corporation. Top sheets are collected (1:50,000) from the Survey of India, Lucknow. The pattern of urban sprawl, its magnitude and effects on Land use/Land cover (LULC) will be identified with the help of temporal data of primary and secondary (satellite images (Google Earth) & ancillary data) and also field survey & ground truth. The collected data will be analysed by using Remote Sensing & Geographical information system (GIS) techniques. GIS software will be utilized for database generation and integration/analysis. Vector database will be created by using GIS. It is used for preparing of maps. In this study is also used other statistical techniques for preparing of graphs & charts.

## RESULT & DISCUSSION

### Urbanization Trend in India

Table 1 clearly depicts the picture of urbanization this urbanizing scenario. The total population is growing at a very rapid rate and so is the urban population which has reached a rate of 32.18 percent in 2011. The urban population growing rate can be attributed to two major growth components i.e. natural growth and in-migration. This phenomenon is in turn having an impact on cities which are becoming more and bigger and the urbanization rates increasing at a very fast pace. This also had an impact on the growth on urban land area, reduction in agriculture land, and increase in number of towns and hence increasing there by the population in Class 1

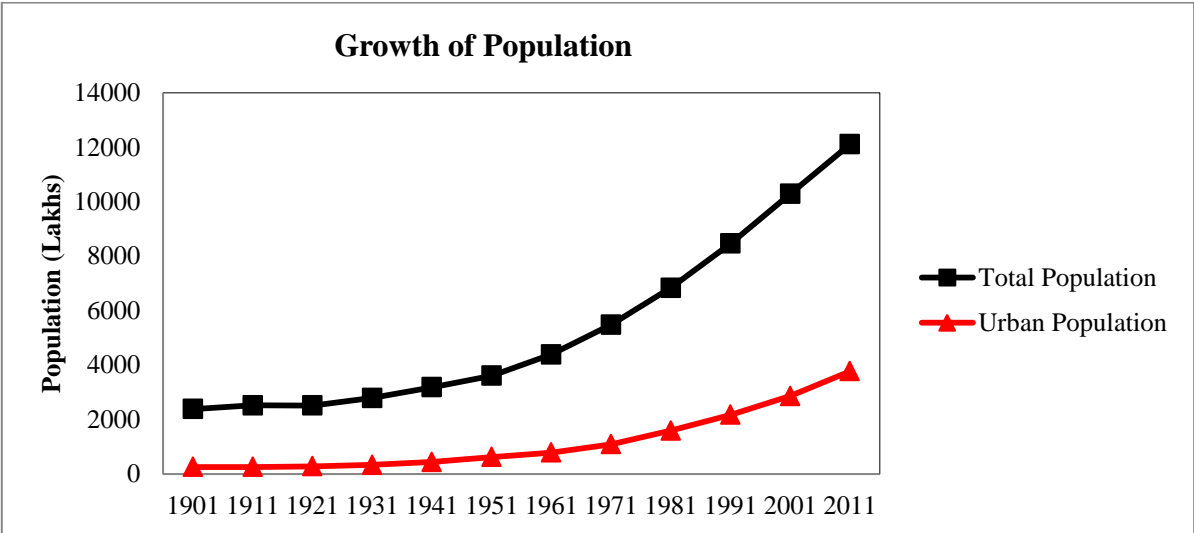
cities table 2 describes the trade of growing population in class 1 cities (having population more than 1 million) as compare to any other class cities. Figure 2 shows the growing population of India from 1901 till 2011. The rising urban population is increasing the stress on the urban land and thereby increasing the load and its usage.

**Table 1: Urbanization trend in India from 1901 to 2011**

Year	Total Population in Lakhs	Urban Population in Lakhs	Urban Population (percent)	No. of UAs/Towns
1901	2383.96	258.55	10.8	1830
1911	2520.93	259.48	10.3	1815
1921	2513.21	280.91	11.2	1944
1931	2789.77	334.62	12.0	2066
1941	3186.60	441.62	13.9	2253
1951	3610.88	624.44	17.3	2822
1961	4392.35	789.37	18.0	2334
1971	5481.60	1091.14	19.9	2567
1981	6833.29	1594.62	23.3	3347
1991	8464.21	2175.66	25.7	3769
2001	10287.37	2861.19	27.8	5161
2011	12105.69	3771.06	31.2	7935

