ASSESSMENT OF URBAN PERI-URBAN INTERACTION IN NATIONAL CAPITAL REGION

Dissertation Submitted in Partial Fulfillment of the Requirement for the Award of the Degree of

MASTER OF PHILOSOPHY

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2010

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CERTIFICATE

I, Tesfayohannes Hailu, do hereby certify that the dissertation entitled "Assessment of Urban Peri-Urban Interaction in National Capital Region" submitted by me is my bona fide work and may be placed before examiners for evaluation.

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Acknowledgements

All organizations and respected individuals who have made direct or indirect supports to realize this study project should get my utmost thanks and appreciations for their efforts. Of all, some have to be particularly appreciated for their particular assistances. In this regard; I am very glad to express my greatest gratitude to my supervisor Dr Milap Punia, professor of GIS and Remote Sensing at Center for the Study of Regional Development, Jawaharlal Nehru University, for his quick responses and giving periodic valuable comments and corrections. He assisted me in providing with various books relevant to the study, articles, and other materials necessary for the study. On top of these; he enabled me add (cultivate) a new knowledge to my previous ones in the course of the study.

Next; I would like to appreciate the Ethiopian and Indian governments for their bilateral agreement and awarding me this scholarship. Furthermore, JNU and Mekelle University are grateful for their giving admission and sponsorship to my program of study.

My greater appreciations are also extended to CSRD staffs for their commitments in giving constructive comments at different progress report sessions.

Tesfayohannes Hailu

May 2010

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ACRONYMS

Agri'l	Agricultural
BPL:	Below Poverty Line
B.N:	Buddha Nagar
Cult'le	Cultivable
Culti.	Cultivators
C.D Block:	Community Development Block
DEL:	Direct Extension Lines
Dist.:	District
DMA:	Delhi Metropolitan Area
EU:	European Union
H.H	Household
HUDA:	Haryana Urban Development Authority
Indu.	Industry
MOUDPA:	Ministry of Urban Development and Poverty Alleviation
MPD:	Master Plan of Delhi
MRTS:	Mass Rapid Transit System
MW:	Mega Watt
NCR:	National Capital Region
NCT:	National Capital Territory
N-Delhi:	NCT-Delhi
NH:	National Highway
NSS:	National Sample Survey
PB:	Planning Board
Pop.	Population
R.P:	Regional Plan
S.R:	Sub-Region
UN:	United Nations
UNCHS:	United Nations Center for Human Settlements
UNDP:	United Nations Development Program
UNESCO:	United Nations Educational, Scientific, and Cultural Organization
UP:	Uttar Pradesh
UPUDA:	Uttar Pradesh Urban Development Authority
WL:	Waiting List

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

The outward expansion of urban settlements is a common characteristic feature in all countries of the world. The rapid urban population growth and the need for vast investment areas are among the major driving forces of continuous urban expansion. India is among the countries having large urban centers with 3 mega cities; namely, Mumbai, Kolkata, and Delhi. The size difference among these mega cities is not as large as it is in some other countries. The World Development Report 2009 noted that "in India and the United States, the size difference between the two biggest cities is relatively small. With populations of more than 22 million people, Mumbai and New Delhi stand shoulder to shoulder." India is also endowed with many other metropolitan cities like Chennai, Pune, Bangalore, Hyderabad, and Ahmedabad. The World Development Report 2009 further explained such "large urban centers and secondary cities also act as local political centers, and provide advanced public health, education, and cultural facilities. Hyderabad, the state capital of Andhra Pradesh with numerous universities, leading institutes for technical education, and private medical colleges, is a seat of learning in southern India."

Of the 3 mega cities, Delhi is the most rapidly growing city in population, areal extent, investment, and employment aspects. The Economic Survey of Delhi (2006) indicates the trend of urbanization of the City as follows: the trend of urbanization in Delhi is reflected in the fact that urban area has increased from 326.54 sq.kms in 1961 to 591.9 sq.kms in 1981 and 700.23 sq.kms in 1991 to 924.68 sq.kms in 2001.This urban area was 22% in 1961, 40% in1981, 47% in 1991 and 62% of the total area in 2001. Similarly, the urban population of Delhi which was 14.37lakhs in 1951, increased to 23.59lakhs in 1961, 84.71lakhs in 1991 and129.05lakhs in 2001. This urban population was 88.72% in1961, 92.73% in 1981, 89.94% in1991 and 93.18% of the total population of Delhi in 2001.

The Economic Survey of Delhi (2006) also reveals that with 13.8 million population size in 2001, Delhi ranked third among the most populous metropolitan Indian cities after Mumbai and Kolkata. The City's population grew annually by 3.85 percent during the period 1991-2001. It is estimated that by the end of next decade it will witness 50% increase in its population. Delhi is overwhelmingly urban with less than 7 percent living in rural areas.

The vibrant growth of Delhi has brought about marked differences in living standards between urban and rural areas. This is also true in other countries. The WDR-2009 describes the situation as "rural-urban gaps in income, poverty, and living standards begin to converge as economies grow, faster for access to social services, and faster in areas of more vibrant growth." Such a growth encouraged more migrants flow to Delhi and caused heavy pressure to the City.

The fast growth of Delhi stressed the necessity of planning Delhi in a Regional context. Since 1956, planners have been given due consideration for a planned de-concentration to outer areas and even outside the Delhi region (PB, 2004). The 1962 Master Plan of Delhi defined Delhi as a Metropolitan area of 2072 sq. kilometers comprising of Delhi and the six ring towns namely Loni and Ghaziabad in U.P., Faridabad, Ballabgarh, Bahadurgarh and Gurgaon in Haryana and Narela in Union Territory of Delhi to achieve a rational growth (Ibid).

The Plan also defined the National Capital Region (NCR) comprising of the Union Territory of Delhi and the 8 adjoining Tahsils and 3 additional Tahsils of Meerut, Hapur, and Buladshahr and recommended the setting up of a statutory National Capital Region Planning Board and development of the Region in accordance with the Regional Plan (PB, 2004).

Taking the recommendations for the Master Plan of Delhi (1962), the Government of India had set up a high power Board for the preparation of Regional Plan of the National Capital Region and finally, the Parliament enacted the National Capital Region

Planning Board Act in 1985. The Board prepared the National Capital Region Regional Plan-2021 in 2004 (Ibid).

The total area of the National Capital Region (NCR) is 33,578 sq. km., comprising of the National Capital Territory of Delhi (1,483 sq. km.), Haryana Sub-region (13,413 sq. km.), Rajasthan Sub-region (7,829 sq. km.), and Uttar Pradesh Sub-region (10,853 sq. km.) respectively.

This study focuses on patterns of estimated interactions between urban and peri-urban areas in NCR. It might be important give additional clarifications on the differences between the two distinct settlement areas. As per the Census of India (2001), the term urban is defined as a settlement that satisfies the requirements: (1) a total population of greater than 5,000; (2) population density of at least 400 persons per square kilometer; (3)75 per cent of the male working population of the settlement should be engaged in non-agricultural activities.

The peri-urban area; on the other hand, is defined as the area: immediately adjoining an urban area, between the suburbs and the country-side. However; these areas (peri-urban) are always difficult to define. Because, they have problems relating to their conceptualization as they are vast transition zones consisting of both urban and rural activities.

Different authors and organizations have given various descriptions about the relationships between urban and peri-urban areas. Among others; we find the following statements: "The perceived link between the city and the countryside is evolving rapidly, shifting away from the assumptions of main stream paradigms to new conceptual landscapes where rural-urban links are being redefined. In this conceptual field, the peri-urban interface is still generally considered as a transitional zone between city and countryside, often described not as a discrete area, but rather as a diffuse territory identified by combinations of features and phenomena, generated largely by activities within the urban zone proper"(Nottingham and Liverpool Universities, 1998).

The urban and peri-urban areas change through time as a result of the outward expansion of the urban area and a corresponding change in the peri-urban interface.

The patterns of urban peri-urban interactions are usually expressed in terms of the flows of people, capital, labor, commodities, and information which may vary from place to place. This study is; however, intended to investigate the urban peri-urban population and workforce interactions between these two distinct geographic areas.

1.2 Objectives of the Study

- Assess urban peri-urban land use changes and identify existing potential interactions between them,
- Identify the distribution of city (Delhi) gravitational fields and draw distribution map of sphere of influence,
- Analyze the strengths of major types of flows: people, and workforce interactions in the urban peri-urban areas of the National Capital Region,
- Correlate the urban peri-urban interactions in the National Capital Region with their relative distances from urban Delhi,
- Address the role of urban peri-urban interactions to enhance integrated regional development, improved service provision, and harmonious social cohesion in the Region.

1.3 Research Hypotheses

- Land use intensity (density) in NCR decreases with distance from the center of the City (Delhi).
- Land use (land cover) change has inverse relationship with distance from the center of the City (Delhi).
- Delhi strength of sphere of influence in NCR is inversely related with distance from City center.
- The degree of population interaction decreases with distance from the center of the City (Delhi).

1.4 Scope of the Study

It is difficult for the researcher to study all aspects of the problem under study for various purposes. For example; all checklists necessary to assess and address the urban peri-urban interactions can not be fully investigated in a Region with a total area of 33,578 sq. km. and a total population of 37, 033,223 with the time assigned and the budget allocated for the program (project) underpinned. Therefore, the researcher has determined the scope of the study and selected specific cases (core issues) relevant to the problem identified (understudy) for his investigation and recommend other issues for further studies.

This study is limited to the major issues relevant to urban and peri-urban interactions in the National Capital Region. Most specifically, the study is limited to: land use changes and interactions, population interactions, work force participation, transport net works, social infrastructure, administrative and service provisions, and basic civic amenities. Other detail urban and peri-urban issues are put forward for other researchers.

1.5 Limitations of the Study

This study entirely depends on secondary data. The absence of current primary data may have certain influence on the research work. The major data base for the study is Census of India, 2001. This indicates that the data were collected some eight years ago and not updated so far. The lack of current data may; therefore, influence the quality of the research outputs. The real current situations could have certain variations from that of the 2001. On top of that; very limited studies on urban peri-urban interactions have been conducted on the area under study. Hence, the researcher is constrained with adequate research experiences on similar cases.

CHAPTER 2: PROFILE OF NATIONAL CAPITAL REGION

2.1 Terminology

The term National Capital Region (NCR) of India is a name given to a large (extended) metropolitan region including the National Capital Territory (NCT) of Delhi and the surrounding districts from the neighbor states: Haryana, Uttar Pradesh and Rajasthan. The history of the National Capital Region (NCR) of India started in 1962 when the Master Plan for Delhi: MPD-1962 was prepared. The rationale for the expansion and planned de-concentration of the NCT Delhi to outer areas encompassing out side the Delhi region started from the desire of the Government of India for planned development. Some details about the progress of the NCR from the idea initiated in 1962 to the realization of the Region through preparing the Regional Plan-2021 are given at the introductory part.

2.2 Position (Boundary) of the Region

As per the Regional Plan-2021 (2004), the National Capital Region lies between $27^{\circ}03'$ and $29^{\circ}29'$ north latitude and, $76^{\circ}07'$ and $78^{\circ}29'$ east longitude. The Region includes the National Capital Territory (NCT) of Delhi and parts of the states of Haryana, Uttar Pradesh and Rajasthan.

In its relative location, the Region is bounded by districts of Haryana and Uttar Pradesh from north, Haryana and Rajasthan from west, Rajasthan and Uttar Pradesh from south, and Uttar Pradesh from east.

2.3 Size of National Capital Region

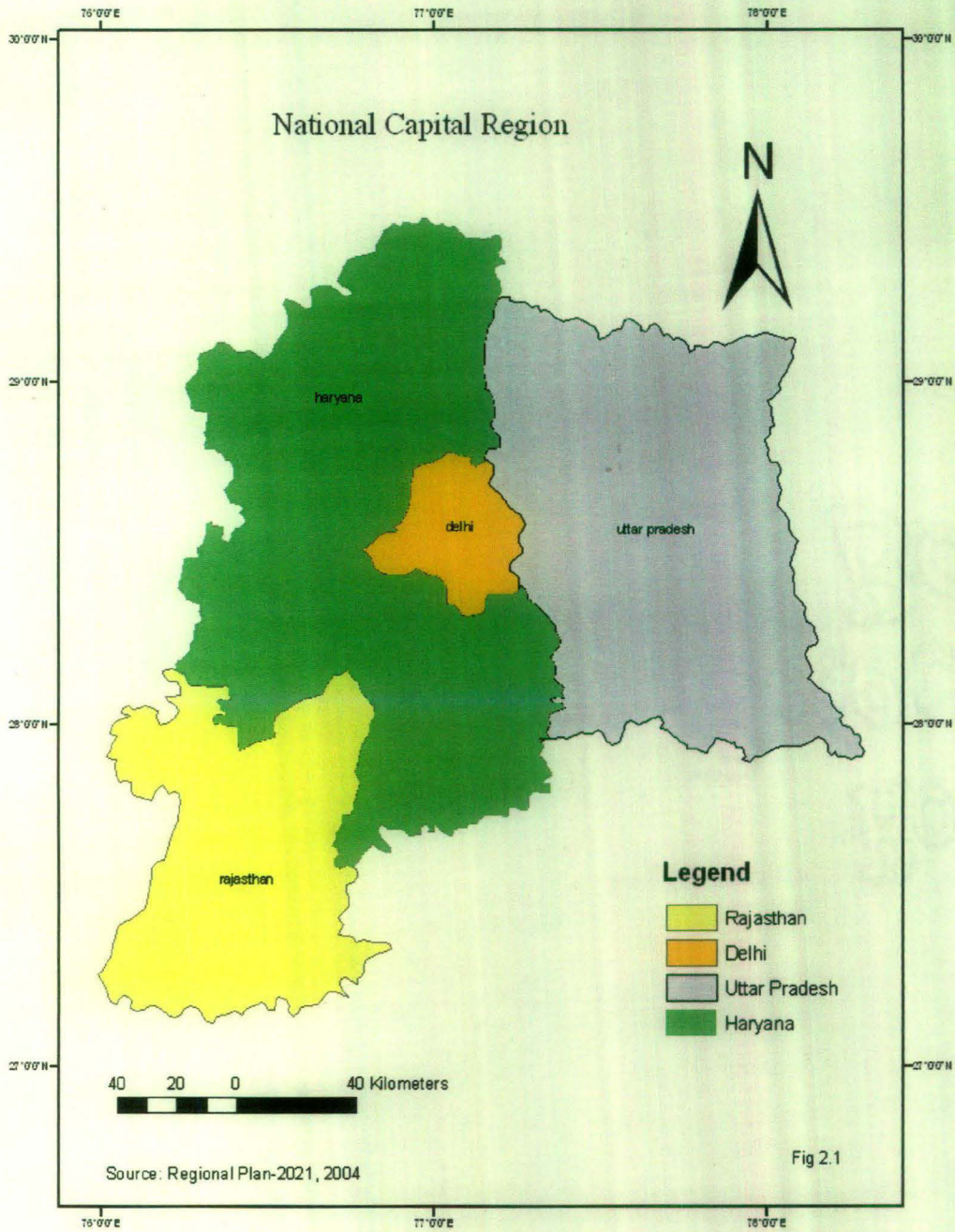
The Region is constituted from four sub-regions. The Regional Plan-2021 (2004) of the NCR states the four constituent areas of the Region as follows:

a. **National Capital Territory of Delhi** (1,483 sq.km): This accounts for 4.41% of the total area of NCR,
b. **Haryana Sub-region**: It comprises the districts of Faridabad, Gurgaon, Rohtak, Sonipat, Panipat, Rewari and Jhajjar. This Sub-region accounts for

30.33% (13,413 sq. km) of the area of the State and 39.95% of the area of the NCR.

c. **Rajasthan Sub-region:** It comprises Alwar district. This Sub-region constitutes 23.32% (7,829 sq. km) of the total area of the NCR.

d. **Uttar Pradesh Sub-region:** It includes five districts of the state, namely: Meerut, Ghaziabad, Gautam Buddha Nagar, Bulandshahr and Baghpat. This Sub-region accounts for 32.32% (10,853 sq. km) of the area of the National Capital Region. The total area of the National Capital Region is; therefore, 33,578 sq. km.

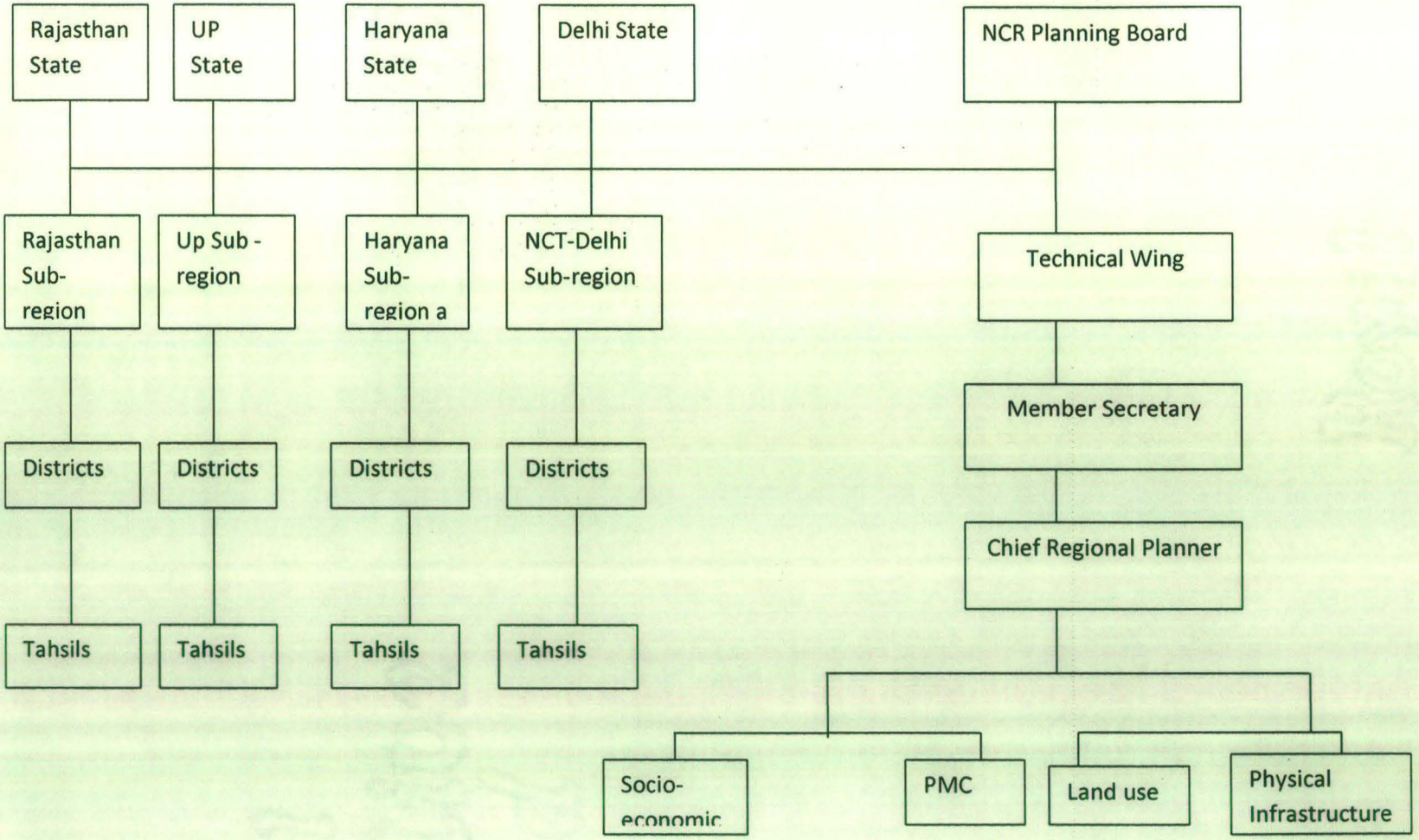

National Capital Region
N
haryana
delhi
uttar pradesh
rajasthan
Legend
Rajasthan
Delhi
Uttar Pradesh
Haryana
40 20 0 40 Kilometers
Source: Regional Plan-2021, 2004
Fig 2.1

2.4 Administrative Divisions of the National Capital Region

The National Capital Region is accountable to two administrative bodies. The sub-regions of the NCR are administratively accountable to their respective state governments while technically to the Planning Board (PB) of NCR. The administrative structures of the sub-regions are: therefore, similar to that of their respective states: district, tahsil, block, gram panchayate and village.

The organizational set-up of the Planning Board is as follows: "The Union Minister of Urban Development and Poverty Alleviation (MOUDPA) is the chair of the Board which consists of 21 senior level members of the Government of India and the participating states and 10 co-opted members. A full time Member Secretary of the rank of the Additional Secretary to the Government of India is the Chief Executive of the Board. The Board's secretariat consists of planning, financing, and administrative wings. The Board has one NCR planning and monitoring cell working within each of the three participating states for coordination and monitoring of projects (Report No. 2, 2006)."

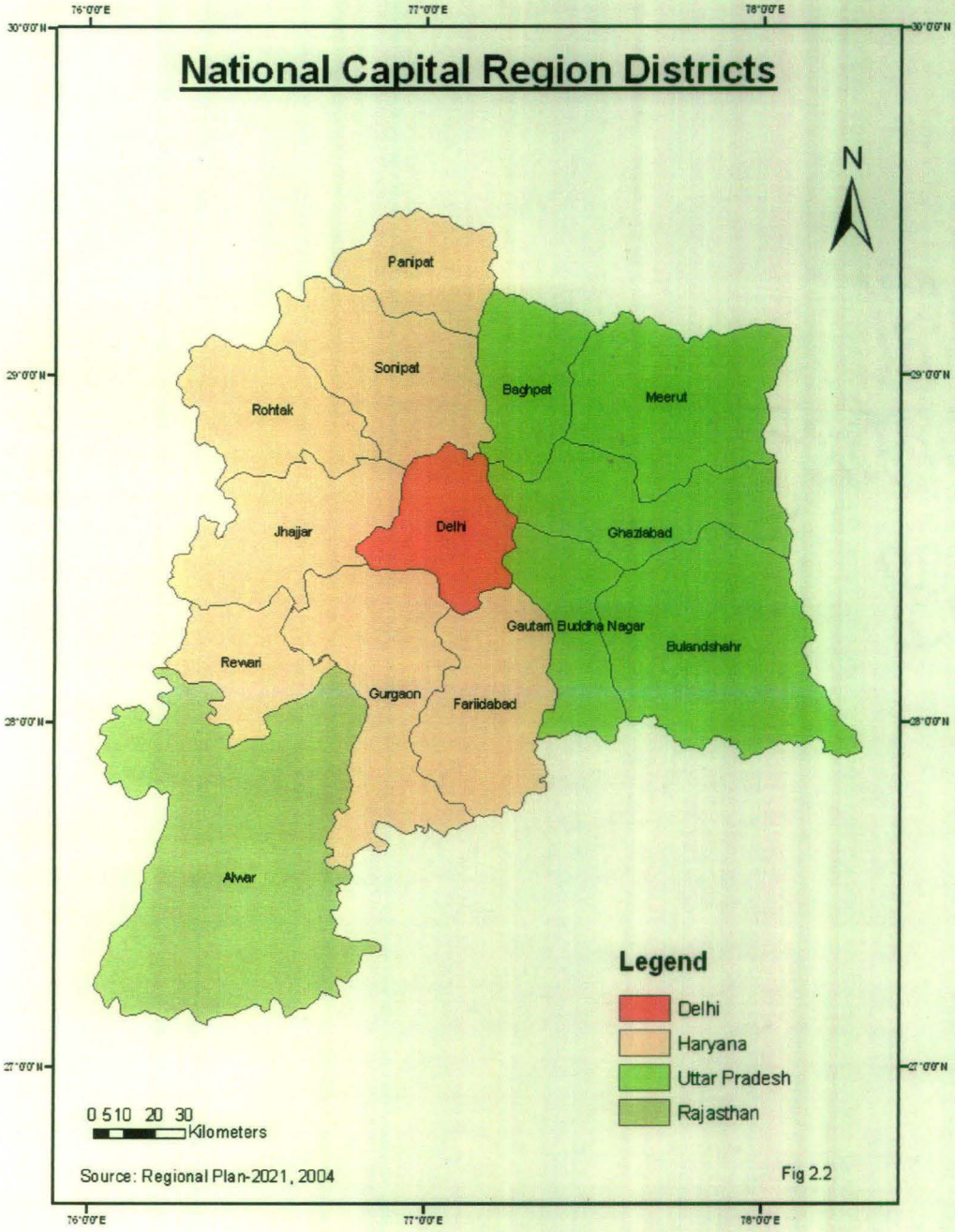
Graph 2.1: Management Structure of National Capital Region



The roles of the NCR Planning Board in the sub-regions are clearly stated as "NCR Planning Board has the mandate to systematically develop the NCR, which is 33.5 thousand sq. km covering Delhi and Parts of Rajasthan, Haryana, and Uttar Pradesh. NCR Planning Board gives significant emphasis to building water supply and sanitation infrastructure in NCR."

"The Board has the mandate of preparing a plan for the development of the NCR and for coordinating and monitoring the implementation of plans and for evolving harmonized policies for the control of land use and development of infrastructure in the Region. The functions of the Board extend to sanction of financial assistance to the implementing agencies of the participating states for setting up projects (Report No. 2, 2006)."

Figure 2.2 below depicts the administrative districts of the National Capital Region.


National Capital Region Districts
N
Panipat
Sonipat
Rohtak
Baghpat
Meerut
Jhajjar
Delhi
Ghaziabad
Gautam Buddha Nagar
Bulandshahr
Rewari
Gurgaon
Faridabad
Alwar
Legend
Delhi
Haryana
Uttar Pradesh
Rajasthan
0 5 10 20 30
Kilometers
Source: Regional Plan-2021, 2004
Fig 2.2

2.4.1 Administrative Divisions of Haryana Sub-region

It has been attempted to show the NCR administrative structure starting from the National Capital Planning Board and the states of Haryana, Rajasthan, Uttar Pradesh and the National Capital Territory of Delhi. This administrative structure further continues to various levels. The state-wise administrative structure of the National Capital Region has four tiers: namely, district, tahsil, block and village. According to their importance to the study, the district and tahsil level structures of each sub-region are further discussed separately as follows.

Haryana Sub-region comprises 7 districts namely Faridabad, Gurgaon, Rohtak, Sonipat, Panipat, Rewari and Jhajjar. These districts are in turn divided in to 27 tahsils. The number of districts and tahsils changes from time to time. The following table 2.1 presents the number of districts and tahsils as well as their changes in time.

Table2.1; Administrative divisions of Haryana Sub-region

No	Administrative units in 1991		Administrative units in 2001		Area (km^2)
	Districts	Tahsils	Districts	Tahsils	
1	Faridabad	Faridabad	Faridabad	Faridabad	422
		Ballabgarh		Ballabgarh	321
		Palwal		Palwal	632
		Hathin		Hathin	359
		-		Hodal	377
2	Gurgaon	Gurgaon	Gurgaon	Gurgaon	739
		Pataudi		Pataudi	177
		-		Taoru	225
		-		Sohna	337
		Nuh		Nuh	464
		-		Punahuna	290
		Ferozepur Jhirk		Ferozepur Jhirk	522
3	Rewari	Rewari	Rewari	Rewari	991
		Bawal		Bawal	265

		Kosli		Kosli	270
4	-	-	Jhajar	Jhajar	1030
		-		Beri	356
		-		Bahadurgarh	511
5	Rohtak	Rohtak	Rohtak	Rohtak	1138
		Maham		Maham	511
6	Sonipat	Sonipat	Sonipat	Sonipat	762
		-		Kharkhoda	299
		Gohana		Gohana	802
		Ganaur		Ganaur	301
7	Panipat	Panipat	Panipat	Panipat	521
		-		Israna	331
		-		Samalkha	449
	Total Area	-		-	13.413

Source: Census of India, 1981, 1991, and 2001.

The number of districts and tahsils in Haryana Sub-region was 6 and 17 in Census year 1991 respectively. However; the number of districts and tahsils has grown to 7 and 27 in the census year 2001. This significant increase in number comes from the rapid population growth in the Sub-region. The total area of Haryana Sub-region comprises 13,413 square kilometers and is inhabited by 8,689,268 persons.

2.4.2 Administrative Divisions of Uttar Pradesh Sub-region

The State of Uttar Pradesh shares 5 districts in the National Capital Region. It is the largest State in population size in India. UP is divided into 71 districts under 18 divisions. The divisions are administered by the division commissioners; while the districts are governed by District Magistrates. The districts are further divided into other administrative units such as sub-divisions (tahsils), blocks and Panchayati Raj that has three-tier structure in the state. The Panchayats are also divided into villages.

The same structure is in practice in the Uttar Pradesh districts in NCR. There are certain administrative structure differences with the other sub-regions of NCR. Here under; the

researcher considers the districts and tahsils for further discussions as per their importance to the study at hand and has attempted to address the changes of the administrative units through time.

Table2. 2: Administrative divisions of Uttar Pradesh Sub-region

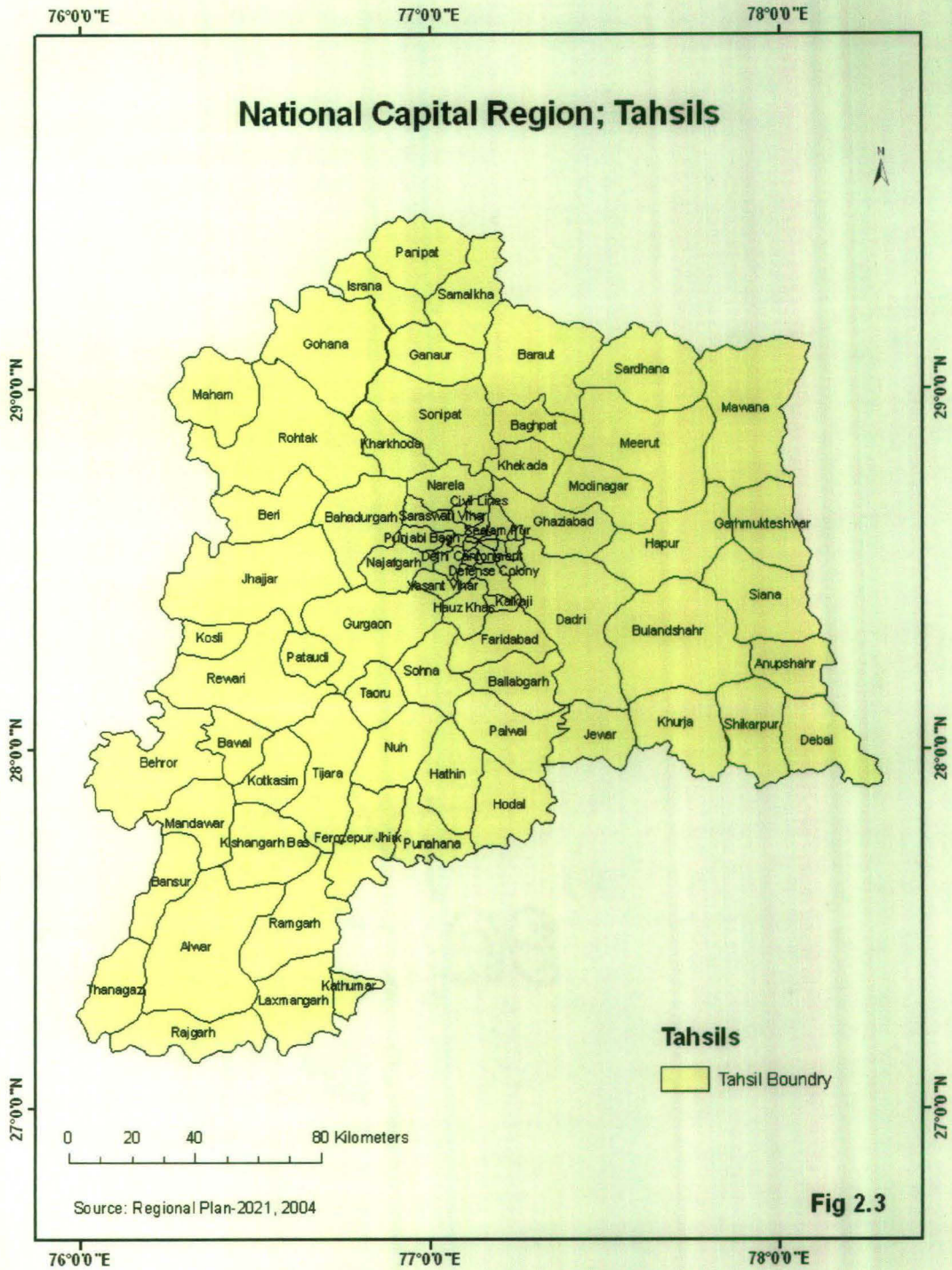
No	Administrative units in 1991		Administrative units in 2001		Area (km^2)
	District	Tahsil	District	Tahsil	
1	Meerut	Meerut	Meerut	Meerut	944
		Mawana		Mawana	1100
		Sardhana		Sardhana	900
2	Ghaziabad	Ghaziabad	Ghaziabad	Ghaziabad	236
		Hapur		Hapur	654
		Modinagar		Modinagar	448
		Garhmuktesh war		Garhmukteshwar	479
3	-	-	Baghpat	Baghpat	1321 (Dist. T.)
		-		Khekada	
		-		Baraut	
4	Bulandshahr	Bulandshahr	Bulandshahr	Bulandshahr	547
		Siana		Siana	685
		-		Debai	234
		-		Shikarpur	268
		Khurja		Khurja	273
		Anupshahr		Anupshahr	841
		-		Sikandrabad	839
5	-		Gautam B. N.	Dadri	625

		-		Jewar	369
	Total Area	-		-	10,853

Source: Census of India, 1981, 1991, and 2001.

