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RESEARCH ARTICLE

POPULATION CHARACTERISTICS AND POTENTIAL A CASE STUDY OF LUCKNOW MUNICIPAL CORPORATION

***Upendra Bhai Patel and Prof. (Dr.) B.L. Teli**

Department of Geography, School of Earth Sciences, HNB Garhwal University (A Central University)
Pauri Campus, Pauri (Uttarakhand) - 246001

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ABSTRACT

The rapid urbanization is the matter of grave concern in contemporary time because it leads to urban sprawl. The numbers of changes have come in urban areas such as development of industry, service sector, employment and educational services. These changes have led to job opportunity and better way of life in urban areas. Consequently, the individuals are migrating from rural areas to urban areas and they are creating many problems in urban areas such as uncontrolled population, inner city neighbourhood, and heterogeneous environment. Social scientists, Geographers & Urban planners identify the pattern of urban sprawl, recognition of magnitude and direction of changing sprawl and its effect on land use/land cover change so they develop a plan to provide basic amenities such as water, sanitation, electricity, etc. Lucknow is also experienced a high rate of urbanization facing the problems of social, infrastructural, industrial and environmental. 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 & ancillary data) and also field survey & ground truth. The collected data will be analyzed by using Remote Sensing & Geographical information system (GIS) techniques and statistical software. The study will provide a methodology for sustainable planning of land use and urban growth using various techniques. Remote Sensing & GIS and satellite images will be used in this study to provide spatial inputs and model for describing growth. This is useful for the urban planning in Developing Countries where land use data is not available regularly. GIS based study will help a lot for monitoring urban sprawl compared to Conventional technique.

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INTRODUCTION

The Urban Sprawl is a most evident global change over the surface of the Earth. It rapidly consumes precious rural land resources at the urban fringe and also results in landscape alteration, environmental pollution, traffic congestion, and infrastructure pressure, rising taxes and neighborhood conflicts. The population growth has led to urbanisation which has risen the unplanned developmental activities in India. It has had negative impact on the resource base, access to infrastructure and the development of the region. The rapid urbanisation has created many problems such as unrestricted growth of the area and unplanned development of residential, industrial and commercial areas. These problems are leading to traffic problems, slums, polluted environment and others all known many problems in both urban and rural areas. The urbanization takes place either in radial direction around a well-established city or linearly along the highways. The sprawl is referred as a dispersed development along with highways, surrounding the city and countryside. The sprawl is a term which is often used to describe perceived inefficiencies of development, including disproportionate growth of urban areas and excessive leapfrog development. The sprawl is a cumulative result of many individual decisions and it requires not only an understanding of the factors that motivate an individual landowner to convert land, but also an understanding of how these factors and individual land-use decisions aggregate over space. There are some of the causes of the sprawl which include population growth, economy and proximity to resources and basic amenities. Consequently, it is an emerging issue for the administration, planners, scientists and academies in the contemporary time where increasing population and migration for better livelihood opportunities have paved way for rapid expansion of the urban centers. India's urban population has grown tremendously in the last few decades. This rapid growth of urban population has come mainly due to large scale of migration of people from rural and smaller towns to bigger cities in search of better employment

Corresponding author:* **Upendra Bhai Patel,
Department of Geography, School of Earth Sciences, HNB Garhwal University (A Central University) Pauri Campus, Pauri (Uttarakhand) – 246001

opportunities and good life style. This rapid population pressure has resulted in unplanned growth in the urban areas to accommodate these migrant people which in turn leads to urban sprawl. It is a growing problematic aspect of metropolitan and bigger city's growth and development in recent years in India. Urban sprawl has resulted in loss of productive agricultural lands, open green spaces, loss of surface water bodies and depletion of ground water. Therefore, there is a need to study, understand and quantify the urban sprawl.

population growth (Bhagat, 2011). The numbers of studies have been conducted by geographers, and scientists in Lucknow region. Shekhar et al. (year) have captured a land use map of Lucknow region. One more study has described the assessment of land use around highly populous business centre in Lucknow (Kumar et al., 2013). Pathak et al. (2009) have found in their study that the issue of urban sprawl is rising due to unplanned and rapid urban growth. Venkatesh Dutta et al. (2010) explained that migration lead to large-scale urban sprawl and the inherent distinctiveness of hydrological

