

Analysis of Population Growth and Urban Development in Lahore-Pakistan using Geospatial Techniques: Suggesting some future Options

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Abstract

Population is the main focus in all studies within the framework of geography because population and basic natural resources are intimately related to each other and with the prospects of urban development and quality of the environment in a region. Therefore, the study and analysis of population growth and distribution in the urban development is the logical starting point for any research of the present nature. Lahore is 2nd largest city of Pakistan in terms of its share in total population of the country. The total population of Lahore was 6,318,745 as per 1998 Census. Systematic monitoring of the urban development, proper management of the City and planned future development would lead to improvement in the living standards and environmental conditions of the millions of people living in the city of Lahore. Remote sensing along with the GIS technology can be used effectively and economically in the analysis and the inventory of urban development and land use and land cover study of the urban settlements. It provides database for the site suitability for further urban development and growth corridors in this fast growing metropolis of the country.

Introduction

With the passage of time due to economic development, industrialization, rural-urban migration and allied factors has brought a major transformation to cities and urban centers throughout the world to grow beyond their usual administrative limits. This phenomenon of urban growth and development is not as simple as it seems but has turned more complex due to this fact that it is largely taking place on open and agricultural lands in and around cities. Therefore, a growing population results in overcrowding in cities and loss of valuable green areas and indigenous vegetation within and outside the city. This has a greater bearing on the green character of many cities of the world. Lahore, the cultural heartland of the people of Punjab-Pakistan is a historic city. It has a recorded history of about 1,000 years. Over centuries; historians have described Lahore as the most enduring and fascinating city

not only of Pakistan but of South Asia. Founded by **Loh**, son of Rama Chandra, more than two thousand years ago, the ancient metropolis enjoyed prominence under various empires, be in Hindu or Mughal, Sikhs or British regime (IMPL-2004).

After Independence in 1947, a large proportion of Muslim migrants from India arrived at Lahore, which resulted in an increase of population of city. Despite this increase in number of people, the areal expansion was not as apparent as it is now a day. This may be because of aftermath of division of sub-continent and unstable conditions in the country as a whole. After this and up till now there has been a steady but consistent spatial growth of Lahore is taking place. During fifties and sixties the Lahore Improvement Trust initiated some new residential projects such as Gulberg, Samanabad, Upper Mall scheme etc.; while Lahore Development Authority(the successor of LIT) also made strides on a number of housing schemes and planning exercises, adding industrial areas, new university campus and airport to the Lahore's cityscape. It is pertinent to mention here that these planned schemes served as main instrument in the Lahore's urban development.

As environment in the urban areas is seemingly altered by anthropogenic activities, the geographers, urban planners, policy makers and administrators are currently being forced to monitor changes in the urban Land Use and the Land Cover (LULC) (Stow and Chen, 2002). Such studies are particularly important because the spatial characteristics of LULC are useful for comprehending various impacts of human activity on the overall ecological condition of the urban environment (Yeh and Li, 1999). LULC change due to human activities is currently proceeding more quickly in the developing countries than in the developed world, and it has been projected that by the year 2020, most of the world's mega cities will be in the developing countries (World Bank, 2007). Increasing population in the cities of developing countries has caused rapid changes in LULC and increased environmental degradation and creates enormous pressure on natural resources (Holdgate, 1993). The role of population growth is particularly important since the urban population in the world is projected to be almost double by the year 2050 (United Nations, 2008).

To assess and monitor urban development on a global as well as regional scale, remote sensing by satellite provides a much more viable and efficient option than field collection of spectral data. Field measurement of vegetation spectral signatures is limiting in that it requires broad-scale extrapolation to the landscape level (Asner et al., 1998), tends to be locationally and temporally dependent (Asner 1998), and is simply very time consuming to collect (Perry and Lautenschlager 1984). Satellite remote sensing platforms, with their ability to provide coverage of the entire Earth possesses significant potential for monitoring vegetation dynamics over large areas (Myneni et al., 1997; Running et al., 2000). Therefore, the use of geospatial techniques such as remote sensing and GIS to evaluate and monitor urban development viz-a-viz population increase and consequent change in land use /land cover using geospatial techniques has been carried out since early 1970's when first Landsat was launched (Kasereka, et al., 2010, Hadeel S. et al., 2009, Rashed et al., 2009, Ishaya et al., 2008, Ifatimehin and Ufuah 2006, Oluseyi 2006, Almas et al., 2005, Bassam et al., 2007, Chen et al., 2008, Dewan and Yamaguchi 2008, Dewan and Yamaguchi 2009, Shuqing et al., 2006, Bushra et al., 2009, Pyšek et al., 2004, Yeakley and Hook 2006).