Uttar Pradesh Sub-region had 3 districts and 11 tahsils in the Census year 1991. In the Census year 2001; however, the number of districts and tahsils raised to 5 and 20 respectively. The Uttar Pradesh Sub-region contributes 11,585,917 (31.28%) of the total population and 10,853 (32.32%) of the total area of the National Capital Region.

The next Figure 2.3 demonstrates the distribution of all tahsils of all districts through out the National Capital Region.


National Capital Region; Tahsils
76°0'0"E
77°0'0"E
78°0'0"E
29°0'0"N
28°0'0"N
27°0'0"N
Paripat
Israna
Samalkha
Gohana
Ganaur
Baraut
Sardhana
Mawana
Maham
Soripat
Baghpat
Meerut
Rohtak
Kharkhoda
Khekada
Modinagar
Narela
Civil Lines
Beri
Bahadurgarh
Saraswati Vihar
Ghaziabad
Gerhmukteshwar
Punjabi Bagh
Seelam Pur
Hapur
Najafgarh
Delhi Cantonment
Defense Colony
Jhajjar
Vasant Vihar
Kalkaji
Siana
Hauz Khas
Dadri
Gurgaon
Bulandshahr
Kosli
Faridabad
Pataudi
Anupshahr
Rewari
Sohna
Ballabgarh
Taoru
Khurja
Shikarpur
Palwal
Jevar
Bawal
Nuh
Debai
Behror
Kotkasim
Tijara
Hathin
Hodal
Mandawar
Kishangarh Bas
Ferozepur Jhirk
Punahana
Bansur
Ramgarh
Alwar
Thanagazi
Kathumar
Laxmangarh
Rajgarh
Tahsils
Tahsil Boundry
0 20 40 80 Kilometers
Source: Regional Plan-2021, 2004
Fig 2.3

2.4.3 Administrative Structure of National Capital Territory of Delhi

Changes in administrative structure are common characteristic features of all cities. The extent and frequency of changes; however, differ from city to city. Such changes usually come from the population and physical growth of the cities. Administrative changes aim at restructuring and bringing new proper urban systems that enable city governments ensure overall development, peace and order in their cities. These changes are essential to provide efficient administrative services through extending proper regulatory systems. Furthermore; appropriate urban administrative set up helps a city government provide efficient municipal services to residents, ensure urban governance, create efficient and effective revenue collection systems, and control illegal activities in its urban territory. The Government of Delhi has made significant administrative set up changes within the decade 1991-2001.The three statutory towns (i) Delhi Municipal Corporation, (ii) New Delhi Municipal Council, and (iii) Delhi Cantonment Board remain unchanged. The number of census towns has been raised from 29 to 59. On the other hand; the number of villages has been reduced from 209 to 165. The major changes made on the district and tahsils by the Government of Delhi are presented by the following table.

Table2.3: NCT –Delhi Sub-region administrative divisions

No	Administrative Units in 1991		Administrative Units in 2001		Area (km^2)
	Districts	Tahsils	Districts	Tahsils	
1	-	Delhi Tahsil	North-West	Narela	440
		-		Saraswati Vihar	
		-		Model Town	
2	-	-	North	Civil lines	59
		-		Sadar Bazar	
		-		Kotwali	
3	-	-	North-East	Seelam Pur	60

		-		Seema Puri	
		-		Shahdara	
4	-	-	East	Gandhi Nagar	64
		-		Preet Vihar	
		-		Vivek Vihar	
5	-	-	New Delhi	Parliament Street	35
		-		Connaught Place	
		-		Chanakya Puri	
6	-	-	Central	Karol Bagh	25
		-		Pahar Ganji	
		-		Darya Ganji	
7	-	-	West	Punjabi Bagh	129
		-		Patel Nagar	
		-		Rajouri Garden	
8	-	Mehrauli Tahsil	South-West	Najafgarh	421
		-		Delhi Cantonment	
		-		Vasant Vihar	
9	-	-	South	Defense Colony	250
		-		Hauz Khas	
		-		Kalkaji	
	Total	-	-	-	1483

Source: Census of India, 2001.

From table 2.3, one can understand that there were major administrative changes through time in the NCT-Delhi. These changes are clearly stated in Atlas of Delhi as follows: Following the passage of the sixty ninth amendment to the Constitution of India, the nomenclature of Delhi was changed to National Capital Territory of Delhi for February 1, 1992. The NCT of Delhi was bifurcated into 9 districts in 1997 and its two tahsils into 27 tahsils. Thus, the NCT of Delhi at the time of Census 2001 is comprised of 9 districts with 3 tahsils in each district (Atlas of Delhi, 2001).

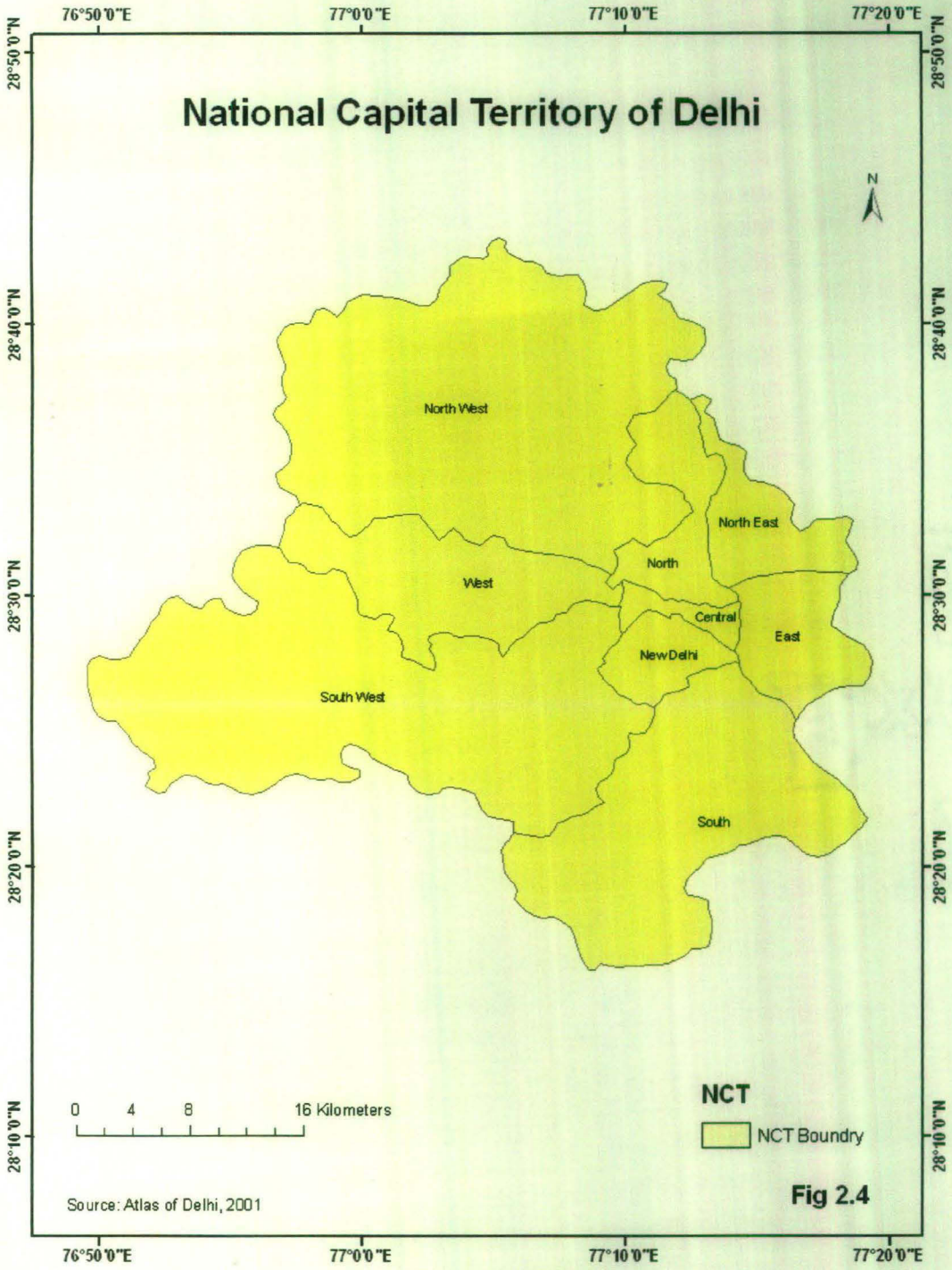
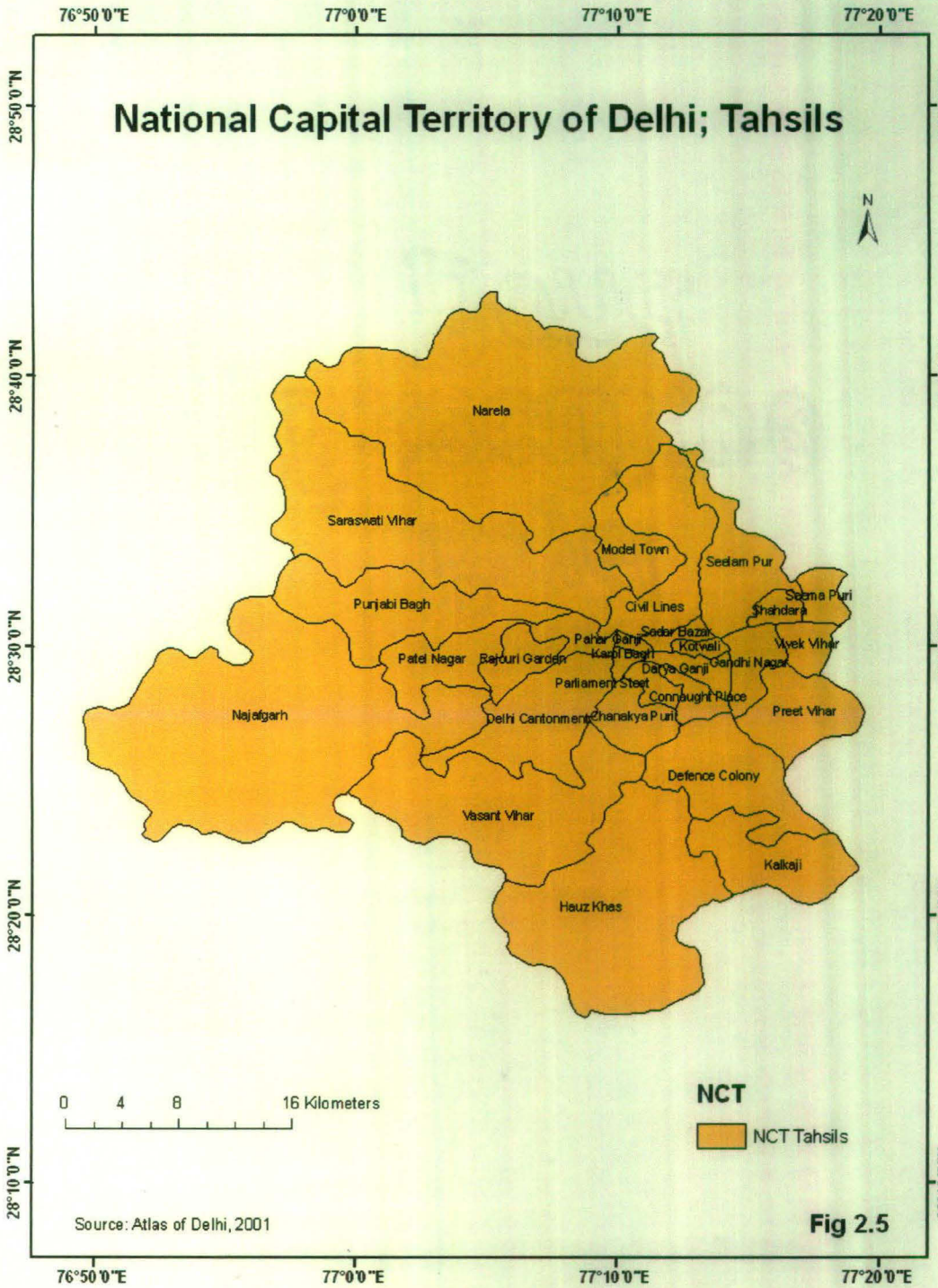

National Capital Territory of Delhi
N
76°50'0"E
77°0'0"E
77°10'0"E
77°20'0"E
28°50'0"N
28°40'0"N
28°30'0"N
28°20'0"N
28°10'0"N
North West
North East
North
West
Central
East
New Delhi
South West
South
0 4 8 16 Kilometers
NCT
NCT Boundry
Source: Atlas of Delhi, 2001

Fig 2.4



2.4.4 Administrative Divisions of Rajasthan Sub-region

Evidences from Alwar district administration (2008) and Census of India (2001) show that the Alwar district has 12 tahsils and each tahsil has a tahsildar as an Administrative Officer whose works in accordance with the land and record systems to serve the rural farmers and landholders. There are also 14 panchayat samits (blocks) and each one has a Block Development Officer to serve as a representative of the district administration in the rural areas.

Table2.4: Administrative divisions in Rajasthan Sub-region

Administrative units in 1991		Administrative units in 2001		Area (km^2)
District	Tahsils	District	Tahsils	
Alwar	Alwar	Alwar	Alwar	1068
	Rajgarh		Rajgarh	1426
	Laxmangarh		Laxmangarh	1156
	-		Kathumar	
	Thanagazi		Thanagazi	1060
	Ramgarh		Ramgarh	586
	Bansur		Bansur	665
	Kishangarh Bas		Kishangarh Bas	748
	-		Kotkasim	
	Mandawar		Mandawar	577
	Tijara		Tijara	675
	Behror		Behror	730
Total	-		-	7,829

Source: Census of India, 1981, 1991, and, 2001.

There was no change in the number of districts in Rajasthan Sub-region in the Census years of 1991 and 2001. However; there was a change in the number of tahsils. Administrative units (Tahsils) Kathumar and Kotkasim were formed in the Census year 2001. Rajasthan Sub-region contributes 8.08% of the total population and 23.32% of the total area of the National capital Region.

2.5 Physical Characteristics of the Region

2.5.1 Physiographic Nature of the National Capital Region

As per the evidences stated in the Regional Plan (2004); the National Capital Region (NCR) is predominantly characterized by three physiographic features: the ridge, the plain and, the flood plains of the major rivers of the Region. The ridge starts from the Aravali hills of Rajasthan and extends to the north-eastern direction through the west and north-west of the NCT Delhi. The Hill around Bhati has a height of 373ms above mean sea level. A major portion of the National Capital Region is categorized as the plains. The Yamuna and other flood plains also covered significant portion of the NCR. The Regional Plan -2021 (2004), states a general picture of the NCR as: The physiography of the Region is characterized by the presence of Ganga skirting it as its eastern boundary, the Yamuna traversing in north-south forming the boundary between Uttar Pradesh and Haryana, and the sand dunes and barren low hills of the , Aravalli chain and its outcrops in the west , flat topped prominent and precipitous hills of the Aravalli range enclosing the fertile valleys and high table lands in the south-west, and the rolling plains dominated by rain-fed torrents in the south. The rest of the Region is plain with a general slope of north-east to south and south-west.

2.5.2 Drainage System

In geomorphology, a drainage system is the pattern formed by the streams, rivers, and lakes in a particular watershed. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land (David, 1998). There are four major rivers and tributaries that cross the NCR north-south direction. They are the Yamuna, Ganga, Kali, and Hindon. The river Ganga forms a

boundary between NCR and the Uttar Pradesh State. River Yamuna, more or less makes central spine of NCR and most of the NCR belongs to its drainage basin.

2.5.3 Vegetation Cover

The National Capital Region has high population density and high land resource demand for various purposes such as for cultivation and settlement. As a result, there is less forest (vegetation) reserve in the Region The forest cover in the National Capital Region accounts for about 121,435 ha (4.02%) of the total area of the Region. The percentage area; however, varies from sub-region to sub-region. Kumar (2008) identified the common tree types in NCR; namely, acacia, khair, dhak, kikar, and babul. Most of the forest resource products of NCR are used as a source of fuel and fodder

2.5.4 Climate

The Uttar Pradesh Sub-region experiences a subtropical monsoon climate, while the other sub-regions of NCR are characterized by a semi-arid climate. Cold winds blowing from Jammu and Kashmir and Himachal Pradesh lower the temperature of the Region in winter season. On the other hand, hot and dry winds blowing from arid and semi-arid areas increase the temperature of the Region in summer season.

The Region receives rainfall in summer season from the moist south-west monsoon winds blowing from the Bay of Bengal. The Region also receives small amount of rainfall in winter season.

Generally, the pattern of climate in the Region can be divided into four seasons: (a) dry cold winter- December to February, (b) hot summer-March to June, (c) Warm-humid, July to September; and, (d) mild cold winter- October to November (Kumar, 2008).

Considering Delhi, it has an extreme climate which is very cold in winter, and extremely hot in summer. The cold season begins in November and reaches its peak at the beginning of the New Year and the first-half of January. After the mid of March, the weather begins to become warm and soon it gets hot so that from April to June one experiences extreme heat when the temperature rises to 45°c by the time. The monsoon arrives towards the end of June, bringing some respite from extreme heat; but, increasing humidity at the same time. Winter starts in late November and peaks up

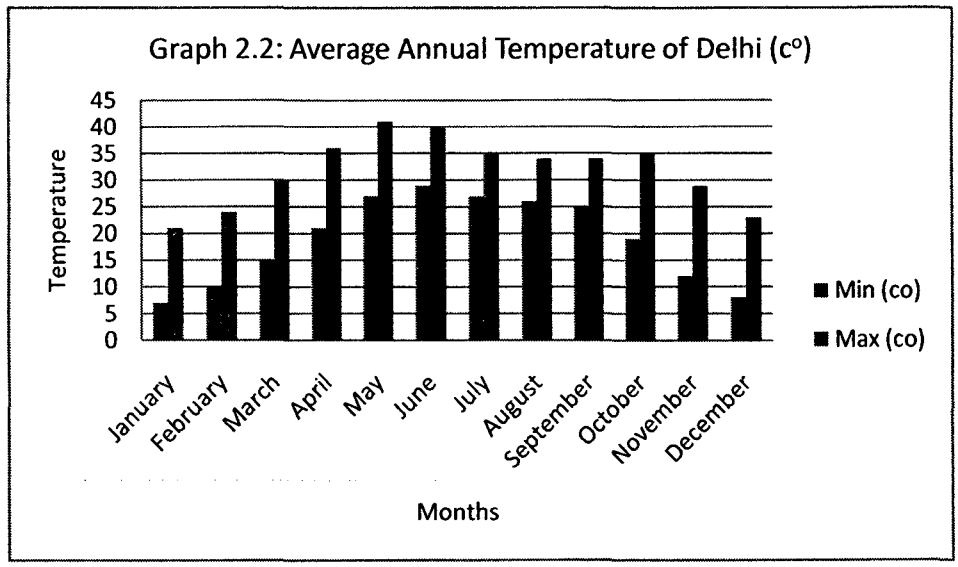
in January. Extreme temperature ranges from -0.6°c to 44.5°c; while, monthly mean temperatures range from 13°c to 32°c. The average annual rainfall for Delhi is approximately 714mm, most of which during monsoon season in July and August. The following table gives general information on the annual temperature and rainfall of Delhi.

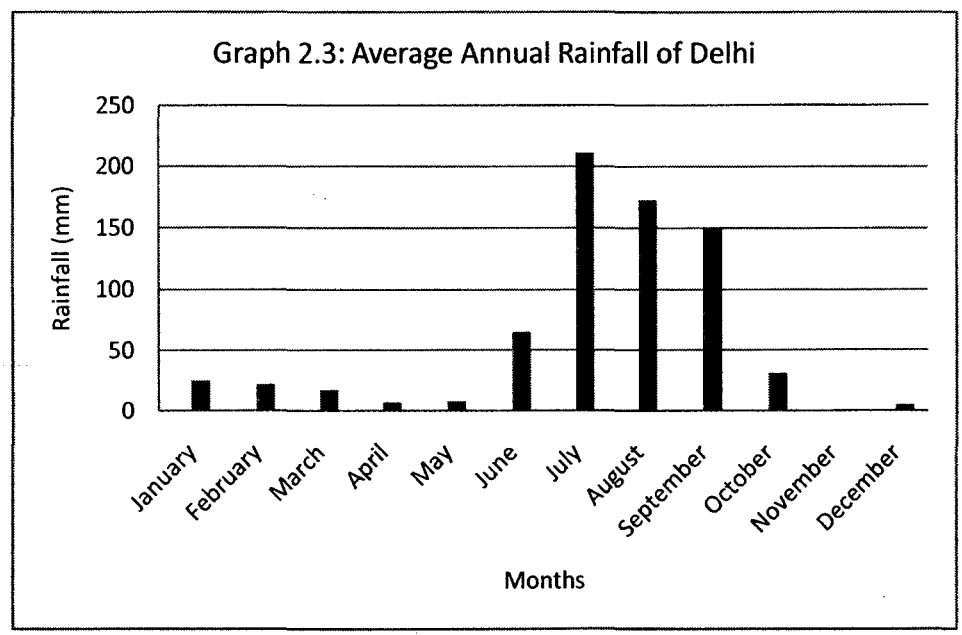
Table 2.5: Annual temperature and rainfall of Delhi

Months	Maximum (c°)	Minimum (c°)	Rainfall (mm)
January	21	07	25
February	24	10	22
March	30	15	17
April	36	21	07
May	41	27	08
June	40	29	65
July	35	27	211
August	34	26	173
September	34	25	150
October	35	19	31
November	29	12	01
December	23	08	05

Source: Delhi Capital, 2007

Winters in Delhi are marked by mist and fog in the mornings and often sun is seen in the afternoon. The cold wave from the Himalayan region makes winters very chilly. In summers the heat wave is immense.





2.6: Demographic Profile of the National Capital Region

2.6.1 Population Size of the National Capital Region

The National Capital Region comprises of the entire National Capital Territory of Delhi, seven districts of Haryana, one district of Rajasthan and five districts of Uttar Pradesh with a total population of 37,033,223 (Census ,2001). The following table provides the sub-region-wise distribution of population in NCR.

Table 2.6: Population size and distribution among NCR sub-regions

No	Sub-region	Total Population	Male Population	Female Population
1	NCT-Delhi	13,782,976	7,570,890	6,212,086
2	Haryana	8,689,268	4,692,391	3,996,877
3	Uttar Pradesh	11,585,017	6,211,565	5,573,452
4	Rajasthan	2,992,592	1,586,752	1,405,840
	NCR Total	37,033,223	20,061,598	17,188,255

Source: Census of India, 2001.

The share of population (13,782,976) of the National Capital Territory of Delhi is by far greater than that of the other sub-regions and has been rapidly increasing as compared to the other sub-regions in the National Capital Region. The next Sub-region having high population share (11,585,017) in NCR is Uttar Pradesh, while Rajasthan Sub-region shares the lowest.

2.6.2 Decadal Population Growth Rate in the National Capital Region

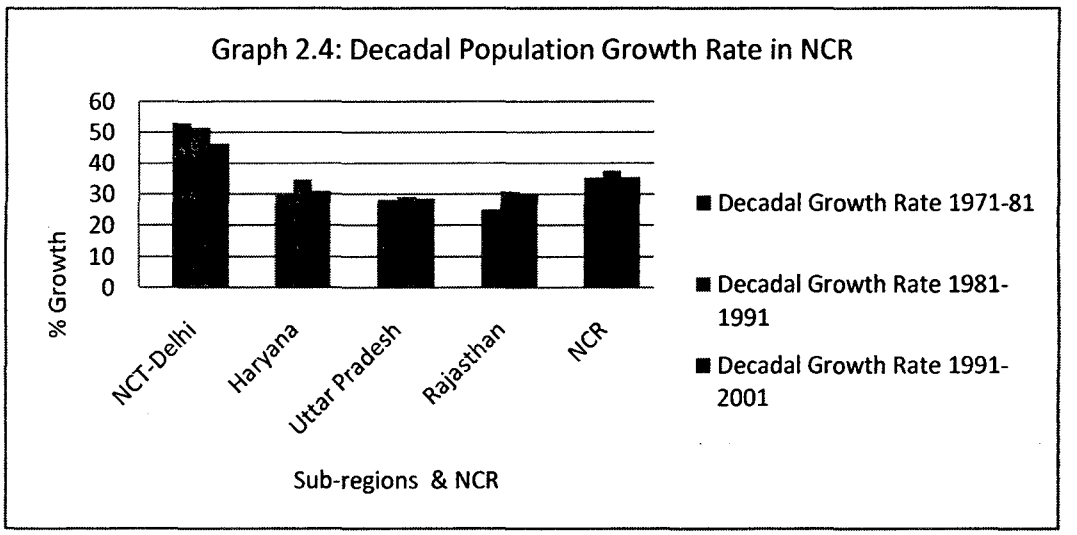
The decadal population growth rate refers to the percentage change in the population resulting from a surplus or deficit of births over deaths and the balance of migrants entering and leaving the Region. The periodic assessment of this growth rate is necessary as it is a factor in planning and addressing the changing needs of the people of the National Capital Region for additional resources, infrastructure, and jobs.

Table2.7: Decadal population growth rate in NCR

No	Sub-regions	Decadal Growth Rate		
		1971-81	1981-91	1991-2001
1	NCT-Delhi Sub-region	53.00	51.45	46.31
2	Haryana Sub-region	30.02	34.53	30.79
3	Uttar Pradesh Sub-region	28.09	29.17	28.53
4	Rajasthan Sub-region	25.06	30.82	30.23
	NCR Average	35.19	37.62	35.34

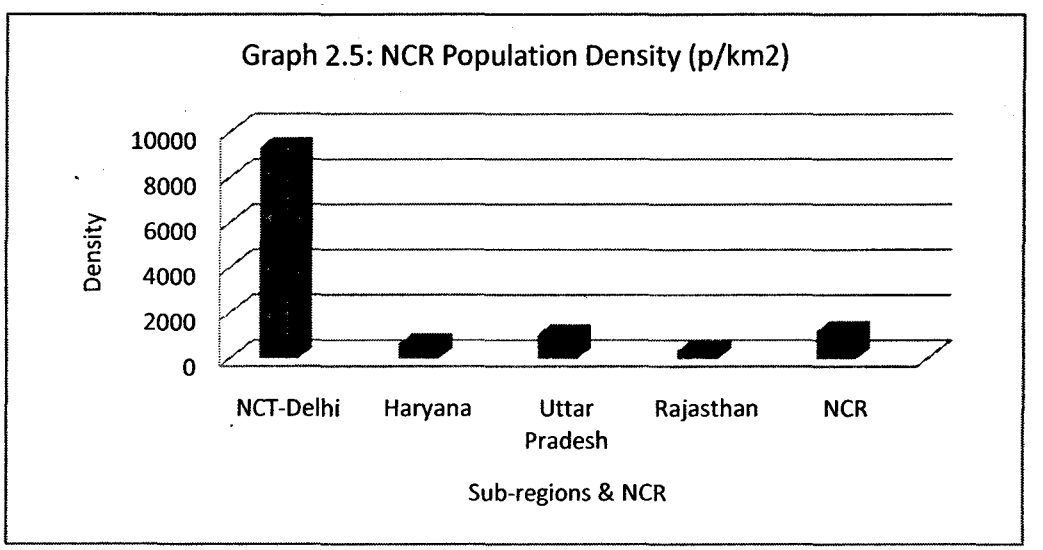
Source: Census of India, 1971, 1981, 1991, and, 2001.

As it is indicated in the table above, the population growth of the National Capital Territory of Delhi has been much higher than any other sub-region of the National Capital Region in each decade since 1971. The city had growth rates of 53.00%, 51.45%, and 46.31% in the three consecutive decades respectively. Despite the declining trend observed in the three successive decades, the city still has high population growth rate. However, measures are being taken to reduce the population pressure and deflect the population migration through moving various industries outside the city and creating sustainable infrastructure for the development of other neighboring cities in the National Capital Region.



2.6.3: National Capital Region Population Density

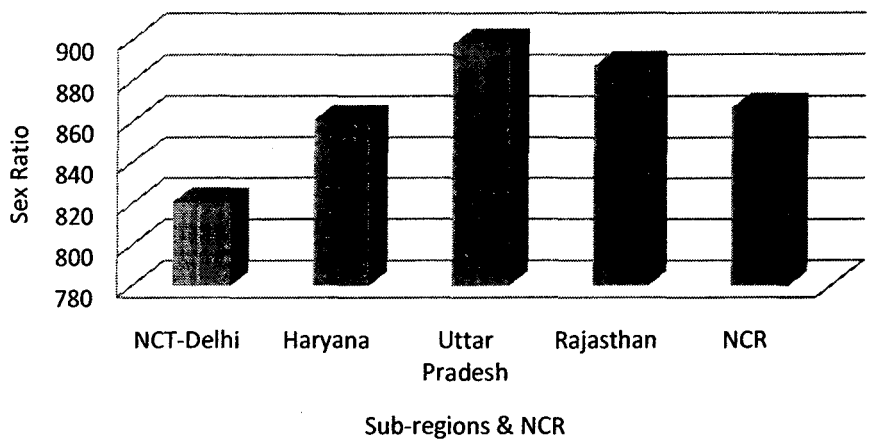
The population density of the National Capital Region has been rapidly increasing over the last two decades, 1981 to 2001. Within the two decades, the population density measured in persons per sq. km increased more than double (4,192 to 9,292p/km^2) in the National Capital Territory of Delhi. In all the other sub-regions of the National Capital Region, the population density increased by 50% to 75% (634 to 1,202) (Regional Plan, 2004). See the trend of population density in NCR in **Graph 2.5** and table 2.8 below.



2.6.4 National Capital Region Sex Ratio

The sex ratio usually refers to the number of women per 1000 men. The average sex ratio for the National Capital Region is 867. Of all the sub-regions of NCR, the NCT- Delhi has the lowest sex ratio (821) followed by Haryana Sub-region (861). The sex ratio of the National Capital Territory of Delhi is much lower than the national average (927). Uttar Pradesh Sub-region has relatively higher sex ratio than the other sub-regions in NCR. Additional information on sex ratio is given in **Graph 2.6** and table 2.8 below.