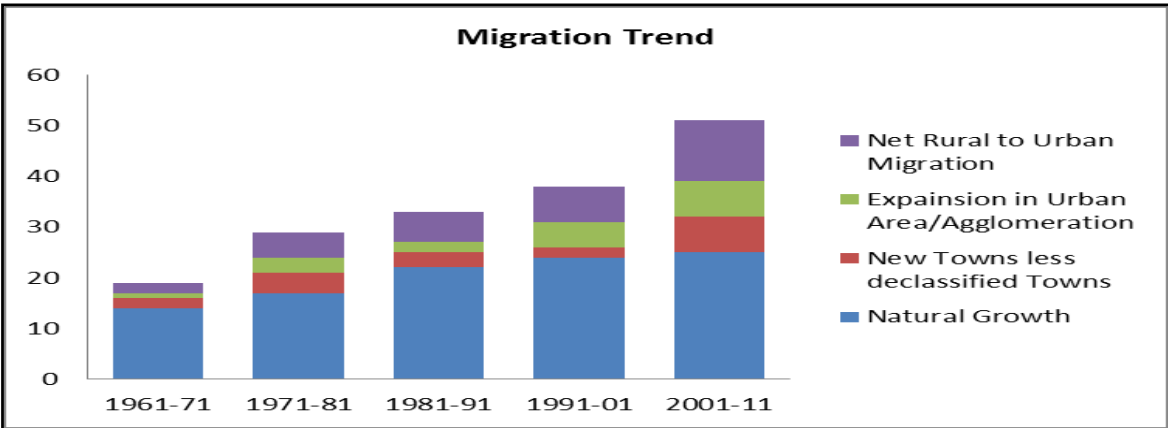
Source: Office of the Registrar General, India

**Figure 2: Growth of Total Population and urban population from 1901 to 2001 in India**



Source: Census of India, Urbanization in India Statistical Unit

**Figure 3: Migration Trend from 1961-2011**



Source: Census of India, IIHS Analysis on Migration

Tracing the rate of change of the component of urban growth from 1961-71 to 2001-11, the rate of nature growth has declined from 59 percent in 1991-01 to 44 percent in 2001-11, whereas the estimated rate of net urban migration has marginally increased from 21 percent in 2001-11. This rapid rate is a result of free – market economy and high population influx which leads to SPRAWL. (Refer fig. 3)

To achieve sustainable urbanization is known to be an outcome of improper planning, inadequate policies and lack of good governance due to various reasons. Inability of the planning machinery to visualize problem area of sprawl and its growth is persistent with the lack of appropriate spatial information and indicators. Lopsided development activities have led to large-scale deforestation and about 30 percent of land has become barren or unproductive. It is thus imperative to study and bring out the intricate and implications associated with the problem of unplanned urban growth or the sprawl. Thus, in the present context, with the escalating pace of urban sprawl, the challenges for further research is to arrive at an integrated spatial planning support system to effectively plan, review and evaluate the different policy option while capturing the dynamics involved.

The investigation of patterns of this kind of growth is very crucial from regional planning point view to provide basic amenities in these regions. It is essential for authorities concerned with administration and management of urban area and urban development to adopt integrated approaches in regional planning while addressing the need of its stakeholder's and manage the resources sustainably. This also necessitates proper planning to manage the urban growth and to mitigate the pressure on natural resources and environment while catering to the need of the economy that sustains these urban areas. It is this philosophy that drive, sustainable development, essentially addressing to balance both economics development and environmental, not only for the present but also for the future generation. Urban growth patterns resulting in sprawl are 'unsustainable'. With the current consumption surging ahead of regions carrying capacity and leading to depletion of natural resources for future generations.

The need for managing urban sprawl also arises out at the global concerns of achieving sustainable urbanization. The study of this kind reveals the type, extent and nature of sprawl taking place in a region and the drivers responsible for the growth. This would help developers and town planners to project growth pattern and facilitate various infrastructure facilities. In this direction, an attempt is made to identify the sprawl pattern and the reasons for this growth outside defined boundaries which result in fringe development.

Hence the study shall aim understanding the major factors of urban growth which are:

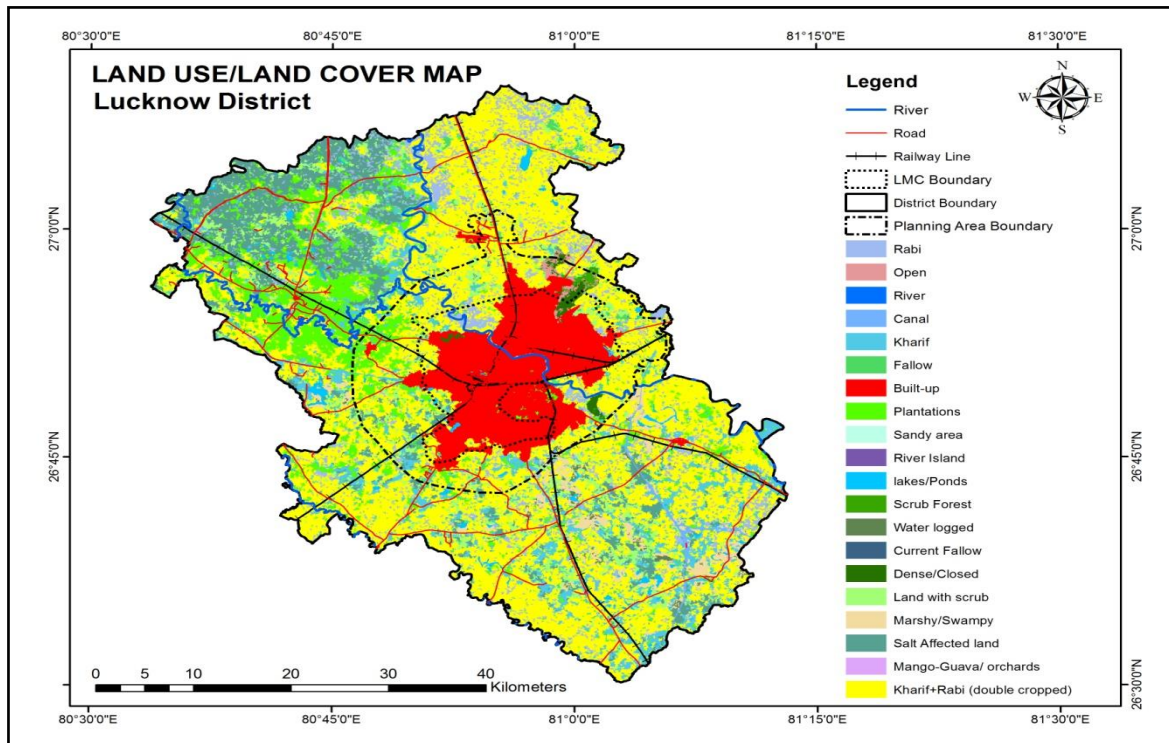
- Population increase due to natural growth
- population increase due to in-migration
- Boundary change
- De-classifications

### **Sprawl in Lucknow**

Sprawl is a very natural phenomenon for any urban Centre which is driven to various push and pull factors occurring within the city. Lucknow has witnessed a great amount of urban expansion in the last few decades. This urban growth, though occurring in the planning area (which is supposed to be under the jurisdiction of the Development authority and reserved for planned developed mentioned in the Master Plan) has seen uncoordinated growth which gives it the name as SPRAWL. The detail study is only done for the inner fringe in the course of the thesis to highlight the issues associated with these specified areas designated for planned

developments seeing unplanned growth. The triggering factors that give rise to such a process or phenomenon have been discussed in the next chapter.

**Figure 4: Land Use/Land Cover of the Lucknow District**



Source: National Natural Resources Census, National Remote Sensing Centre, ISRO, Dept. of Space, Hyderabad

But, how can we actually say that whether sprawl is a phenomenon characterizing the Lucknow city. For this reason the Google imagery was overlaid with the different boundaries to see the growth pattern of the city. It was found that the city is witnessing rapid growth along the corridors and specifically outside the city limits which further confirms its existence as sprawl. Also the ribbon, low density development typically characterizing sprawl is witnessed in the case specific. Other factors in the subsequent factors will try in providing a basis for the above mentioned argument.

### **FACTORS LEADING TO SPRAWL**

\Sprawl has various contributing factors that lead to this process. The various factors discussed in this chapter are Demographic, Physical/Spatial covering Land and infrastructure aspects, Social and Environmental, Economic and Governance related. The factors have been tried to be analyzed with respect to Lucknow (taken as case study to prove the factors) from both the point of views – City (which is regarded as an area where these factors play major role) as well as the fringe (which is supposed to be the spatial manifestation of sprawl).