Population Profile

Population is the main focus in all studies within the framework of geography because population and basic natural resources are intimately related to each other and with the prospects of urban development and quality of the environment in a region. Therefore, the study of population growth and distribution is the logical starting point for any research of the present nature. Under the Devolution Plan, the dichotomy between urban and rural areas has ended. A district now comprises of Tehsil (without any distinction between urban and rural areas in it), while a City district comprises of Towns. The population details about Lahore city (comprising Metropolitan Corporation and Cantonment) have been provided in this research are in accordance with the new set-up. The total population of Lahore was 6,318,745 as per 1998 Census. As table-1 reveals that the population of the city has grown more than 25 times since the beginning of the 20th century from a population of 202,964 persons in 1901 to 6,318,745 in 1998 as against Pakistan which recorded 1,657,700 to 132,352,000 during the same period. From 1901 to 1921, the yearly growth rates were slow which can be attributed as under enumeration of population and difficulty in areal coverage. Since then onwards the rate of population growth remained steady and after Independence in 1947 it picked up at faster rate i.e.; 4.35 and 4.51 percent during the intercensal period 1951-61 and 1961-72 respectively. This had registered a corresponding increase in population of 52.65 and 67.36 percent. This increase can be attributed due to substantial rural to urban migration, which took place during that period. The drop in average annual growth rate to 3.71 percent during 1972-81 and further decrease to 3.32 percent for 1981-98 can be due to decline in fertility. A glance at the table -1 and Fig.2 shows that the overall increase in population of Lahore has been about six times during 47 years of its Census history i.e.; 1951-98. The population of the city grew at an average rate of 3.32 percent during the intercensal period 1981-98 (17 years) and registered an increase of 74.20 per cent over 1981 when the population was 3,544,942 (Fig.2).

Table 1
Population, Intercensal Increase and Growth Rates of Lahore-Pakistan, 1901-2009*

Census Year	Population		Inter-censal Increase (%)		Avg. Annual Growth Rate (%)	
	Lahore	Pakistan	Lahore	Pakistan	Lahore	Pakistan
1901	202964	16577000	-	-	-	-
1911	228687	19382000	12.67	16.9	1.20	1.6
1921	281781	21109000	23.22	8.90	2.11	0.9
1931	429747	23552000	52.51	11.50	4.31	1.1
1941	671659	28282000	56.29	20.10	4.57	1.9
1951	849476	33449000	26.47	19.40	2.38	1.7
1961	1296477	42880000	52.62	28.00	4.32	2.4
1972	2169742	65309000	67.36	52.30	4.79	3.8
1981	2952689	84254000	36.08	29.00	3.48	3
1998	5143495	132352000	74.20	54.98	3.32	2.6
2009*	8,462,000	165445000	23.51	48.11	2.37	2.2

Source: District Census Report of Lahore-1961 and Pakistan Statistical Year Book 1977 (Karachi: Statistics Division, Govt. of Pakistan, 1978) and City Report Lahore Population and Housing Census 1998. Government of Pakistan, Statistics Division, Population Census Organization-2004.* Punjab Development Statistics-2009