Graph 2.6: NCR Sex Ratio



2.6.5 Literacy Rate of the National Capital Region

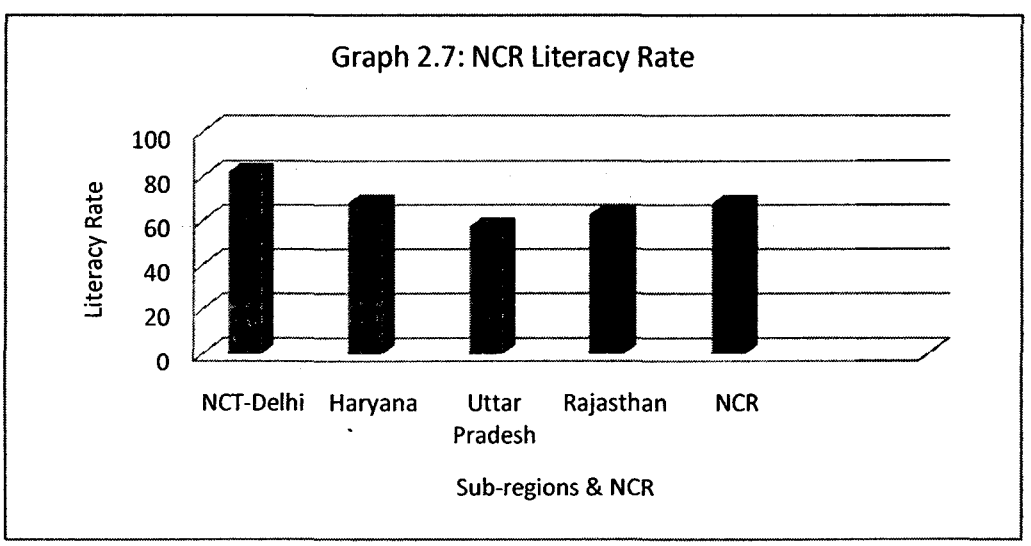
As per the Census of India (1991), the term **Literacy Rate** refers to the total percentage of population of an area at a given period of time. There is high literacy rate variation among the Indian states. This is also true in the NCR sub-regions. Table 2.8 indicates the existing gap among NCR sub-regions.

Table 2.8: NCR population density, sex ratio, and literacy rate

No	Sub-regions	Population Density (p/km^2)	Sex Ratio	Literacy Rate
1	NCT-Delhi	9,294	821	81.82
2	Haryana	651	861	67.91
3	Uttar Pradesh	1066	898	57.36
4	Rajasthan	357	887	62.48
	NCR Average	1202	867	67.39

Source: Census of India, 2001.

The average literacy rate of the National Capital Region is 67.39% which is greater than the national average (64.84%). The National Capital Territory of Delhi which is among the states (Kerala, Mizoram, Lakshadweep, Goa, Chandigarh, A & N Islands, and Pondicherry) having high literacy rate (80% and above) has a literacy rate of 81.67%. Haryana Sub-region also has a literacy rate of 67.91%, above the national average. The other two sub-regions, Rajasthan and Uttar Pradesh have a literacy rate below the national average. **Graph 2.7** gives additional insight on the gaps in literacy rate.



2.6.6 Economic Base of National Capital Region

The major economic bases of the peripheral areas of the NCR are agriculture and other primary activities. However; the major economic bases of the core areas of the National Capital Region include the non-agricultural activities. The industrial activities in NCR have been developing over more than three decades during which substantial structural changes have taken place. Trade and commerce form another important component of the economic base of the Region (Regional Plan, 2004).

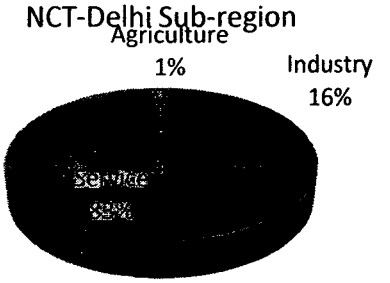
Table 2.9: Percentage share of sectors in Gross Domestic Product in NCR Sub-regions

No	Sub-regions	Agriculture	Industry	Services	Total
1	NCT-Delhi	1.43	16.06	82.51	100.00
2	Haryana	29.00	28.00	43.00	100.00
3	Uttar Pradesh	43.00	20.00	37.00	100.00
4	Rajasthan	22.50	32.50	45.00	100.00

Source: Economic Survey of Delhi, 2002, Haryana Statistical Abstract, 2003, Uttar Pradesh State Profile, 2004, and, Economy of Rajasthan, 2003.

The NCR sub-regions could be divided in to two groups based on their major economic bases. Table 2.9 indicates that the service sector as a major economic base of the NCT-Delhi (82.51%), Haryana (43%), and Rajasthan (45%) sub-regions. Concerning to this, the Economic Survey of Delhi (2004) states " Delhi's economy rests primarily on a strong and growing (tertiary) sector comprising of trade, hotels and restaurants, transport, communications, financial and insurance services, real estate, public administration and other business services". Given the highly urbanized character of Delhi, industry, trade and commerce provide the maximum employment opportunities for people, not agriculture. On the other hand; agriculture forms the major economic base of Uttar Pradesh Sub-region. **Graph 2.8** shows a clear picture of the economic bases of the NCR sub-regions.

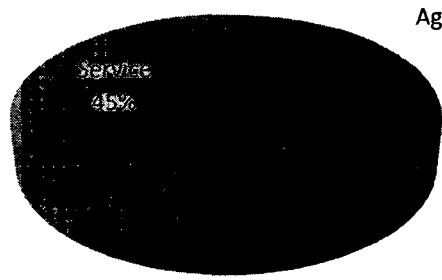
Graph 2.8: Percentage Share of Sectors in GDP in NCT-Delhi Sub-region



Graph 2.9: Percentage share of Sectors in GDP in Haryana Sub-region

Graph 2.10: Percentage Share of Sectors in GDP in UP Sub-region

Graph 2.11: Percentage Share of Sectors in GDP in Rajasthan Sub-region



Sources: Economic Survey of Delhi, 2002, Haryana Statistical Abstract, 2003, Uttar Pradesh State Profile, 2004, and, Economy of Rajasthan, 2003.

CHAPTER3: LITERATURE REVIEW

3.1 Conceptual Frameworks of the Study

3.1.1 Urbanization and Urban-Rural Relationships

The United Nations (UN, 1996) defined the term urbanization as, "Urbanization, in conventional terms, refers to the process through which society is transformed from one that is predominantly rural, in economy, culture, and life style, to one that is predominantly urban. It is also a process of territorial reorganization in that it shifts the locations, as well as characteristics, of population and production activities. Typically, urbanization is defined by simply proportion of a nation's population residing in areas that are classified, by national census authorities, as urban places. Since definitions of what is or is not urban differ from one country to another; however, so do interpretations of what the designation urban implies."

The UN has repeatedly assessed the process of urbanization and described as the 20th century as a witnessing the rapid urbanization of the world's population; as the global proportion of urban population rose dramatically from 13% (230 million) in 1900, to 29% (732 million) in 1950, to 49% (3.2 billion) in 2005. The same report projected that the figure is likely to rise to 60% (4.9 billion) by 2030 (UN World Urbanization Prospects Report, 2005).

The definition of urban area varies considerably from country to country. The researcher; however, has adopted the urban definition of the Census of India (2001). The Census of India (2001) defined the urban area as the following: (a) All statutory places with a municipality, corporation, cantonment board, notified town area committee, etc. (b) A place satisfying the following three criteria simultaneously:

i. A minimum of population of 5,000,
ii. At least 75 per cent of male working population engaged in non-agricultural pursuits; and,

iii. A density of population of at least 400 per square kilometer (Census of India, 2001).

According to the Census, the "rural sector" shall mean any place as per the "latest Census" which meets the following criteria:

i. A population of less than 5,000,
ii. Density of population less than 400 per square kilometer; and,
iii. More than 25 per cent of the male working population is engaged in agricultural pursuits (Ibid).

Urban-rural relationships: It has become increasingly difficult to perceive urban and rural areas as mutually exclusive entities. Hence, the concept of urban-rural linkage was adopted by organizations such as the UNCHS and the EU Committee of Spatial Development. The term urban-rural relationship is used to emphasize the visible and invisible flows of people, capital, goods, information and technology between urban and rural areas" (Davoudi, 2001).

3.1.2 Concepts of Peri-Urban Area (Interface)

The Latin American, Asian and European research outputs have greatly contributed to the development of the conceptual framework for understanding the expansion of cities into the adjacent rural areas and form the peri-urban interfaces. Nottingham and Liverpool Universities (1998) and Racodi (1998) state the peri-urban area as a dynamic transition zone where urban and rural economic, social and structural change development processes meet, mix, and interact at the edge of cities. Universities of Bangor, Birmingham, University College of London (2003), and Adell (1999) conceptualize the Peri-Urban Area as a unique dynamically changing space having low built environment and density, mixed agricultural land uses, green spaces, and industrial land uses.

3.2 Theoretical Frameworks of Urban Peri-urban Interaction

3.2.1 Urban Expansion and Formation of Peri-Urban Structure

Evidences of strong empirical regularities in the patterns of metropolitan development in market-oriented economies have been remarked by Ingram (1998). He summarized the movements towards the fringes as: (1) a dispersal process from center to the periphery, (2) highly decentralized manufacturing employment, (3) increased reliance on road-based transport for passengers and freight, and (4) land markets are strong determinants of out ward movement. Liang (2008) discusses urban expansion as the outcomes of the influence of various urban centers. He further recommends how to assess the urban influence domains using gravity model as, "The urban gravitational field theory can be applied to the study on the influence domain of cities. If a settlement is influenced by several cities, the settlement belongs to the influence domain of the city possessing the largest influence force, and the total urban influence force for a settlement is the sum of the gravitational field for all the cities." Adell (1999) considers the Latin American urban expansions as the formation of complex and heterogeneous peri-urban structure, while McGee (1991) describes such extensive peri-urban areas as mega-urban regions. Urban expansion in India is predominantly the result of spatial expansion of cities and towns. Gupta (2008) indicates that the total urban population increased eight-fold between 1901 and 1991, the number of settlements only doubled. In other words, urban expansion in India has been due to the enlargement of existing towns and cities.

3.2.2 Urban Peri-Urban Interactions and Flows

Browder (1995) summarizes the peri-urban literature as featuring four key themes: (1)the importance of peri-urban agriculture and rural linkages, (2) the importance of the formal economy in the peri-urban areas, (3) conflictive land property ownership issues, and (4) the demographic processes that under pin fringe development. The terms interactions, linkages and flows between rural and urban areas are usually used

interchangeably in the literature of urban and peri-urban areas, though they differ slightly. Various linkages have been identified by different scholars. Unwin (1989); for example, proposes four kinds of linkages (economic, social, political, and ideological) and many more flows that are derived from them. On the other hand; Douglas (1998) has identified five types of flows: people, production, commodities, capital and information.

3.2.3. Urban-Rural Linkages (Interactions) in Peri-Urban Areas

Tacoli (1998) discusses the rural-urban inter- linkages in the peri-urban areas which vary according to the size of cities, towns and the relative peri-urban areas. It also varies due to other factors such as land markets and land uses. Douglas (1998) and Unwin (1989) have identified various types of flows (interactions): (i) flows of people expressed in migration as an explanatory element, (ii) flows of goods: exchange of goods that takes place at various levels, and (iii) sectoral interactions. Tacoli (1998) defines the sectoral interactions as rural activities taking place in urban areas (urban agriculture) and urban activities such as manufacturing and services taking place in rural areas. The International Institute for Environment and Development (2008) discloses that the rural-urban interactions in peri-urban areas have strong influences on natural resources. However, local governments neglect these areas and result in misuse of valuable resources. Understanding such problems, Narain (2009) forwards the following recommendations. "Devising policy interventions for the peri-urban interface requires explicit attention to strengthening rural-urban linkages that materialize through the two-way flow of goods and services between villages and urban centers."

3.2.4. Land Use and Transportation

Rodrigue (2008) discusses that each type of land use has its own specific mobility requirements, transportation is a factor of activity location, and is therefore associated intimately with land use. Transportation and land use interactions mostly consider the

retroactive relationships between activities, which are land use related, and accessibility, which is transportation related.

Rodrigue (2008) further indicates that the key for understanding urban entities lies in the analysis of patterns and processes of transport and land use systems. These systems are highly complex and involve several relationships between the transport system, spatial interactions and land use. Fazal (2005) addresses the complex transport problems and the measures taken in India in that investments have been made in the past few years in an attempt to improve transport: (1) construction of flyovers in a large number of cities: (2) widening of roads: and (3) construction of the Mass Rapid Transit System (MRTS) in Delhi.

Narain (2009) gives due emphasis to the peri-urban lands what he called them the common property resources. As the peri-urban interface emerges, there is a need for protecting common property resources that are diverted to other activities and purposes, or to provide an alternative to those who have conventionally depend on them for their sustenance.

3.2.5 Urban Land Use (Land Cover) Classification and Theories

Urban land is divided into different zones for different activities and purposes. Anderson (1976), states that urban or built-up land comprises of areas covered by structures (residential, industrial, and commercial areas), high-ways, transportation, power, and communication facilities. Several descriptive and analytical models of urban land use have been developed overtime, with increased levels of complexity. Rodrigue (2008) mentioned some of the models including the Concentric Model developed by Burgess (1925), the Sector Model developed by Hoyt (1939) and the Multiple Nuclei Model developed by Harris and Ulman (1945).

CHAPTER 4: RESEARCH METHODOLOGY AND DATA BAESES

4.1 Methodology Concepts and Formulation of a Problem

The research methodology contextually includes methodology and methods. The research methodology is a way in which a research problem is systematically solved. It may also be understood as a science of studying how research is done scientifically. "Research methods may be understood as all those methods or techniques that are used for condition of research. Research methods or techniques; thus, refer to the methods the researchers use in performing research operations" (Kothari, 2009). Kothari (2009) also indicates that "the scope of research methodology is wider than that of the research methods. Thus, when we talk of research methodology, we not only talk of the research methods but also consider the logic behind the methods we use in the context of our research study and explain why we are using a particular method or technique and why we are not using others so that research results are capable of being evaluated either by the researcher himself or by others."

Devising the right research methodology is a major task of a researcher. This helps him as a manual (tool) throughout his research operation. Kothari (2009) states the importance of appropriate research methodology as: "For one who is preparing himself for a career of carrying out research, the importance of knowing research methodology and research techniques is obvious since the same constitute the tools of his tasks. The Knowledge of methodology provides good training especially to the new researcher and enables him to do better research. It helps him to develop disciplined thinking or a 'bent of mind' to observe the field objectively. Hence, those aspiring for careerism in research must develop the skill of using research techniques and must thoroughly understand the logic behind them."

Regarding the formulation of the research problem i.e. the 'Urban Peri-urban Interaction in National Capital Region', efforts have been done to make the research problem specific. The research problem is examined whether it is feasible and

operational. The research problem is also clearly defined in order to determine the relevant data to be collected.

At this step, major objectives to be achieved by the study are formulated. The objectives are limited in number, but central to the study problem. Setting clear objectives helps a researcher as a guiding procedure.

Four assumptions (hypotheses) are formulated and tested by the study. These hypotheses are designed to indicate the right track for the researcher. They are also formulated with the intention of examining the quality of data.

4.2 Development of Literature Review

The researcher has made adequate literature survey relevant to the research problem. Different websites, books, government reports, and conference proceedings are some among the sources of the reviews. These earlier studies enabled the researcher develop adequate literature review for the study. The beginning of the review stresses on the concepts of urban and urban-rural relationship which result in the formation of the urban peri-urban interface (area). Next, the urban peri-urban concepts and relationships are reviewed. Finally, the basic theories for urban peri-urban interactions; and, land use theories, models; and, interactions are reviewed.

4.3 Data Bases of the Study

Various data bases are used for the study. The contribution of each data base for the study; however, varies greatly. The Census of India (1971, 1981,1991, and 2001); mainly, the town and village directory provides the study with population, workforce, land use, basic civic amenities and census houses, literacy rate, sex ratio, and life expectancy data. Other important data bases include: (1) Economic Survey of Delhi, Haryana Statistical Abstract, Uttar Pradesh State Profile, and Rajasthan Statistical Abstract (2002) provide with percentage share of sectors in Domestic Product in NCR sub-regions; (2) The data for the per capita of sub-region domestic product at prices 1999-2006 (Rs) are collected

from Directorate of Economics and Statistics of Governments of Delhi, Rajasthan, Haryana, and UP (2006); (3) The NSS 55th Round (1999-2000) contributes the data for Employed and Unemployed persons per 1000; (4) The Planning Department of Uttar Pradesh, Geography of Haryana and Governments of Rajasthan and Delhi (2001) are taken as the sources of road transport by area and population in NCR; (5) Length of road in Delhi for 1974-2007 is taken from the Directorate of Economics and statistics, Government of Delhi; (6) The Central Electricity Authority supplies the data for sub-region wise energy received and peak load for NCR; and (7) The data for the status of telecommunication expansion are collected from the Ministry of Telecommunication (2003). Atlas of Delhi (Census of India, 2001) and NCR maps (PB, 2004) are also taken as sources of spatial data to produce different types of maps.

4.4 Research Design

Designing a research is another major task of a researcher. Designing the right structure of a study indicates a clear direction of the research project. Kothari (2009) states about the role of appropriate research design as: "The preparation of such a design facilitates research to be as efficient as possible yielding maximal information. In other words, the function of research design is to provide for the collection of relevant evidences with minimal expenditure of effort, time, and money." The researcher has designed how the required data could be collected from the data bases identified at 4.3 above. There was no need for sampling design, since the study is limited to secondary data.

4.5 Identification of Methods

1. Gravity Model: Walter Isard states the gravity model as: "The gravity model illustrates the macroscopic relationships between places (as homes and work places). It has long been posited that the interaction between two locations decline with increasing distance, time, and cost between them, but is positively associated with the amount of activity at each location (Isard, 1955). Furthermore, the Dictionary of Social Sciences describes the gravity model as "an extension of Isac Newton's formula for

gravity to the analysis of movement between places, such as traffic flows, migration, or trade. The pull of gravity is positively related to the size of the objects and inversely related to the distance between objects; thus, in most models, flow increases with and ... "(Mayhew, 2009). The Dictionary of Geography; on the other hand, states gravity model as: "a model of the interaction between two population centers based on ... widely criticized, but is still used to predict future interactions. The gravity model may be applied to fields of influence of settlements, trade, traffic ..."(Mayhew, 2009).

The gravity model states that the magnitude of movement (interaction) between two settlements is directly proportional to the product of their 'masses' (population) and inversely proportional to the distance between them. Hence, the model is employed to compute the interaction between urban and peri-urban areas of the National Capital Region.

I. The gravity model is defined by:

$$I_{ij} = k \frac{PiPj}{Dij^b}$$

Where, I_{ij} = Interaction between the town center (i) and other settlement (j),

P_i and P_j = population of the town center (i) and other settlement (j),

k = Constant,

b = friction coefficient for distance,

D_{ij} = distance between the town center (i) and settlement (j).

The gravity model is; particularly, employed to measure:

- Population flows; and,
- Labour flows between urban and peri-urban areas in NCR.

II. The researcher has calculated the distribution of City gravitational fields and drawn the distribution map of the sphere of influence. The following formula is taken to calculate the City gravitational fields:

$$Fd = \frac{P}{d^b}$$

Where, d= distance between urban center and other settlements,

P= (City) population,

Fd= the City's influence strength on the settlements located at d km away; and,

b = friction coefficient for distance.

III. The influence for smaller settlements under the shield of the bigger city is an eccentric circular region. The smaller settlements do not locate on the center of the circular area, but locate on the extended line from the bigger city to the smaller settlements. City influence domains are circular area mosaic in the real world (Liang, 2008).

The total gravitational field for urban influence force is calculated by the following formula:

$$Fi = \sum_{j=1} \frac{Pj}{Dij^2}$$

Where, Fi= total gravitational field for i^{th} gravitational settlement,

Pj= city's total urban population; and,

Dij= the distance between gravitational settlement i and city j.

IV. It is necessary to aggregate the total potential interaction that exists between the urban centers and the multiple numbers of peri-urban areas of the NCR. The total interaction potential between places i and j is; therefore, computed by the following gravity formula:

$$\sum_{i=1}^{n} Iij = k \sum_{i=1}^{n} \frac{PiPj}{dij^{b}}$$

Where, k = constant,

b = distance friction coefficient

I_{ij} = total interaction between places i and j,

P_i = population of place i,

P_j = population of places j,

D_{ij} = distance between places i and j.

2. Correlation

Interrelationship studies between different variables are very helpful tools in promoting research and opening new frontiers of knowledge. Thus, correlation studies are very widely used for a variety of purposes and are considered to be basic tools for detailed analysis and interpretation of statistical data relating to two or more variables (Elhance, 2004).

Identification of the causal relationships among the different characteristics of any study is an essential concern of a scientific investigation. A causal relationship between the two characteristics exists only when one of them may logically be considered as the cause of the other. The factor which is supposed to be the cause is known as the independent variable and the one which is supposed to be the effect is known as the

dependent variable. Thus, the variations in dependent variable may be explained in terms of the variations in the independent variable (Aslam, 2002).

To represent the correlation between two variables, we consider the values of the independent and the dependent variables as X and Y coordinates of a two dimensional space (Ibid).

Karl Pearson's Product Moment Correlation Coefficient is employed in this study to measure the degree and direction of linear correlation of variables.

The **SPSS Statistical Data Editor** is used in testing all propositions. The technique is employed to measure the relationships between variables in the four research hypotheses identified in chapter 1.

3. GIS Techniques and other Methods

A **model** is designed to illustrate the administrative structure of the National Capital Region. This includes the different levels of administrative structure of NCR such as sub-regions, districts and tahsils.

ArcGIS is used to illustrate the distribution of city gravitational fields and draw distribution map of city sphere of influence on its neighboring areas. **ArcGIS** is also used to visualize the degree of urban peri-urban population and workforce interactions in the National Capital Region and to determine the boundaries of NCR, its districts and tahsils as well as the boundaries of the NCT-Delhi. On the other hand, simple descriptive statistical tables are used as analytical tools in many parts of the study.

Various types of maps, charts, and graphs are other essential explanatory tools employed to analyze the various issues discussed in different parts of the study. These are help full for quick understanding of the facts under study.

CHAPTER 5: DETERMINANTS OF URBAN PERI-URBAN INTERACTION

5.1 Population and Urban Growth in NCR

5.1.1 Population Growth and Distribution in NCR

As per the UN report (2007), the world's total population is 6.6 billion and slightly more than half live in urban areas and the majority of this in developing countries. Nowadays, this rapid urban population growth is a challenge for developing countries. Since the growth is inevitable, governments have to develop timely policies that turn these potential crises into opportunities. The UN report (2007) says, "This wave of urbanization is without precedent. The changes are too large and too fast to allow planners and policy-makers simply to react. In Africa and Asia, the number of people living in cities increases by approximately 1 million, on average, each week. Leaders need to be proactive and take far-sighted action to fully exploit the opportunities that urbanization offers."

Rapid urban growth is a function of two major factors (causes): (1) natural increase that results from the excess of births over deaths within a city. This is caused by the natural reproduction of urban residents; (2) net migration that causes urban growth when migration to urban center exceeds migration out of the urban center. The rapid urban growth could be resulted in high unemployment, adverse problems of providing basic urban services, improper urban growth, and urban violence. The UN-Habitat (2002) witnesses that rapid urban growth hampers sustainable development as stated below. "As the world's cities expand at the rate of 10 percent per year, due to rural urban migrations sparked by poverty and conflicts in rural areas, it has become difficult to plan their socio-economic development and infrastructure." Habitat further indicates the negative effects of rapid urban growth saying that "there is strong evidence that poverty, deprivation and environmental problems are some consequences of rapid urban growth."

The formation and planning of the National Capital Region was with the intention of solving the problems which could be caused by the rapid growth of Delhi. The NCR plan was formulated to bring about a balanced and planned development leading to dispersal of economic activities and immigrants to Delhi. The regional plan of NCR (2004) gives more information on this issue as follows: "Regional Plan-2001 provides a unique model for sustainable urban development within a predominantly rural setting and seeks to achieve its objectives through an inter-related policy framework relating to population (re-distribution), settlement systems, regional land use patterns, environmental factors, economic activities and infrastructural facilities." Such a balanced and planned development scheme could be resulted in a positive urban peri-urban interaction that may also bring about sustainable and integrated regional development. The formation of the National Capital Region was to develop a metropolitan area around Delhi, so as to divert increasing pressure of population. The population growth of the National Capital Region is best explained by the population growth of the four constituent sub-regions of NCR as follows.

Table 5.1: Distribution of population among sub-regions of NCR

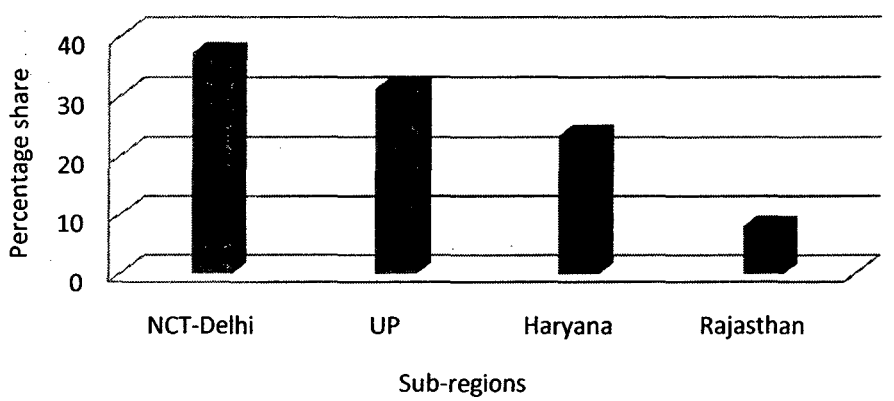
Sub-regions	Population			Decadal growth rate (%)		Share of population (%)		
	1981	1991	2001	1981-91	1991-01	1981	1991	2001
NCT-Delhi	6220406	9420644	13782976	51.45	46.31	31.28	34.43	37.22
U.P	6968646	9001704	11570117	29.17	28.53	35.05	32.90	31.24
Haryana	4938541	6643604	8689268	34.53	30.79	24.84	24.28	23.46
Rajasthan	1755575	2296580	2990862	30.82	30.23	8.83	8.39	8.08
NCR	19883168	27362532	37033223	37.62	35.34	100.00	100.00	100.00

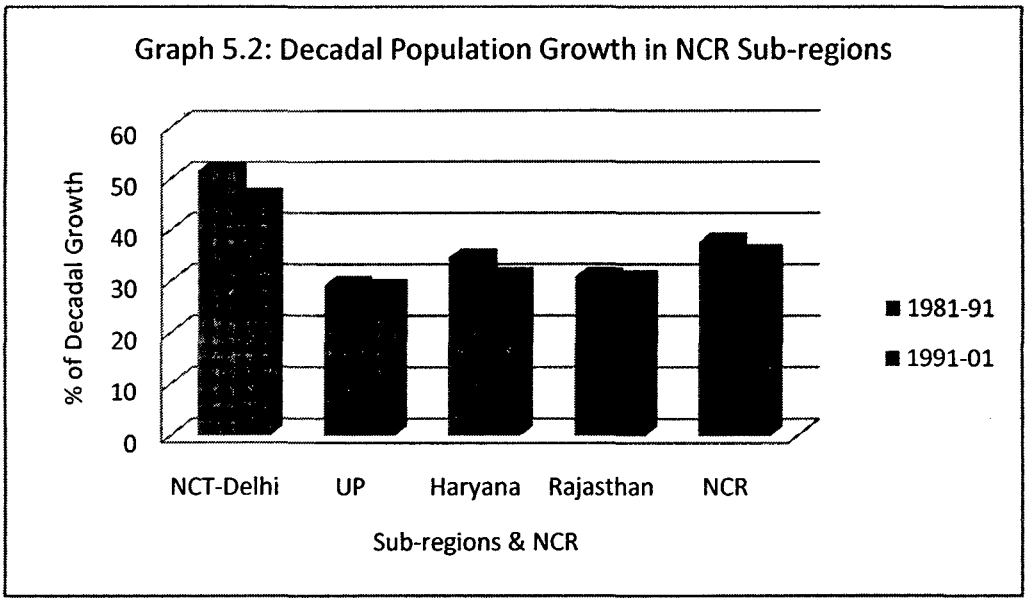
Source: Census of India, 1981, 1991, and 2001.

The National Capital Territory of Delhi is central to the National Capital Region. This sub-region has the largest population concentration (13,782,976 in 2001) in the region. The percentage share of population in **table 5.1** tells us that the NCT- Delhi (37.22%), UP (31.24%), Haryana (23.46%), and Rajasthan (8.08%) constitute the total population of NCR. The unique characteristic features that could be observed from **table 5.1** are the growing trend in the percentage share of population in NCT-Delhi sub-region on the one hand, and the declining trend in the percentage share of population in UP, Haryana, and Rajasthan sub-regions on the other.

The decadal population growth rates of the four sub-regions: Delhi, UP, Haryana and Rajasthan include 46.31, 28.53, 30.79, and 30.23% respectively. The growth rate of Delhi is by far greater than the others. However; there is a declining trend of decadal population growth rate in all sub-regions. Graphs 5.1 and 5.2 below describe better about the distribution and growth of population in NCR.

Graph 5.1: Percentage Distribution of Population in NCR Sub-regions




Graph 5.2: Decadal Population Growth in NCR Sub-regions
% of Decadal Growth
60
50
40
30
20
10
0
NCT-Delhi
UP
Haryana
Rajasthan
NCR
Sub-regions & NCR
1981-91
1991-01

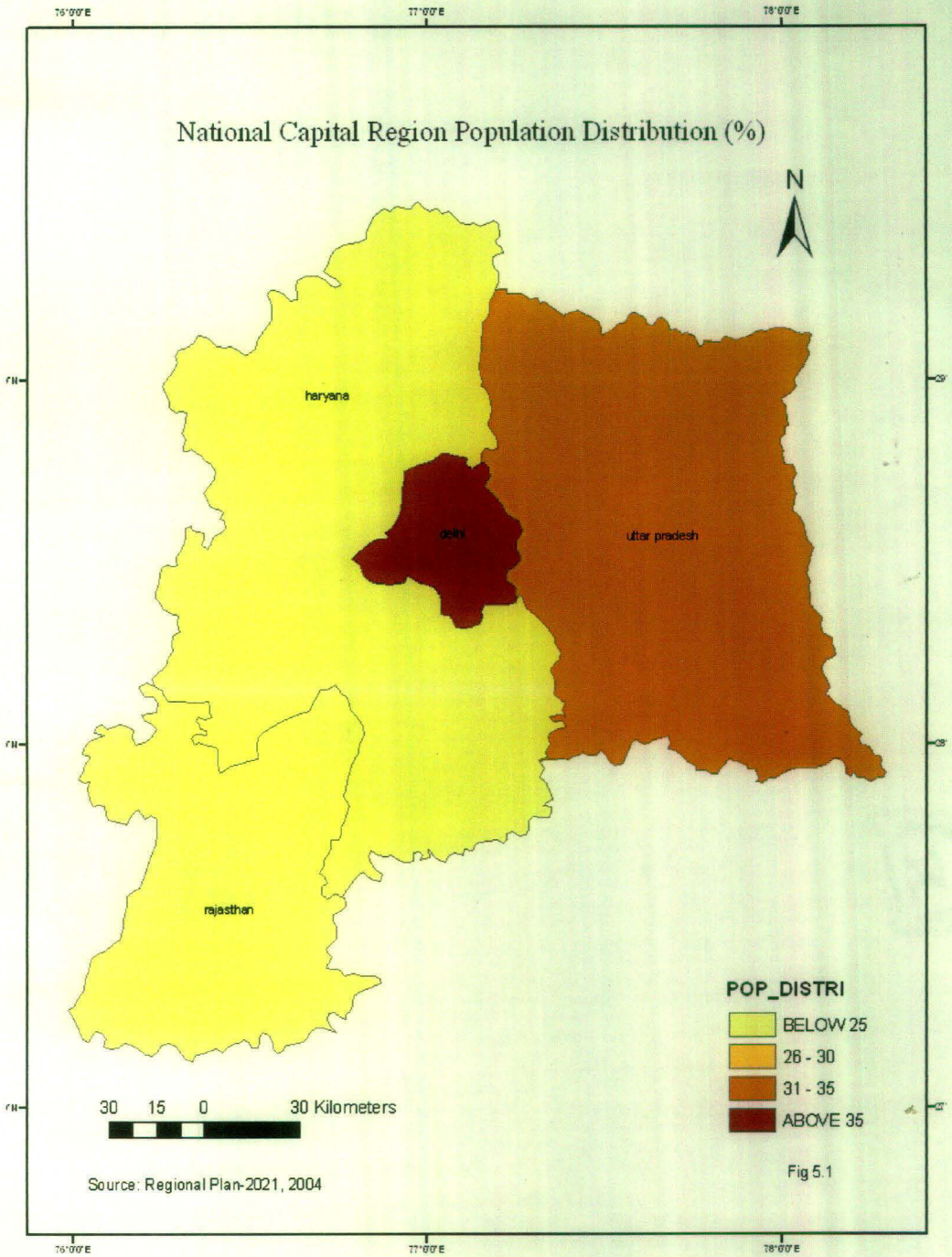

National Capital Region Population Distribution (%)
N
haryana
delhi
uttar pradesh
rajasthan
30 15 0 30 Kilometers
POP_DISTRI
BELOW 25
26 - 30
31 - 35
ABOVE 35
Source: Regional Plan-2021, 2004

Fig 5.1

5.1.2 Distribution of Population by Sector

The unequal distribution of population among sectors can also be taken as a determinant factor of urban peri-urban interaction in the National Capital Region. The urban and rural sectors are the two distinct human settlements having different ways of life. There has been continuous transformation from traditional rural economy to modern urban industrial economy. This process of transformation refers to urbanization and is the result of demographic process and poverty induced rural- urban migration. India is one of the countries having low level of urbanization. However; evidences show that urbanization in India has increased more than three times within the last four decades i.e. from nearly 78.9 million in 1961 to 285.3 million in 2001. As per the Census of India; nearly 28% of the Indian population lives in urban areas.

