

Directions of Urban Growth: Spatio-Temporal Analysis of Lucknow City

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Abstract

Urban growth refers to the physical expansion of the cities and towns due to population growth and migration which is called urbanization. It is a global phenomenon in developing countries like India, where the population is over one billion, we can say one-sixth of the world's population. This type of growth is affected agriculture land and also surrounding habitation. So many cities formulated development plans. Geographers, planners, scientists require information about to the population growth rate, pattern and extent of expansion of city. In the lacking of this type of information, most of the growth areas lacking of basic amenities and infrastructure facilities.

This study represents the sprawling of the Lucknow city has led to the change land use at the urban fringe and the surrounding rural hinterland since many years ago. The population growth in the core area of the city finally resulted in out migration of population from city centre at the urban-rural fringe. The land use and land cover change is a natural process and cannot be stopped but it can be controlled to minimize the harmful impacts of urban growth on environment and resources. Physical expansion and pattern of growth can be detected with the help of ancillary and temporal data. Geographic Information System (GIS) provide the advance techniques and methods to the study of urban growth for sustainable development.

Keywords: *Urban growth pattern & direction, Urban-rural fringe, LU/LC change, GIS*

Introduction

India has only 2% of global land and 4% of water, but it has 16% of the population of the world. Urbanization is an indicator of the level of development of any region. The phenomenon of urbanization depends solely on the resource base of any region. In 1947, there were only 3 cities above a million populations i.e. Chennai, Kolkata and Mumbai. Today these numbers have grown rapidly to 53 Urban Agglomerations in 2011 from 35 Urban Agglomerations in

2001. Statistics show that 18.8 percent of urban population in 1951 has risen to 27.8 percent in 2001 to and further to 31.16% in 2011. The number of census towns has increased from 1362 in 2001 to 3894 in 2011. 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 economics, social, cultural and political activities. More and more towns and cities are blooming with a change in the land use along the highways and in the immediate vicinity of the city. Urbanization is a form of metropolitan growth that is a response to often bewildering sets of economic, social and political forces and to the physical geography of an area. 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.

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

This study has been carried out in Lucknow which the capital of Uttar Pradesh and most populous state in the country. It lies between 26°45' to 26°55' North latitude and 80°50' to 81° East longitudes in the Northern Gangetic plains. It is covering an area of 310 sq. km. The city lies at an average altitude of 110 meters above mean sea level and generally slopes to the east. Lateral slopes are towards the River Gomati, which flows from north-west to south-east through the heart of the city.

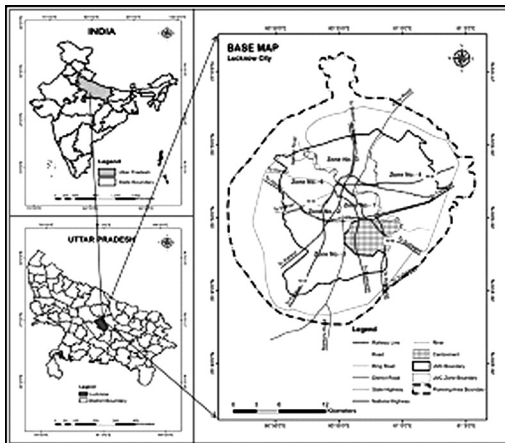


Fig.1: Location of the Study Area

The River Gomati flows through the city, dividing the whole city diagonally into trans-Gomati and Cis-Gomati regions. Some of the tributaries of this river are

the Kukrail, Loni and Beta. The more densely populated areas of the city are on the southern bank of the River Gomati and several planned residential colonies have been developed to the north of the River.

As per the census 2011, the population of Lucknow urban has 2817105. The district has a literate population 2226403. The Lucknow Municipal Corporation is divided into 6 zones and has 110 wards according to 2011 Census.

Objective

The main objective of the research is to develop plan for urban growth forecasting and its 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 analysis the growth pattern of the city of Lucknow and its sprawl.
- To suggest planning strategies for and integrated and planned development.

Database & Methodology

The data collection is done from both primary and secondary data sources. The primary data collected by field survey. The secondary data is (spatial/physical details) from the office of Town & Country Planning Organization, Lucknow Development Authority and also collected from Lucknow Municipal Corporation. Toposheets 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.