Computed from 1951-61-72-81- and 1998 Census

*Estimated Population: Statistical Year Book of Pakistan-2009 p.309

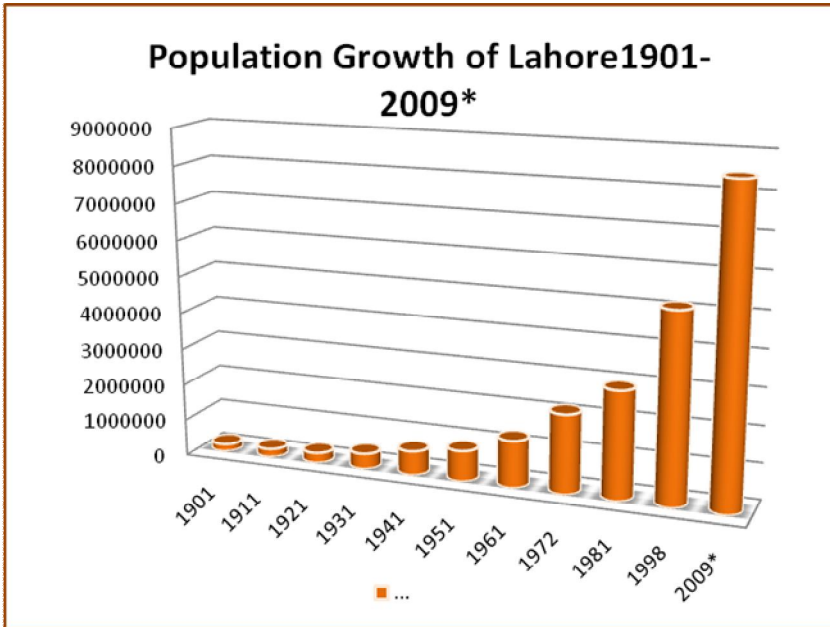


Fig.1

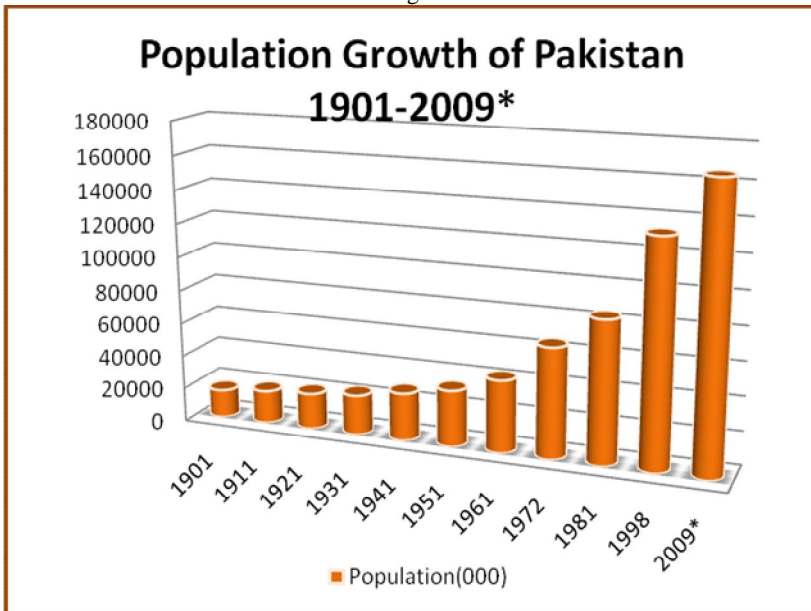


Fig.2

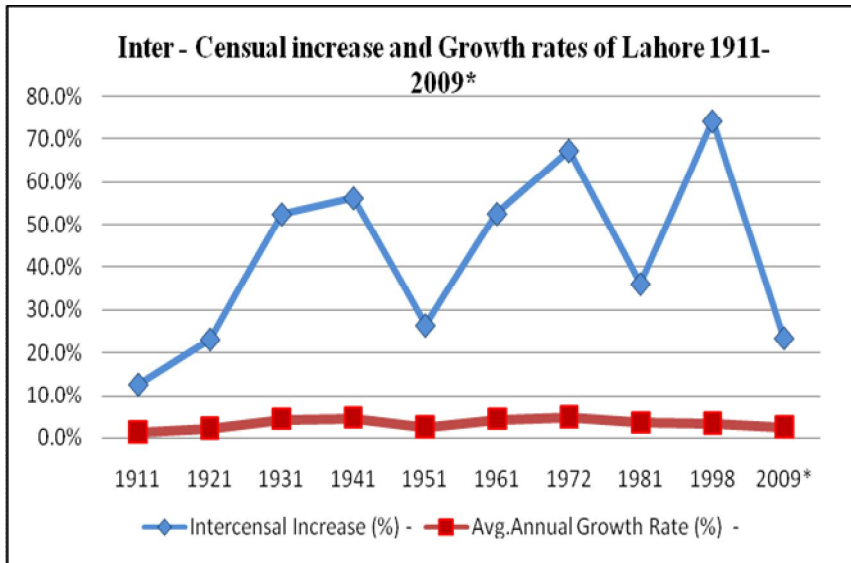


Fig.3

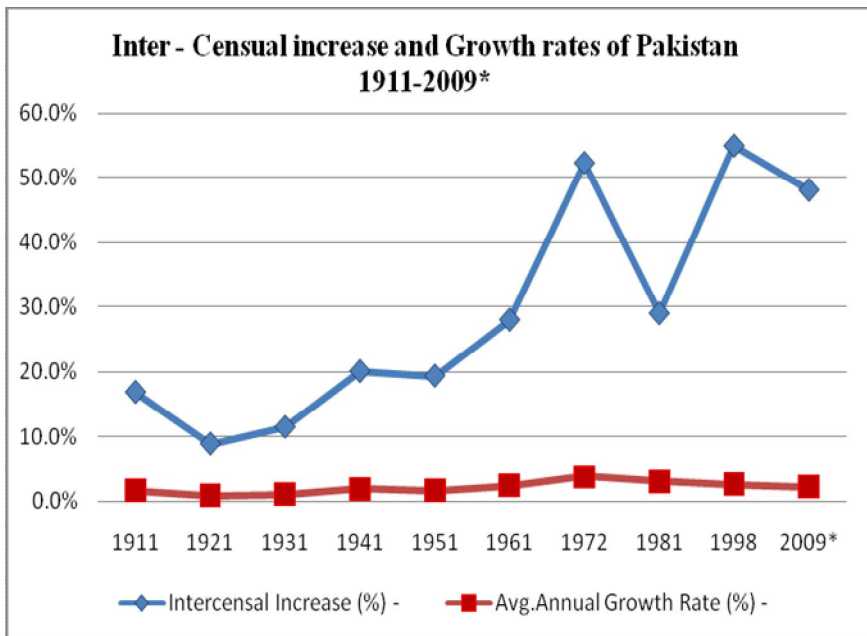


Fig.4

Material and Methodology

Remote Sensing quickly replaced laborious and inexact data collection by plane table surveying and field sketching (Robinson, 1995).Planimetrically corrected ortho-rectified

digital images of high spatial resolution are being used all over the world for cartographic map preparation. By applying image-processing techniques, the base map was developed.

Base map is essential for any GIS based research because it is the only entity which directs the data to a clear spatial dimension. The Survey of Pakistan is sole authority of mapping and surveying all over Pakistan. But, besides that, different other governmental organizations are also developing their own land use maps like LDA, WASA, the Punjab Urban Unit and Lahore Municipal Corporation, etc. The SOP has traversed every inch of Pakistan on papers but digital cartography is in infancy in the organization.

To develop any GIS model, it is essential to make a suitable base map in vector format so that there can be attached attribute data to the geographical entities such as Polygon (Regional Feature), Polyline (Linear feature) or Point (Exact object location). Taking available Union Council level, the City District Government Lahore's administrative map (on appropriate scale) prepared by the NESPAK for Lahore Development Authority, the base map for present research has been produced. This map consists of 151 polygons, one of Lahore Cantonment and the rest for 150 (rural / urban) union councils of the Lahore district.