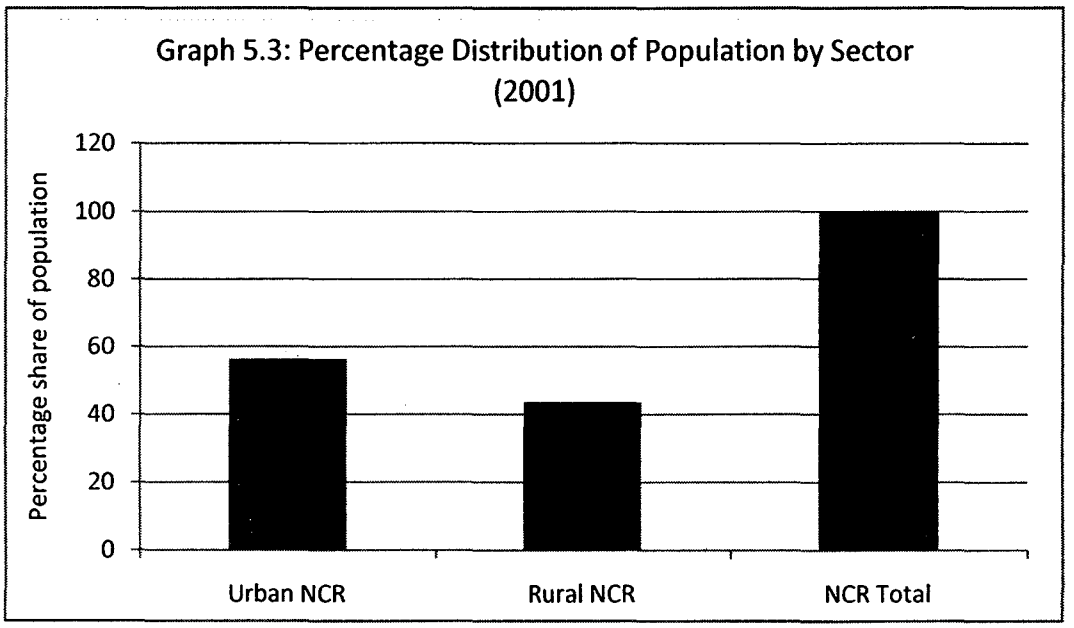
The level of urbanization in the National Capital Region is computed from urbanization data of its four sub-regions. Of all the sub-regions; the NCT-Delhi is highly urbanized (93%) and is the deriving force for the formation of NCR. However; other sub-regions also have relatively high percentage of urbanization which is above the proportion of the national urban population. It is attempted to show the trend of urbanization in the National Capital Region using table 5.2 below.

Table 5.2: Urban- rural components of population in NCR

Urban-Rural Components	Population			Percent Share		
	1981	1991	2001	1981	1991	2001
Total NCR	19883168	27362532	37033223	100.00	100.00	100.00
Urban NCR	9120172	13744784	20832700	45.87	50.23	56.25
Rural NCR	10762996	13617748	16200523	54.13	49.77	43.75
Urban NCR excluding NCT-Delhi	3351972	5273159	8012939	24.53	29.39	34.46

Source: Census of India, 1981, 1991, and 2001.

There is a continuous high rate of urbanization (see table 5.2) in the National Capital Region throughout the decades 1971-81, 1981-91 and 1991-01 (45.87%, 50.23%, and 56.25%). On the other hand; there is continuous decreasing trend in the proportion of the rural population in NCR throughout the decades (54.13%, 49.77%, and 43.75%). The high proportion of urbanization in NCT-Delhi rises greatly the percentage of urban population in NCR. Graph 5.3 explains well about the trend and level of urbanization in NCR.



5.1.3 Population Change in NCT-Delhi and other Class I Towns in NCR

This part discusses on the National Capital Territory of Delhi and the other Class I towns (district capitals) in the National Capital Region. These cities and towns have their own ways of interaction (urban-urban interaction) that may bridge further to the urban peri-urban interaction. However, it is necessary to explore the trend of population change which is a determinant factor for both urban-urban and urban peri-urban interactions.

The population of the National Capital Region is rapidly growing from time to time. The total population of the Region was 19,018,909 in 1981. This number has grown to 37,033,214 in 2001 which is nearly to be doubled. When we consider the decadal

population growth of the particular cities or towns, we can observe greater variations. Some of them show decreasing while others have increasing trends.

Table 5.3: Population change in NCT-Delhi and other class I towns (district capitals) in NCR

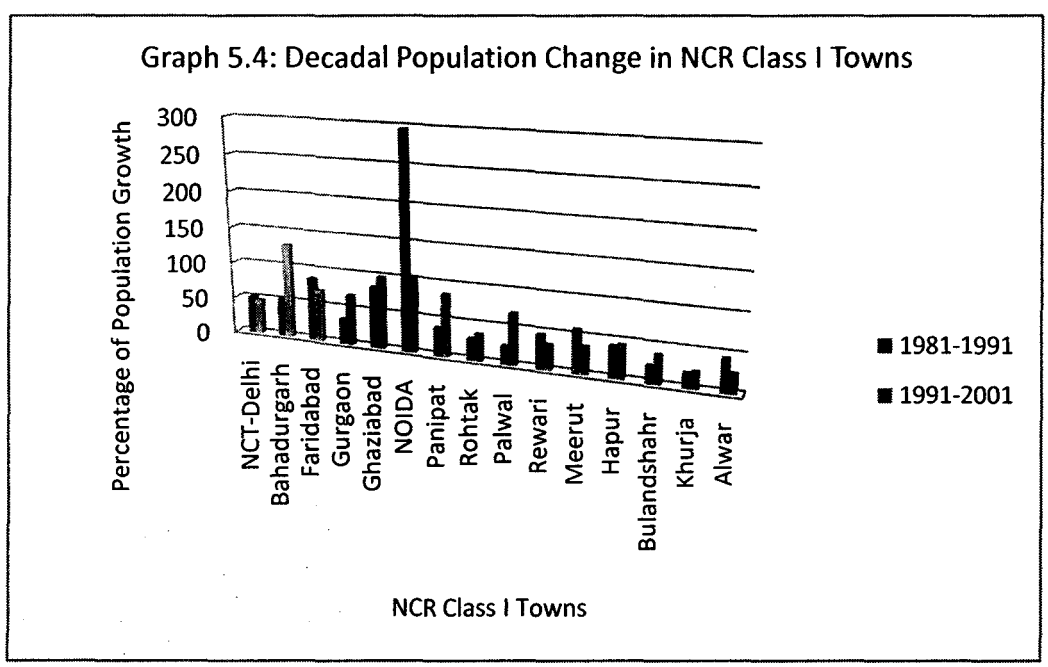
S.No	Name of Towns	Population (Persons)			Decadal Growth (%)	
		1981	1991	2001	1981-91	1991-01
1	NCT-Delhi	6220406	9420644	13850507	51.45	47.02
2	Bahadurgarh	37488	57235	131924	52.68	130.50
3	Faridabad	330864	617717	1054981	86.70	70.79
4	Gurgaon	100877	135884	229243	34.70	68.70
5	Ghaziabad	297429	548320	1089180	84.35	98.64
6	NOIDA	37000	146514	293908	295.98	100.60
7	Panipat	137927	191212	353983	38.63	85.13
8	Rohtak	166767	216096	294537	29.58	36.30
9	Palwal	47328	59168	100528	25.02	69.90
10	Rewari	51562	75342	100946	46.12	33.98
11	Meerut	536615	849799	1167399	58.36	37.37
12	Hapur	102837	146262	211987	42.23	44.94
13	Bulandshahr	103436	127201	176256	22.98	38.56
14	Khurja	67119	80305	98403	19.65	22.54
15	Alwar	145795	210146	265850	44.14	26.51
	NCR Total	19018909	26446180	37033214	39.05	40.03

Source: Census of India, 1981, 1991, and 2001.

Table 5.3 reveals that some cities and towns show decreasing trend of decadal population growth. These include the NCT-Delhi, Faridabad, NOIDA, Rewari, Meerut, and Alwar. The rest nine towns of the Region indicate an increasing trend of decadal population growth. However; the average trend of decadal population growth in the

National Capital Region reflects a slight increase (0.98%). The decadal decrease in population growth (4.43%) in the NCT-Delhi witnesses the policy effect. The policy measure taken to deflect the population pressure in urban Delhi and to shift heavy industries outside the city also resulted in fast population and investment growth in the surrounding towns. For instance, NOIDA, the well planned industrial township around urban Delhi that harmonizes residential and industrial sites has grown four times within one decade (1981-91) from 37,000 to 174,500. The actual increase or decrease in the decadal population growth of the NCR towns is depicted in Graph 5.4 below.

Graph 5.4: Decadal Population Change in NCR Class I Towns



5.1.4: Population Growth and Migrants into Delhi, 1961-1991

Urban population grows rapidly as people flow from rural areas to cities and towns in search of employment, educational and health opportunities and better standard of living. Some people also move to urban centers when their farm land can no longer support them. There is a continuing trend of migration towards the larger urban agglomerations such as Delhi and create strains to city governments to provide even the minimal basic services such as housing, water, electricity, and sanitation facilities. Table 5.4 accounts about the role of migration in urban growth and urbanization in Delhi.

Table 5.4: Population growth and migration into Delhi

Year	Total Population	Growth Rate	Growth of Population	Components of Natural Increase	Components of Net Migration
1961	2,658,612	52.44%	-	-	-
1971	4,066,698	52.96%	1,408,086	773,546 (54.94%)	634,540 (45.07%)
1981	6,220,406	52.96%	2,153,708	1,202,868 (55.85%)	952,840 (44.15%)
1991	9,420,644	51.44%	3,200,238	1,895,238 (59.22%)	1,305,000 (40.78%)

Source: Census of India, 1961, 1971, 1981, and 1991.

The role of migration in population growth and urbanization in Delhi is very high witnessing high urban peri-urban interaction (see table 5.4) in both of the three consecutive decades; despite, a slight decline from 1971- 1991 given as 45.07%, 44.15%, and 40.78%. However; the combined (average) population growth rate of Delhi moves up and down throughout the given decades as 52.44%, 52.96%, 52.96%, and 51.44% respectively.

5.1.5 NCT-Delhi Sector-wise Population Growth and Distribution

Delhi is the third largest metropolis by population size in India following to Mumbai and is the fastest growing city in the country with over 46% decadal population growth rate from 1991-2001, more than double the national decadal growth rate (21.34%). A large portion of this high growth rate is attributed to high level of immigration. Concerning to this, the Directorate of Economics and Statistics of the Government of Delhi put forward the following statements. "The annual average exponential growth rate of Delhi was the highest (6.4%) during 1941-1951 due to the large-scale migration from Pakistan to India after partition in 1947. Since then the annual growth has been recorded at 4.22% during 1951-1961; 4.25% during 1961-1971; 4.25% during1971-1981; and 4.15% during 1981-1991. The annual growth rate of population of Delhi during 1991-2001 has been

recorded as 3.85% and it is almost double the national average." Table 5.5 provides more information about the issue under discussion.

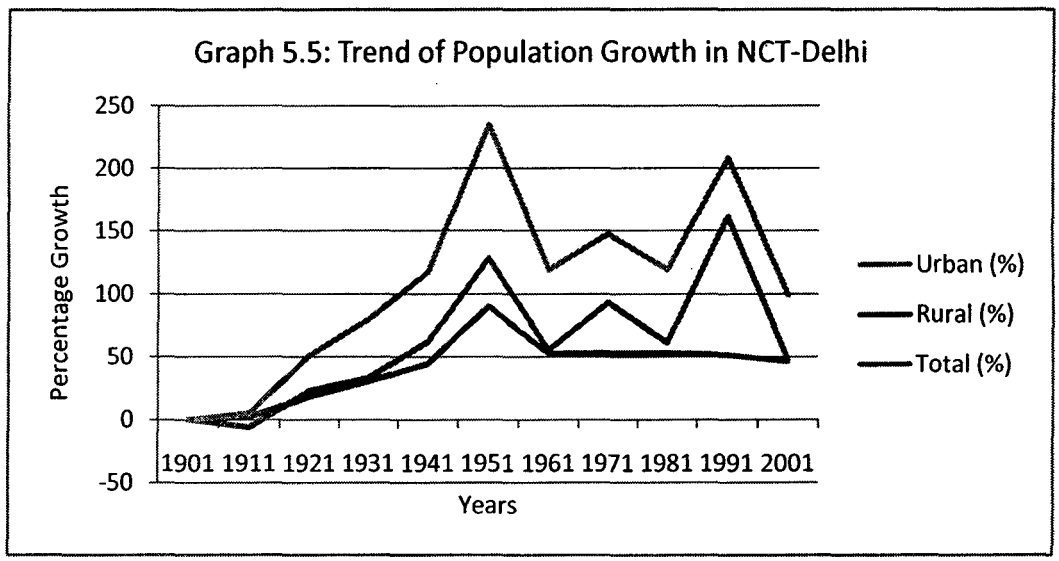
Table 5.5: Trend of population growth in NCT-Delhi, 1901-2001

Years	Total		Rural		Urban	
	population	Decadal growth	population	Decadal growth	population	Decadal growth
1901	405819	-	191704	-	214115	-
1911	413851	01.98	175907	-8.24	237944	11.13
1921	488452	18.03	184032	4.62	304420	27.94
1931	636246	30.26	188804	2.59	447442	46.98
1941	917939	44.27	222253	17.72	695686	55.48
1951	1744072	90.00	306938	38.10	1437134	106.58
1961	2658612	52.44	299204	2.52	2359408	64.17
1971	4065698	52.93	418675	39.93	3647023	54.57
1981	6220406	53.00	452206	8.01	5768200	58.16
1991	9420644	51.45	949019	109.86	8471625	46.87
2001	13782976	46.31	963215	1.50	12819761	51.33

Source: Census of India, 2001.

Table 5.5 presents total population, percentage of decadal growth rate of total population, total rural population, decennial percentage growth rate of rural population, total urban population, and decadal percentage growth rate of urban population in every decade. The table also indicates that the total population living in urban areas in 1901 was very low (0.21 million). However; the total population of urban Delhi dramatically increased to 12.82 million in 2001. The percentage of urban population in NCT-Delhi in 1901 was 52.76%. The urban population; however, increased to 93.18% in 2001 witnessing fast urbanization process in the National Capital Territory

of Delhi. Graph 5.5 illustrates the trend of decennial growth rate of both total, rural, and urban population of NCT-Delhi Sub-region.



5.1.6: Uttar Pradesh Sub-region Sector-wise Population Growth

The Uttar Pradesh Sub-region of the National Capital Region includes the districts Meerut, Baghpat, Ghaziabad, Bulandshahr, and Gautam Buddha Nagar. This Sub-region has a share of 11,570,117 (31.24%) population in the Region followed to NCT-Delhi (37.22%). Table 5.6 is presented to examine the growth of population within the decades ranging in 1961-2001 both at sub-region and sector levels.

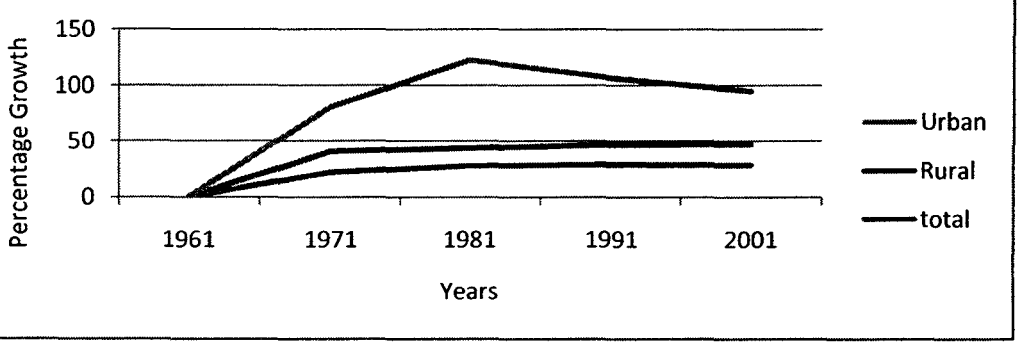
Table 5.6: Growth of population in Uttar Pradesh Sub-Region, 1961-2001

Year	Total		Rural		Urban	
	Population	Decadal Growth (%)	Population	Decadal Growth (%)	Population	Decadal Growth (%)
1961	4450172	-	3671496	-	778676	-
1971	5440296	22.25	4351826	18.53	1088470	39.78
1981	6968646	28.09	5019579	15.34	1949067	79.06
1991	9001704	29.17	5884092	17.22	3117612	59.95
2001	11570117	28.53	6955440	18.21	4614677	48.02

Source: Census of India, 2001.

Comparing with that of the NCT-Delhi, the UP Sub-region had been growing at a lower rate (see table 5.6). There was a steady growth of population from 1971-1991 with percentage decadal growth of 22.25%, 28.09%, and 29.17% respectively. However; there had been a declining trend from 1991-2001 (29.17%-28.53%). Considering the percentage of decadal rural population growth, there was a decline in 1971-1981 (18.53%-15.34%). This was followed by an increase during the period 1981-2001 (17.22%-18.21%). The percentage of decadal urban population growth; on the other hand, indicates that there was high growth rate from 1971-1981 (39.78%-79.06%) and then shows a sharp declining trend from 1981-2001 (79.06%-48.02%). Generally speaking, there is inverse relationship between the urban and rural decadal population growth in UP Sub-region. For better information, see graph 5.6 below.

Graph 5.6: Percentage of Population Growth in UP Sub-region



5.1.7 Tahsil Level Trend of Population Growth in Uttar Pradesh Sub-region

It has been mentioned that next to the National Capital Territory of Delhi Sub-region, Uttar Pradesh Sub-region has large share of population (11,785,017) in the National Capital Region. Population growth greatly affects the urban peri-urban interaction in Uttar Pradesh. It has been attempted to assess tahsil level trend of population growth for three consecutive years. The following table (table 5.7) is employed to give a clear picture of trend of population growth in UP Sub-region.

Table 5.7: Tahsil level trend of population growth in Uttar Pradesh Sub-region

Districts	Tahsils	1981	1991		2001	
		Total Pop.	Total Pop.	Decadal %Change	Total Pop.	Decadal %Change
Meerut	Meerut	1061211	1398938	31.82	1813446	29.63
	Mawana	485964	593788	22.19	686899	15.68
	Sardhana	537489	619353	15.23	505616	-18.36
Dist. total	-	2084664	2612079	23.08	3005961	15.08
Ghaziabad	Ghaziabad	519938	857497	64.92	1630374	90.13
	Hapur	475321	638630	34.36	774007	21.20
	Modingar	358743	461870	28.75	555054	20.18
	Garhmukteshwar	226330	279346	23.42	331122	18.53
Dist. total	-	1580332	2,237,343	41.57	3290557	47.07
Baghpat	Baghpat	682582	835833	22.45	191508	-77.08
	Khekada	-	148160	-	323087	118.06
	Baraut	-	251650	-	850007	237.77
Dist. total	-	682582	1235643	-	1364602	10.44
Bulandshahr	Bulandshahr	596573	734102	23.05	735177	0.15
	Siana	385417	444985	15.46	471001	5.85
	Debai	-	164891	-	380648	130.85
	Shikarpur	-	162415	-	381958	135.17
	Khurja	556155	673102	21.03	400932	-40.43

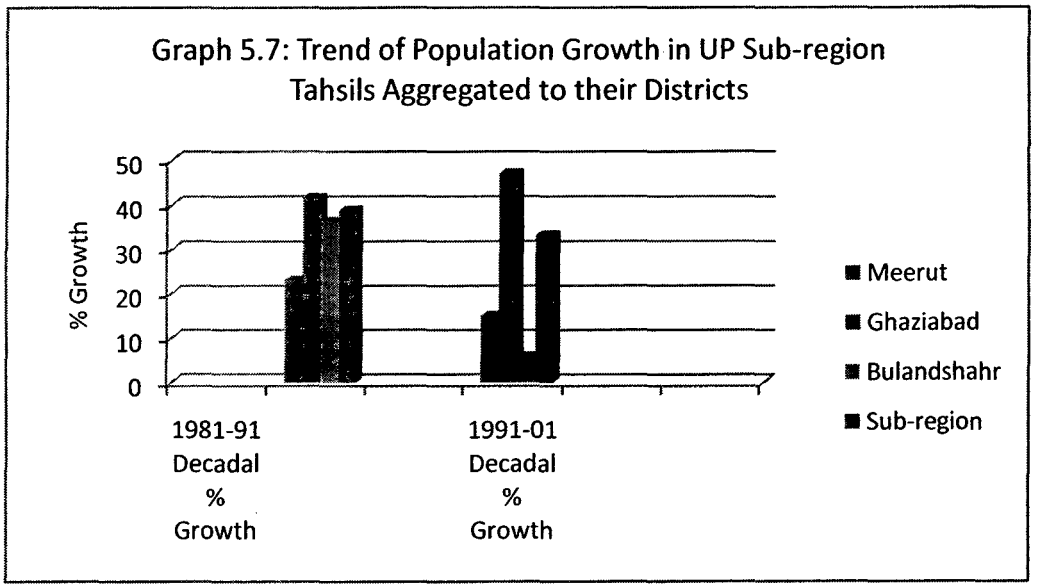
	Anupshahr	484437	580028	19.73	300743	-48.15
	Sikandrabad	-	-	-	252831	-
Dist. total	-	2022582	2759523	36.43	2923290	5.93
Gautam B.N.	Dadri	-	-	-	691062	-
	Jewar	-		-	250566	-
	Gautam B.N.	-	-	-	258979	-
Dist. total	-	-	-	-	1200607	-

Source: Census of India, 1981, 1991, and 2001.

There was high rearrangement of administrative units in Uttar Pradesh Sub-region in 2001. As a result, eight administrative C.D. Blocks (Khekada, Baraut, Debai, Shikarpur, Sikandrabad, Dadri, Jewar, and Gautam Buddha Nagar) were transformed into tahsil level. Gautam Buddha Nagar was transformed into district and tahsil level as well (see table 5.7).

The changes in administrative units resulted in changes on the decadal growth of both districts and tahsils. For instance, there is a negative population growth in tahsils Sardhana, Baghpat, Khuja and Anupshahr, because of the shift of land and population to form other tahsils or a district. On the other hand; tahsil Ghaziabad has 90.13% decadal population growth rate. The newly established tahsils such as Khekada (118.06%), Baraut (237.77%), Debai (130.85%), and Shikarpur (135.17%) have very high population growth rate.

The overall trend of decadal population growth rate in Uttar Pradesh Sub-region shows a declining trend from 38.84% (in1991) to 33.24% (in 2001). Graph 5.7 is presented to give additional information on the general trend of decadal population growth rate in UP Sub-region.



5.1.8 Haryana Sub-region Sector-wise Population Growth

Haryana Sub-region comprises seven districts namely: Faridabad, Gurgaon, Rewari, Jhajjar, Rohtak, Sonipat, and Panipat. This sub-region has a share of 23.46% (8,689,268) of the total population of the National Capital Region. The State of Haryana had a population growth of 28.06% which is above the national average (21.34%) during the same period. The following table (table 5.8) presents the total and sector-wise population growth for four decades as compared to the respective state average growth.

Table 5.8: Growth of population in Haryana Sub-Region, 1971-2001

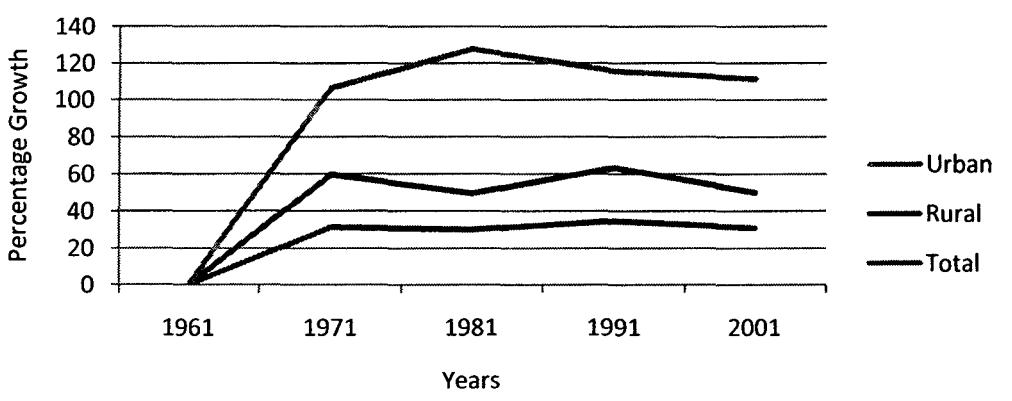
Year	Total		Rural		Urban	
	Population	Decadal Growth (%)	Population	Decadal Growth (%)	Population	Decadal Growth (%)
1971	3798228	31.27	3120856	28.32	677372	46.87
1981	4938541	30.02	3731837	19.58	1206704	78.14
1991	6643604	34.53	4808344	28.85	1835260	52.09
2001	8689268	30.79	5725499	19.07	2963769	61.49

Source: Census of India, 2001.

The decadal population growth rate of Haryana Sub-region dose not show regular increasing or decreasing trend (see table 5.8). The percentage of decadal total population growth decreased from 31.27% to 30.02% during the period 1971-1981. On the next decade (1981-1991), the percentage growth increased from 30.02% to 34.53%. Finally, it has dropped from 34.53%-30.79% during the period 1991-2001.

Similarly, the sector-wise decadal population growth has no regular trend. The percentage of decadal rural population growth decreased from 28.32% to 19.58% during the period 1971-1981. Then, it increased from 19.58% to 28.85% during the decade 1981-1991 until it has dropped into 19.07% in1991-2001. On the contrary to the rural trend, the percentage of decadal urban population growth had increased from 46.87% to 78.14% during the period 1971-1981. However; it had been dropped from 78.14% to 52.09% in the decade 1981-1991 until it had increased to 61.49% during the period 1991-2001. Similar to the case of UP, the urban and rural decadal growth rates of Haryana Sub-region for the given decades have inverse relationship. Graph 5.8 is employed to give further information on sector-wise decadal population growth in Haryana Sub-region.

Graph 5.8: Percentage of Population Growth in Haryana Sub-region



5.1.9 Tahsil Level Trend of Population Growth in Haryana Sub-region

Haryana sub-region constitutes the largest share of land area in NCR and comprises seven districts and twenty seven tahsils as well. Haryana Sub-region is also a home for 8,689,263 total population. Table 5.9 is presented to show the general tahsil level trend of population growth in Haryana Sub-region.

Table 5.9: Tahsil level trend of population growth in Haryana Sub-region

Districts	Tahsils	1981	1991		2001	
		Total Population	Total Population	Decadal Change (%)(1981-1991)	Total Population	Decadal Change (%)(1991-2001)
Faridabad	Faridabad	517597	557781	7.76	927973	66.37
	Ballabgarh	112677	301661	167.72	436150	44.58
	Palwal	355820	467237	31.31	404130	-13.51
	Hathin	112673	150561	33.63	203881	35.41
	Hodal	-	215587	-	221142	2.58
Dist. total		1098767	1692827	54.06	2193276	29.56
Gurgaon	Gurgaon	403932	519065	28.50	629557	21.29
	Pataudi	64953	84019	29.35	100890	20.08
	Taoru	-	-	-	123182	-
	Sohna	-	-	-	140620	-
	Nuh	168523	231753	37.52	212834	-8.16
	Punahuna	-	-	-	206758	-
	Ferozepur Jhirk	226460	311253	37.44	243828	-21.66
Dist. total		863868	1146090	32.67	1657669	44.63
Rewari	Rewari	345386	439697	27.31	543187	23.53
	Bawal	70695	87680	24.03	110549	26.08
	Kosli	80740	95924	18.81	110991	15.71
Dist. total		496821	623301	23.46	764727	22.69
Jhajar	Jhajar	331037	448429	17.69	382118	-14.78

	Beri	-	-	-	135260	-
	Bahadurgarh	201369	258615	28.31	370014	40.08
Dist. total		532406	707044	32.80	887392	25.51
Rohtak	Rohtak	520583	620366	19.17	758710	23.30
	Maham	150819	171521	13.73	181326	5.72
Dist. total		671402	791887	16.44	940036	18.71
Sonipat	Sonipat	474116	602766	27.13	603243	0.08
	Kharkhoda	-	121574	-	160083	31.67
	Gohana	262196	309655	18.10	339666	9.69
	Ganaur	119567	152100	27.21	175833	15.60
Dist. total		855879	1186095	38.58	1278825	7.82
Panipat	Panipat	492286	677157	37.55	596897	-11.85
	Israna	-	-	-	121992	-
	Samalkha	-	-	-	248449	-
Dist. total		492286	677157	37.55	967338	42.85

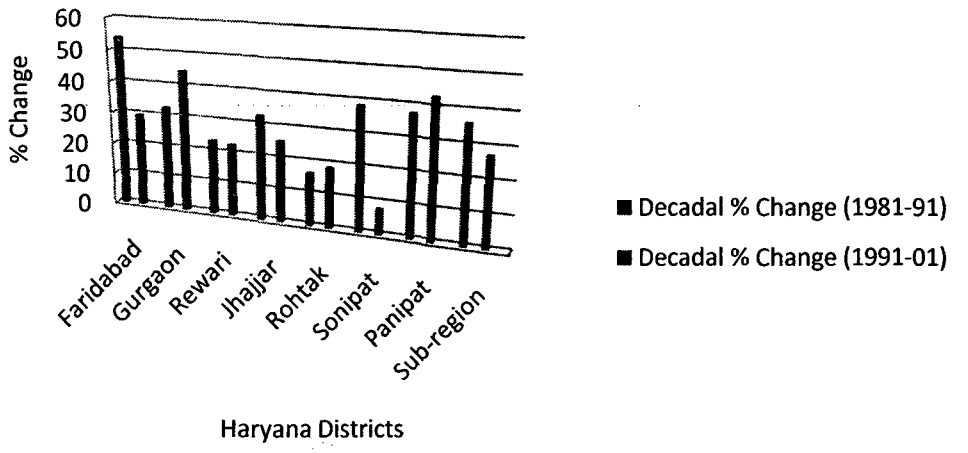
Source: Census of India, 1981, 1991, and 2001.