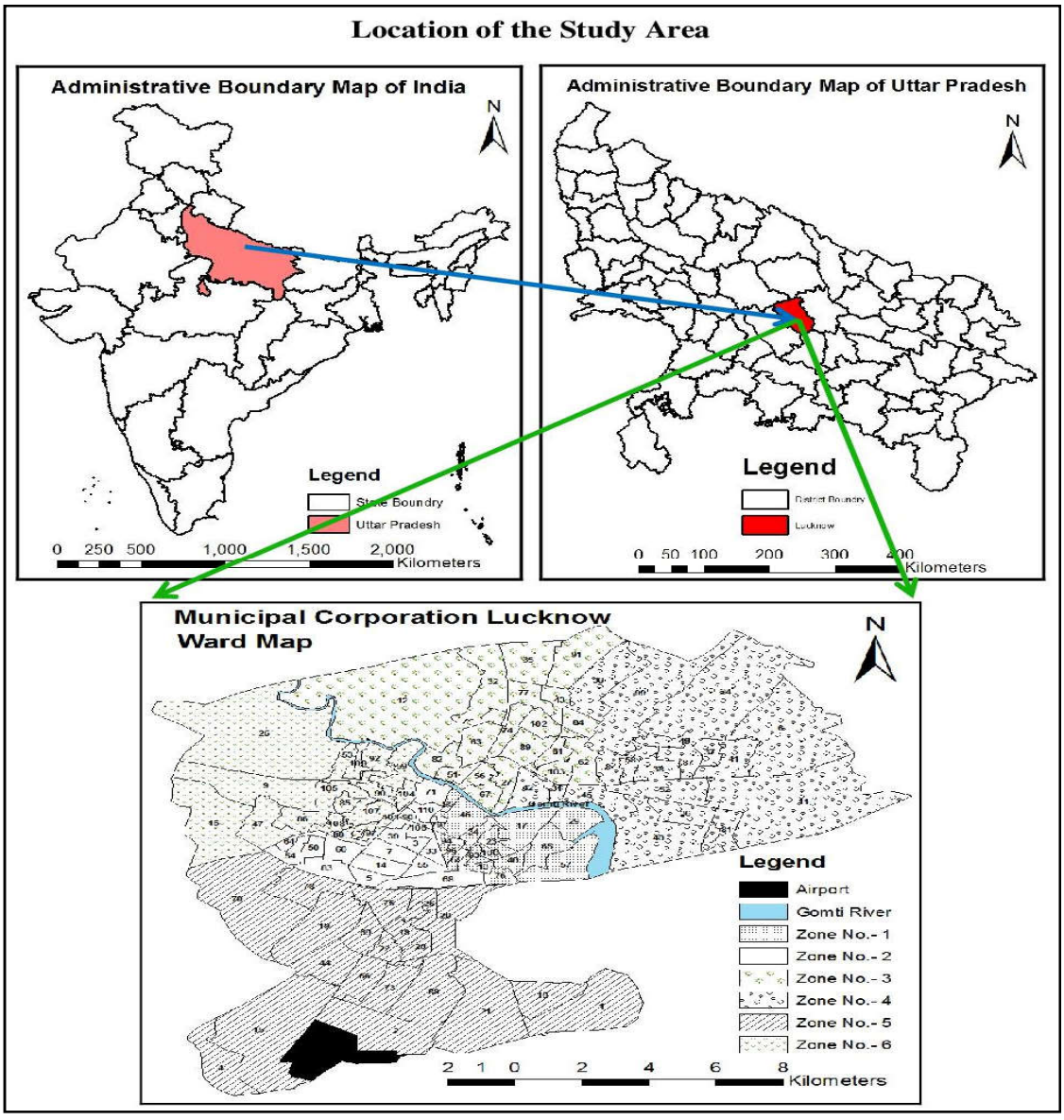

Fig.1. Location of the Study Area

Literature Review

The understanding of changes in population growth in urban areas is very important to study for future habitation. The understanding of population growth and population characterization through historical and current population provides the necessary data to evaluate impacts on socio-economic development, to delineate urban growth boundaries or municipal service areas, to develop land use zoning plans, and to determine future infrastructure requirements (Nagendra *et al.,* 2004). An assessment of the relative contributions of various factors that causes unregulated spatial expansion is very important to understanding the dynamics of urban 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.

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 $26^0$45' to $26^0$55' North latitude and $80^0$50' to 81^0 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. 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.

Research Objectives

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

1. To analyze the ward-wise population characteristics and spatial distribution of its.
2. To predict population for the year 2021, 2031 & 2041.

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 (demographic details) from the office of Directorate of Census Operations, Lucknow and also collected from Lucknow Municipal Corporation. The Ward map of this region was obtained from Lucknow Municipal Corporation. Toposheets are collected (1:50,000) from the Survey of India, Lucknow. Ward Map is used for database generation of polygon features (polygon map) of the study with the help of toposheets. Population data is used for find out the characteristics of population (distribution, density, literacy rate, sex ratio, population projection etc.). 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 and Results

Decadal Population

As per the provisional census data for the year 2011, LMC's total population is 28.17 lakh. There is a growth of almost six times in the city population in the last six decades, from 5 lakh in the year 1951 to 28 lakh in the year 2011. LMC's decadal population growth rate of 28.87% for the last decade is less than the country urban population growth rate (31.80%) and is at a little higher side from state urban population growth rate i.e. 28.75%. Population figure since 1951 and decadal growth in the population is shown in Table 1 and Figure 2:

The average decadal growth rate of LMC from 1951 to 2011 has been 36.14%. The table of demographic growth rate of Lucknow Municipal Corporation (LMC) shows more than 70% of the growth between the year 1981 and 1991, the rapid growth rate during this decade was due to change in the municipal boundary area. Before the year 1987 area under municipal limits was 118 sq. km which was expanded to 350 sq. km hence the nearby settlements and villages also became part of the municipal limit resulting into high population growth in the decade. The recent trends of population growth in the last two decades have been towards decreasing side. The reasons for declining growth rate can be stabilization in birth rate and heavy migration from LMC towards metro cities like Delhi and Mumbai.