#### **1. Population**

**Lucknow Urban Agglomeration (LUA)** – Lucknow Urban Agglomeration (LUA) became a million-plus area in 1981. Besides the areas under jurisdiction of the Lucknow Municipal Corporation, the agglomeration also includes the Lucknow Cantonment. Census 2001 estimated the population of the Lucknow Urban Agglomeration as 22.46 lakhs. This included an estimate of about 60,000 as population of the Lucknow Cantonment and 21.85 lakhs population of Lucknow City. The LUA population in 2011 is 29.01 lakhs. The population of the Lucknow City Cantonment has remained constant in the last three decades. (Refer Table 2)

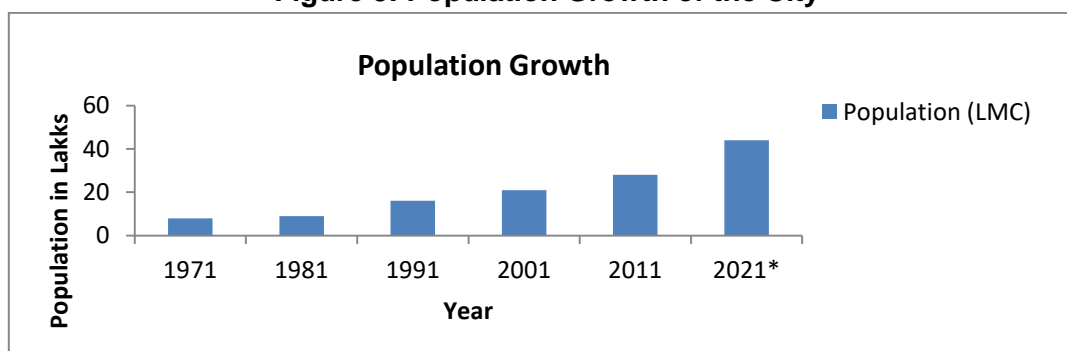
**Table 2: Population of LC and LUA from 1971-2021**

Year	Lucknow Municipal Corporation				Lucknow U.A.	
	Pop. (LMC)	Growth Rate (%)	Area (sq.km)	Density (sq.km)	Pop. (UA)	Growth Rate (%)
1971	8,27,000	14.60	110.00	10,712	8,13,982	
1981	9,47,990	22.38	146.00	6,493	10,07,604	23.79
1991	16,19,116	70.79	159.26	10,819	16,69,204	65.66
2001	21,85,927	35.00	310.00	7,049	22,45,509	34.53
2011	28,15,601	28.80	310.00	9,082	29,01,474	29.00
2021*	44,40,000	57.69	414.34	10861	45,00,000	39.49

Source: Master Plan 2021, Census of India

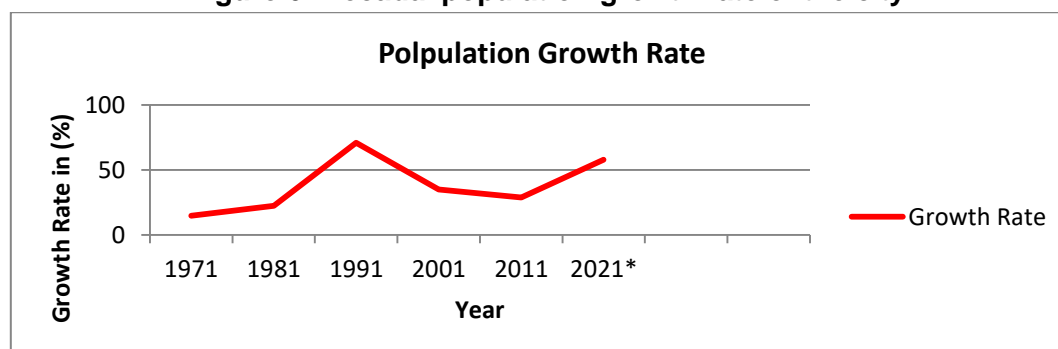
**Lucknow City (Municipal Corporation limits, LMC)** – The population of Lucknow has seen a considerable rise since 1971. The population of Lucknow City was 8.27 lakhs in 1971 and has risen to 28.15 lakhs in 2011 (Census of India, 1971, 2011). The growth rates have shown considerable rise in population trends from 14.6 percent in 1971, 22.38 percent in 1981, 70.79 percent in 1991, 35 percent in 2001 and 28.8 percent in 2011. The expected population growth rate is 57.69 percent in 2021 with a population of 44.40 lakhs (Refer Table 2 and Fig. 5 & 6). The great influx of population is a factor that poses a demand for land and hence may be one of the reasons for the city sprawling across boundaries at the fringes.

**Figure 5: Population Growth of the City**



Official records show that Lucknow's population grew more than that of other cities in the 1980s– mainly due to the extension of the jurisdiction of the Lucknow municipal corporation – from 14,594 increase in 1981 to 88,751 increase in 1991 in the 1990s, average growth rate was comparable to that of cities of similar size, more that Kanpur and Nagpur, but lower than Jaipur and Surat.