Table 5.9 makes clear that there are significant growth variations among districts and among tahsils. Districts such as Faridabad (29.56%), Rewari (22.69%), Jhajjar (25.51%), and Sonipat (7.82%) have a decreasing population growth trend; while districts Gurgaon (44.63%), Rohtak (18.71%), and Panipat (42.85%) show an increasing population growth trend. The population growth variation is even wider in the case of tahsils. Some tahsils such as Bawal (-13.51%), Nuh (-8.16%), Ferozepur Jhirk (-21.66%), Jhajjar (-14.78%), and Panipat (-11.85%) have negative population growth while tahsils like Faridabad (66.37%), and Bahadurgarh (40.08%) have relatively higher population growth than the others.

The major reason for the wider variations in population growth comes from the frequent rearrangement of the administrative units. When one district or tahsil is created, it shares both land area and certain population size from the others causing lower or negative population growth in the districts or tahsils.

Generally speaking, Haryana Sub-region has a declining (36.18% to 27.33%) trend of population growth. Graph 5.9 below demonstrates the trend of population growth in Haryana Sub-region.

Graph 5.9: Trend of Population Growth in Haryana Sub-region
Tahsils Aggregated to their Districts



5.1.10: Rajasthan Sub-region Sector-wise Population Growth

Rajasthan Sub-region includes only one district called Alwar having a total population of 2,990,862 (Census, 2001) and constituting 8.08% of the total population of the National Capital Region. This Sub-region; however, constitutes significant part of the total area (23.32%) of the NCR. This part of the study discusses the total and sector-wise growth of population in Alwar through the help of five years census data presented in table 5.10 below.

Table 5.10: Growth of population in Rajasthan Sub-Region, 1961-2001

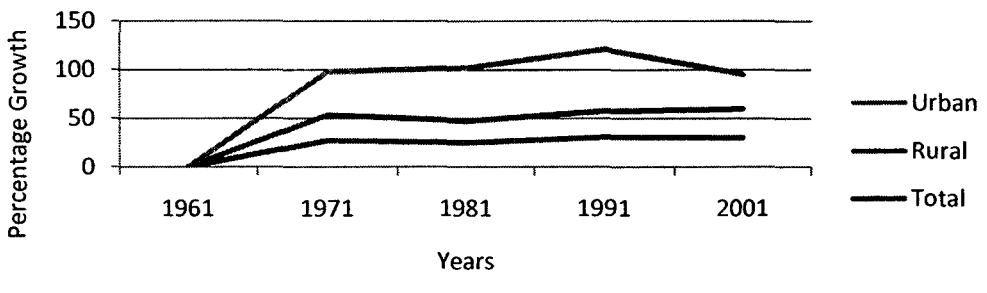
Years	Total		Rural		Urban	
	Population	Decadal Growth (%)	Population	Decadal Growth (%)	Population	Decadal Growth (%)
1961	1100372	-	1012480	-	87892	-
1971	1403787	27.57	1276905	26.12	126882	44.36
1981	1755575	25.06	1559374	22.12	196201	54.63
1991	2296580	30.82	1976293	26.74	320287	63.24
2001	2990962	30.23	2556369	29.35	434493	35.66

Source: Census of India, 2001.

Certain fluctuations are observed in total population growth in Rajasthan Sub-region (see table 5.10). The total population growth rate decreased from 27.57% to 25.06% during the period 1971-1981. Then, the growth increased from 25.06% to 30.82% in the decade 1981-1991 until it slightly decreased to 30.23% during the period 1991-2001.

There was a decreasing trend (26.12% to 22.12%) in the rural population growth rate during the period 1971-1981. However; the rural population growth rate of Rajasthan Sub-region continuously increased from 22.12%-29.35% throughout the period 1981-2001. On the other hand; the urban population growth rate of the Sub-region was continuously increasing from 44.36% in 1971 to 63.24% in 1991; but, it sharply declined to 35.66% in 2001. These trends are clearly demonstrated in graph 5.10 below.

Graph 5.10: Percentage of Population Growth in Rajasthan Sub-region



5.1.11 Tahsil Level Trend of Population Growth in Rajasthan Sub-region

Rajasthan Sub-region is the smallest of the four sub-regions of the National Capital Region in both area (23.32%) and population size (8.08%). This Sub-region comprises one district (Alwar) and twelve tahsils. The district Alwar has a total population of 2,992,892(Census of India, 2001), with decennial growth rate of 30.23 %. About 85 % of the total population of the district live in rural areas and are engaged in small scale farming practices. Table 5.11 is expected give adequate information on tahsil level trend of population growth in Rajasthan Sub-region.

Table 5.11: Tahsil level trend of population growth in Rajasthan Sub-region

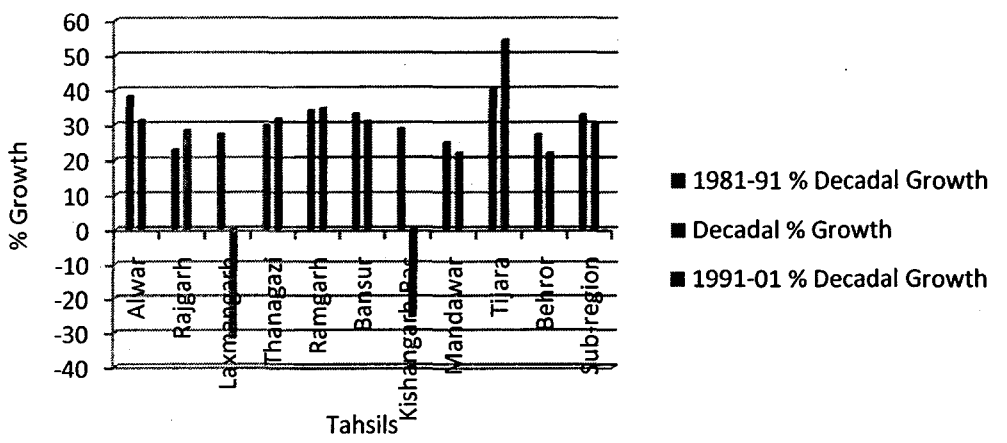
District	Tahsils	1981		1991		2001	
		Total Pop.	Decadal Change (%)	Total Pop.	Decadal Change (%)	Total Pop.	Decadal Change (%)
Alwar	Alwar	311548	38.07	432952	38.07	568530	31.31
	Rajgarh	194089	22.89	238519	22.89	306226	28.37
	Laxmangarh	278709	27.32	354847	27.32	241708	-31.88
	Kathumar	-	-	-	-	206685	-
	Thanagazi	110970	29.87	144119	29.87	189977	31.82
	Ramgarh	111712	34.09	149796	34.09	201757	34.69
	Bansur	122896	33.11	163582	33.11	214351	31.04
	Kishangarh B.	168542	28.91	217264	28.91	161629	-25.61
	Kotkasim	-	-	-	-	117687	-
	Mandawar	129703	24.91	162010	24.91	197582	22.00
	Tijara	129538	40.40	181877	40.40	280772	54.37
	Behror	197866	18.96	251614	27.16	305688	21.90
Dist. T.	-	1755575	30.82	2296580	30.82	2992892	30.32

Source: Census of India, 1981, 1991, and, 2001.

As per table 5.11, tahsils of Rajasthan Sub-region with increasing decadal population growth trend include Rajgarh (22.89 to 28.37%), Thanagazi (29.87 to 31.82%), Ramgarh (34.09 to 34.69%), and Tijara (40.40 to 54.37%) in a given decade 1991-2001. Those tahsils with decreasing decennial population growth trend; on the other hand, include Alwar (38.07 to 31.31%) , Laxmangarh (27.32 to -31.88%), Bansur (33.11 to 31.04%), Kishangarh Bas (28.91 to -25.61%), Mandawar (24.91 to 22.00%), and Behror (27.16to 21.90%) in the same decade. Tahsils Laxmangarh and Kishangarh Bas have negative trend of population growth; because, part of their population is shifted to form the new tahsils called Kathumar and Kotkasim.

The sub-region decadal population growth trend shows a slight decline from 30.82 to 30.32% in the years 1991-2001. Graph 5.11 below could give a clear picture of the decennial population growth trend in Rajasthan Sub-region.

Graph 5.11: Decadal Population Growth in Rajasthan Sub-region Tahsils



5.1.12 Trend of Population Density in National Capital Region

The population density in the National Capital Region is expected give a clear picture about the distribution of population and the degree of potential urban peri-urban interaction in the region. Density plays a greater role in planning and allocating of resources as well as devising solutions to overcome the effects of overcrowding. It also

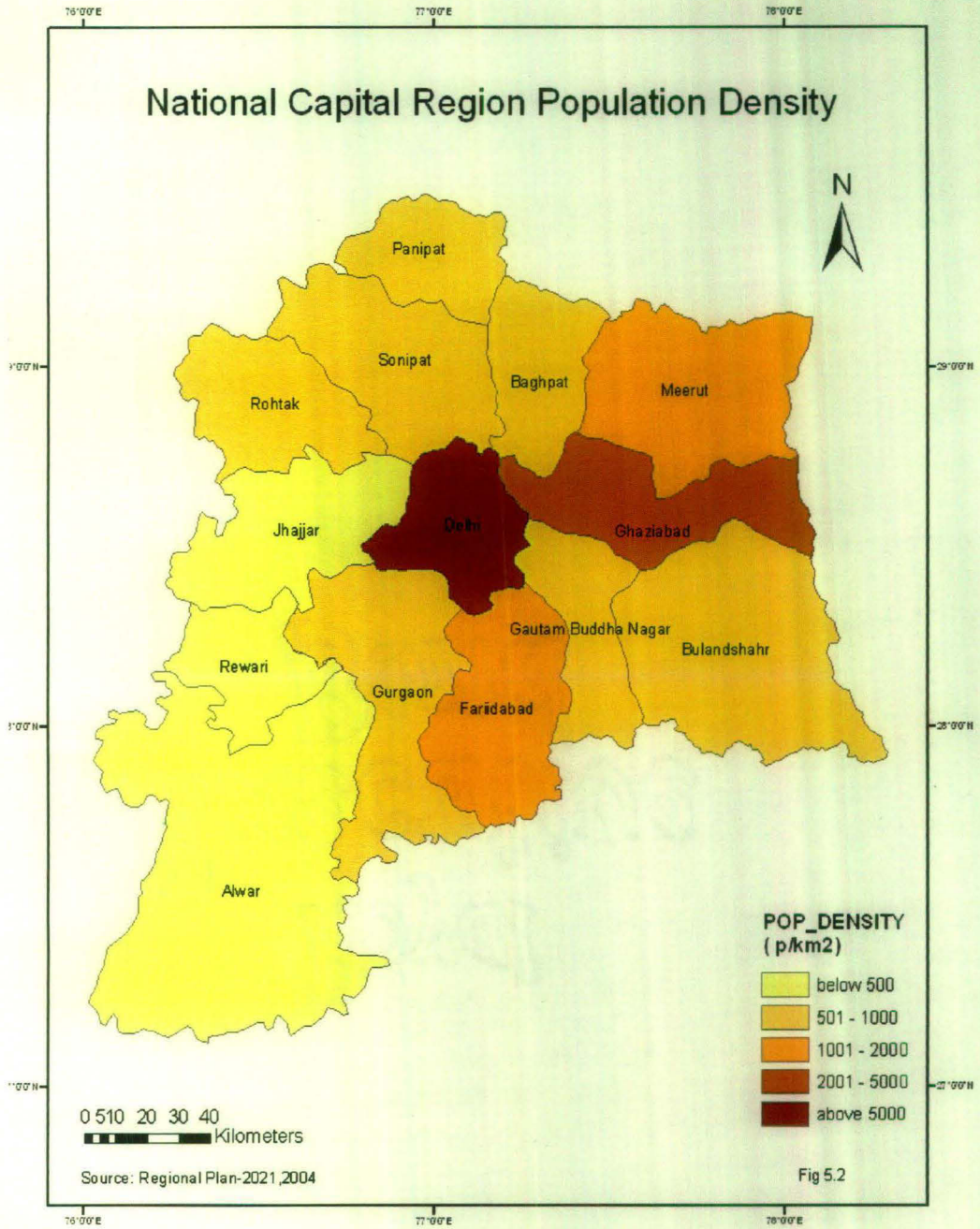
helps give decisions about the distribution of basic services and expanding the provision of infrastructure in the Region so as to bring sustainable and integrated development in NCR.

Table 5.12: Trend of population density in National Capital Region

Sub-region	Total Area (sq.km)	Total Pop.			Pop. Density (P/km^2)		
		1981	1991	2001	1981	1991	2001
NCT-Delhi	1483	6220406	9420644	13850507	4194	6352	9340
Haryana	13413	4938541	6643604	8689268	368	495	648
Rajasthan	7829	1755575	2296580	2990862	224	293	382
UP	10853	6968646	9001704	11570117	642	829	1066
NCR	33578	19883168	27362532	37032000	592	815	1103

Source: Census of India, 2001.

Table 5.12 reveals that Delhi Sub-region has the highest population density (9340p/km^2) in the National Capital Region followed by Uttar Pradesh (1066p/km^2) in 2001. Rajasthan sub-region; on the other hand, has the lowest density among the NCR sub-regions. The average density for NCR increased throughout the decades (1981-1991 and 1991-2001) as 592, 815, and 1103 p/km^2 respectively. However; the percentage increase in density in all sub-regions and NCR decreased. The percentage increase in NCR; for example, decreased from 37.67% to 35.34%.


National Capital Region Population Density
N
Panipat
Sonipat
Baghpat
Meerut
Rohtak
Jhajjar
Delhi
Ghaziabad
Gautam Buddha Nagar
Bulandshahr
Rewari
Gurgaon
Faridabad
Alwar
POP_DENSITY
(p/km2)
below 500
501 - 1000
1001 - 2000
2001 - 5000
above 5000
0 510 20 30 40
Kilometers
Source: Regional Plan-2021,2004
Fig 5.2

5.2 Sub-region Wise Economic Disparities in NCR

It was identified long before that there were real economic disparities among the NCR sub-regions. It was also addressed that these disparities could largely be attributed to the problems of weak interactions (relationships) among the sub-regions, the core and peripheries, as well as the urban and peri-urban areas. The Regional Plan of NCR (2004) explains the problem as "this is primarily a problem of relationship rather than a problem of scarcity." The Regional Plan extends its justification as "the economic strength of the core, rather than being shared with the periphery remains confined to the core itself and keeps on multiplying the gravitation of the core. This 'Center Periphery' relationship has helped to raise the income levels in Delhi with per capita income of Rs. 36,515 (1999-2000 prices), as compared to the all-India (Rs.15,562) and the surrounding states of Haryana (Rs.21,551), Rajasthan (Rs. 12,533), and Uttar Pradesh (Rs. 9,765)."An interesting question to rise here is what improvements have been taken place after the implementation of the NCR Plan? The researcher has attempted to find out relevant answers taking two factors into consideration. These factors include the per capita of the sub-regions and the proportion of population below poverty line in the sub-regions of the National Capital Region.

5.2.1 Per Capita of Sub-regions Domestic Product at Prices 1999-2006 (Rs)

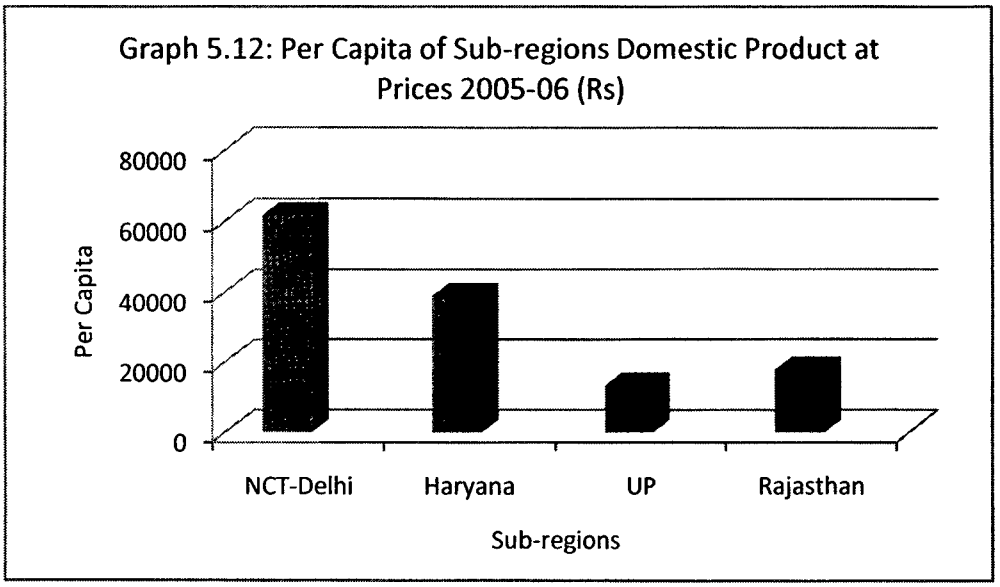
Comparison of sub-regions on the basis of per capita is useful; because, it indicates estimated (generalized) differences of living standards in each sub-region and enables examine the level of integrated development in National Capital Region.

Table 5.13: Per capita of sub-regions domestic product at prices 1999-2006 (Rs.)

Sub-regions	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
NCT-Delhi	38682	41436	43587	45483	49825	55215	61676
Haryana	21966	24138	26077	28259	31509	35044	38832
UP	9405	9511	9781	10435	11250	11941	13262
Rajasthan	13477	12897	14165	13126	16704	16800	17863

Source: Directorate of Economics and Statistics of Respective State Governments, 2006.

Table 5.13 presents the per capita of NCR sub-regions domestic product at prices 1999-2006 including some years before and after the implementation of the NCR Plan. Although it is early to evaluate the achievements in a few number of years, the data can show whether the differences in per capita are improved, remain unchanged, or increased. Clearly, the differences in per capita have increased to a higher level. One can see that the per capita of the NCT-Delhi Sub-region is more than four times that of Uttar Pradesh Sub-region. Such differences are also true among other sub-regions. The reasons could be of various types; however, some reasons like the construction of the NCR networks can take a long time and can have long term effects. Pictorially, the per capita of the sub-regions are depicted in graph 5.12 below.



5.2.2 Sub-region Wise Proportion of Population below Poverty Line

The proportion of population below poverty line is taken as a parameter to compare existing economic disparities among sub-regions. Below Poverty Line (BPL) as a parameter (measure) is useful to compare sub-regions' disparities based on quality of life which includes both economic and social indicators. However; it is very disputable for its accuracy. The National Health Profile (2007) accounts the proportion of population below poverty level for NCR sub-regions as follows.

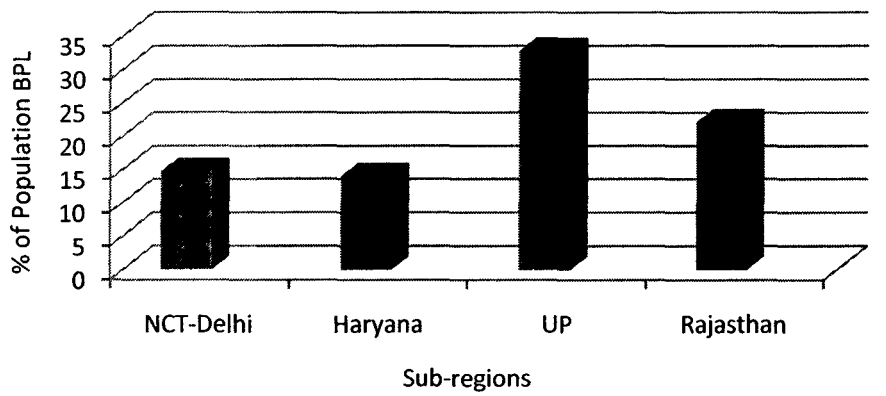
Table 5.14: Sub-region wise proportion of population below poverty line (2004-05)

Sub-regions	Poverty Line (Rs Per Capita)		Percentage of Persons		
	Rural	Urban	Rural	Urban	Combined
N. Delhi	410.28	612.91	6.9	15.2	14.7
Haryana	414.76	504.49	13.6	15.1	14.0
UP	365.84	483.26	33.4	30.6	32.8
Rajasthan	374.57	559.63	18.7	32.9	22.1

Source: National Health Profile, 2007.

The sub-region wise proportion of population below poverty line in table 5.14 above has a clear relationship (correlation) with the results occur in table 5.13 (per capita of sub-regions). Delhi and Haryana sub-regions with highest per capita income have lower proportion of population below poverty line, 14.7% for Delhi and 14.0% for Haryana. On the other hand; Uttar Pradesh Sub-region with the lowest per capita income has the highest proportion of population below poverty line (32.8%). The proportion of population below poverty line in NCR sub-regions is graphically represented as follows.

Graph 5.13: Sub-region-wise Proportion of Population below Poverty Line (2004-05)



5.2.3 Sub-region Wise Employment and Unemployment Levels

Sub-regional economic disparities could be assessed using employment and unemployment indicators. To indicate regional labor market disparities, the Eurostat Information (2009) put forward the following statements. "Employment and unemployment levels are important indicators of both economic and social health. Countries with high levels of employment and low levels of unemployment- tend to be performing well economically. In addition, employment is an important determiner of individual well-being, self-esteem and social harmony and equity."

The researcher has taken the 1999-2000 55th Round National Sample Survey on regional (state) employed and unemployed sections of the labor-force as indicators of sub-regional economic disparities. With certain limitations (for they are state level data),

they are expected give adequate in sight on the supposed disparities. The 55th Round NSS considers the number of employed per 1000 persons according to usual status taking both principal and subsidiary status into considerations by sex and residence for Delhi, Haryana, Uttar Pradesh, and Rajasthan states during 1999-2000. The term employed refers to the persons (15-65 years old) who were available for paid employment or self-employment during the reference period.

Table 5.15: Employed per 1000 population

Sub-regions	Rural			Urban		
	Male	Female	Persons	Male	Female	Persons
N. Delhi	520	29	308	528	105	332
Haryana	475	202	346	506	98	314
UP	481	201	345	490	94	304
Rajasthan	500	388	446	486	138	323

Source: Employed and Unemployed Persons in India, NSS 55th Round 1999-2000.

Table 5.15 presents both sector and sex-wise employed persons in NCR sub-regions. Accordingly, the NCT-Delhi Sub-region with 332 employed per 1000 persons has comparatively high number of employed persons followed by Rajasthan Sub-region with 323 employed per 1000 persons respectively. Uttar Pradesh Sub-region with 304 employed per 1000 persons; however, comparatively has the lowest number of employed persons in the National Capital Region.

The 55th Round NSS (1999-2000) also provides the number of unemployed per 1000 persons according to usual status taking both principal and subsidiary status into considerations by sex and residence for Delhi, Haryana, Uttar Pradesh, and Rajasthan states during 1999-2000. The term unemployed refers to the persons (15-65 years old) who were with out jobs during the reference period.

Table 5.16: Number of unemployed persons per 1000

Sub-regions	Rural			Urban		
	Male	Female	Persons	Male	Female	Persons
N. Delhi	21	8	15	18	5	12
Haryana	6	0	3	14	3	9
UP	6	1	4	23	3	14
Rajasthan	4	1	2	14	4	9

Source: Employed and Unemployed in India, 55th Round NSS (1999-2000).

The table (table 5.16) showing the sector and sex-wise number of unemployed persons per 1000 indicates remarkable differences among the NCR sub-regions. The Uttar Pradesh and NCT-Delhi sub-regions stood first and second with the level of unemployment 14 and 12 persons per 1000. On the other hand; Rajasthan and Haryana sub-regions have comparatively low number of unemployed persons per 1000. However; this level of unemployment in the National Capital Region sub-regions seems to have certain limitations of under estimation.

5.2.4 Economic Disparities and Migration

This part of the study analyzes the origin and destination (direction) of migrants and their implication on economic disparities. The NCT-Delhi which is supposed to have many opportunities is the destination of the migrants. Reasons for migration could be of various types. However; economic cases often dominate the others. Table 5.17 below is employed to give more clarification on the issue under discussion.

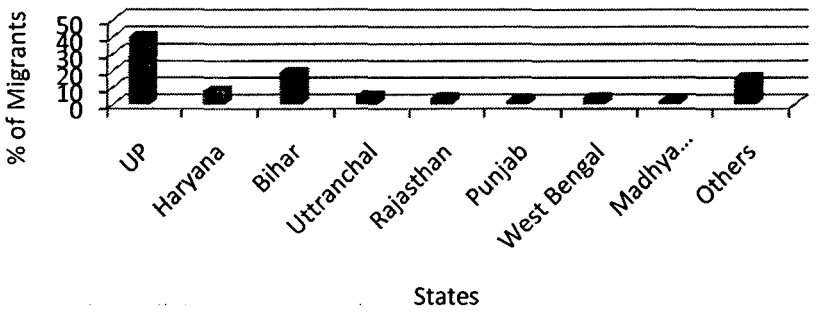
Table 5.17: Classification of migrants by place of last residence

No	Place of last residence	% of Migrants to Delhi	
		1981-91	1991-01
1	Uttar Pradesh	48.25	40.05
2	Haryana	11.51	7.87
3	Bihar	10.69	19.09
4	Uttaranchal	-	5.11
5	Rajasthan	6.00	4.06
6	Punjab	5.28	2.16
7	West Bengal	5.72	3.88
8	Madhya Pradesh	2.64	1.82
9	Others	12.91	15.96

Source: Economic Survey of Delhi, 2007.

The origins of migrants to Delhi are identified by their place of last residence (see table 5.17). The higher the number of migrants may indicate the lower opportunities in the origins. Therefore; the higher number of migrants or 48.25% in 1981-91 and 40.05% in 1991-01 from Uttar Pradesh enables one assume that there are lower opportunities in Uttar Pradesh than in Delhi. Similar circumstances are observed in Haryana with migrants 11.51% (1981-91) and 7.87% (1991-01), Bihar with migrants 10.69% (1981-91) and 19.09% (1991-01) and Rajasthan with migrants 6.0% (1981-91) and 4.06% (1991-01) respectively (see graph 5.14 below).

Graph 5.14: Migrants to Delhi by Place of Last Residence (1991-01)



Another important aspects of migration as indicators of economic disparities include the reasons for migration. Relevant studies show that nearly one third of the migrants flow to urban centers for employment purposes. India in Sociology (2008) forwards the following relevant statements. "Employment appears to the one of the main reasons for migration of the people. Economic constraint at the native place of the migrants motivates or couples the people to leave their original place in search of livelihood or economic betterment at different destinations in urban zones."

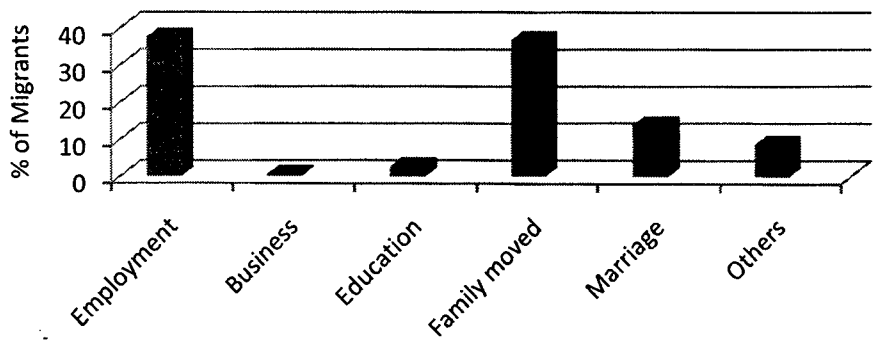
Table 5.18: Migrants classified by reasons for migration

No	Reasons	% of Migrants	
		1981-91	1991-01
1	Employment	31.29	37.6
2	Business	4.07	0.5
3	Education	2.28	2.7
4	Family moved	41.45	36.8
5	Marriage	15.62	13.8
6	Natural calamities	0.13	-
7	Others	5.16	8.6

Source: Economic Survey of Delhi, 2007.

Classification of migrants by their reasons for migration presented by table 5.18 above ensures that above 72% of the migrants move for two reasons i.e. employment and family moved. 31.29% in 1981-91 and 37.60% in 1991-01 of the migrants to Delhi moved for employment purposes. The other major factor for migration is family moved which can have implicit economic cases. These circumstances clearly indicate that migration can help as important indicator in the analysis of economic disparities among places. Graph 5.15 helps for quick understanding about the reasons for migration.

Graph 5.15: Migrants to Delhi by Reasons for Migration (1991-01)



5.3: Distribution of Workers by Sectors

5.3.1: Distribution of Workers in Primary Sector

The distribution of workers in the National Capital Region is mainly based on the economic structure of the Region. For the census year 1991, of the total 7,731,689 NCR workers, we find 2,683,797 (34.71%) primary sector workers; 1,763,850 (22.81%) secondary sector workers; and, 3,284,042 (42.48%) tertiary sector workers respectively. The distribution of workers reveals that the majority (42.48%) of the NCR workers are tertiary workers, while primary (34.71%) and secondary (22.81%) sectors represent second and third places. This indicates that (since 1991) majority of the NCR workers engage in urban economy and witnesses a high rate of transformation of agricultural

economy to urban economy. It might be interesting to see the rate of such transformation through the distribution of workers in each NCR sub-region in tables 5.19, 5.20, and 5.21 below.

Table 5.19: Distribution of workers in primary sector in NCR, 1991

Sub-region	Culti.		Agri. laborers		Livestock, Forestry, etc		Mining &Quarrying	
	Workers	%	Workers	%	Workers	%	Workers	%
NCT-Delhi	33296	1.86	25195	3.07	19024	32.59	7042	50.72
Haryana	677117	37.82	286950	34.94	13605	23.31	4462	32.14
Rajasthan	222065	12.40	35158	4.28	4087	7.00	2004	14.43
UP	857869	47.92	473885	57.71	21662	37.11	376	2.71
NCR total	1790347	100.0	821188	100.0	58378	100.0	13884	100.0

Source: Census of India, 1991.

As per the Census of India 1991 (in table 5.19), workers engaged in cultivation, agriculture, livestock, forestry, mining and quarrying are considered as primary sector workers. Of the total 2,683,797 NCR (1991) primary sector workers, 1,790,347 are cultivators, while 821,188; 58,378; and 13, 884 engage in agriculture, livestock, forestry, mining and quarrying. Cultivators and agricultural laborers are largely concentrated in UP (47.92 and 57.71%) and Haryana (37.82 and 34.94%) while livestock and forestry are largely found in UP (37.11%) and Delhi (32.59%) respectively. More than half of mining and quarrying workers concentrate in NCT-Delhi.

5.3.2: Distribution of Workers in Secondary Sector in NCR

Workers engaged in household and other than household industries and in construction activities are considered as secondary sector workers. The distribution of these workers in the National Capital Region Sub-regions is presented by table 5.20 below.

Table 5.20: Distribution of workers in secondary sector in NCR, 1991

Sub-region	Household industry		Other than Household industries		Construction	
	Workers	%	Workers	%	Workers	%
NCT-Delhi	41788	32.48	689163	53.79	231571	65.41
Haryana	26371	20.50	248635	19.41	52744	14.90
Rajasthan	6524	5.07	34083	2.66	8611	2.43
UP	53978	41.95	309259	24.14	61123	17.26
NCR total	128661	100.00	1281140	100.00	354049	100.00

Source: Census of India, 1991.

Sub-region Uttar Pradesh shares 41.95% (see table 5.20) of the NCR household industry workers followed by the NCT-Delhi with 32.48%. On the other hand; the NCT-Delhi Sub-region leads in both industry (other than household industry) and construction sector number of workers with 53.79 and 65.41% respectively. UP followed the NCT-Delhi in both industry and construction sector number of workers with 24.14 and 17.26% of total in NCR.

5.3.3: Distribution of Workers in Tertiary Sector in NCR

A tertiary sector of an economy is a service industry. As per the 1991 Census of India, those who work in trade & commerce; transport, storage & communication; and other services are recognized as tertiary sector workers. The fastest growing proportion of workers in National Capital Region is observed in tertiary sector. Table 5.21 provides adequate facts favoring the issue under discussion.

Table 5.21: Distribution of workers in tertiary sector in NCR, 1991

Sub-region	Trade & Commerce		Transport, Storage &Communication		Other services	
	Workers	%	Workers	%	Workers	%
NCT-Delhi	709614	62.40	246490	59.85	965194	55.63
Haryana	164767	14.49	71813	17.44	336704	19.41
Rajasthan	29796	2.62	11370	2.76	53142	3.06
UP	233030	20.49	82169	19.95	379953	21.90
NCR total	1137207	100.00	411842	100.00	1734993	100.00

Source: Census of India, 1991.