Analysis & Results

Sprawl has various contributing factors that lead to this process. The various factors discussed here. 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).

The spatial factors that would be discussed to prove to a reason for sprawl are evolution of the city relating the history and vision of the city which it was built, change in boundaries, topography and regional setting, Land and Density, Infrastructure and Transport, Housing and others. Since it is difficult to delineate all aspects due to overlaps, some aspects may find repetition and lack of distinctive character.

1. Changes in Boundaries

There has been continuous change in the boundaries of the city both in terms of the municipal limits or municipal boundary and planning area. (Refer Fig.2)

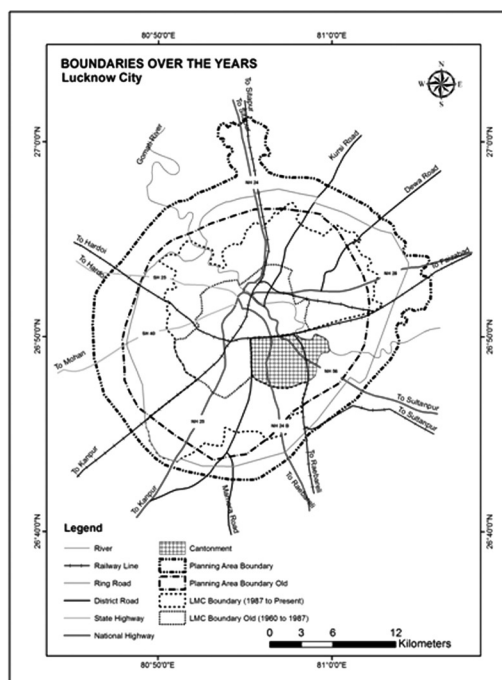


Fig.2: Change in the Municipal Boundary and Planning Area Boundary

Source: Master plan 1995, 2001 and 2021

Municipal Area Boundary-

- By Municipal Corporation formed in 1960 (under Municipal Act, up 1959)
- First boundary – 1961 – 80.50 sq. km – engulfing 43 villages
- Revised boundary – 1987 – 243.66 sq. km – engulfing 84 villages
- New boundary – 2009 – 310.00 sq. km – engulfing 123 villages (Refer Fig. 2)

The municipal boundary of the city has been revised thrice engulfing more and more villages but also extending services to a larger area.

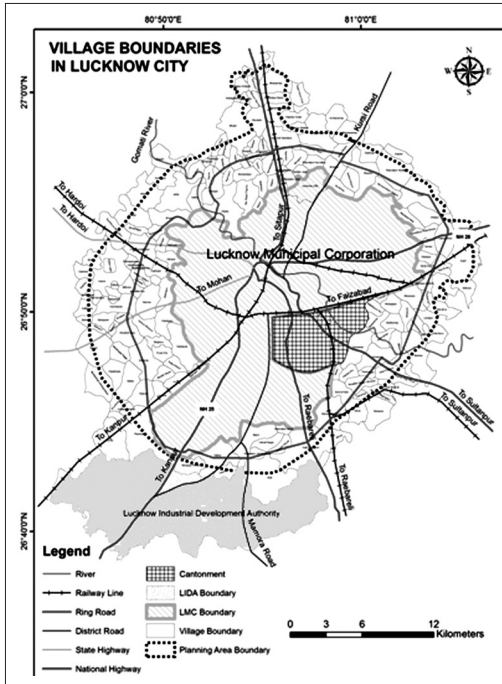


Fig.3: Village Boundaries and various boundaries, LIDA Boundary reserved for Industrial Area

Source: Master plan 2021, Extended Master Plan 2021

Planning Area Boundary-

- By Lucknow Development Authority formed in 1974 (under UP Urban Planning and Development Act, 1973)
- First Boundary – **1991 – 414 sq. km.**
- Second boundary – **2001 – 608 sq. km.** – engulfing 152 villages (completely 129 and partly 23 nos.)
- **City area = 310 sq. km, Cantonment area = 27.8 sq. km**
- Fringe Area (**Between Municipal and planning area**) is 270.2 sq. km. and

is 44% of the total Planning area and has 15% of the total population area residing in this area.