**Figure 6: Decadal population growth rate of the city**

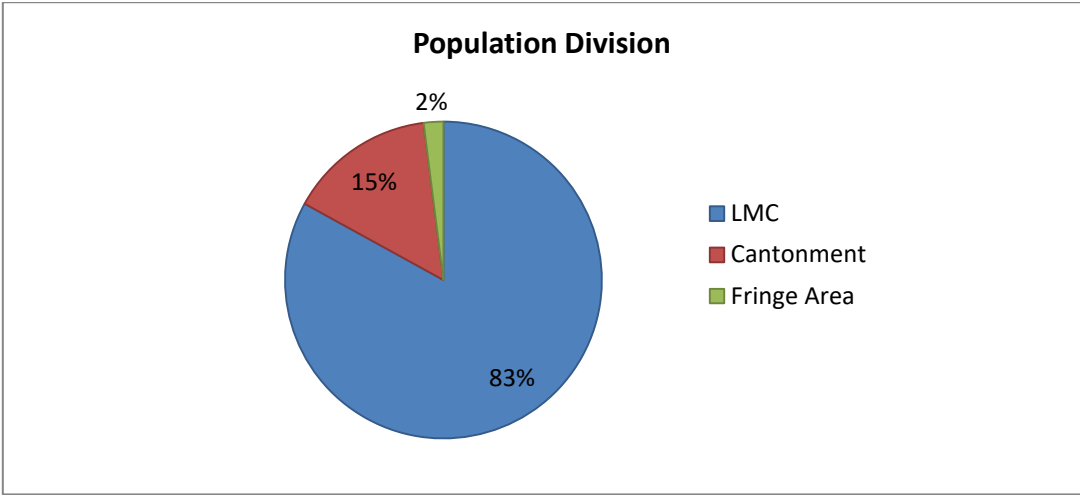


**Population Density:** The population density has shown a considerable decrease in 1981 as compared to 1971 i.e. 107 pph to 64 pph. The sudden decrease in population density was due

to the expansion in municipal limits. In 2001, the density is 91 pph for the city. The population growth projected varies between 3.51 to 4.37 percent per year over different 5 years periods until 2021, somewhat higher than for the average growth rate of cities of similar size in the country and the state.

**Lucknow Planning/Development Area:** The population of the planning area in 2001 was 24.46 lakhs whereas in 2011 the population is 34.03 lakhs. The population rise is 39.10 percent as compared to 29 percent Growth rate of the city and urban agglomeration. This clearly indicates that the fringes are growing as a faster rate as compared to the city. Hence, people are moving to the outskirts of the city for shutting down, increasing the load on the fringes.

**Figure 7: Population division in Planning Area-Lucknow 2011**



Source: Census of India, Village Directory 2011, LDA

The division of population in the planning area accounts for most of the population nearly 83 percent living in the city whereas a considerable amount of 15 percent of the total population living in the Fringe area and only 2 percent in the Cantonment. (Refer Fig.7 and Table 4)

**Table 3: Planning Area population growth rate viz a viz District, LMC and LUA**

Lucknow	District	LMC	LUA	Planning Area
Population 2001 (Lakhs)	36.5	21.85	22.45	24.46
Population 2011 (Lakhs)	45.9	28.16	29.02	34.03
Growth (%)	25.80%	28.80%	29%	39.10%
Area 2011 (sq. km.)	2,528	310	340	608

Source: Master Plan 2021, Census of India, Town Village Directory 1991, 2001, 2011

**2. Migration**

Migration is considered yet another major reason for population influx in the city which in turn arises the need/demand for housing. Migration into Lucknow accounts for 37 percent increase in population over the last decade i.e. from 2001 to 2011 and 36 percent in 2001. Of the 5.76 lakh people added to the LUA during 1991-2001, about 2 lakh were migrants. In comparison, the natural growth was 3.68 lakh. Census 2001 estimates that in the last decade, Lucknow received 2,07,3077 migrants, 56.6 percent of which were from rural area and cities the following as reasons (Refer Fig. 8 & 9)

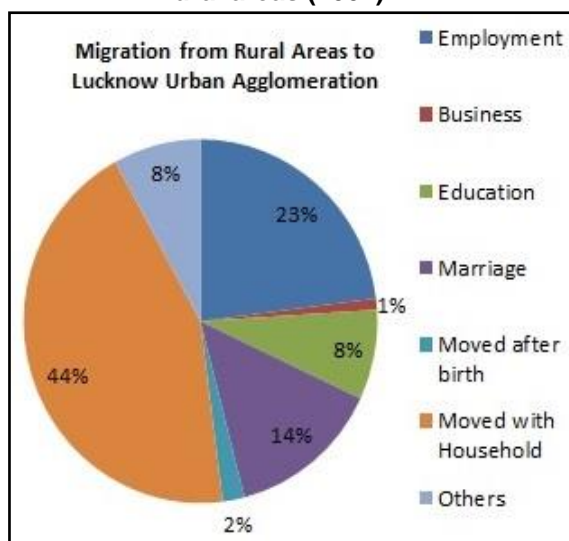
- As a Capital City, Lucknow offers better social and physical infrastructure and activities compared to other cities in the state. With a population density of 91 persons per



hectors, Lucknow is recognized as a low-density-low-rise city with open spaces and grocery. The City is also comparatively cleaner than most other cities in the state.