Table 5.21 reveals that the NCT-Delhi is the largest service provider in NCR than the other sub-regions and has the highest proportion of tertiary sector workers in trade and commerce (62.40%), transport, storage, and communication (59.85%), and other services (55.63%) respectively. The Regional Plan of NCR (2004) describes Delhi as the largest development center in the Region as follows: "Delhi remains the largest growth center of the Region in terms of manufacturing, trading/commercial activities and hence there is higher concentration of employment. The number of workers in manufacturing (both household and other than household) in 1991 was 7.31 lakhs constituting about 52% of the manufacturing in the Region. Similarly the workforce engaged in trade and commerce works out to 7.10 lakhs accounting for as high as 62% of the overall trade and commerce in the Region. Delhi's construction activity is considerably high (2.32 lakhs) constituting nearly 65% of the overall construction force in the Region."

5.3.4: Trend of Distribution of Workforce in National Capital Region

This part examines the trend of the distribution of workers by sector in National Capital Region for three decades (1971-2001). The trend of workforce distribution can give certain information about those sectors which are declining or increasing through time

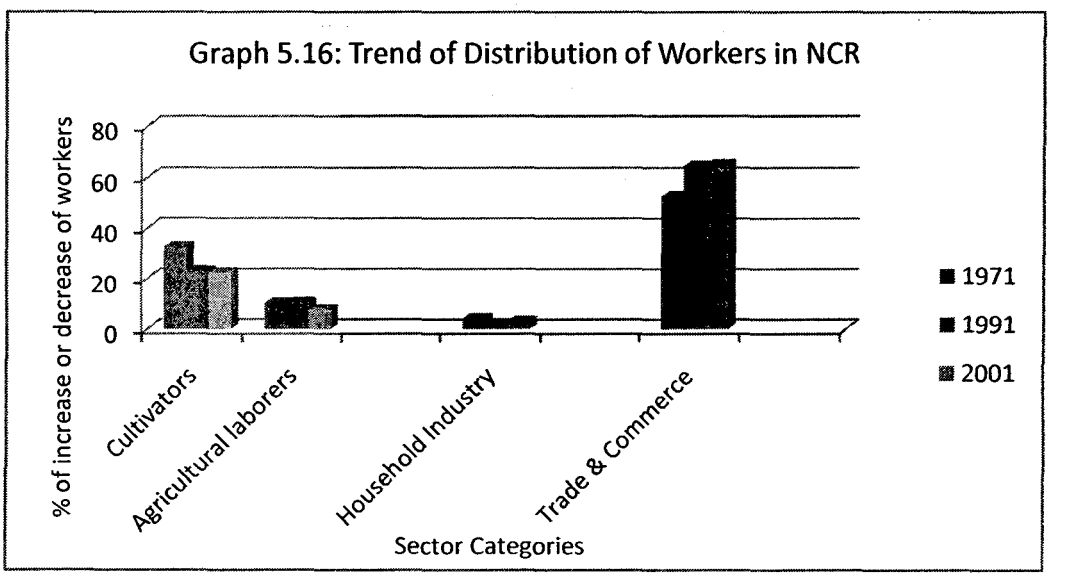
and their implication to bring about integrated development in the Region. Table 5.22 overlooks the trend of workforce distribution in NCR.

Table 5.22: Trend of distribution of workforce in NCR

years	Culti.		Agri. laborers		H.H. Indust.		Trade, Comm. And Others		NCR T Workers	
	Workers	%	Workers	%	Workers	%	Workers	%	workers	%
1971	1270942	32.66	401725	10.32	166572	4.28	2051693	52.73	3890932	100
1991	1790347	23.16	821188	10.62	128661	1.66	4991493	64.55	7731689	100
2001	2970780	22.47	1024627	7.75	426267	3.23	8599267	65.05	13218840	100

Source: Census of India, 1971, 1991, and 2001.

Table 5.22 indicates that there exists a decreasing trend in both cultivators (32.66% to 22.47%), agricultural laborers (10.32% to 7.75%), and household industry (4.28% to 3.23%) through out the three successive decades. However; trade, commerce and others have shown higher increasing trend (52.73% to 65.05%) within the referenced decades (see graph 5.16 below).



5.4: Land Utilization in National Capital Region

5.4.1: Land Use Policy Directions in National Capital Region

The Regional Plan indicates that land use and land allocation policy directions are as per the Regional Plan. The sub-regions; in their Sub-regional Plans and Master Plans, prepare the specific and detailed land use directives. This is clearly stated in RP-2021 as "the detailed specific reservations of areas for various land uses of sub-regional and urban importance will be detailed out in the sub-regional plans and Master Plans which are to be prepared by the respective participating states, within the overall framework of the Regional Plan."

5.4.2 Regional Land Use Legal Status

The Regional Plan (2004) makes clear that the Regional Plan 2001 of NCR was prepared through active participation of all concerned stakeholders and approved on November3, 1988; and enacted from January 23, 1989.

The implementation of the Regional Plan policies is being undertaken by the concerned central ministries and participating state governments through their various departments.

5.4.3 Land Utilization in National Capital Region

As per the Census of India (2001), the land area (ha) in the National Capital Region is classified into five categories known as the five-fold land utilization classification. These categories include: (i) forest area, (ii) total irrigable area, (iii) un-irrigable area, (iv) cultivable waste, and (v) area not available for cultivation (non-agricultural use). Except for the NCT-Delhi, land areas are aggregated to their district level so as to make the data more manageable. Land utilization in the National Capital Region is presented by table 5.23 as follows.

Table 5.23: Land utilization in National Capital Region (ha), 2001

District/ S.R	Total Area (ha)	Forest Land		Total Irrigable.		Un-irrigable.		Culti'le Waste		Non-agri'l use	
		Area	%	Area	%	Area	%	Area	%	Area	%
NCT-Delhi	147488	1181	0.8	34034	23.07	11544	7.82	10720	7.27	89689	60.81
Panipat	120850	2300	1.9	98793	81.75	1997	1.65	3626	3.0	18474	15.28
Sonipat	209844	1600	0.76	157908	75.25	13750	6.55	8664	4.13	26547	12.65
Rohtak	163664	2300	1.4	123422	75.41	20200	12.34	3775	2.3	15956	9.75
Jhajjar	185118	2700	1.45	119931	64.78	37425	20.21	4688	2.53	18942	10.23
Rewari	149503	4600	3.07	100549	67.25	22154	14.81	1893	12.66	19557	13.08
Gurgaon	264628	20500	7.74	130878	49.45	71091	26.86	6740	2.54	50166	18.95
Faridabad	188479	7900	4.19	143150	75.95	13766	7.30	6891	3.65	21224	11.26
Meerut	238439	4854	2.03	183230	76.84	7713	3.23	8820	3.69	23772	9.97
Ghaziabad	176992	18749	10.6	126346	71.38	11327	6.39	6228	3.51	17668	9.98
Baghpat	116450	3429	2.94	94784	81.39	5619	4.82	4174	3.58	16426	14.10
Bulandshahr	283379	16225	5.72	219330	77.39	10768	3.79	10139	3.57	26917	9.49
Gautam B.N	122168	4714	3.85	89783	73.49	3042	2.49	7481	6.12	14863	12.16
Alwar	861340	122072	14.27	333999	38.77	187004	21.71	51690	6.00	117307	13.62
NCR	3228342	213124	6.6	2043371	63.29	417400	12.92	135529	4.19	477508	14.79

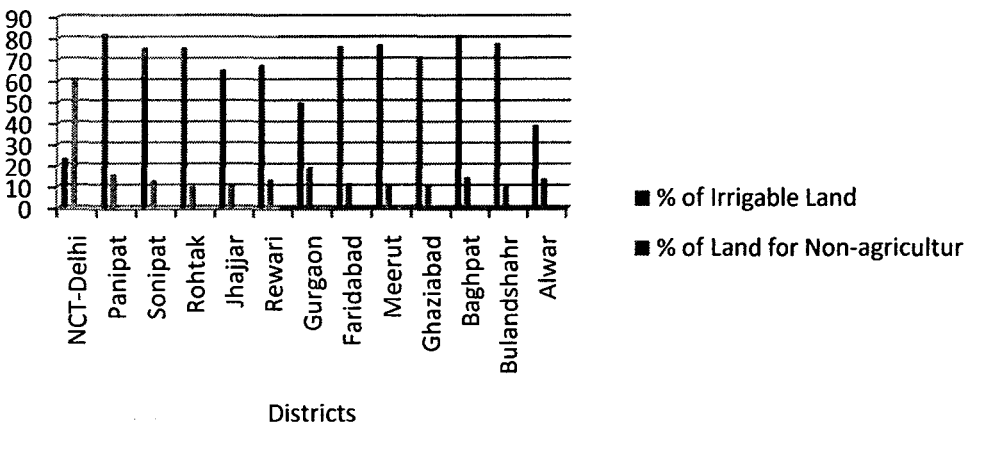
Source: Census of India 2001.

The percentage of NCR non-agricultural area in the census year 2001 is 14.79% (see table23). At the same time, the non-agricultural area in the NCT-Delhi is 60.81% witnessing high rate of urbanization in the National Capital Territory of Delhi. Among the NCR districts, Gurgaon (18.95%), and Panipat (15.28%) have percentage of non-agricultural area above the NCR average. Districts Baghpat (14.10), Alwar (13.62%), and Rewari (13.0-8%) also have built-up area just close to the NCR average. However;

districts Bulandshahr (9.49%), and Rohtak (9.75%) have lowest non-agricultural area indicating slow rate of urbanization.

The percentage of irrigable area of the National Capital Region is 63.29%. The districts Panipat (81.75%) and Baghpat (81.39%) have the highest percentage of irrigable areas above the average NCR. The unique characteristic feature of these districts is that they also have high built-up (non-agricultural) areas which reflect that they enjoy useful land area for both building and agriculture. The NCT-Delhi (23.07%), Alwar (38%), Gurgaon (49.45%) have lowest irrigable area below the NCR average. Graph 5.17 gives further useful information on percentage of irrigable and non-agricultural land areas.

Graph 5.17: Land Utilization in NCR (ha) (2001)



Note that the total area of the National Capital Region shows certain reduction which might be resulted from missing in enumeration during the Census year 2001.

Correlation Test: Land Use Intensity (Density) and Distance from City-center

It has been attempted to find out whether there exists a direct relationship between land use intensity and distance variables. Distances are measured in kilometers from city-center (Delhi) to district headquarters while land use data for each district and the NCT-Delhi are aggregated from Census of India 2001. For NCT-Delhi, half of its radius is taken as an average distance. The term **land use intensity** refers to the concentration of

activity on a property. However; according to **Native Language: English-Ireland** (2005) "land use intensity does not have a single precise definition. In agricultural contexts, it may relate to the number of crops (or livestock) raised on the land in a period; in a populated area it may relate to housing density or planned population density."Here; the researcher is only intended (interested) to assess the existing population concentration per hectare (density) on particular locations. In this case, the term land use intensity is to mean population density causing intensive land use.

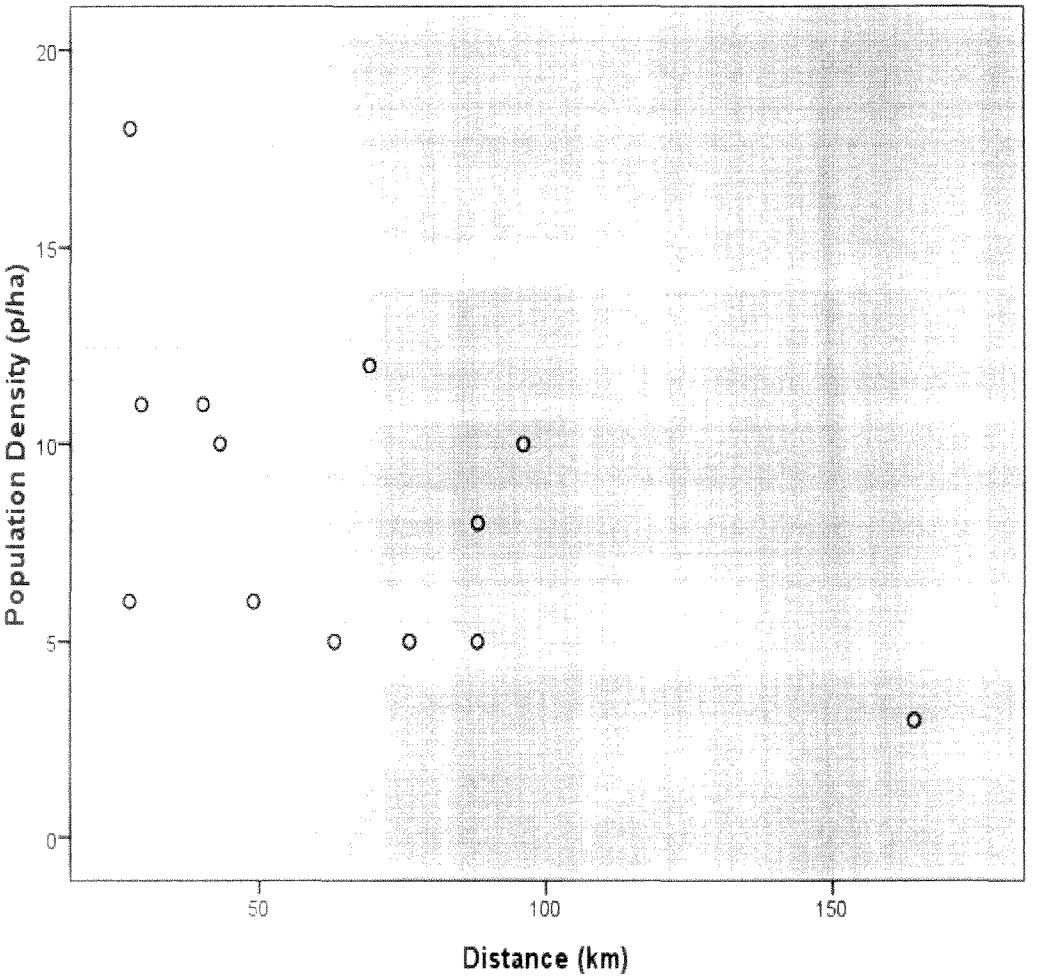
Karl Pearson's Product Moment Correlation Coefficient is used to compute the correlation between the two variables.

Table 5.24: Correlation between density and distance from city-center

S.No	Districts/Sub-region	Distance(km) (x)	Population Density/ha (y)
1	NCT-Delhi	12	93
2	Gurgaon	27	6
3	Ghaziabad	27	18
4	Faridabad	29	11
5	Baghpat	40	11
6	Gautam Buddha N.	43	10
7	Sonipat	49	6
8	Jhajjar	63	5
9	Meerut	69	12
10	Rohtak	76	5
11	Panipat	88	8
12	Rewari	88	5
13	Bulandshahr	96	10
14	Alwar	164	3

Source: Compiled from Census of India, 2001

5.1 Scatter plot showing distance and population density variables



Correlations between distance from city-center and population density in NCR

		Distance (km)	Population Density (p/ha)
Distance (km)	Pearson Correlation	1	-.546
	Sig. (2-tailed)		.054
	N	13	13
Population Density (p/ha)	Pearson Correlation	-.546	1
	Sig. (2-tailed)	.054	
	N	13	13

The tabulated value of t for 11(13-2) degree of freedom is 3.11 at 1%, 2.20 at 5% and 1.80 at 10% levels of significance. The computed value (2.1615) of t (significance test of correlation coefficient) is greater than the 10% tabulated value of t. Hence; the correlation coefficient is significant at 10% level. Note that is an out layer and not considered in the computation.

The computed result shows that there exists inverse relationship between land use intensity expressed in population density and the distance from city-center to the periphery. The result indicates as distance from city-center toward the periphery increases the strength of land use intensity declines.

5.4.4 Land Use Change in National Capital Region

The major reasons for the rapid land use changes in NCR belong to the rapid urban population growth in the NCT-Delhi and other NCR towns that caused the need for planned sustainable development. These resulted in the emergence and implementation of the NCR Plan with the aim of decongesting Delhi and developing the neighboring towns through relocating major economic activities such as industries and infrastructure development. In addition to the relocation of economic activities, the provision of cheap land enhanced the growth of real estates and dispersal of urban settl centers. This relocation of economic activities, dispersal of settlements and spatial expansion of urban centers brought about significant land use/ land cover changes in NCR. The extent of land use change in the Region is given by table 5.25 below.

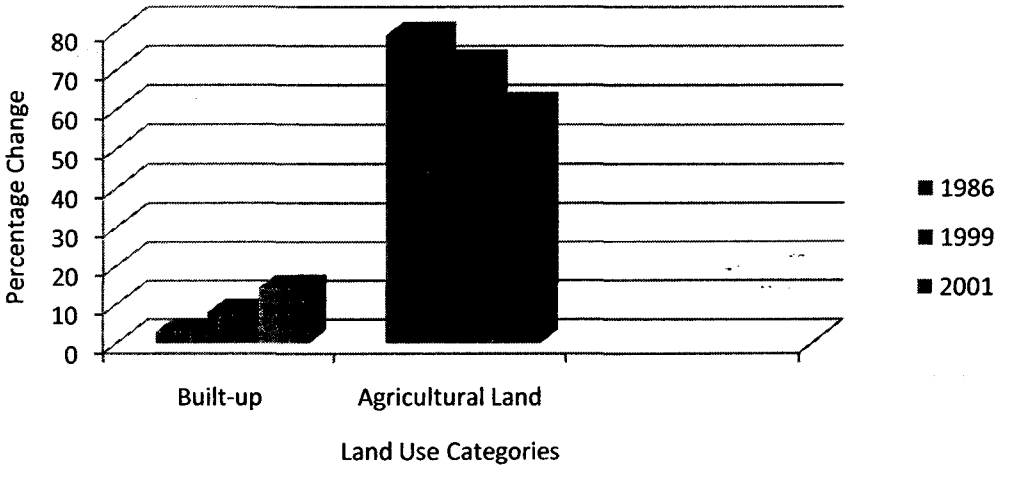
Table 5.25: Land use change in National Capital Region (in hectares)

year	Built-up		Agricult.		Forest		WasteL.		Water		Other		Total	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
1986	98794	2.94	2650585	78.94	77512	2.31	185886	5.53	3235	0.09	341788	10.18	3357800	100
1999	263500	7.85	2404964	71.62	121435	3.61	200535	5.97	24217	0.72	343149	10.22	3357800	100
2001	477508	14.22	2043371	60.85	213124	6.35	135529	4.04	24217	0.72	464051	13.82	3357800	100

Source: Regional Plan 2021, 2004, and Census of India, 2001.

Referring to table 5.25, the built-up area of NCR had grown from 2.94% to 7.85% in the years 1986-1999. This indicates that the growth in 13 years was 4.91%. However; within the years 1999-2001, the built-up area had rapidly grown from 7.85% to 14.22% which is about to double within two years. On the other hand; agricultural land use declined from 78.94% (in1986) to 71.62% (in1999). This sector had; further, sharply declined from 71.62% (in1999) to 60.85% (in2001). Other land use categories such as forests increased from 2.31% (1986) to 6.35 % (in2001), while waste land decreased from 5.53% (in1986) to 4.04% (in2001). An interesting picture of land use change is presented by graph 5.18 below.

Graph 5.18: Percentage of Land Use Change in NCR, 1986-2001 (ha)



The population of NCR had increased by about 10 million within one decade (1991-2001). This gives certain insight on how land use changes inline with population growth. As population grows rapidly, land resource becomes more and more scarce. It is possible to see how land per capita decreases with population growth in the following three consecutive decades.

Table 5.26: Land per capita in National Capital Region (ha)

Sub-region	Total Area	Total Population			Land per capita		
		1981	1991	2001	1981	1991	2001
NCT-Delhi	148300	6220406	9420644	13850507	0.024	0.016	0.014
Haryana	1341300	4938541	6643604	8689268	0.276	0.202	0.154
Rajasthan	782900	1755575	2296580	2990862	0.446	0.341	0.262
UP	1085300	6968646	9001704	11570117	0.156	0.121	0.094
NCR	3357800	19883168	27362532	37032000	0.169	0.123	0.091

Source: Compiled from Census of India, 2001.

Table 5.26 indicates that the rate of change of land per capita is highest in the NCT-Delhi where there is high population growth rate. The land per capita in Delhi had decreased from 0.024 ha or 240m^2 (1981) to 0.016 ha or 160m^2 (1991) and then to 0.014 ha or 140m^2 (2001). The trend is the same in the other three NCR sub-regions. The changes in the four sub-regions changed NCR land per capita from 0.169 ha or 1,690m^2 (1981) to 0.123 ha or 1,230m^2 (1991) and then to 0.091 ha or 910m^2 (2001).

Correlation Test: Land Use Change and Distance from City-center

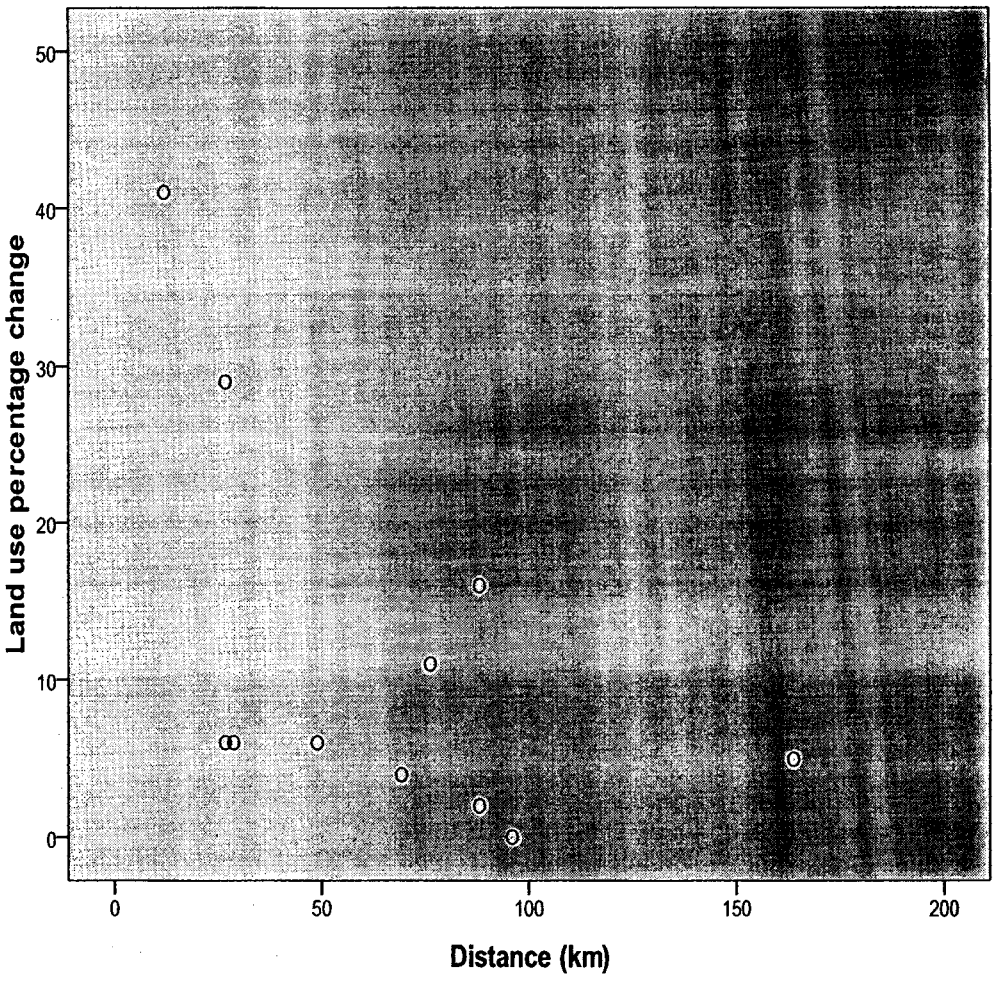
Karl Pearson's Product Moment Correlation Coefficient (through the application of SPSS statistical data editor) is used to prove whether there exists a direct relationship between the percentage change of agricultural land into non-agricultural within the time period of 1991-2001 and distance variables. Distances are measured in km from city-center (Delhi) to district headquarters of the National Capital Region.

Table 5.27: Correlation between percentage of land use change in NCR and distance from city-center to district headquarters

S.No	Districts/Sub-region	Distance(km) (x)	Land Use %age Change (y)
1	NCT-Delhi	12	41
2	Gurgaon	27	29
3	Ghaziabad	27	6
4	Faridabad	29	6
5	Sonipat	49	6
6	Meerut	69	4
7	Rohtak	76	11
8	Panipat	88	2
9	Rewari	88	16
10	Bulandshahr	96	0
11	Alwar	164	5

Source: Compiled from Census of India, 2001

5.2 Scatter plot showing distance and land use percentage change variables



Correlations between distance from city-center and land use percentage change in NCR

		Distance (km)	Land use percentage change
Distance (km)	Pearson Correlation	1	-.519
	Sig. (2-tailed)		.102
	N	11	11
Land use percentage change	Pearson Correlation	-.519	1
	Sig. (2-tailed)	.102	
	N	11	11

The tabulated value of **t** for 9(11-2) degree of freedom is 3.25 at 1%, 2.26 at 5% and 1.83 at 10% levels of significance. The computed value (1.8215) of **t** (significance test of correlation coefficient) is less than even the 10% tabulated value of **t**. Hence; the correlation coefficient may be considered as insignificant.

The computed result shows that there exists inverse relationship between the percentage change of agricultural land into non-agricultural uses and the distance from city-center to the periphery. The result implies that as distance from city-center toward the periphery increases the percentage change of agricultural land into non-agricultural uses declines.

5.5 Infrastructure Provision in National Capital Region

5.5.1 Physical Infrastructure

The infrastructure sector in National Capital Region can be categorized under two major categories namely as physical and social sections. The physical infrastructure includes transport facilities, power (energy) supply, and telecommunication facility. On the other hand; the social infrastructure considers the provision of health and education services.

5.5.1.1 Transport Facilities in the National Capital Region

The Functional Plan on Transport prepared and approved by the NCR Planning Board in 1996 suggested construction of road and rail linkages along the high-density routes, in and around the Capital and also in the National Capital Region (RP-2021, 2004). The total length of roads, road length by area and population of the four NCR sub-regions up to the year 2001 are presented by table 5.28 below.

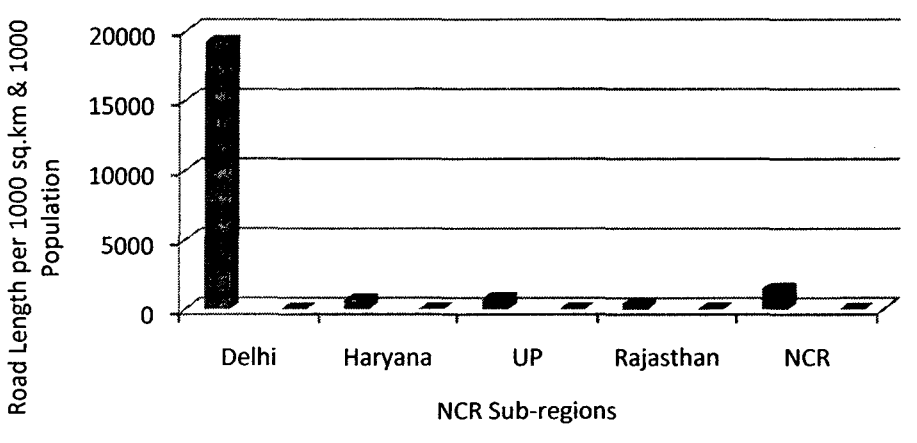
Table 5.28: Road transport by area and population in NCR

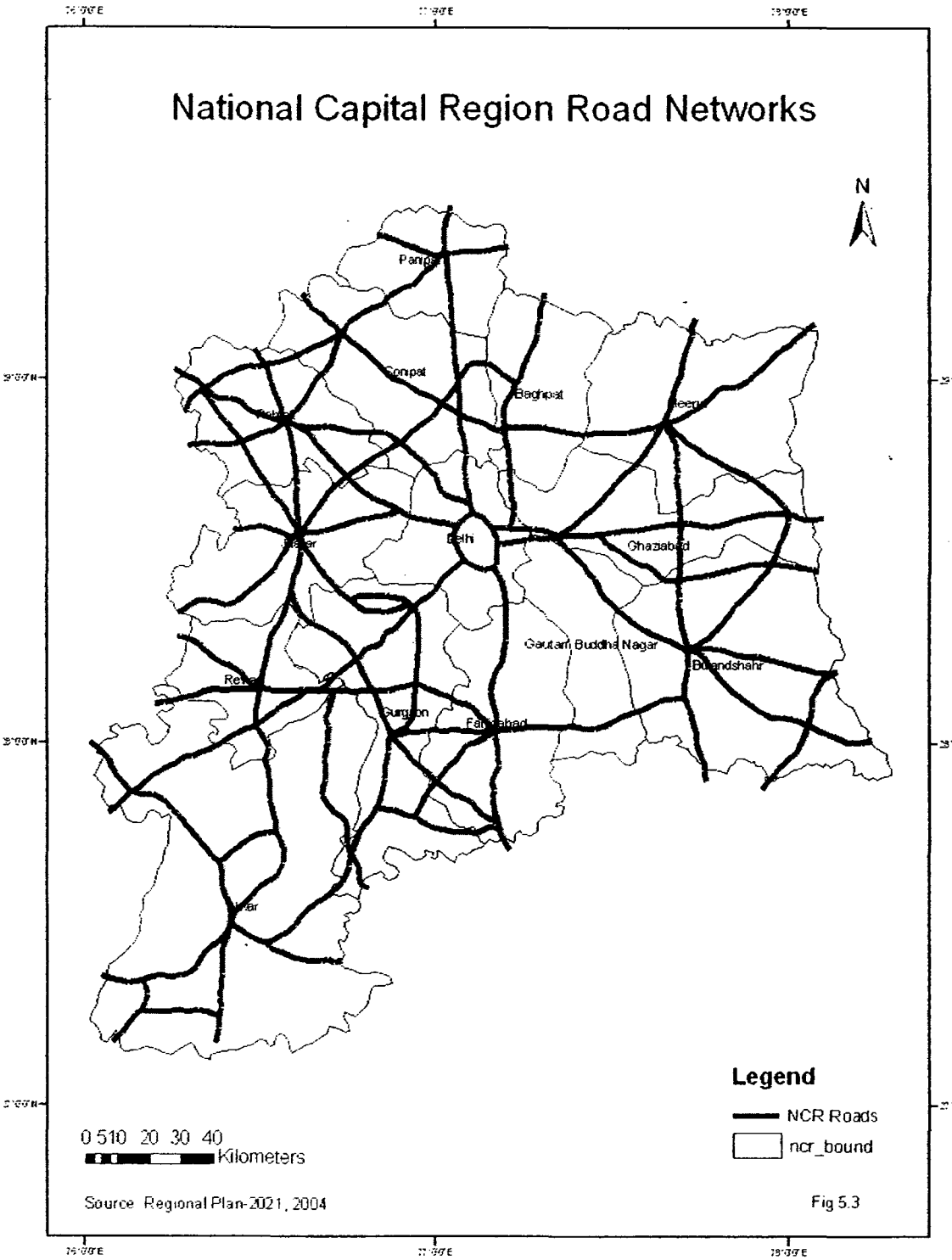
Sub-region	Total road length (km)	Road length per 1000 km^2	Road length (km) per 1000 population	Road length (km) per 1000 vehicles
Delhi	28508	19223	2.06	8.24
Haryana	8957	668	1.40	-
UP	8454	779	1.38	-
Rajasthan	3511	419	1.17	-
NCR	49430	1472	1.33	-

Source: Census of India, 2001, Planning Department of UP, Geography of Haryana, Government of Rajasthan, and Economic Survey of Delhi, 2001.