Table 1. Population details for Lucknow Municipal Corporation (LMC)

SI. No.	Year	Population LMC	Decadal Change	Decadal Growth Rate
1	1951	459484		
2	1961	615523	156039	33.96 %
3	1971	774644	159121	25.85 %
4	1981	947990	173346	22.38 %
5	1991	1619116	671126	70.79 %
6	2001	2185927	566811	35.01 %
7	2011	2817105	631178	28.87 %

Source: Census of India and Provisional Census Data 2011

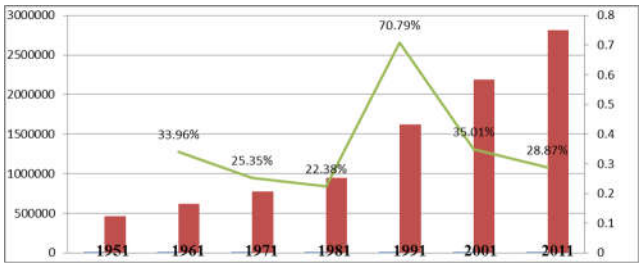

Fig. 2. Population LMC

Population Distribution

The spatial distribution of population has been examined based on the ward population. LMC has 110 wards with ward population varying from 69,000 in ward number 21 to 11,000 in ward number 31 and an average ward population of 25,000. Sizes of the wards varies a lot in the city, towards the inner city side the ward areas are less however as we move towards the outskirts side the ward area increases. The ward-wise population distribution of LMC is shown in Table 2 and Figure 3:

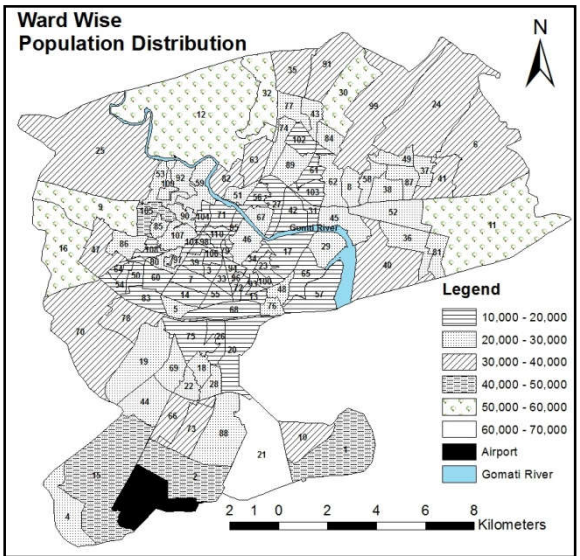

Fig.3. Ward Wise Population Distribution

Table 2. Ward Wise Population Distribution

Ward No.	Population	Ward No.	Population	Ward No.	Population	Ward No.	Population
1	43,282	29	22,318	57	17,016	84	26,103
2	41,971	30	53,630	58	23,299	85	26,973
3	17,988	31	11,065	59	22,074	86	24,452
4	22,717	32	52,328	60	18,365	87	22,154
5	21,960	33	17,224	61	17,218	88	26,217
6	38,910	34	15,832	62	24,040	89	22,266
7	18,999	35	31,756	63	30,739	90	24,495
8	25,553	36	26,795	64	17,919	91	34,352
9	50,574	37	21,207	65	15,583	92	27,897
10	38,053	38	20,544	66	32,880	93	13,780
11	54,513	39	14,829	67	20,828	94	17,606
12	55,227	40	31,412	68	14,747	95	13,468
13	19,668	41	34,903	69	24,770	96	19,274
14	19,946	42	16,816	70	34,253	97	22,774
15	46,057	43	24,961	71	13,367	98	14,342
16	55,566	44	29,270	72	17,657	99	37,468
17	16,072	45	29,036	73	39,612	100	17,353
18	23,292	46	24,264	74	23,256	101	19,155
19	23,588	47	32,543	75	16,314	102	14,384
20	19,054	48	21,552	76	20,055	103	17,010
21	68,993	49	21,023	77	20,361	104	18,788
22	27,010	50	18,196	78	36,173	105	41,909
23	19,263	51	22,192	79	19,524	106	19,082
24	35,400	52	21,938	80	20,501	107	23,720
25	35,312	53	29,006	81	26,055	108	12,195
26	19,965	54	17,086	82	37,800	109	23,179
27	18,326	55	17,087	83	16,256	110	18,404
28	25,218	56	16,353				

Source: Census of India and Provisional Census Data 2011

Population Density

The overall livability of a place is dependent on the population density of that place, in case of Lucknow as per the provisional figures of Census India, 2011; the population density is 8049 persons/sqkm (approx. 80 pph). The average population density of LMC being on the lower side of the permissible limits of the UDPFI guidelines for metropolitan cities; it is also the lowest when compared to other mega cities like Bangalore, Hyderabad, Ahmadabad and Chennai as given in Table 3 and figure 4:

Table 3. Population Density Comparison of Lucknow With

SI. No.	City	Density (persons/sqkm)
1	Bangalore	37449
2	Ahmedabad	30275
3	Chennai	26597
4	Hyderabad	18480
5	Pune	12777
6	Lucknow	8049