- LIDA (Lucknow Industrial Development Authority) area covers 37 villages covering an area of 141.26 sq. km. The industrial area is located outside the planning area of Lucknow.

The planning area has also been revised two times. Master Plans for Lucknow were prepared thrice; first in 1971 with a vision of 1995, then in 1991 for 2001 and finally in 2004-05 for 2021. In the first master plan the planning area was earmarked as regulated area which was soon amended in the second master plan. Hence, in history only two Planning Area boundaries have been designated for planned development. Master plans are considered to be an effort towards planned development reducing the chances of unplanned development leading to sprawl. Failure of master Plan implementation also is a major reason leading to sprawl.

The current practice, generally, involve spatial planning to ensure the best land use, distribution of necessary urban infrastructure and services judiciously, proper implementation of the plan and smooth management of urban functioning of the services. In practice, all these matters are not achieved as they should have been. Consequently, the concept of urban sprawl-emergence of a situation of unauthorized and unplanned development, normally at the fringe areas of cities especially haphazard and piecemeal construction of homesteads, commercial areas, industrial areas and other non-conforming land uses, generally along the major lines of

communications or roads adjacent to specified city limits, is observed which is often termed as the Urban Sprawl.

The various boundary changes decide the area to be designated as sprawl. Hence, if the uncontrolled growth takes place outside the planning area boundary it is sprawl for sure since no plan has been prepared for it for planned development.

But if uncontrolled growth takes place outside the jurisdiction of the service and piecemeal development activities come in near the outskirts it is also referred as sprawl. Hence the area outside the municipal area has been considered for sprawl as it shows glimpses of uncoordinated growth.

2. Topography

The lowest altitude is of 110 meters above mean sea level for the city. Generally slopes to the east. Highest level is 123.5 meters. Lateral slopes are towards the River Gomti, which flows from north-west to south-east through the heart of the city. There is no physical barrier that restricts growth of the city except some reserved forests and flood plains. Floods in 1915, 1923, 1960 and 1984 –Barrage and bridge made which led to development in Trans Gomti.

3. Growth Pattern

The city has been sprawling at a very rapid rate engulfing villages of surrounding areas and densification near the river beds in the city.

- Municipal Boundary till 1987 (80.48 sq. km.)
- Growth Mainly towards Sitapur, Faizabad and Kanpur Road

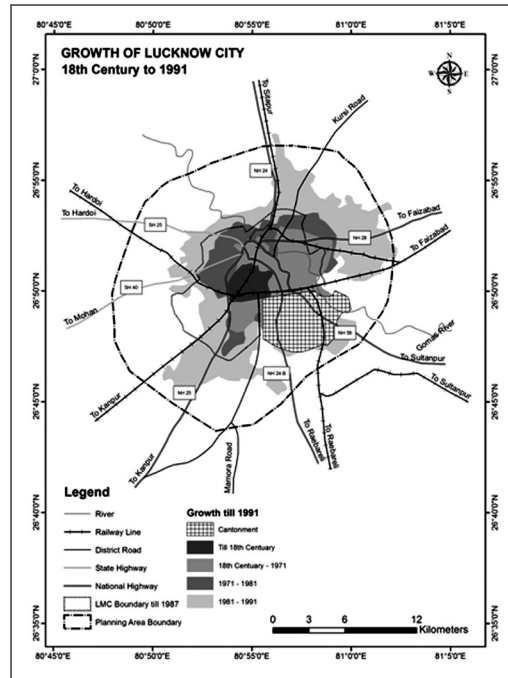


Fig.4: Growth from 18th Century till 1991

Source: Master plan 2001, 2021

- Planning area boundary taken as 8 km. radius outside municipal boundary 413 sq. km.
- 63 sq. km. of sprawl in 1991.
- Sprawl covers 18.9% of the total area between planning and municipal boundary (333 sq. km.)
- Also it is 15.2 % of the total planning area (414 sq.km.).

The maximum growth in developed land is evident in 1981-91. There has been a constant rise in the growth percentage but declined after 1991 considerably. The growth pattern remained organic till 1981-91 and suddenly after 1991 the pattern drifts into a ribbon development enjoying benefits of transit oriented development and accessibility.