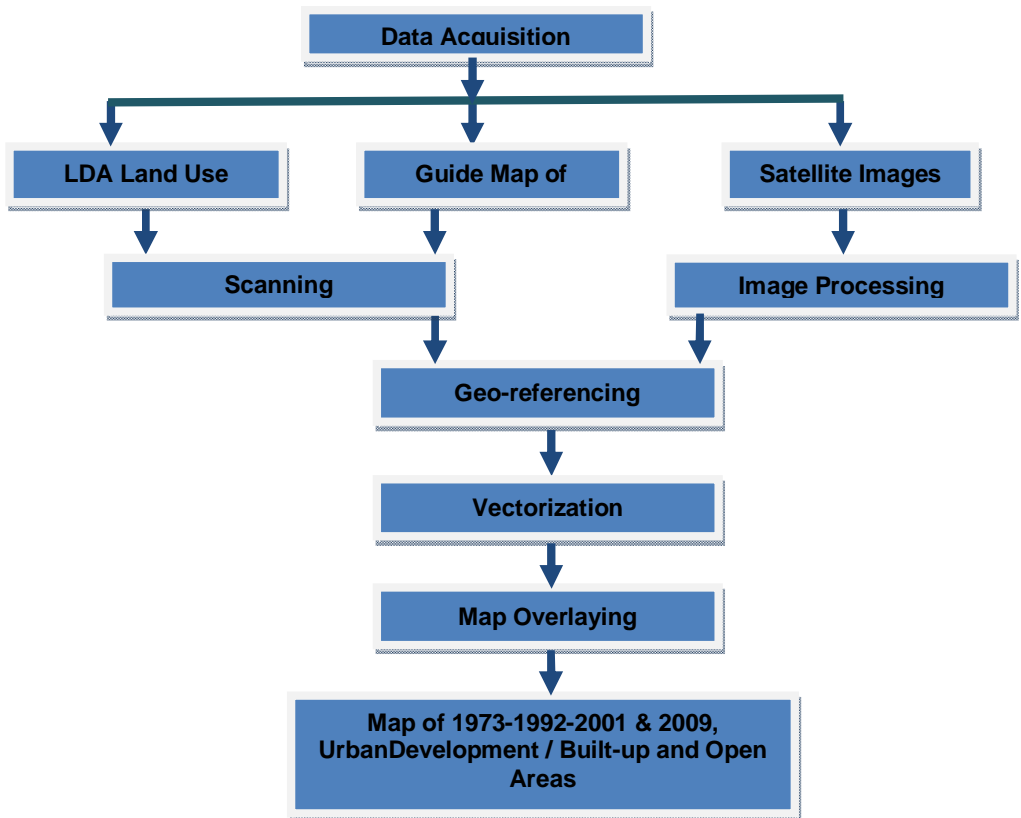


Fig.5Flow Diagram to Depict Urban Development

The base map file was then retrieved into ERDAS Image as a vector layer. The Landsat TM was first geo-referenced with the help of corrected images and topographical maps. These images were then spatially geo-referenced to a Universe Transverse Mercator (UTM) projection using first order polynomial and were re-sampled with nearest neighbor algorithm. Ground Control Points (GCPs) were selected from Landsat TM image and topographical sheets of the Survey of Pakistan. A root means square of one pixel (30 m) was accepted for rectification.

As mentioned earlier, there were image and non-image sources of data for Lahore. The researcher was interested in detecting the historical urban development and growth of the Metropolitan Lahore. The maps available were scanned as described earlier and then georeferenced for digitization. This yielded a cartographic form as project file in Arc View version 3.1. Each of these maps and images acted as a theme that could be superimposed on the other. Soft, on screen digitization for change detection as shown in the workflow has been achieved (Fig.5).

The growth map of the City depicts that during the period of 63 years since Independence, Lahore's growth has resulted in major development in south and southeast directions. The growth towards north and west has been checked by River Ravi, which constitute a physical barrier in those directions. Similarly expansion towards east has also been greatly checked by the Indian boarder (Fig.6).The physical growth of Lahore during the last sixty three years has been along major roads such as, Ferozepur Road, G.T Road and Multan Road .Further in the north-south axis, it has created a rectangular developed area .Within the city itself the rapid development after 70's took place along the major British period arteries such as along Canal bank, the Mall, Mayo and Lytton road. Many planned and unplanned housing schemes were initiated by both public and private enterprise result in present day scenario.