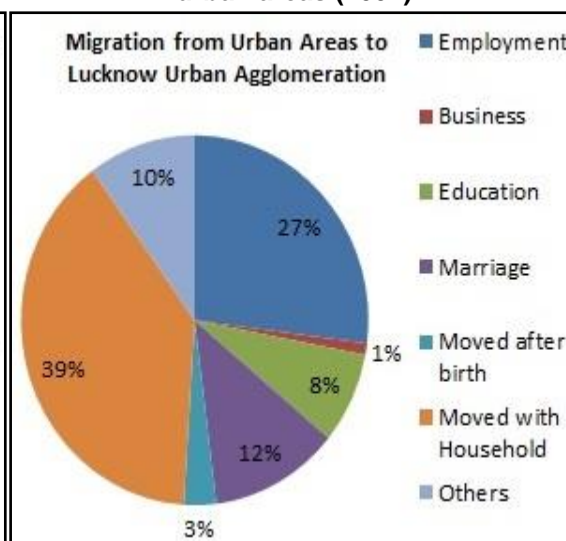
- The City offers better employment opportunities and education facilities.
- Lucknow’s position as a city bordered by smaller towns like Hardoi and Sitapur in the northwest, Barabanki in the northeast, Rae Bareli in the south-east and Unnao in the south west attract migrants in search of better employment opportunities and higher order services like education and health. According to the census, 22 percent of the migrants from rural areas and 27 percent from urban areas cited ‘employment’ as the reason for migration. The other reasons for migration include business reasons, education opportunities, marriage etc.

**Figure 8: Reasons for migration from Rural areas (2001)**



Source: Census of India

**Figure 9: Reasons for migration from urban areas (2001)**



Source: Census of India

### 3. Gender Ratio

In the Lucknow City, in 2011, there has been a steady increase in the number of women per 1000 men—from 829 in 1971 to 849 in 1981, 862 in 1991 and 893 in 2001. While this rise is attributable partly to natural growth, discussions with the LDA identify the cause as being the ‘security’ that the city offers and the good education facilities factors that have meant that a lot of women and children are staying in Lucknow even when the male members of the family are working elsewhere. An additional factor could be that entire rural families are migrating in search of employment instead of the general practice of only men migrating.

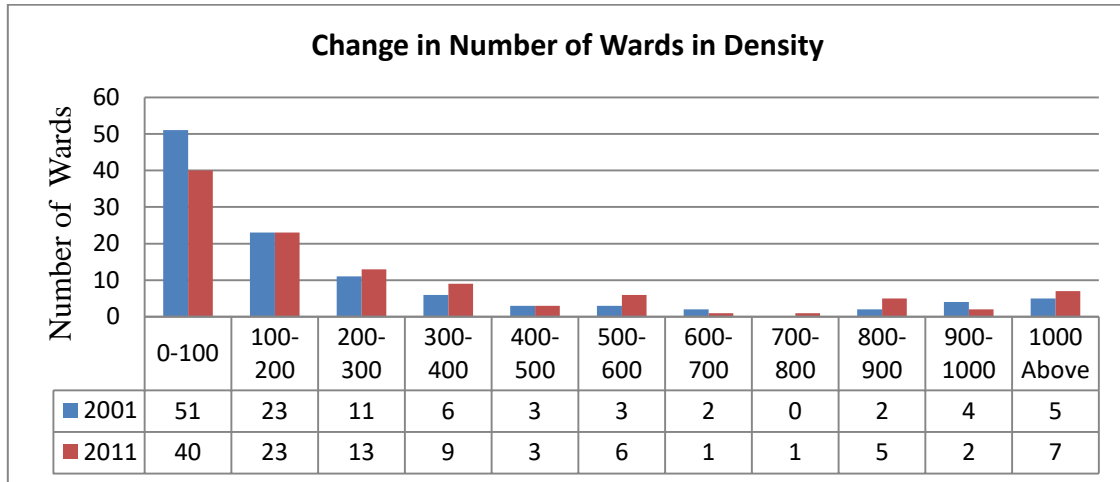
### 4. Density

Density of the city is 91 pph in 2011 when population is 28.15 lakhs (Delhi had density of 90 pph in 2011). The density of the city is more towards the old areas with minimum density towards the Fringes. The peripheral wards in the city are rapidly changing to higher density ranges (Refer Fig. 10) the city can be categorized as low density low rise development city.