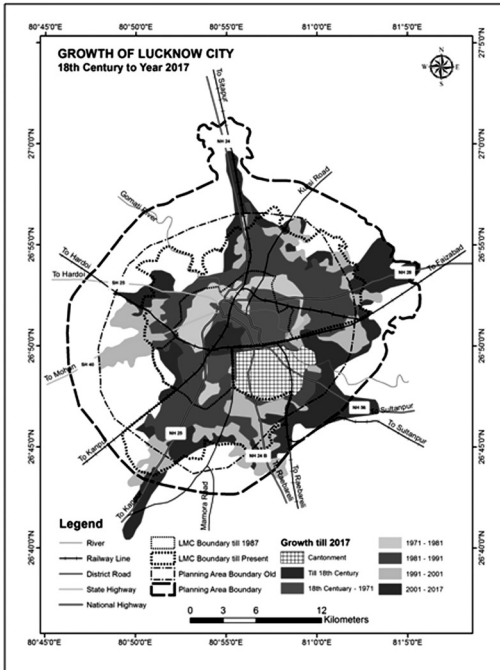


Fig.5: Growth from 18th century till date
Source: Master plan 2001, 2021

- Revised Planning Area Boundary in 2001
- The growth direction shows ribbon development along major NH's and SH's
- Sprawl is visibly evident on Sitapur, Faizabad and Sultanpur Road.

Fig.4 & Fig.5 shows the development/growth pattern of the city from 18th century till 2017. The growth pattern of the city in terms of percentage and area is described in Table 1.

Average growth rate of the built up area is 35%. Significance of growth direction decides the pace of sprawl.

Table 1: Growth Pattern of the City

| | 1961 | 1971 | 1981 | 1991 | 2001 | 2011 | 2021* |
|-----------------------|-------|--------|------|--------|-------|------|--------|
| Area (sq. km.) | 80.48 | 110 | 146 | 230.26 | 290.5 | 359 | 414.34 |
| Rate of Growth | 60% | 36.60% | 57% | 56% | 26% | 24% | 230% |

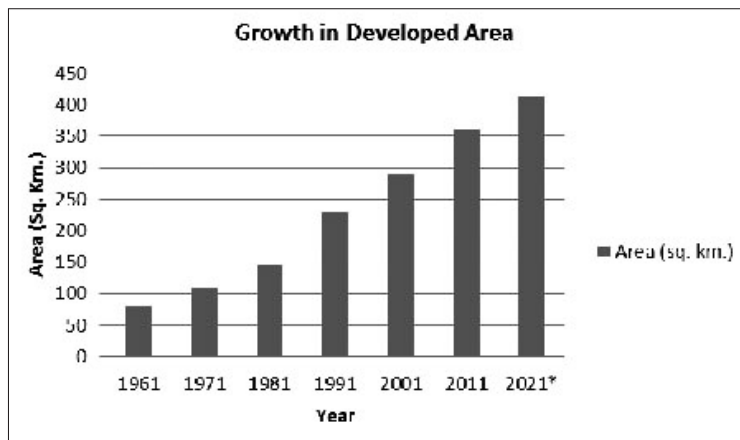


Fig.6: Growth Pattern of the Development since 1961

- Planning area engulf 153 villages
- 110 sq. km. of sprawl in 2013
- Sprawl covers 36.9% of the total area between planning and municipal boundary (298 sq. km.)
- Also it is 18.1 % of the total planning area (608 sq. km.)

Fig.7 and Table 2 show that around 110 sq. km of development is beyond the municipal limits in the urban fringes. Development spreads to 16 villages on Faizabad Road and 9 on Sultanpur Road. A total of 41 villages are wholly under sprawl and 37 partly are under sprawl. The rate is increasing with a rapid rate since the agriculture use is changing to non-agriculture use.