Source: Census of India and Provisional Census Data 2011

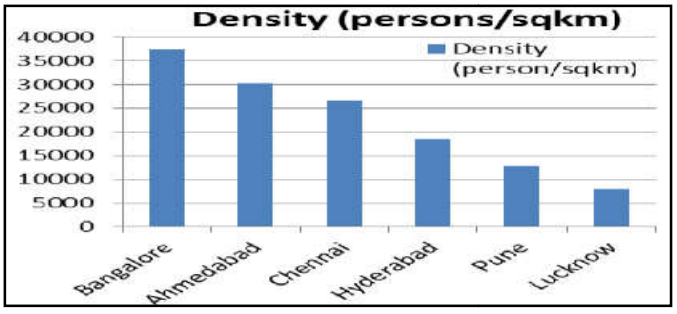

Fig.4. Population Density

Population density of LMC has remained almost same since the year 1951 due to continuous change in the municipal corporation boundary before 1991. Perhaps after the last expansion which took place in the year 1987, the population density has increased manifold from 4262 persons/sq.km (46 pph) in 1991 to 8049 persons per sq. km (approx. 80 pph) in 2011 due to continuous growth in the population whereas city area has not been expanded in the recent decades. From 1951 to 2011 changes in population density figures and area in LMC has been given in Table 4:

Table 4. Lucknow Population Density Scenario over the Years

SI. No.	Year	Population Total-LMC	Area in sqkm	Density (persons/sqkm)
1	1951	459484	48	9573
2	1961	615523	107	5753
3	1971	774644	101	7670
4	1981	947990	118	8034
5	1991	1619116	350	4626
6	2001	2185927	350	6246
7	2011	2817105	350	8049

Source: Census of India and Provisional Census Data 2011

Ward wise population density

The average population densities of wards in LMC is 400 pph. Ward numbers 90, 79, 46, 94, 89, 97, 107 and 113 have the highest density which is more than 800 pph whereas ward numbers 19, 17, 20, 25, 4, 47, 40 18 have least density which is less than 30 pph. As shown in the Figure/Map: Wards in the core city area have higher density than the wards on the periphery areas. Wards along the Gomati River, and wards located in the northern side of the city have high density. The overcrowding in these wards is the consequence of being the old historic city with specialized and intense trade and commerce activities being taken up; the overcrowding indicated by the densities call for decongestion of these areas. Ward wise population density and their comparison with UDPFl guidelines have been given in Table 5 and Figure 5&6:

Table 5. Ward Wise Density Analysis for LMC

Ward No.	Area (ha)	Population	Density (persons/ha)	Comparison with UDPFI Norms (125-175 persons/ha)
1	387	43282	112	Within the standard
2	829	41971	51	Within the standard
3	63	17988	286	Above the standard
4	896	22717	25	Below the standard
5	231	21960	95	Below the standard
6	893	38910	44	Below the standard
7	119	18999	160	Within the standard
8	542	25553	47	Below the standard
9	376	50574	135	Within the standard
10	351	38053	108	Below the standard
11	876	54513	62	Below the standard
12	1181	55227	47	Below t:he standard
13	26	19668	756	Above the standard
14	231	19946	86	Below the standard
15	1061	46057	43	Below the standard
16	560	55566	99	Below the standard
17	1203	16072	13	Below the standard
13	77	23292	302	Above the standard
19	1957	23588	12	Below the standard
20	893	19054	21	Below the standard
21	918	68993	75	Below the standard
22	108	27010	250	Above the standard
23	197	19263	98	Below the standard
24	545	35400	65	Below the standard
25	1639	35312	22	Below the standard
26	139	19965	144	Within the standard
27	96	18326	191	Above the standard
28	210	25218	120	Below the standard
29	336	22318	66	Below the standard
30	414	53630	130	Within the standard
31	55	11065	201	Above the standard
32	573	52328	91	Below the standard
33	67	17224	257	Above the standard
34	122	15832	130	Within the standard
35	400	31756	79	Below the standard
36	646	26795	41	Below the standard
37	435	21207	49	Below the standard
38	279	20544	74	Below the standard
39	42	14829	353	Above the standard
40	959	31412	33	Below the standard
41	252	34903	139	Within the standard
42	148	16816	114	Below the standard
43	100	24961	250	Above the standard
44	376	29270	78	Below the standard
45	61	29036	476	Above the standard
46	25	24264	971	Above the standard
47	1203	32543	27	Below the standard
48	197	21552	109	Below the standard
49	233	21023	90	Below the standard
50	107	18196	170	Within the standard
51	100	22192	222	Above the standard
52	321	21938	68	Below the standard
53	156	29006	186	Above the standard
54	78	17086	219	Above the standard
55	78	17087	219	Above the standard
56	63	16353	260	Above the standard
57	491	17016	35	Below the standard
58	542	23299	43	Below the standard
59	239	22074	92	Below the standard
60	163	18365	113	Below the standard
61	76	17218	227	Above the standard
62	201	24040	120	Below the standard
63	365	30739	84	Below the standard
64	132	17919	136	Within the standard
65	61	15583	255	Above the standard
66	773	32880	43	Below the standard
67	123	20828	169	Within the standard
68	41	14747	360	Above the standard
69	102	24770	243	Above the standard
70	226	34253	152	Within the standard
71	167	13367	80	Below the standard
72	25	17657	706	Above the standard
73	170	39612	233	Above the standard
74	122	23256	191	Above the standard
75	187	16314	87	Below the standard