The city had an average population density of 65 pph in 1981, 108 pph in 1991, 70 pph in 2001 and 91 pph in 2011. The average population density is low as per the UDPFI. The standard density is 150 pph (125 to 175 pph for metro cities as per UDPFI). The city limits can accommodate 46.5 lakhs i.e. 18.35 lakhs more of the total population presently living in the city. The ward wise growth rate of population supports the fact that the peripheral wards viz., Adarshnagar, Jai Praksh nagar, Rajajipuram, Daultaganj and Aliganj have recorded the

maximum growth during 1981-1991 while other wards viz., Gontinagard, Indiranagar, Triveninagar, Sarojininagar and Kharika have sprung up after 1980's along the major axes of the city corridors, absorbing the growing population as the ability of the inner city to absorb the population growth has reached near its saturation point. It is evident that maximum ward wise density (within city) in 2001.

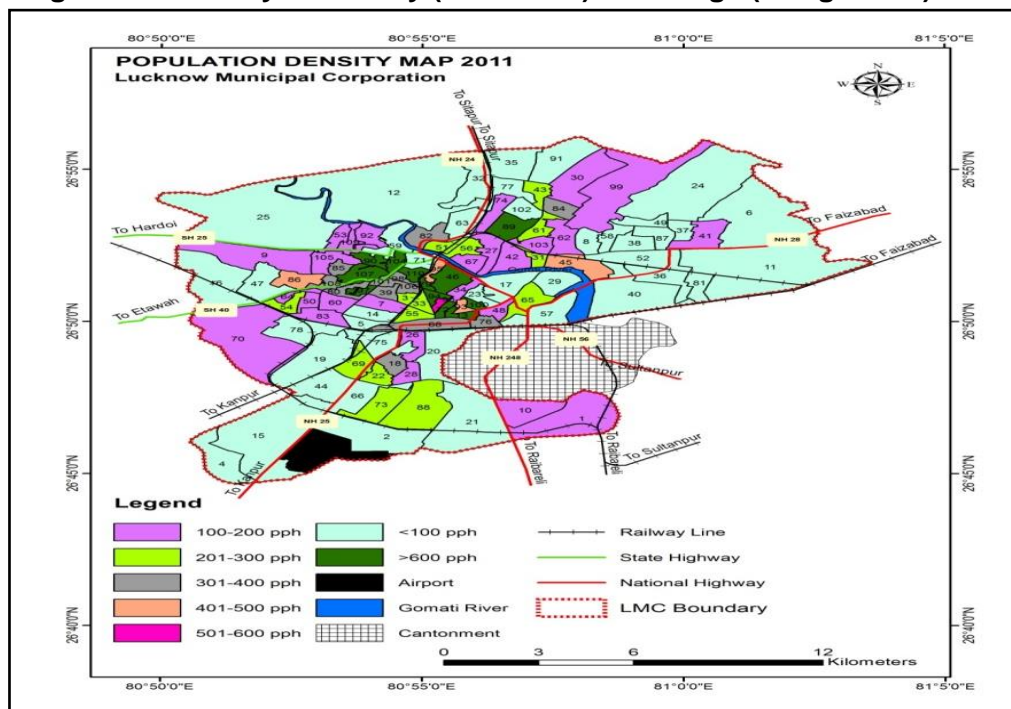
**Figure 10: Change in Ward Densities 2001 and 2011**



Source: Lucknow Municipal Corporation, Ward wise population

1450 pph and in 2011 it rose to 3063 pph. Maximum village wise density (fringes) in 2001 was pph and lowest was 2 pph. But it can also be seen that the less dense wards are changing into dense wards and so on showing rising density within the city. (Refer Fig. 11). Any other city the core of the city is most dense. This indicates that Lucknow's growing population is setting mostly in new extensions of the city. Hence overcrowding or high density in city can be one of the reasons for moving to the outskirts but the overall average city density shall within permissible or acceptable limits.

**Figure 11: Density of the city (ward wise) and fringe (village wise) 2011**



Source: Lucknow Municipal Corporation, ward wise population 2011

## Issues

As above results have given a glimpse of the various factors responsible for sprawl in Lucknow one of the factors have high impact, while the others have medium and low impact. There is certain issue related with the city and fringe development that is giving way to sprawl.