With 28,508 km total length of road, 19,223 length of road per 1000km^2, and 2.06 km road length per 1000 population; Delhi ranked first in transport service provision among the NCR sub-regions (see table 5.28). Haryana Sub-region followed Delhi with 8,957 km total length of road, and 1.4 km road length per 1000 population. The National Capital Region has a total length of road 49,430 km, 1,472 km length of road per 1000 km^2, and 1.33 km road length per 1000 population. The NCR Plan (2004) indicates how these road facilities are spatially organized and operate throughout the National Capital Region as follows. Graph 5.19 presents road transport by area and population.

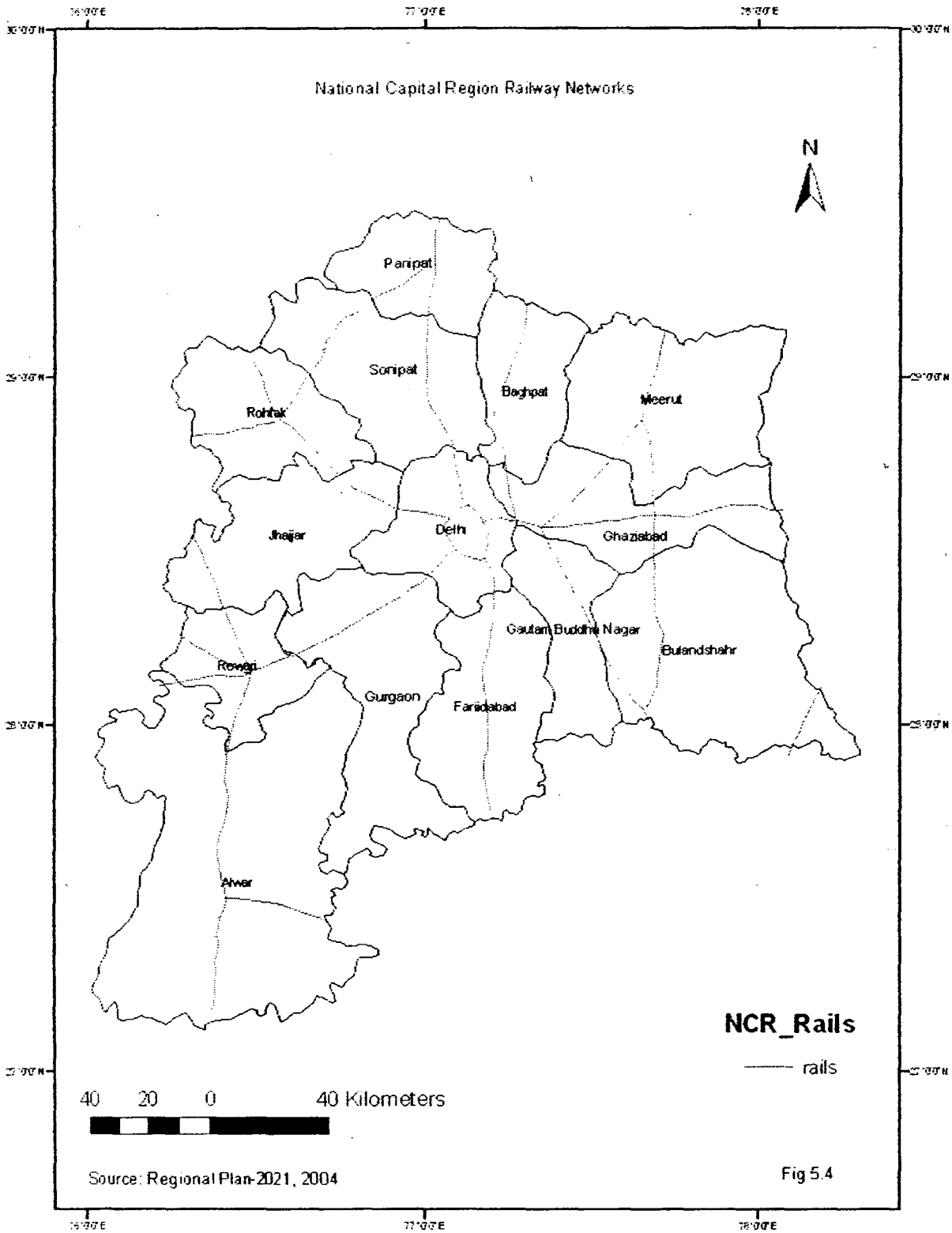
Graph 5.19: Road Transport by Area and Population in NCR




National Capital Region Road Networks
N
Panipat
Sonipat
Baghpat
Meerut
Delhi
Ghaziabad
Gautam Buddha Nagar
Bulandshahr
Gurgaon
Faridabad
Legend
NCR Roads
ncr_bound
0 5 10 20 30 40
Kilometers
Source Regional Plan-2021, 2004
Fig 5.3

The, "existing road network in the region shows convergence of five National Highways i.e., NH-1, 2, 8, 10 &24 on Delhi and two National Highways namely NH 58 and NH 91 meet NH 24 at Ghaziabad. These National Highways have four lane divided carriageways on most stretches of NCR except Delhi-Rohtak (NH 10), Ghaziabad-Meerut (NH 58) and Ghaziabad-Bulandshahr (NH 91) which have two lanes. In addition to this, NH 71 and NH 71A also pass through the Region. Other State Highways also serve in strengthening the regional road network."

The Regional Plan suggests that the development of road network alone will not be able to meet the transport demand in the National Capital region. Therefore; it is necessary to develop the railway network of the Region to overcome the gap between demand and supply.


National Capital Region Railway Networks
N
Panipat
Sonipat
Baghpat
Meerut
Rohtak
Jhajjar
Delhi
Ghaziabad
Gautam Buddha Nagar
Bulandshahr
Rewari
Gurgaon
Faridabad
Alwar
NCR_Rails
rails
40 20 0 40 Kilometers
Source: Regional Plan-2021, 2004
Fig 5.4

The system of the networks is designed in an integrated manner as: (i) Rapid-Regional Rail Network which connect the regional towns among each other and with Delhi; (ii) Regional Rail Network that could be extended to the sub-regional centers to serve as feeder system to the Rapid-Regional Rail Network and accelerate development process in the Region; and, (iii) Orbital Rail Corridor connecting to radial rail corridor of Indian Railway.

The National Capital Territory of Delhi is a focal point where trips start and radiate to all directions of the NCR. Table 5.28 illustrates that the density of the transport networks decreases as one moves from the core to the periphery. The trend of network development in this Sub-region is presented in table 5.29 as follows.

Table 5.29: Trend of road development by area and population in Delhi (1995-2001)

Years	Total length of road (km)	Average length of road per 1000 km^2	Road length per 1000 population	Road length per 1000 vehicles
1995-96	25,948	17497	2.21	9.87
1996-97	25,949	17497	2.19	9.11
1997-98	26,323	17750	2.14	8.67
1998-99	26,698	18002	2.09	8.31
1999-00	26,730	18024	2.01	7.97
2000-01	28,508	19223	2.06	8.24

Source: Economic Survey of Delhi, 2002, Government of the NCT of Delhi.

Table 5.29 reminds that there is an increasing trend in the total length of roads in NCT-Delhi. Similarly; there is an increase in the average length of road per 1000 km^2. The road length per 1000 population and the road length per 1000 vehicles; however, show a slight declining trend except in the year 2000-01.

5.5.1.2 Power Supply

Supply of power infrastructure is one of the key factors to ensure an integrated and sustainable development in a country or a region. This is because; the role of energy in any aspect of an economy is indispensable. Concerning to this; UNDP (2010) put forward a statement like "Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development--- social, economic, and environmental --- including livelihoods access to water, agricultural productivity, health, population levels, education, and gender-related issues."In this part, it is attempted to assess the status of power provision in the National Capital Region using sub-region wise energy received and peak load in table 5.30 below.

Table 5.30: Sub-region wise energy received and peak load in NCR

Sub-regions	Energy received (Mkwh)			Peak Load (MW)		
	1988-99	1990-00	2000-01	1998-99	1999-00	2000-01
Delhi	16257	17452	18432	2484	2930	3094
Haryana	6153	6609	6983	1154	1103	1143
Rajasthan	1199	1072	1072	365	361	326
UP	5462	5323	5323	1406	1480	1595
Total NCR	29071	30635	31810	5410	5874	6158

Source: Central Electricity Authority (PB-2021, 2004).

The data in table 5.30 are taken from the Regional Plan (2004). It presents the existing energy received and peak demand in NCR. These data indicate the available energy requirements and peak loads and also reminds that power shortages could be one of the major constraints in the process of planned development and growth of economic activities in the National Capital Region.

5.5.1.3 Telecommunication Facility

Telecommunication facility is another major type of physical infrastructure that plays a key role in enhancing sustainable and integrated regional economic, social and environmental development. It also contributes a vital role to improve overall economic growth and quality service provision such as education and health care services. Access to telephone facility promotes collaborative work in business activities, sharing information, and scientific studies. It is attempted to assess the level of this key infrastructure in the National Capital Region. Table 5.31 helps understand the status of switch capacity in NCR.

Table 5.31: Status of switch capacity in the National Capital Region

S. No	Categories	Status		Percentage Increase
		2001	2003	
1	Switch Capacity	995,248	1,411,650	41.84
2	Direct Extension Lines (DEL)	846,628	1,888,067	123.01
3	Waiting List	34,912	10,411	-70.18

Source: Ministry of Telecommunication, 2003 (PB-2021, 2004).

Table 5.31 reveals that remarkable progresses had been made within two years (2001-02 and 2002-03) in improving the switch capacity by 41.84% and the direct extension lines (DELs) by 123.01% and reducing the waiting list by 70.18% respectively. Concerning to these progresses, the Regional Plan (2004) accounts the following statements. "As per the status provided by the Ministry of Telecommunication, the switch capacity in NCR has increased from 995,248 in 2001 to 1,411,650 in 2003. Similarly, the capacity of Direct Extension Lines (DELs) has increased from 846,628 to 1,888,067 and Wait List (WL) has reduced from 34912 to 10411 during the same period."

It might be interesting to see the spatial distribution of the Switch Capacity and the Direct Extension Lines (DELs) among the towns of the National Capital Region. These include the towns of Delhi Metropolitan Area (DMA) and the NCR Priority towns. Table 5.32 presents how the Switch Capacity and DELs are spatially distributed in the Region.

Table 5.32: Status of DELs, Switch Capacity and Waiting List for NCR Towns

Name of NCR Towns	Telecom Circle	Switch Capacity		DELs		Waiting List	
		2001	2003	2001	2003	2001	2003
DMA Towns							
Faridabad	Haryana	84630	113500	76462	87019	6790	434
Ballabgarh	Haryana	18500	23000	16814	17912	927	0
Bahadurgarh	Haryana	14500	26300	11030	15141	861	268
Gurgaon	Haryana	101300	137800	81531	90142	4423	1133
Kundi	Haryana	2500	6600	2132	3010	225	0
Ghaziabad	UP	118500	164000	104632	120060	4351	657
Noida	UP	95256	125756	81900	933441	350	501
Loni	UP	5500	12000	4568	9099	1472	190
Total	-	440686	608956	379191	1275824	19399	3183
Priority Towns							
Rohtak	Haryana	38006	57250	31271	38048	429	1107
Rewari	Haryana	10000	18600	9885	14874	2083	859
Palwal	Haryana	9000	13500	7899	10549	628	304
Panipat	Haryana	40900	59350	35840	47619	1029	158
Dharuhera	Haryana	1500	3800	1445	2558	421	170
Meerut	UP	94000	111000	79632	80887	2808	978
Bulandshahr	UP	17500	21500	12906	16332	2260	590
Khurja	UP	9000	11500	5282	8082	1820	558
Hapur	UP	16000	19100	13212	17587	1108	140
Alwar	Rajasthan	31000	37488	24917	32613	114	264

MIA-Alwar	Rajasthan	1400	1400	1204	1207	35	80
Bhiwadi	Rajasthan	6000	9600	4362	8196	233	57
Sonipat	Haryana	-	35868	-	28126	-	0
Total	-	274306	399956	227855	306678	12968	5265

Source: Ministry of Telecommunication, 2003 (PB-2021, 2004).

As per table 5.32; there is high concentration of Switch Capacity and DELs in Gurgaon, Ghaziabad, NOIDA, and Faridabad as they are NCR policy areas and cities with high population concentration. Similarly; Meerut has high concentration for it is a million city. These cities also have maximum number of residents in their waiting lists. However; the number of residents in the waiting list is dramatically reduced (in 2003) to a minimum number in both DMA and Priority towns of NCR.

5.5.2 Social Infrastructure in National Capital Region Sub-regions

The term social infrastructure mainly refers to the expansion of educational, health, law and order (administrative) and recreational facilities. This is because; the expansion of such infrastructure contributes a vital role to ensure an overall sustainable and integrated development. In this part, education, health, and administrative infrastructure provisions are given due emphasis for they are major factors in development processes.

5.5.2.1. Educational Infrastructure in National Capital Region

The development of education infrastructure is one of the determinant factors for sustainable and integrated development in a region or a country. Here, the writer is more interested to assess the distribution of educational infrastructure (facilities) in the National Capital Region which may have significant implication on urban per-urban interaction in the Region.

The data about educational infrastructure are compiled from Census of India, 2001. They include the different levels of educational institutions. These are expected give

adequate information about the existing gap between NCR sub-regions as well as among NCR districts given in table 5.33 below.

Table 5.33: Educational institutions by districts in NCR

District/Sub -Region	Primary schools	Middle schools	Secondary Schools	Sr. Sec. Schools	Higher Education	Technical Education
NCT-Delhi	2406	666	405	1141	114	35
Panipat	211	131	85	30	2	5
Sonipat	434	306	214	94	1	30
Rohtak	313	222	195	36	2	15
Jhajjar	326	201	126	44	3	3
Rewari	369	144	93	40	2	3
Gurgaon	775	248	146	47	1	5
Faridabad	423	202	121	51	1	8
Meerut	887	274	55	44	3	2
Ghaziabad	714	238	39	29	12	6
Baghpat	487	129	54	41	2	3
Bulandshahr	1348	284	93	69	20	10
Gautam.B.N.	460	115	40	30	6	5
Alwar	3885	0	0	356	39	9
NCR	13,038	3,160	1,666	2,052	208	139

Sources: Census of India, 2001 and Socio-economic profile of Delhi, Planning Department, Gov't of Delhi, 2001-02.

The writer considers the Regional (from Regional Plan 2001) standards to analyze the distribution of social infrastructure in the National Capital Region. As per table 5.33 above, in most cases, the Region didn't achieve the required norms. For example, NCR

has only satisfied the norm in the provision of primary schools which is one to 2,840, while the norm is one to 5,000. Considering from the sub-regions, the NCT-Delhi satisfied the requirements for the primary schools and the higher education respectively.

In addition to the distribution of educational facilities, the literacy rate of the Region is taken as a measure to assess the status of educational infrastructure in National Capital Region. The United Nations Educational, Scientific and Cultural Organization (UNESCO) defined literacy as the "ability to identify, understand, interpret, create, communicate, compute and use printed and written materials associated with varying contexts. Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and participate fully in their community and wider society." However; the Researcher has selected the definition of literacy (as a working definition) given by the Census of India, 1991 as follows. **Literacy Rate:** The total percentage of the population of an area at a particular time aged seven years or above who can read and write with understanding. Here the denominator is the population aged seven years or more." Accordingly, the district level literacy rate of the National Capital Region is given by table 5.34 below.

Table 5.34: Literacy rate by district in National Capital Region

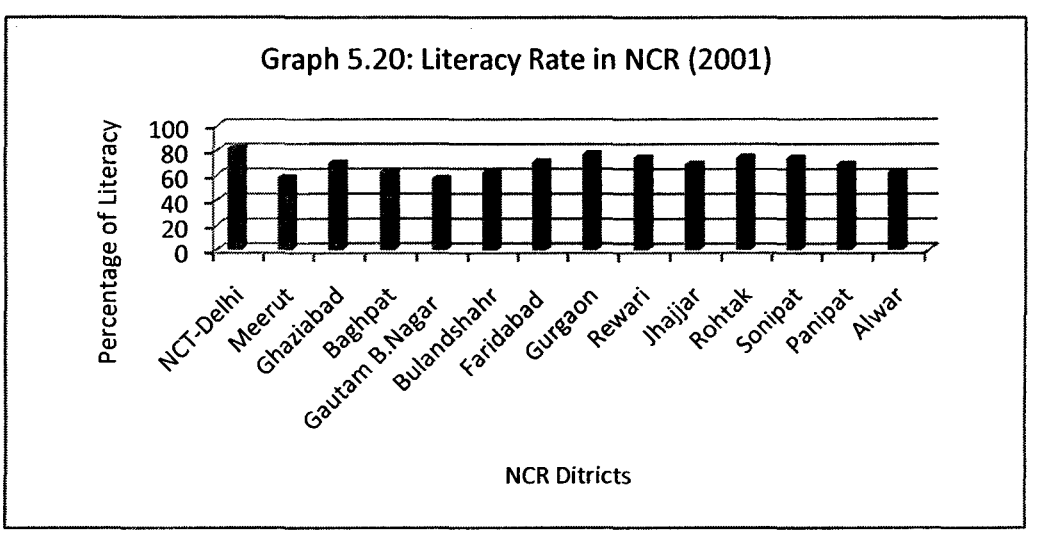
S. No	Sub-region	Districts	Literacy Rate (%)
1	Uttar Pradesh	Meerut	58.00
		Ghaziabad	69.70
		Baghpat	63.10
		Gautam Buddha Nagar	57.36
		Bulandshahr	63.00
2	Haryana	Faridabad	70.79
		Gurgaon	77.00
		Rewari	74.00
		Jhajjar	69.00

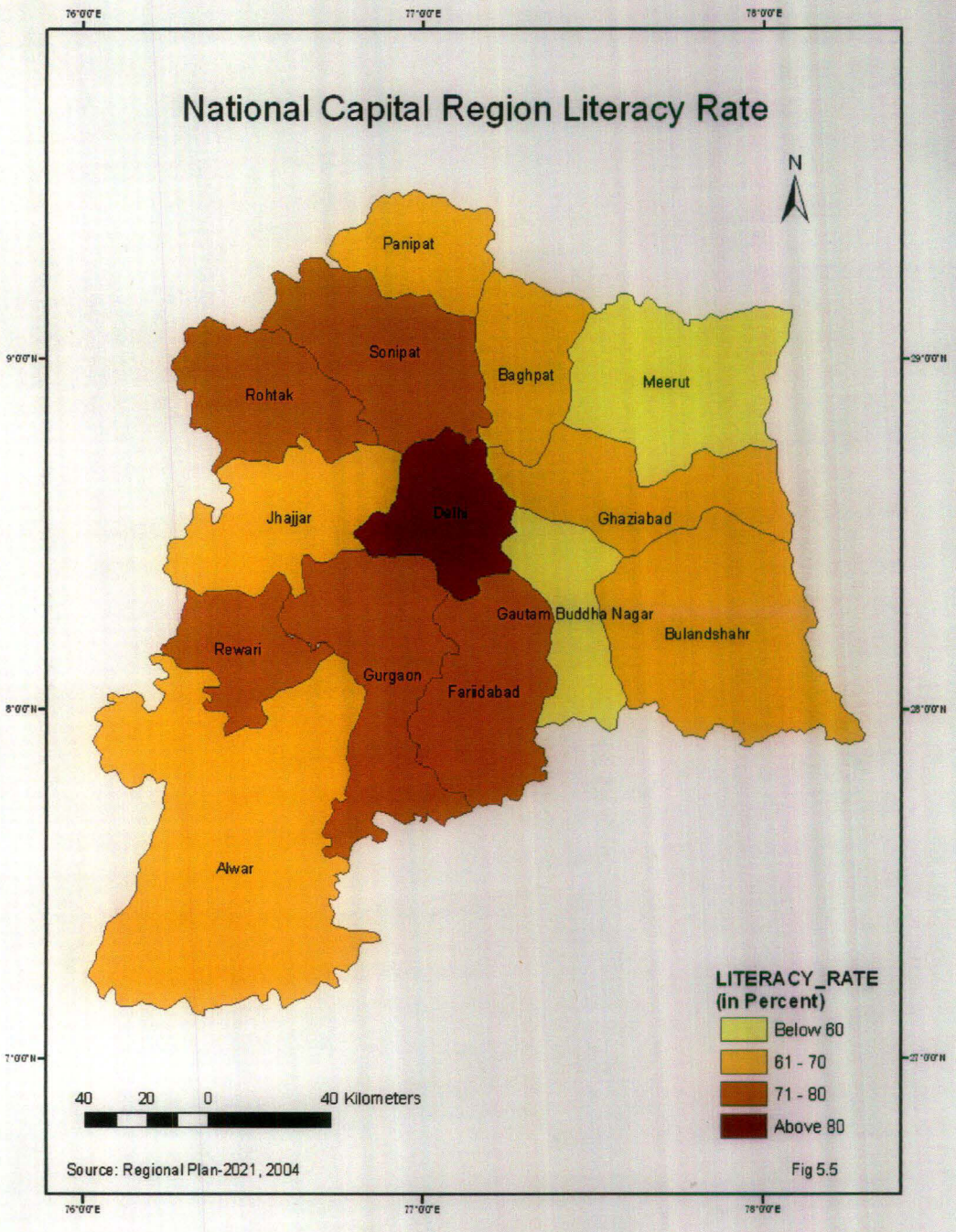
		Rohtak	74.56
		Sonipat	73.71
		Panipat	69.00
3	NCT-Delhi	North-west	80.57
		North	80.10
		North-East	77.53
		East	84.91
		New Delhi	83.24
		Central	79.69
		West	83.39
		South-West	83.61
		South	81.96
4	Rajasthan	Alwar	62.48

Source: Census of India, 2001.

There are significant differences in literacy rate in NCR districts ranging from 57.6% in Gautam Buddha Nagar in Uttar Pradesh to 84.91 in East District of NCT-Delhi (see table 5.34). District Meerut also has low literacy rate (58.0%). As per the Census of India 2001; the NCT-Delhi has the highest literacy rate (81.82%) in NCR followed by Haryana (67.91%); while Rajasthan (62.48%) and Uttar Pradesh (57.36%) remained lower (see graph 5.20 below).

Graph 5.20: Literacy Rate in NCR (2001)




National Capital Region Literacy Rate
N
Panipat
Sonipat
Baghpat
Meerut
Rohtak
Jhajjar
Delhi
Ghaziabad
Gautam Buddha Nagar
Bulandshahr
Rewari
Gurgaon
Faridabad
Alwar
LITERACY_RATE
(in Percent)
Below 60
61 - 70
71 - 80
Above 80
40 20 0 40 Kilometers
Source: Regional Plan-2021, 2004
Fig 5.5

5.5.2.2 Health Infrastructure in National Capital Region

Health infrastructure includes provision of all types of health care facilities such as health care institutions, adequate number of hospitals with adequate number of beds, sufficient number of primary health centers and sub-centers, and adequate number of medical colleges to satisfy the needs of the people. Here, the objective is to assess the status and the distribution of health care infrastructure in National Capital Region. The data about the health care infrastructure are compiled from Heath Information of India (2002) and from Socio-economic Profile of Delhi. Table 5.35 accounts about state level provision of health care infrastructure in NCR member (participating) states.

Table 5.35: Health infrastructure in National Capital Region

States	Allopathic hospitals	Allopathic Dispensaries	Primary Health Center	Sub-center	Community Health Center
NCT-Delhi	88	968	808	42	202
Haryana	79	133	399	2299	63
UP	735	1750	3761	20153	261
Rajasthan	113	268	1616	9400	261

Source: Health Information of India, 2002, Ministry of Health and Family Welfare.

Since data are compiled at state level, they might not reflect the exact situation in NCR. However; it is possible to give relevant assumptions based on the given state level data. Data in table 5.35 show that there is unequal distribution of health care infrastructure in NCR. From table 5.35 it is also possible to calculate the hospital-population ratio and compare with the norms stated in the Regional Plan (2004). Only NCT-Delhi can satisfy the norms or requirements (1:250,000) in distribution of hospitals. Others are below the norms when compared with their respective state total population.

The level of health care infrastructure in the Region can also indirectly be assessed by other indicators (measures) such as life expectancy at birth. Life Expectancy at birth is the expected number of years of life remaining at a given age. The Mosby's Medical

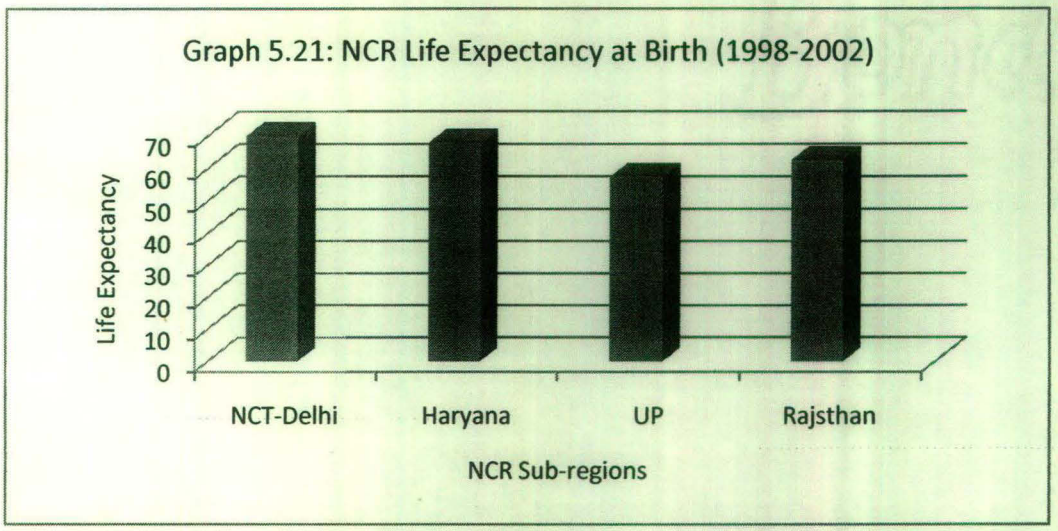
Dictionary (2009) has defined the term adequately as follows. "Life Expectancy: the probable number of years a person will live after a given age, as determined by mortality in a specific geographic area. It may be individually qualified by the person's condition or race, sex, age, or other demographic factors."

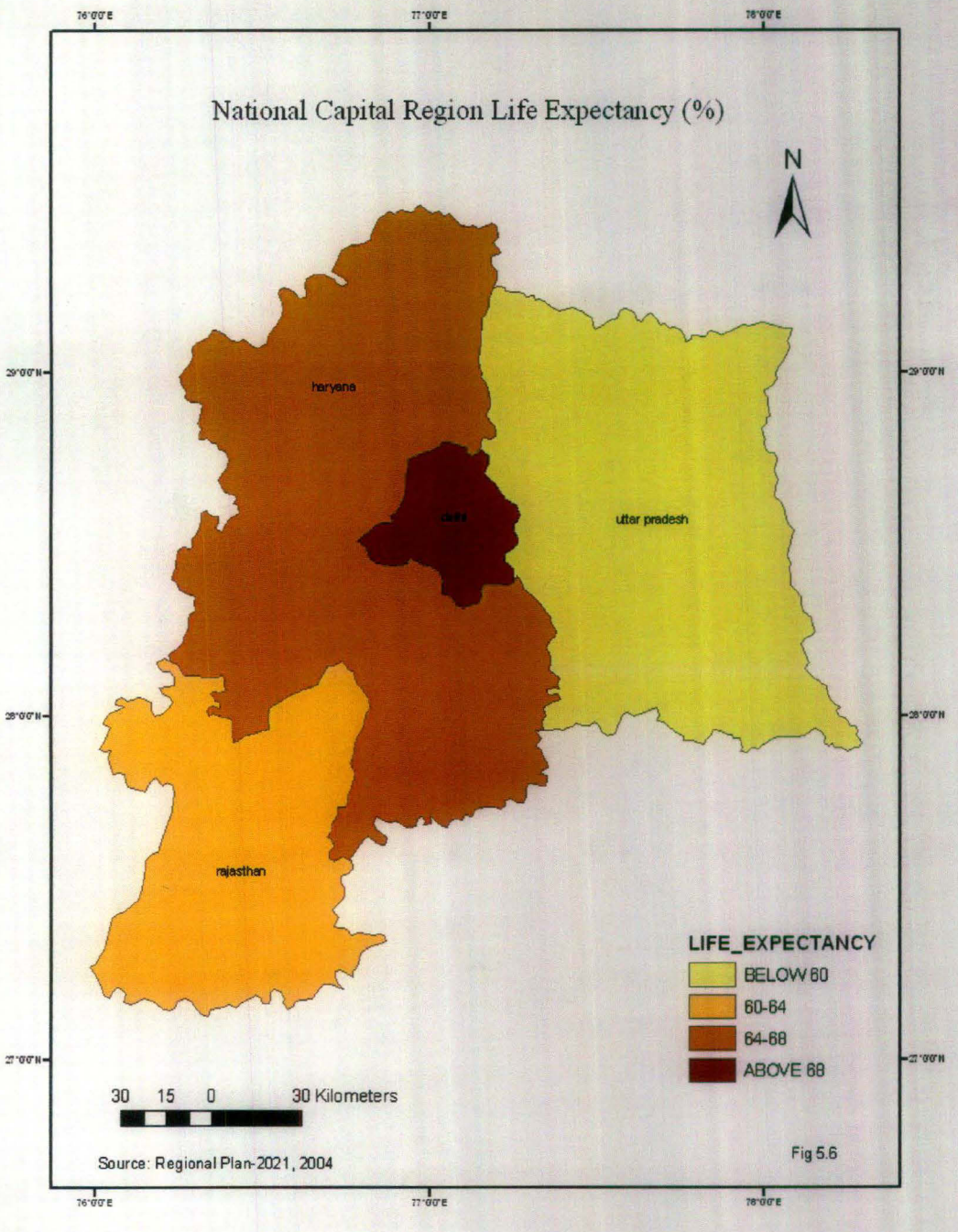
Table 5.36: NCR life expectancy at birth by sex (1998-2002)

S. No	NCR Sub-regions	Male	Female	Persons
1	NCT-Delhi Sub-region	-	-	69.9 (2006)
2	Haryana Sub-region	64.7	65.4	67.91
3	Uttar Pradesh S.R	59.4	58.5	58.40
4	Rajasthan Sub-region	60.5	61.6	60.50

Source: Health Information of India, 2005, Ministry of Health and Family Welfare, Registrar General of India, 2003.

It has been noted (in table 5.35) that Delhi has comparatively better health care infrastructure than the other participating states in NCR. These high provisions of medical facilities have made Delhi's life expectancy at birth 69.9 years respectively. The life expectancy at birth correlates with the per capita income of the sub-regions indicated in table 5.13. Tables 5.34 and 5.35 also reflect correlations (linkages) between health care infrastructure and life expectancy in the other sub-regions of the National Capital Region. These differences in life expectancy are reflected in graph 5.21 below.


Graph 5.21: NCR Life Expectancy at Birth (1998-2002)
Life Expectancy
70
60
50
40
30
20
10
0
NCT-Delhi
Haryana
UP
Rajsthan
NCR Sub-regions


National Capital Region Life Expectancy (%)
N
haryana
delhi
uttar pradesh
rajasthan
LIFE_EXPECTANCY
BELOW 60
60-64
64-68
ABOVE 68
30 15 0 30 Kilometers
Source: Regional Plan-2021, 2004
Fig 5.6

5.5.2.3 Administrative Service Provision in National Capital Region

The administrative structure refers to the different tiers of the Region or the participating states where the administrative bodies dispose their legal and regulatory services to the public. It is also a means where they maintain peace and order, deliver various types of social services, conduct electoral activities, and communicate with the people of the Region at large. Administrative structures vary from country to country. The administrative structure which is functional in the National Capital Region is provided by table 5.37 below.

Table 5.37: Administrative divisions in National Capital Region

Sub-region	Districts	Tahsils	M.Corp	M. Cl	M. Commit	M. Board	C. Towns	N. Panchayat	Villages
NCT-Delhi	9	27	3	1	-	-	59	-	165
Haryana	7	27	1	6	19	-	12	11	2488
UP	5	18	2	-	-	19	9	35	-
Rajasthan	1	12	-	1	-	-	3	5	1995
NCR	22	84	6	8	19	19	83	51	

Source: Census of India, 2001.