Continue……

76	55	20055	365	Above the standard
77	292	20361	70	Below the standard
78	1063	36173	34	Below the standard
79	16	19524	1220	Above the standard
80	65	20501	315	Above the standard
81	278	26055	94	Below the standard
82	119	37800	318	Above the standard
83	99	16256	164	Within the standard
84	86	26103	304	Above the standard
85	81	26973	333	Above the standard
86	53	24452	461	Above the standard
87	239	22154	93	Below the standard
88	120	26217	218	Above the standard
89	27	22266	825	Above the standard
90	16	24495	1531	Above the standard
91	507	34352	68	Below the standard
92	144	27897	194	Above the standard
93	29	13780	475	Above the standard
94	21	17606	838	Above the standard
95	27	13468	499	Above the standard
96	38	19274	507	Above the standard
97	29	22774	785	Above the standard
98	46	14342	312	Above the standard
99	266	37468	141	Within the standard
100	26	17353	667	Above the standard
101	52	19155	368	Above the standard
102	171	14384	84	Below the standard
103	149	17010	114	Below the standard
104	30	18788	626	Above the standard
105	218	41909	192	Above the standard
106	63	19082	303	Above the standard
107	29	23720	818	Above the standard
108	33	12195	370	Above the standard
109	156	23179	149	Within the standard
110	26	18404	708	Above the standard
Total	33305	2817105		

Source: Census of India and Provisional Census Data 2011

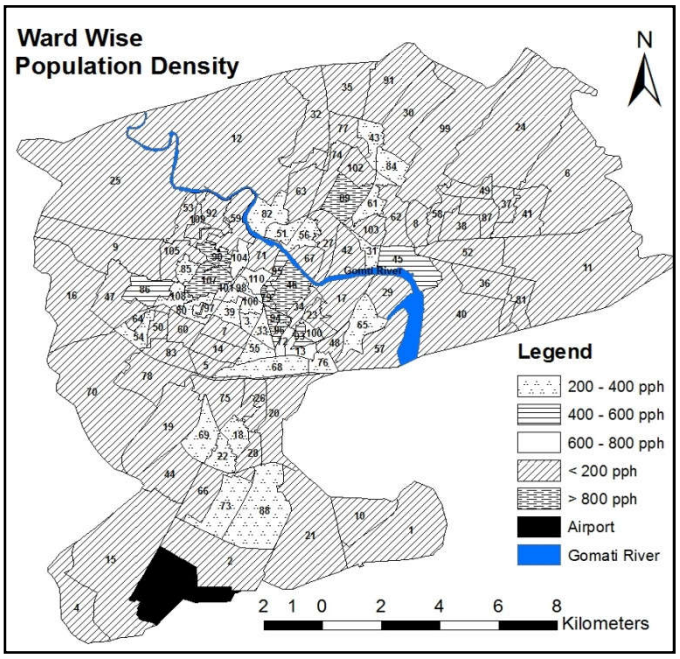

Fig.5. Ward Wise Population Distribution

Migration Pattern in Lucknow

The main reasons of migration are related with economic factors such as employment and business, various other social reasons like movement of family members from the rural to urban areas due to marriage and other social ties, etc. The higher level of migration of educated, skilled and semi-skilled workers from the rural areas to the urban areas has been observed in LMC. As per the data available from Study on Counter Magnet Areas to Delhi, NCR by National Capital Region Planning Board, total in-migrants in LMC for the decade 1991-2001 have been 2, 36,788 in numbers and out migration were 75,486. Table 6 shows the in and out migration pattern of some of the major towns of Uttar Pradesh. As shown in the table 6 and figure 7 LMC attracts maximum number of migrants from followed by Kanpur and Meerut city.

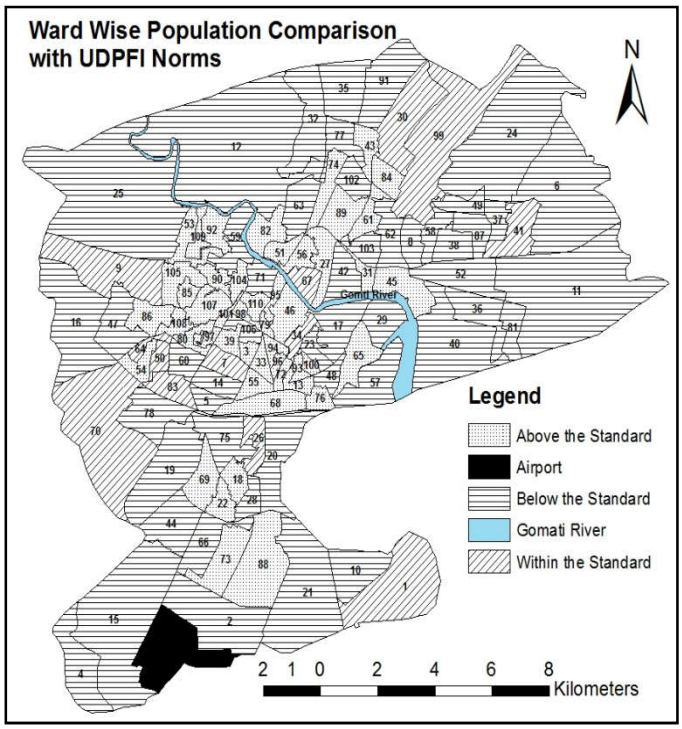

Fig.6. Ward Wise Population Comparison with UDPFI Norms

Table 6. Migration Pattern Key Towns of Uttar Pradesh 1991-2001

S. No.	Cities	In Migration	Out Migration
1	Lucknow	236788	75486
2	Meerut	115870	137589
3	Agra	84025	107301
4	Kanpur	178397	45052
5	Allahabad	76191	89092
6	Bareli	86352	100634
7	Varanasi	68324	85724