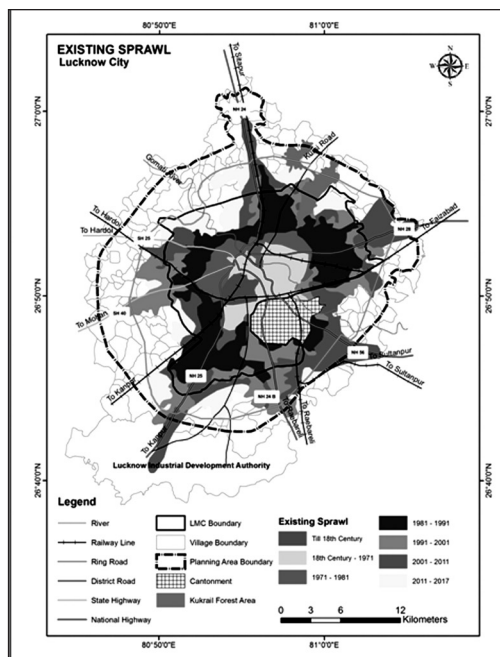


Fig.7: Existing Growth beyond Service Boundary (Existing Fringe Development)

Source: Master Plan 2001, 2021

Table 2: Existing Growth Pattern along the Major Corridors

| Road Direction | Fringe Area (in sq. km) | % of Fringe Development to Total | Engulfed Villages due to Development | |
|----------------|----------------------------|-------------------------------------|---|-----------|
| | | | Fully | Partly |
| Sitapur Road | 13.3 | 12.1 | 6 | 10 |
| Kursi Road | 5.2 | 4.7 | 1 | 2 |
| Faizabad Road | 35.6 | 32.4 | 16 | 10 |
| Sultanpur Road | 23 | 20.9 | 9 | 1 |
| Raebareli Road | 12 | 10.9 | 5 | 2 |
| Kanpur Road | 2.2 | 2 | - | 2 |
| Mohan Road | 11.3 | 10.3 | 1 | 6 |
| Hardoi Road | 7.4 | 6.7 | 3 | 4 |
| TOTAL | 110 | 100 | 41 | 37 |

4. Transportation and Linkages

Connectivity: The Inter District Linkages suggest that Lucknow is connected by 3 NHs and 4 SHs. The city spreads in a maximum of 15 km radius public transport share is extremely weak only 4%, hence increased dependence on private vehicles which is 80%, while IPT is 16%. Public transport routes only covers along the inner radial road and along major corridors for the

fringe areas. No bus stand or railway station is present in the fringe area (Area between Planning and Municipal Boundary).

Trip length is 6 km for the city and maximum upto 11 km, indicating sprawl. All villages in the fringe are approachable by paved roads as per Census 2001. Sprawl likely to increase in the future due to increase in the spread of the city and hence increasing traffic load on the main city.

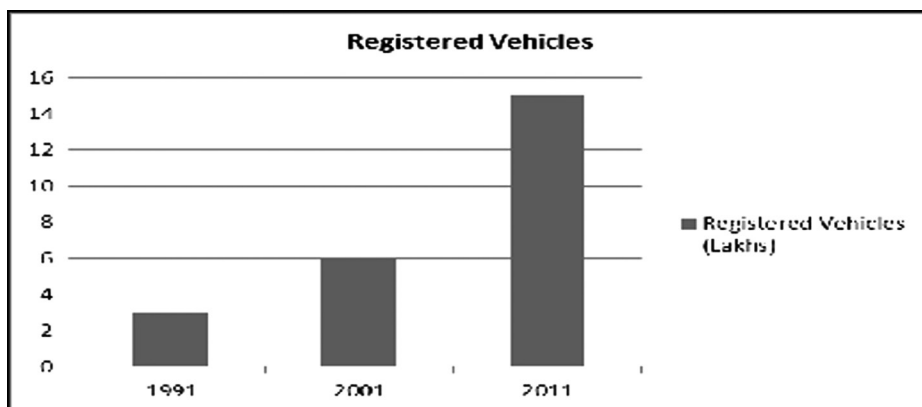


Fig. 8: Increase in the number of Registered Vehicles 1991-2011

Source: RTO Lucknow, CMP Lucknow

Fig.8 shows the decadal increase in the number of registered vehicles from 1991 to 2011. There has been 137% increase during 1991-2001 in vehicles and 112% increase during 2001-2011. There is increasing traffic Load, indicates demand which ultimately results in sprawl.

| | | |
|----------------|---------------|---------------|
| Industrial | 5.25 | 1.96 |
| PSP | 13.52 | 5.04 |
| Recreation | 51.01 | 19.03 |
| Agriculture | 129.00 | 48.11 |
| Transportation | 7.00 | 2.61 |
| Total | 268.12 | 100.00 |