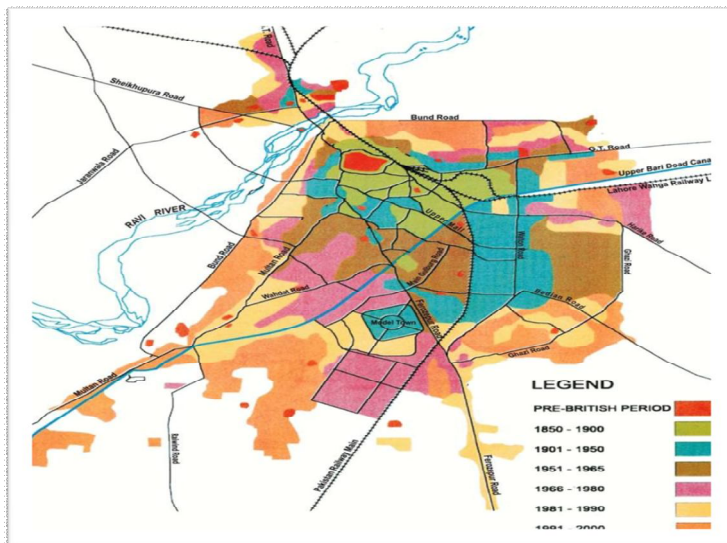


Fig.6 Urban Development and Areal Expansion of Lahore 1850-2000 onwards
Source: After LDA, 2004 (modified)

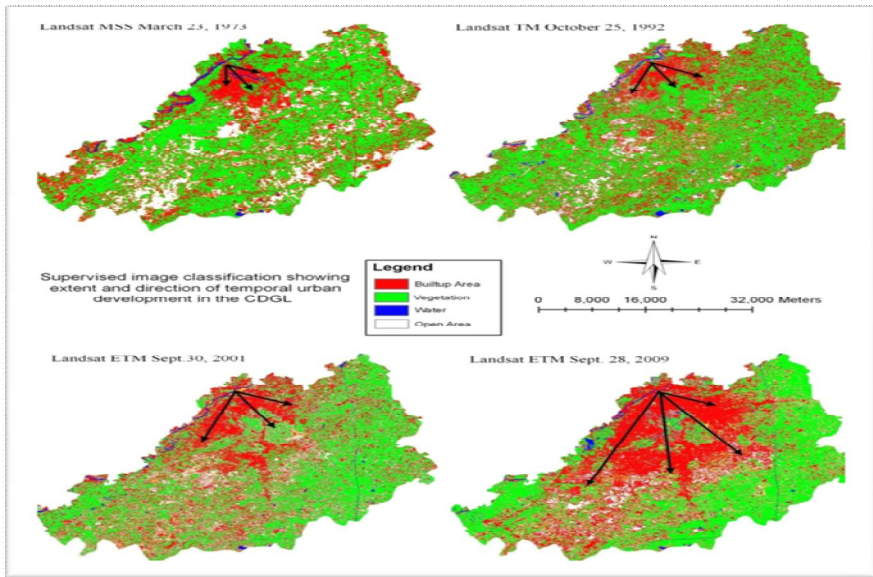


Fig.7 Extent and direction of urban development in Lahore

Analyses of two input raster files were done and a new file was produced. The new file contains class values that indicate how the class values from the original files overlap. The City District Government of Lahore has administratively divided the city into 150 Union councils. The boundaries of these Union Councils were demarcated on the vector file and then it was superimposed on the raster file, which was produced from the previously explained techniques.

Results and Discussion

Population growth always acts as impetus to urban development and vice versa. In this research population growth of Lahore has been studied and geospatial techniques have been applied to monitor urban development. The results revealed that Lahore has grown in all directions since 1947 due to population growth and urban development. A glance at the map reveals that most of these Union Councils are either in the south or to the west of the City, supporting the previous findings of the study that the city is growing in these two directions. It is apparent from the analysis that the physical configuration of Lahore district has been affected by numerous constraints, like River Ravi, which threatens the physical expansion of the built up area in the North and North-West direction. The proximity of Wagha border in the East allows the City sprawl only towards the Southern and Southwestern directions. In addition to these, there are a number of intangible constraints, which are not easy to quantify but can be observed, like congestion at the City center, traffic problems, solid waste management, and depleted housing conditions within the core of the City that force people to move to the outskirts of

the City.