Source: on Counter Magnet Areas to Delhi & NCR by National Capital Region Planning Board

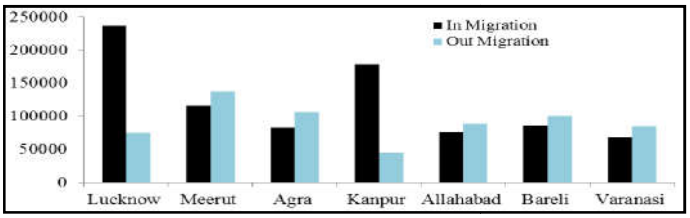

Fig.7. Migration Pattern in Some of the Towns of Uttar Pradesh

Total children (0-6 age group) in LMC are 293,697 accounts to 10% of the total population. Out of the total age group 0-6 population, 52% accounts for male population while 48% accounts for female population. Child sex ratio of girls is 896 per 1000 boys which is less than the total sex ratio of the city as given in Table 7.

Table 7. Population Details of Age Group 0-6

Indicators	Population	(%)
Population total (Age group 0-6)	293697	10.43 %
Male Population	154226	10.56 %
Female Population	139471	10.28 %
Sex Ratio for 0-6 age group	904	

Source: Census of India and Provisional Census Data 2011

Sex Ratio

One of the basic demographic characteristics of the population is the sex composition. Sex ratio is defined as "the number of females per 1000 males". In any study of population, analysis of sex composition plays a vital role. The sex composition of population is affected by differentials in mortality conditions of males and females, sex selective migration and sex ratio at birth. As per provisional figures 2011, Census of India, the Sex ratio of LMC is 928 females per thousand males which are higher than the district (917) and state (908) however lower than the national level figures i.e. 947. Sex ratio in the city has shown improvement from the last year census from 893 females per 1000 males in 2001 to 928 females per 1000 males in the year 2011. The ward-wise sex ratio of Lucknow shows that the highest sex ratio of 1040 is found in ward number 103 while the lowest is found in ward number 67 with 796 females per 1000 males in 2011 as shown in Table 8 and Figure 8.

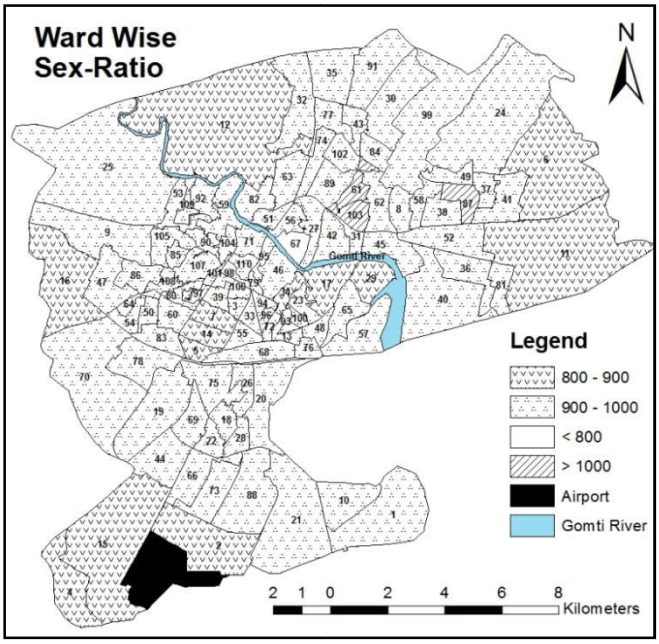

Fig.8. Ward Wise Sex Ratio

Literacy Rate

Literacy rate reflects the socio-economic development of any region. LMC has the highest literacy rate of 82.50% when compared to the district, state and urban India literacy rate. The high literacy rate can be attributed to LMC being one of the leading centers of higher education in the state. Table shows the literacy rate comparison of Lucknow with state and country as shown in Table 9 and Figure 9. The literacy rate of LMC has increase from 77.11% in 2001 to 85.20% in 2011 Census. Males have a higher literacy rate at 86.04% compared to 78.70% for females. However, the gap between literacy rates for males and females has narrowed, compared to that prevailing in 2001 as given in Table 10.

Table 8. Ward Wise Sex Ratio

Ward No.	Sex Ratio	Ward No.	Sex Ratio	Ward No.	Sex Ratio	Ward No.	Sex Ratio	Ward No.	Sex Ratio	Ward No.	Sex Ratio	Ward No.	Sex Ratio
1	921	17	882	33	949	49	907	65	935	81	917	96	937
2	891	18	955	34	891	50	946	66	937	82	933	97	942
3	962	19	937	35	909	51	955	67	796	83	959	98	925
4	892	20	930	36	938	52	942	68	942	84	939	99	938
5	899	21	916	37	988	53	927	69	946	85	940	100	960
6	881	22	912	38	986	54	929	70	918	86	934	101	985
7	899	23	966	39	940	55	936	71	933	87	1072	102	966
8	938	24	935	40	912	56	957	72	940	88	956	103	1040
9	909	25	935	41	952	57	919	73	920	89	944	104	970
10	920	26	931	42	903	58	927	74	915	90	944	105	945
11	887	27	947	43	920	59	918	75	904	91	934	106	941
12	887	28	919	44	927	60	944	76	922	92	914	107	938
13	934	29	890	45	927	61	1035	77	942	93	965	108	985
14	898	30	918	46	963	62	913	78	912	94	910	109	940
15	886	31	978	47	922	63	928	79	916	95	951	110	980
16	887	32	934	48	951	64	944	80	933				