Source: Master Plan 2021

Table 4: Land Utilization for Fringe – 2021

| 2021 Land Use classification for Fringe | | |
|---|----------------|------------|
| Land Use | Area (Sq. Km.) | % to total |
| Residential | 58.62 | 21.86 |
| Commercial | 3.72 | 1.39 |

Table 4 shows the land division in the fringe. Fig.10 shows the land division in the planning area. The land use distribution in the fringe indicates the predominant use of residential after agriculture and recreation. This suggests that most of the

development is due to people settling in the fringes. Lucknow Planning area has 80% land dedicated to mango and green belt on the western side of the city. This natural barrier forced the development pattern southwards, north and east.

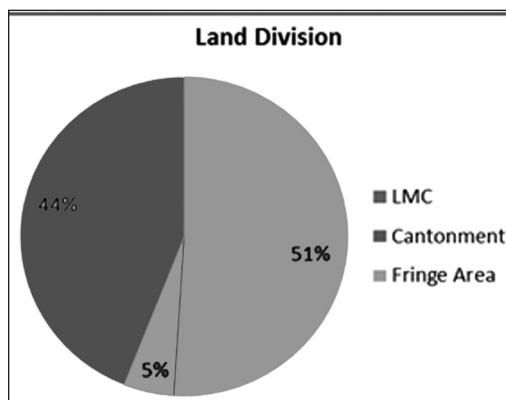


Fig.9: Land Division in Planning Area
Source: Master Plan 2021

The master plan of the Lucknow envisaged more and more area because of the in-migrating population and growing aspirations of the city and being Lucknow as the capital of India's most populous state and is surrounded by a number of small town so, the city has seen a steady increase a population arising from natural growth, the incorporation of peri urban areas in the 1980's and witnessed a radial growth – greater along the Faizabad Road and the Trans Gomti area. In recent years, the city is witnessing a real estate boom with a large number of private developers entering the market. The latter has not been factored into the Master Plans – the formal basis for Government planning.

The Master Plan 2021 estimates that Lucknow covered an area of 16,270 hectares in 2004-05. Compared to 1987

when the area was estimated at 9170 hectares, there has been a 77.4% increase in the total area in 2004-05. Trends in land uses has been interesting, especially the fact that residential use has grown dramatically in comparison to all other uses. The largest proportion of all the developed land uses is concentrated in the Lucknow municipal corporation area. It is interesting to note that virtually there are no parks and institutional areas within the old city. This is despite the fact that the old city originally had open spaces for recreation. A large proportion of the undeveloped land is in the rest of LDA area. The residential area is proposed to go down. This is not practical especially in the light of the fact that the area under residential land-use is continuously going up. In addition, the government's proposed land bank scheme proposes the development of several new housing projects.

Table 5: Land put to Non-agricultural use in fringe of Lucknow – 2010

| Categories of Land Transformation | Area | |
|-----------------------------------|-----------|-------|
| | (Km. Sq.) | % |
| Agriculture to built up land | 76.37 | 62.98 |
| Plantation to built up land | 1.69 | 1.4 |
| Wetlands to built up area | 1.45 | 1.19 |
| Wasteland to built up area | 1.17 | 0.96 |
| Rural to built up area | 2.93 | 2.42 |
| Forest area to built up area | 0.39 | 0.32 |
| Water body to built up area | 0.74 | 0.61 |
| Land under transformation | 36.52 | 30.12 |
| Total | 121.26 | 100 |

Source: Study on Urban Sprawl and Water Stress, Dutta et al, 2010

Also, land is available only in the fringes for development. The city has no land available where development can take place. It also does not have any dead pockets of land except the flood plains and reserved areas.

- The constant conversion of agriculture land into non-agricultural land use is a major threat to the phonological sensitivity of the region as a whole. The belt of Lucknow region has rich alluvial soil capable of producing food crops. The development pattern should be on holistic policy.