Despite all these constraints, the city growth has been taking place soon after 1947. This trend can be seen in the densification of the built up area through sub-division of larger plots / houses into smaller ones. It is evident that filling in of the vacant pockets of land in the City has been one of the factors of vegetation loss. Apart from the densification within built up area, growth and development along the sub-urban zone, fringes and periphery is also continuing in the form of the establishment of new residential and commercial schemes. This trend can be observed along both sides of Ferozpur Road, Shahdara area and the abandoned riverbed across the Bund road. Across the River Ravi, there has been vast open area still available for residential and commercial purposes. The natural vegetation of these areas can be protected by some legislation to protect the indigenous vegetation of Lahore. There are a number of housing schemes coming up towards the south-west direction of the City. This can provide a corridor for future urban development and consequent vegetation loss. Therefore, it is recommended that the indigenous vegetation should be preserved rather than to remove it and replaced by some alien species of the plants, which can harm the overall environment of the City. In this growth corridor of Lahore, both public and private housing schemes are establishing fast but in a scattered way. These areas are growing farther from the present City center of Lahore. This trend led to the ribbon development along Multan Road, Ferozpur Road and G.T. Road. Figure-1 shows the major growth areas around Lahore. It indicates that the city of Lahore has grown in Data Ganj Baksh Town, Aziz Bhatti Town, Nishtar Town, Wagha Town and Raiwind.

FUTURE OPTIONS:

Future development options in Lahore are towards south and southwest, as shown in the figure below. Although, Lahore has the potential to develop all-around that includes its expansion towards east (Wagha border) and north-west (towards River Ravi), but the following Union Councils with open areas of more than 20 percent of their total land area is potentially important for further urban development and suggested growth corridors (Table-2).

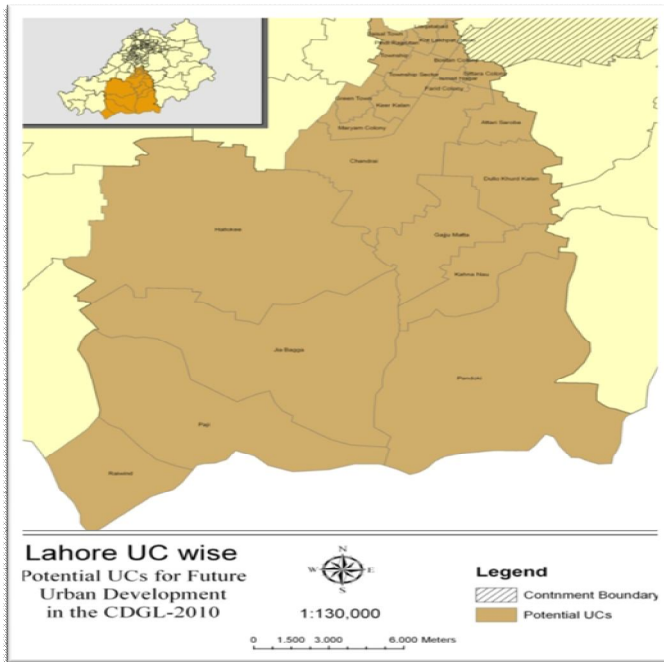
Table 2
Union Councils with 20% or more Open Area for Future Urban Development in Lahore-2009

UC_No	Name	% of Open Land
128	Faisal Town	20.00
129	Liaqatabad	20.00
130	Kot Lakhpat (New)	20.00
131	PindiRajputan	20.47
132	Township	21.05
133	Township Sector	21.05
134	Bostan Colony	21.43
135	Ismail Nagar	21.43
136	Sittara Colony	21.53
137	Farid Colony	22.22

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138	Keer Kalan	22.38
139	Green Town	23.81
140	Maryam Colony	23.81
141	AttariSaroba	25.00
142	DulloKhurd Kalan	25.00
143	Chandrai	26.25
144	Hallokee	27.16
145	GajjuMatta	30.10
146	KahnaNau	30.96
147	JiaBagga	31.75
148	Paji	33.33
149	Raiwind	33.33
150	Pandoki	33.33

Source: Author



Source: Author Fig.8 Growth corridors of Lahore

From the above table and Fig.8, it is apparent that in 2009, there were only 23 Union Councils in the CDGL, which holds 20% or more of their lands open for development (Table-2). A glance at the map reveals that most of these Union Councils are either in the south or to the west of the City, supporting the previous findings of the study that the city is growing in these two directions. Systematic monitoring of the urban development, proper management of the City and planned future development would lead to improvement in the living standards and environmental conditions of the millions of people living in the city of

Lahore. Remote sensing along with the GIS technology can be used effectively and economically in the analysis and the inventory of urban development, land use / land cover study of the urban settlements and the vegetation cover. It provides database for the site suitability for further urban development in this fast growing metropolis of the country.

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