Source: Census of India and Provisional Census Data 2011

Table 9. LMC Literacy Rate Comparison with Country and State

Urban Area	Literacy Rate
Urban India	80.73%
Urban Uttar Pradesh	77.01%
Urban Lucknow District	81.91%
LMC	82.50%

Source: Census of India and Provisional Census Data 2011

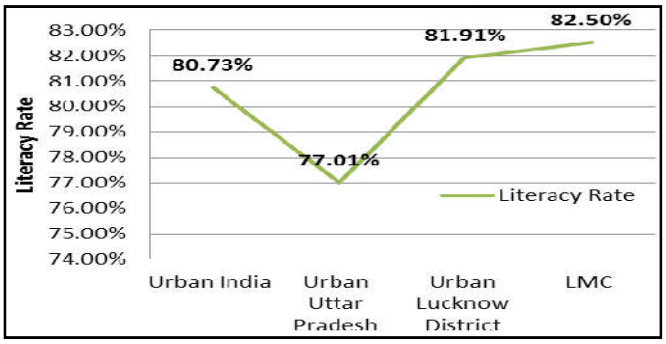

Fig.9. LMC Literacy Rate Comparison with Country and State

Table 10. Literacy Rate Details in LMC

Description	Census 2001		Census 2011	
	Literates	%	Literates	%
Total Literates	14,74,733	77.11%	20,81,727	82.50%
Male Literates	8,27,793	81.72%	11 ,24,261	86.04%
Female Literates	6,46,940	71.91 %	9,57,466	78.70%

Source: Census of India and Provisional Census Data 2011

while the Scheduled tribe contributes a minimal of 0.22% of the total population in year 2011 as given in Table 12.

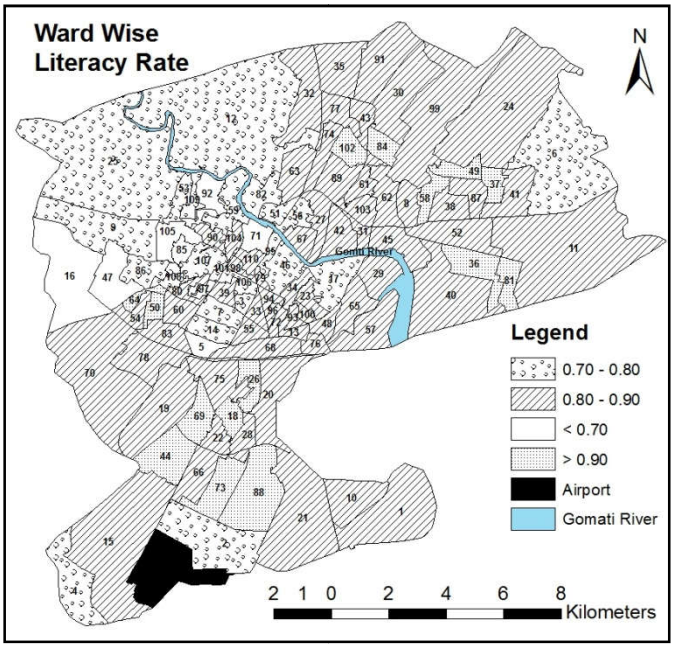

Fig.10. Ward Wise Literacy Rate

Table 11. Ward-Wise Literacy Rate Details in LMC

Ward No.	Literacy Rate	Ward No.	Literacy Rate	Ward No.	Literacy Rate	Ward No.	Literacy Rate	Ward No.	Literacy Rate
1	84.23%	23	81.88%	45	81.96%	67	81.35%	89	87.30%
2	76.04%	24	82.71%	46	79.86%	68	81.81%	90	84.96%
3	73.95%	25	71.48%	47	66.26%	69	91.46%	91	88.15%
4	77.31%	26	91.35%	48	84.69%	70	82.99%	92	68.39%
5	68.60%	27	84.14%	49	92.50%	71	68.66%	93	89.87%
6	73.52%	28	87.30%	50	91.31%	72	84.54%	94	80.42%
7	79.81%	29	84.03%	51	71.48%	73	93.10%	95	72.29%
8	81.01%	30	82.61%	52	85.52%	74	83.98%	96	86.75%
9	70.31%	31	84.67%	53	76.96%	75	86.21%	97	74.95%
10	86.80%	32	81.13%	54	86.72%	76	83.26%	98	87.85%
11	82.40%	33	82.90%	55	87.37%	77	84.11%	99	88.21%
12	75.37%	34	82.53%	56	79.57%	78	83.34%	100	83.32%
13	87.52%	35	83.27%	57	81.16%	79	82.42%	101	73.79%
14	75.93%	36	90.25%	58	92.45%	80	89.36%	102	93.78%
15	83.39%	37	91.71%	59	71.95%	81	94.13%	103	86.48%
16	69.76%	38	88.06%	60	86.15%	82	75.23%	104	88.87%
17	79.84%	39	85.91%	61	83.59%	83	88.55%	105	68.25%
18	92.14%	40	86.95%	62	83.47%	84	92.74%	106	74.84%
19	85.72%	41	85.73%	63	88.78%	85	66.88%	107	74.42%
20	84.59%	42	88.95%	64	90.74%	86	76.40%	108	76.57%
21	88.07%	43	84.33%	65	86.10%	87	89.23%	109	75.75%
22	89.30%	44	92.13%	66	85.65%	88	94.21%	110	83.11%