Inference

| ASPECT | INFERENCES | ISSUES |
|----------------------|--|--|
| Growth Pattern | Was organic till 1991 and then became ribbon development pattern (TOD), increasing infrastructure load on the major transport corridor. | 1. Ribbon development increases the load and cost of service/ infrastructure provision. 2. Transport sector lacking considerably to afford the demand. 3. Free market forces leading to land value speculation. 4. Scattered development due to lack of monitoring. |
| Rate of Sprawl | Sprawl and related developments are engulfing a total of 78 villages leading to acquisition of land for private colonization and developments. | |
| Change in Boundaries | A lot of area nearly 110 sq. km built area is outside Municipal limit. hence giving way to jurisdictional and service problems, unauthorized constructions etc. | |
| Topography | The eastern side of the city within planning area is mango belt hence restricting construction possibility. River Gomti acted as a barrier till cross links were made. | |
| Transport | Congested roads, high V/C ratios, inadequate road widths and low travel speed are characteristic of the city. Average trip length is increasing from 6 km to 9 km. | |

Conclusion & Recommendations

Conclusion:

This study has 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.

- The City lacks green spaces (only 8%) as compared to 33% pen spaces as per MoUD and 20 to 25 per UDPFI.
- Higher migration rate (of family) increasing housing demand in the city.
- Depleting water resources due to over exploitation of ground water through tube wells born the periphery of the city and the fringes.

- Increased rate of water, air and noise pollution in the city making the ambient quality inappropriate survival ultimately affecting the quality of life.
- 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 are 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.
- Lacking physical infrastructure provisions in fringe area in all the aspects of water supply waste collection, sewerage and drainage.
- Distorted streetscape along the major corridors in the fringes due to haphazard and piecemeal constructions all along.
- 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.

Recommendation:

The various issues at the city and fringe level require immediate attention. Hence this study details out the various recommendations and strategies based on the identified issues. The recommendations are given at city level and fringe level both. If the city is self-sufficient to accommodate the people, they would restrain themselves from moving outwards.

1. At City Level

- Developing the vacant areas into recreational space as the city lacks chunks of green space (open to built is low)
- Developing the city's infrastructure and transport facilities that would restrain people from moving outwards to the fringes.
- Water management and pollution control to reduce the declining water levels and increasing pollution.
- Modify/Increase the FAR as per the rising demands in the city
- **Extended Master Plan** for the developed fringes is proposed for Lucknow which also proposed an outer Ring Road to enhance the transport network.
- **Single Window Approach** needed for colonizers and builders that will unbiased the total development and licensing procedure related to land transactions.

- Lack of implementation, monitoring and rigid rules leading to scattered development needs proper **check and monitoring**. Hence both preventive and curative measures essential.
- Stringent Planning Interventions making it a **mandate rather than a mere provision or clause**.
- Monitoring and Management Body to check the implementation of schemes thereby reducing unauthorized construction and unwanted land value speculation
- **Holistic Policy Framework** required for fringe development keeping in view all parameters demographic, social, spatial, economic and environmental and governance related.

2. At Fringe Level

- Development shall be restrained from the ecologically sensitive/non-suitable areas as identified by Master Plan like Food Plains, Forests etc. and suitability analysis shall be the basis of development (Refer Figure 7.1)
- Dividing the fringe areas into zones according to its potential to be developed so as to ensure planned development in the future.
- Infrastructure provisions to be extended to the Fringe zone in the stages of development prescribed under Zonal Plans (In Pune Fringe Zones have been marked and Development Plan prepared for the same)
- Developing activity nodes in the fringes areas (zone wise) to facilitate compact development.
- Provision of Physical Infrastructure to be included for fringes in the Master Plan.
- Constitution of **DPC and MPC** as per the 73rd and 74th CAA to manage the transitional areas.
- Ribbon Development Prevention Policy shall be framed so as to regulate the development along the corridors.
- Development Charges shall be made high in the high potential areas along major transport corridors to reduce unwanted development.
- Separate cell to be framed in the development Authority to monitor and frame separate guidelines for fringe areas.
- Imposition of appropriate policy of land tax, which includes charging higher vacant land rates and lower on agricultural land. This shall help in speculation of land prices and encourage agricultural produce
- Financial assistance in form of grants and loans to develop the fringes and avoid city problems/aggravate fringe conditions.

Hence, it can said that sprawl and development of fringe is an essence, a natural phenomenon which can only be channelized and not restricted.

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