- Higher migration rate (of family) increasing housing demand in the city.
- Free market economy leading to land value speculation as private developers entering the market. This is making affordable housing and land a dream for the common people near the Lower density (90 pph only) in the city as compared to prescribed norms of UDPFI. The city capable of accommodating more population if the density can be taken anything between pph to 150pph.
- Restricted FAR for development within the city forcing people outwards the city while many capable of accommodating and absorbing more population.
- Development spreading on ecologically sensitive areas and agriculturally suitable land.
- Scattered/unplanned development in the fringes and lack of integrated development plan with the city.
- There are vacant plots in the fringe, occupancy rate are low which creates unnecessary demand & housing shortage in the city.
- Developments taking place on marshy lands and flood plains in the city which suggest development taking place on ecologically sensitive sites.

## Suggestions

- The problems faces due to urban sprawl, it is suggested that the town planners and policy makers should coordinate with the academicians, geographers and NGOs.
- The city development plan should prepare according to sprawl.
- To create awareness among the students and citizens of study area about problem related with the urban sprawl.
- In the present research work, maximum civic amenities are concentrated in the core part of the city, hence decentralization of services are must for future planning.

## Conclusion

The present work is evaluated the urban area and urban sprawl of Lucknow city. It includes major civic amenities in the study area. The study is investigated the development of urban area from its starting to present extension in LMC. It also studied the urban sprawl of Lucknow city occurred in last three decades.

- The Lucknow city extension process initially very slow, but after 1992, city expands rapidly.
- The extension of CBD playing vital role to extent the city boundary.
- The rapid population growth is one of the major reasons of extension of urban area.
- The city extension results electoral wards were grew from 87 to 110 wards.

Thus, it may be summed up in a manner that still there are many milestones which should unturned for maximum benefits of the development and future growth of the city and fringes with will absorb the growing population of the city and aspirations. And if the areas are proper developed as per plan it will become the role model for the development of other peri-urban area of the city and other city areas. So, in larger context there is need of careful attention from authority side and implementation side.

## References

1. Bhagat R B (2011): Emerging Pattern of Urbanization in India, Economic & Political Weekly, Vol. XLVI, No. 34.
2. Bhatia, A.S. (1992): Rural-Urban Migration: Study of Socio-Economic Implications, Deep and Deep Publications.
3. Brueckner J K (2000): Urban Sprawl: Diagnosis and Remedies, International Regional Science Review 23(2): 160 – 171.
4. Chauhan, D.S. (1966): Trends of Urbanization in Agra, Bombay, Allied Publishers.
5. Dr. Venkatesh Dutta (2012): War on the Dream – How Land use Dynamics and Peri-urban Growth Characteristics of a Sprawling City Devour the Master Plan and Urban Suitability: A Fuzzy Multi-criteria Decision Making Approach, 3th Annual Global Development Conference Urbanization and Development: Delving Deeper into the Nexus-June 16-18.
6. N.R.S.A. (1990): Mapping and Monitoring Urban Sprawl of Madras, Unpublished Project Report.
7. Nagendra H, Munroe D K, and J Southworth (2004): From pattern to process: landscape fragmentation and the analysis of land use/land cover change, Agriculture, Ecosystems and Environment 101, 111–115.
8. NRSA (1991): Mapping of Million-plus cities: Land use and urban sprawl mapping of Chennai, unpublished project report.
9. Pathak, Virendra and Shukla, S. P. (2009): Urban growth monitoring techniques for sustainable development in Recent trends in management, technology and environment, Macmillan Publishers India Limited, pp. 108-115.
10. Prasada Raju, P.V.S.P. (1988): Urban Landuse/cover mapping of Hyderabad and its Environs using IRS-1A LISS II data, (Unpublished report).
11. Swadesh Kumar, Ram Nayan Yadava, Sudhir Kumar Singh, and Sk. Mustak (2013): Assessment of Land Use around highly populous business centre of Lucknow City using GIS techniques and high resolution Google Earth's Quick bird satellite data, Bulletin of Environmental and Scientific Research, Vol. 3, Issue(1),pp.8-14.
12. Urban Development Plans Formulation Implementation (UDPFI) Guidelines (2012).
13. Venkatesh Dutta, Ashutosh Singh and Nupoor Prasad (2010): Urban sprawl and water stress with respect to changing landscape: Study from Lucknow, India, Journal of Geography and Regional Planning Vol. 3(5), pp. 84-105.