Source: Census of India and Provisional Census Data 2011

SC & ST Population

Schedule Caste and Schedule Tribe population are two main detenninants of social composition of any city in India, since, these being marginalized in the society fron1 the ancient times but soon after independence the Indian government is taking initiatives to uplift and bring the people these groups at par with the society and hence the needs of this section of society should be taken into account in any development project to ensure inclusive and holistic development. In LMC, the Scheduled caste contributes 10.75% of the total population

Population Projection for LMC

Population Growth of any place not only depends upon natural increase but also on in-migration. In addition to Lucknow's rapid socio-economic development that had a significant impact on the urbanization in the city, future growth is governed to a large extent by the development patterns in the city. The extent of in-migration in LMC is mainly the impact of the key projects that are influencing socio-economic development in the city and peri-urban areas. The population of LMC has been projected up to the horizon year 2041 taking

Table 12. SC & ST Population Share in LMC

Description	SC Population		ST Population	
	Total	%	Total	%
Total Population	302938	10.75%	6319	0.22%
Male Population	159411	10.91%	3376	0.23%
Female Population	143527	10.58%	2943	0.22%

Source: Census of India and Provisional Census Data 2011

Table 13. Population Projection for LMC till the Year 2041

Year	Census Population	Arithmetic Progression	Geometric Progression	Incremental Increase	Average	Population Growth Rate
1951	459484					
1961	615523					33.96%
1971	774644					25.85%
1981	947990					22.38%
1991	1619116					70.79%
2001	2185927					35.01%
2011	2817105					28.87%
2021		3319549	3983025	3630403	3644325	29.36%
2031		3886360	5375465	4714298	4658707	27.83%
2041		4453171	7253639	5955225	5887345	26.37%

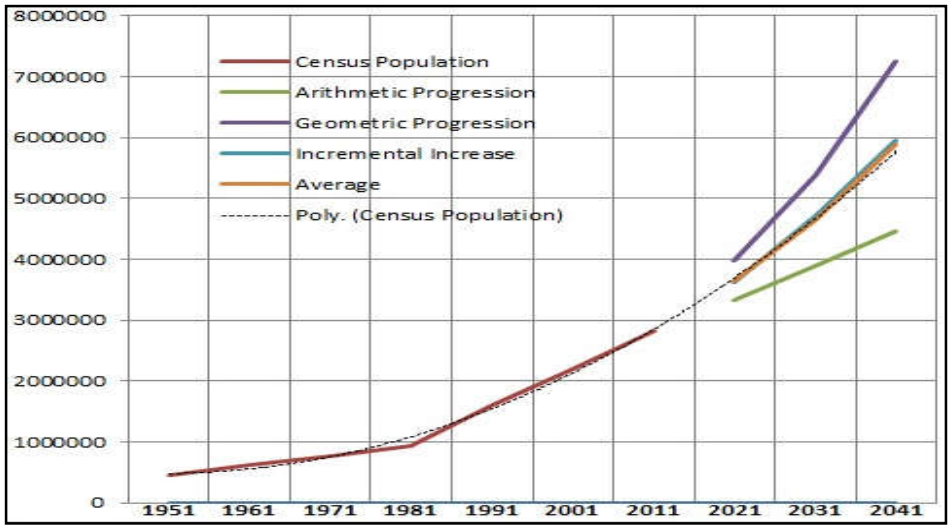

Fig.11. Various Methods of Population Projection for LMC

into consideration the decadal population trend of census of India and provisional figures of census from 1951 to 2011. The population is projected using three statistical methods viz. Arithmetic Progression Method, Incremental Increase Method and Geometric Progression Method. The average decadal population growth rate of LMC has been 33%. There is fluctuation in growth rate between the decades 1981 to 1991 due to expansion of municipal boundaries and jurisdiction change. Table 13 and figure 11 given below shows results of various population projection methods applied for LMC. Average of all the three methods i.e. Arithmetic, Incremental and Geometric Progression methods is best suitable with earlier population growth trends for LMC. As shown population in population projection figure, average population growth rate curve is virtually matching the census growth rate of the city. The projected population for the year 2021, 2031 and 2041 is 3644325, 4658707 and 5887345 respectively for Lucknow.

Conclusion

This paper demonstrates that Geographical information system (GIS) analyzes the population characteristics and showing demographic profile of LMC. The Ward Map is found to be useful in mapping and quantifying the ward-wise characteristics of population. The above study provides a methodology for better estimation of population growth using various arithmetic and geometric progression with time. GIS has been used in this study to provide spatial distribution of population and test the statistical model describing growth. This is useful for the planning authorities in developing countries where using Conventional techniques.

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