Table 5.37 reveals that the NCR sub-regions slightly vary in their administrative structures. In the National Capital Territory of Delhi; for example, municipal committee, municipal board, and Nagar Panchayat are not considered as tiers; while all except municipal board are considered as administrative tiers in Haryana Sub-region. Similarly; municipal council, municipal committee and villages are not taken as tiers in UP. Instead; the Nagar Panchayat is taken as the lowest tier. Furthermore; municipal committee and municipal board are not included in the administrative structure of Rajasthan Sub-region.

5.6 Provision of Basic Civic Amenities in National Capital Region

The public civic amenities could be various resources, facilities, services, benefits, etc. that are continuously provided to the public to be used with or with out charges. The Tenth Five Year Plan of India (2002-07) has briefly and clearly summarized what public civic amenities include as follows. "Services such as water supply and sanitation, roads and drains, street-lights, collection and disposal of solid waste, maintenance of public places, burial grounds and crematoria, cattle grounds, registration of births and deaths, maintenance of markets have long been seen as the functions of municipal bodies. In addition; they perform certain regulatory functions relating to construction of buildings, public health areas such as eating places, slaughter houses and tanneries, etc." There are also various amenities that peri-urban or rural authorities provide to the peri-urban or rural communities. The status of the provision of these public civic amenities in the National Capital Region is assessed separately in each sub-region in the following sub-sections.

5.6.1 Percentage Distribution of Amenities in Haryana Sub-region

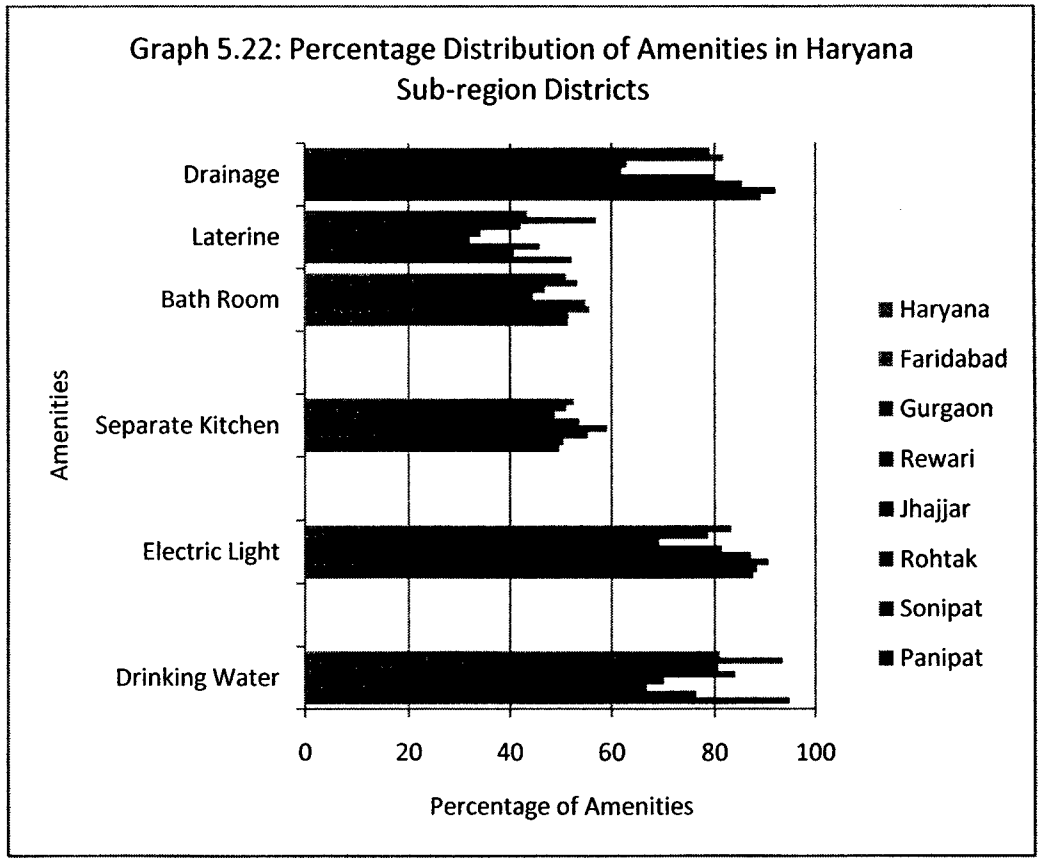
In all sub-regions limited and similar types of amenities such as supply of drinking water, electric light, availability of separate kitchen, bath room, latrine, and drainage are taken from Census of India (2001) to assess the level of provision of amenities. Percentages are used to indicate the level or coverage of each amenity in its respective sub-region. It might be time taking to make comparisons among sub-regions for the civic amenities under consideration presented in four separate tables; but, useful for adequate understandings. Table 5.38 below provides district level percentage distribution of the six types of amenities in Haryana Sub-region.

Table 5.38: District level percentage distribution of drinking water and other basic civic amenities in Haryana Sub-region.

Districts	Total number of Households	%age of Amenities					
		Drinking water	Electric light	Separate kitchen	Bath room	Latrine	Drainage
Panipat	159,684	94.89	87.64	49.79	51.52	52.22	89. 20
Sonipat	214,640	76.38	88.31	50.62	51.69	40.72	92.07
Rohtak	160,449	66.79	90.73	55.40	55.66	45.94	85.45
Jhajjar	144,355	70.08	87.15	59.13	54.92	31.96	79.84
Rewari	130,864	84.10	81.41	53.72	44.52	34.11	61.94
Gurgaon	263,751	80.70	69.17	48.95	46.97	42.13	62.98
Faridabad	366,715	93.50	78.77	51.21	53.37	57.08	81.76
Haryana	1,440,458	80.92	83.31	52.69	51.24	43.45	79.04

Source: Census of India, 2001.

Comparing the provision of each amenity (using table 5.38), supply of electric light (83.31%) and drinking water (80.92%); except Rohtak district, are relatively better than the others. However; there is low provision of bath room (52.69%), separate kitchen (51.24%), and latrine (43.45%) in the sub- region. A striking point here is that Gurgaon; which is member of Delhi Metropolitan Area (DMA), has very low or below average provisions of separate kitchen (48.95%), bath room (46.97%), and latrine (42.13%). Another point that may invite rise a question is about the data referring better provision (79.04%) of drainage facility while provision of kitchen, bath room and latrine remain very low. District-wise differences in provision of basic civic amenities in Haryana Sub-region are given in graph 5.22 below.



5.6.2 Percentage Distribution of Amenities in UP Sub-region

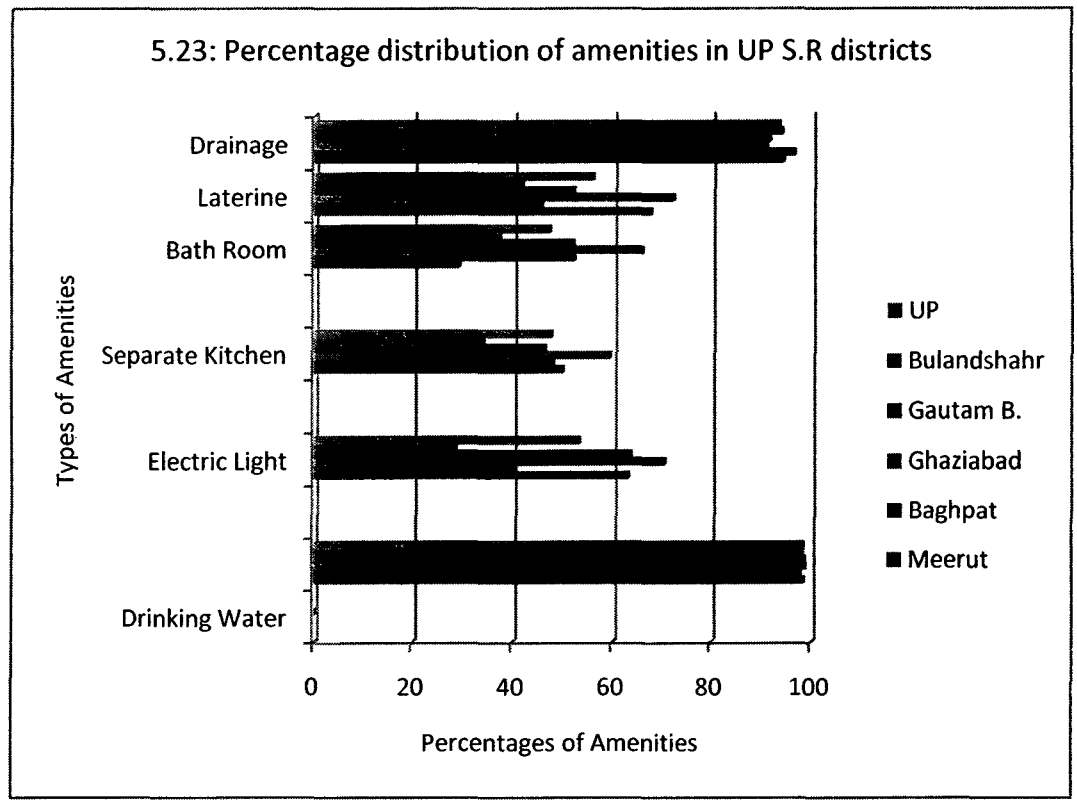
Similar to that of Haryana Sub-region, data for the six types of civic amenities are taken from Census of India, population provisionals (2001). These are helpful to understand the level of each amenity in UP Su-region and make comparisons among the districts. Later; these will be compared with the other sub-regions to determine the level of supply in the National Capital Region. The percentage distribution of amenities in UP Sub-region is given by table 5.39 as follows.

Table 5.39: District level percentage distribution of drinking water and other basic civic amenities in UP Sub-region

District	Total number of households	%age of amenities					
		Drinking water	Electric light	Separate kitchen	Bath room	latrine	Drainage
Meerut	447,747	98.52	63.18	50.01	29.35	67.76	94.38
Baghpat	173057	97.87	40.38	48.06	52.21	45.75	96.62
Ghaziabad	526,770	98.84	70.63	59.47	66.05	72.45	91.08
Gautam B.N	204,454	98.71	63.68	46.32	52.06	52.16	91.74
Bulandshahr	463,103	98.37	28.66	34.15	37.43	41.82	94.10
UP S.R	1,815,131	98.46	53.31	47.60	47.42	55.99	93.58

Source: Census of India, 2001.

Table 5.39 witnesses that Sub-region Uttar Pradesh has high achievement in drinking water supply with sub-region average of 98.46%. The sub-region average supply of street-light (53.31%), separate kitchen (47.60%), bath room (47.42%), and latrine (55.99%) are; however, very low. District Bulandshahr has the lowest supply in all electric light (28.66%), separate kitchen (34.15%), bath room (37.43%), and latrine (41.82%) followed by Baghpat with lower supply of electric light (40.38%), separate kitchen (48.08%), and latrine (45.75%) respectively. Meerut (million city) also has 29.35% supply of bath room. Graph 5.23 gives a clear picture about the status of the provision of civic amenities in UP Sub-region districts.



5.6.3 Percentage Distribution of Amenities in Rajasthan Sub-region

Rajasthan Sub-region has only one district. Hence; there is no inter-district comparison. However; in order to determine the level of provision of amenities in the Sub-region and to make comparisons with other sub-regions, data for the six types of amenities (drinking water, electric light, separate kitchen, bath room, latrine and drainage) are taken as it has been done in other sub-regions. The percentage distribution of basic civic amenities in Rajasthan Sub-region is presented in table 5.40 as follows.

Table 5.40: District level percentage distribution of drinking water and other basic civic amenities in Rajasthan sub-region

District	Total number of households	%age of amenities					
		Drinking water	Electric light	Separate kitchen	Bath room	latrine	Drainage
Alwar	461,080	64.77	52.36	71.13	23.90	19.75	37.75

Source: Census of India, 2001.

Provision of basic civic amenities in Rajasthan Sub-region is generally at its lowest level as compared to the other sub-regions of National Capital Region. Availability of bath room (23.90%), latrine (19.75%), and drainage facilities (37.75%) is by far below 50%. Although above 50%, the provision of drinking water (64.77%) and electric light (52.36%) is unsatisfactory. The only satisfactory one in the Sub-region is the availability of separate kitchen (71.13%).

5.6.4 Percentage Distribution of Amenities in NCT-Delhi Sub-region

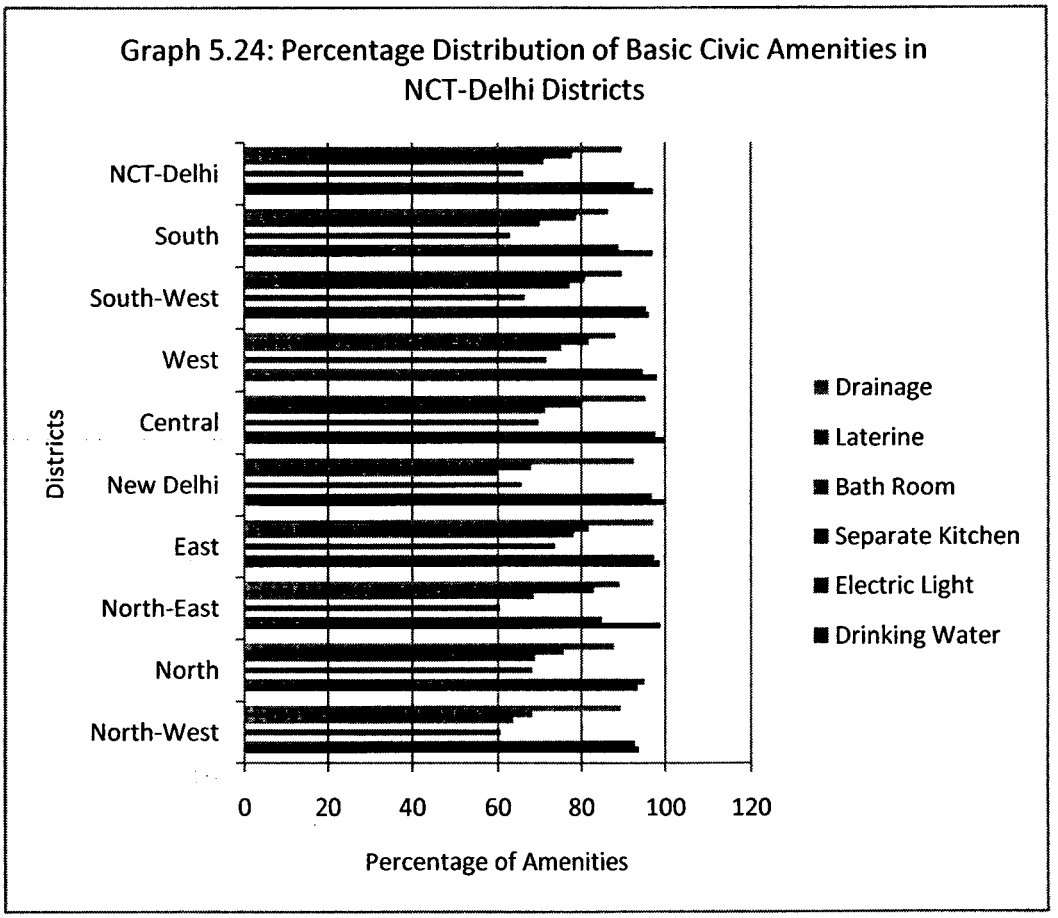
The rapid rate of urbanization in Delhi has resulted in sharp increase in size and density of population. As it is stated in the Economic Survey of Delhi (2006) "with 13.8 million population in 2001, Delhi ranked third among the most populous metropolitan Indian cities after Mumbai and Kolkata. The city's population grew annually by 3.85 percent during the period 1991-2001." With the rapid population growth, the needs for shelter and provision of basic civic amenities increased. The Economic Survey of Delhi further described the problem as follows. "Because of the lack of adequate developed land at affordable prices to different categories of residents on the one hand and continuous flow of migrants on the other, various types of unplanned settlements have come up in Delhi." These unplanned settlements made the City problems more complex and difficult to provide the basic civic amenities. This is well addressed by the Economic Survey of Delhi as "with the emergence of various types of settlements, particularly unplanned settlements, the urban area in Delhi has become a very typical and difficult subject for management by concerned agencies." However; with its vibrant economic development, Delhi is expected to provide better services and civic amenities for its residents than the other sub-regions of the National Capital Region.

Table 5.41: District level percentage distribution of drinking water and other civic amenities in NCT-Delhi

District	Total number of households	%age of amenities					
		Drinking water	Electric light	Separate kitchen	Bath room	latrine	Drainage
North-W.	522,254	93.87	92.95	60.62	63.59	68.25	89.56
North	140,688	93.52	95.23	68.18	68.85	75.76	87.92
North-East	292,357	98.81	85.04	60.56	68.57	83.12	89.30
East	265,990	98.80	97.38	73.68	78.31	81.80	97.36
New Delhi	38,120	99.80	96.95	65.69	59.92	67.97	92.81
Central	110,182	100.00	97.81	69.66	71.28	80.04	95.53
West	407,473	98.18	94.81	71.64	75.21	81.85	88.34
South-W.	331,373	96.26	95.57	66.41	77.22	80.99	89.93
South	439,712	97.14	89.07	62.88	70.02	78.87	86.72
NCT-D.S.R	2,554,143	97.24	92.84	66.08	71.01	77.96	89.94

Source: Census of India, 2001.

Comparatively, Delhi provides basic civic amenities better than the other sub-regions in National Capital Region (see table 5.41). The NCT-Delhi is doing better provisions in drinking water (97.24%), electric light (92.84%), and drainage (89.94%). However; the provision of separate kitchen (66.08%) is not encouraging. Comparing with other sub-regions, Delhi stood first in provision of electric light (92.95%), bath room (71.01%), and latrine (77.96%) and second in provision of drinking water (97.24%), and drainage (89.94%). Graph 5.24 demonstrates the status of the provision of civic amenities in NCT-Delhi Sub-region.



Below; it is attempted to summarize the level of the provision of basic civic amenities at sub-region and NCR levels. These are already given in the preceding tables, but, here reviewed for quick comparisons.

Table 5.42: Sub-region level percentage distribution of drinking water and other basic civic amenities in NCR

Sub-region	%age of amenities					
	Drinking water	Electric light	Separate kitchen	Bath room	latrine	Drainage
NCT-Delhi	97.24	92.84	66.08	71.01	77.96	89.94
Haryana	80.92	83.31	52.69	51.24	43.45	79.04
UP	98.46	53.31	47.60	47.42	55.99	93.58
Rajasthan	64.77	52.36	71.13	23.90	19.75	37.75
NCR Average	85.35	70.46	59.38	48.39	49.29	75.08

Source: Census of India, 2001.

Table 5.42 indicates that the provision and distribution of drinking water and drainage facility; except in Rajasthan Sub-region, are encouraging (above 80%). Supply of electric light in NCT-Delhi (92.84%) and Haryana (83.31%) sub-regions is also encouraging. However; supply of separate kitchen, bath room, and latrine facilities is lower in all sub-regions of NCR.

5.7: Status of Shelter Provision in NCR Sub-regions

Lack of adequate housing affects sustainable regional development in many ways and housing development should; therefore, be part of integrated regional development strategy. Adequate housing provision can have vital roles to the success of regional development programs (strategies). This issue is well addressed by the NCR Planning Board as follows. "A number of public agencies, area development authorities, state housing boards, local bodies, etc. are involved in the delivery of both developed plots and built-up dwelling units. Many public sector undertakings and Central Government agencies also construct houses for their employees as staff quarters. Besides these, cooperative societies are also active participants in housing production." The status of

shelter provision in the National Capital Region sub-regions is separately discussed as follows.

5.7.1 Status of Shelter Provision in Haryana Sub-region

The Haryana Urban Development Authority (HUDA) is a body set up with the main purposes (functions) of development, acquisition, and provision of land for residential, commercial and industrial use as well as making developed lands available to the Haryana Housing Board and other housing development corporations for the provision of cheap homes to the lower class of the society. HUDA (2009) also framed a policy for low cost and affordable housing projects with an objective to provide affordable dwelling units to the people belonging to lower and middle income category. Here, it is attempted to assess the status and distribution by comparing the number of households with corresponding number of residential houses.

Table 5.43: Distribution of census houses used as residence in Haryana Sub-region

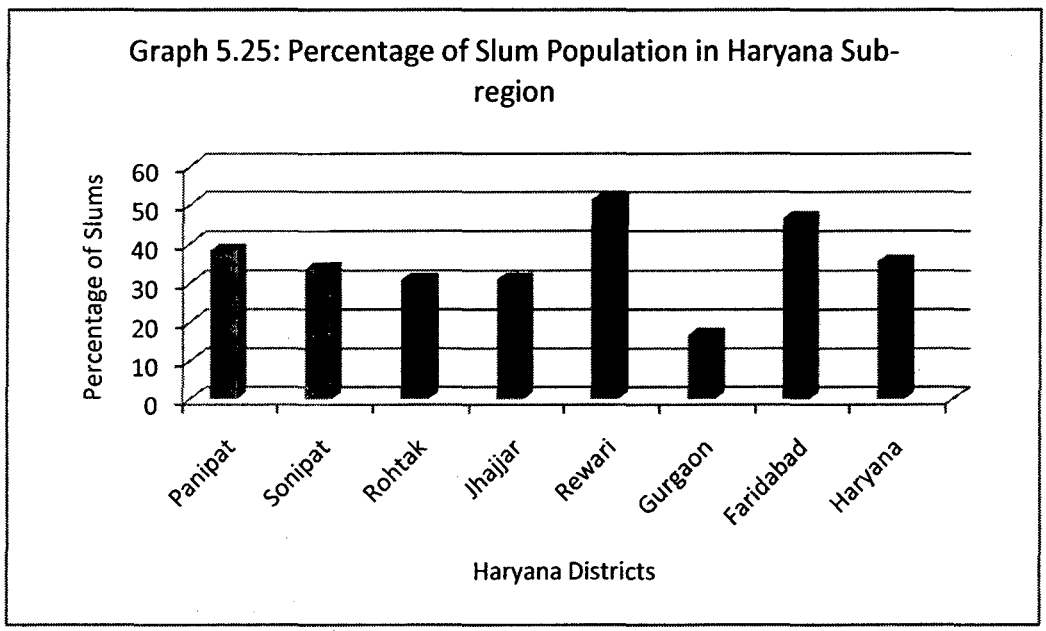
District	Total number of households	Total number of Census houses	Short-fall	Percentage	%age of slum population
Panipat	159,684	158,423	1,261	0.79	38.25
Sonipat	214,640	213,069	1,571	0.73	33.51
Rohtak	160,449	159,140	1,309	0.82	30.78
Jhajjar	144,355	142,506	1,849	1.28	30.90
Rewari	130,864	129,693	1,171	0.89	51.27
Gurgaon	263,751	261,316	2,435	0.92	16.64
Faridabad	366,715	363,249	3,466	0.95	46.55
S.R total	1,440,458	1,427,396	13,062	0.91	35.41

Source: Census of India, 2001.

Haryana Sub-region has lower short-fall of residential houses (0.91%) than the other sub-regions of National Capital Region (see table 5.43). Inter-district comparisons have been made using the data in table 5.43 above. Accordingly; districts Jhajjar (1.28%),

Faridabad (0.95%), and Gurgaon (0.92%) have relatively high short-falls while other districts recorded lower. However; the percentage distribution of slum population in Haryana is very high than in the other sub-regions. This indicates that many of the residential houses are poor in quality. Districts Rewari (51.27%), Faridabad (46.55%), and Panipat (38.25%) have very high percentage of slum population, while the Sub-region Haryana has average 35.41% of slum population. This is well described using graph 5.25 below.

Graph 5.25: Percentage of Slum Population in Haryana Sub-region



5.7.2: Status of Shelter Provision in Uttar Pradesh Sub-region

Evidences (such as India Housing) indicate that the Uttar Pradesh Urban Development Authority (UPUDA) offers a wide variety of flats, duplexes, condominiums, apartments, and plots. With the growing demands for homes, UPUDA is undertaking a huge number of housing construction projects and increasing the production of housing units at a faster rate. The status and distribution of residential houses in Uttar Pradesh Sub-region are assessed by comparing the number of households with corresponding number of residential houses.

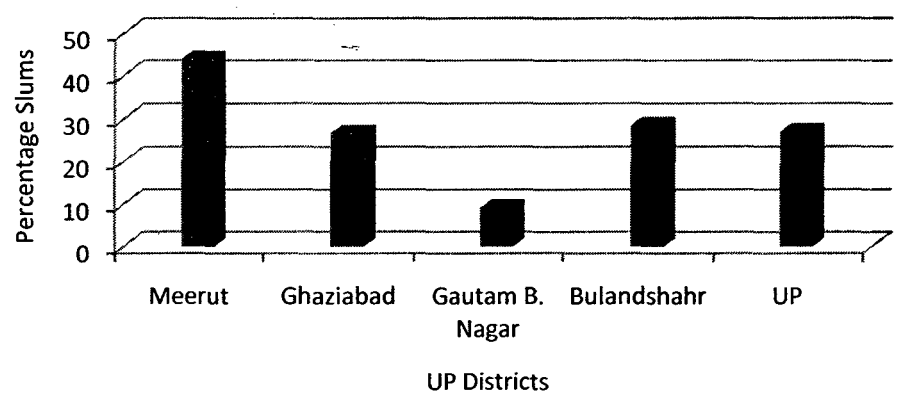
Table 5.44: Distribution of census houses used as residence in UP Sub-region

District	Total number of households	Total number of census houses	Short-fall	Percentage	%age of slum population
Meerut	447,747	438,635	9,112	2.04	43.87
Baghpat	173,057	171,765	1,292	0.75	-
Ghaziabad	526,770	518,961	7,809	1.48	26.72
Gautam B. N.	204,454	199,228	5,226	2.56	9.12
Bulandshahr	463,103	457,945	5,158	1.11	28.53
S.R total	1,815,131	1,786,534	28,597	1.58	27.06

Source: Census of India, 2001.

Table 5.44 reveals that district Meerut has the highest housing short-fall with a deficit of 9,112 housing units (2.04%) followed by Ghaziabad with 7,809 (1.48%). Meerut also has the highest percentage of slum population (43.87%). Gautam Buddha Nagar and Bulandshahr districts have short-falls 5,226 (2.56%) and 5,158 (1.11%) respectively. The total short-fall for Uttar Pradesh Sub-region is 28, 597 housing units (1.58%) with slum population of 27.06%. Generally; UP has percentage of slum population lower than Haryana; but, higher than Rajasthan and NCT-Delhi sub-regions. The pictorial representation of the percentage of slum population in UP Sub-region is given in graph 5.26 below.

Graph 5.26: Percentage of Slum Population in UP Sub-region



5.7.3: Status of Shelter Provision in Rajasthan Sub-region

Rajasthan Urban Housing and Habitat Policy-2006 considers housing as the first and for most program area of promoting sustainable human settlement development. It also considers adequate housing as basic human right and as integral part of overall economic development. The major issue of discussion here is addressing the level of housing provision in Alwar district or Rajasthan Sub-region of NCR. To attain the desired results, it is attempted to compare the number of households with corresponding number of residential houses. Table 5.45 is employed to show the number of Alwar households and available residential houses

Table 5.45: Distribution of census houses used as residence in Rajasthan Sub-region

District	Total number of households	Total number of census houses	Short-fall	Percentage	%age of slum population
Alwar	461,080	453,796	7,284	1.58	6.11

Source: Census of India, 2001.

As per table 5.45, the existing short-fall of housing units in Rajasthan Sub-region is 7,284 (1.58%). This is similar to that of Uttar Pradesh Sub-region; but, higher than that of Haryana Sub-region. The percentage of slum population in Rajasthan Sub-region is the lowest (6.11%) among the sub-regions of the National Capital Region.

5.7.4: Status of Shelter Provision in NCT-Delhi Sub-region

The Economic Survey of Delhi (2006) indicates that the city has a large housing stock. It could be interesting to see the size and distribution of the census houses into various uses as follows. According to 2001 Census," there were 25.54 lakh households in Delhi compared to 18.62 lakh households in 1991. There were 33.80 lakh census houses in 2001 of which 30.02 lakh houses were occupied and 3.78 lakh were vacant. Out of the occupied houses only 23.16 lakh (78.18%) were being used exclusively for residential purposes."The above evidences indicate that 2.38 lakh households have no residential houses while 3.78 lakh census houses are sill vacant. The Survey didn't account about

the reasons. Although the city has large number of residential houses, it could not satisfy the growing demand for housing due to rapid population growth as a result of natural increase and high rate of migration from various parts of the country. Concerning to this, the NCR Regional Plan-2021 (2004) stated the following statements. "The migrants come to Delhi in search of gainful employment opportunities, which are easily available in unorganized and informal segments of the metropolitan economy." The Plan further explained the problem as "most migrants are unskilled construction workers, low wage earners in small scale industrial activities, petty traders, and community service personnel who may not be able to move out to any far-away location where they do not have any assured source of earning." For more information, the level of residential housing provision and distribution in NCT-Delhi is presented by table 5.46 as follows.

Table 5.46: Distribution of census houses used as residence in NCT-Delhi Sub-region

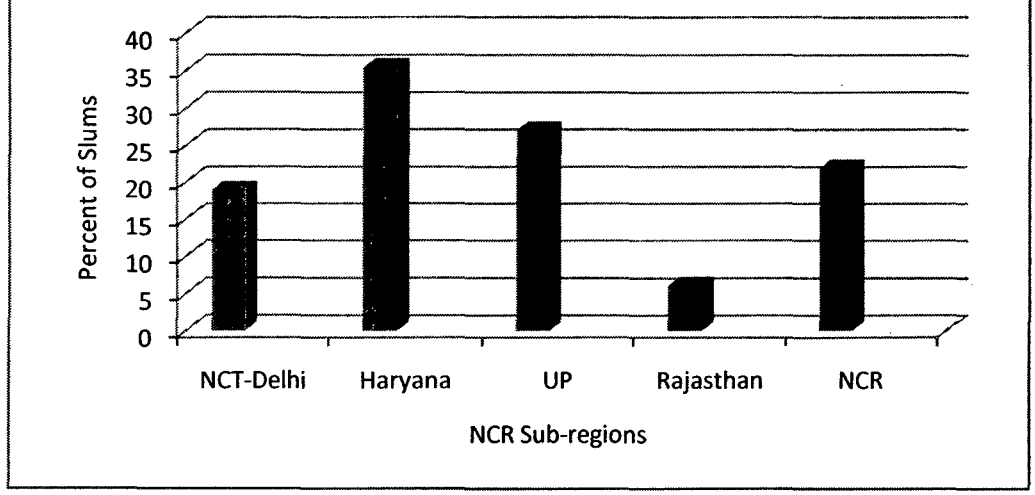
District	Total number of households	Total number of census houses	Short-fall	Percentage	%age of slum population
North-West	522,254	500,646	21,608	4.14	-
North	140,688	135,505	5,183	3.68	-
North-East	292,357	279,780	12,577	4.30	-
East	265,990	255,877	10,113	3.80	-
New Delhi	38,120	37,057	1,063	2.79	-
Central	110,182	111,395	1,213	1.10	-
West	407,473	390,851	16,622	4.08	-
South-West	331,373	316,907	14,466	4.37	-
South	439,712	422,999	16,713	3.80	-
S.R total	2,554,143	2,450,817	103,326	4.04	18.89

Source: Census of India, 2001

The NCT-Delhi has high housing short-fall (4.04%) as compared to the other sub-regions of the National Capital Region. As per table 5.46 above a total number of 103,326

households have no shelter. Districts North-West with 21, 608 (4.14%), South with 16,713 (3.80%), West with 16,622 (4.08%), South West with 14,466 (4.37%), and East with 10,113 (3.80%) have high residential housing short-falls for the reasons underpinned above. Here, we can assume that the above 3.78 lakh vacant houses were built for non-residential purposes. Another major problem in Delhi is the existence of significant number of slum population (18.89%) which mainly resulted from the continuous inflow of large number of migrants. The NCR Regional Plan-2021 (2004) stated the problem as "because of acute shortage of affordable shelter, many of the migrants tend to encroach city space and squat on all forms of land." These situations increase the number of slum population in NCT-Delhi. District level slum population data are not available; however, the combined slum population of NCT-Delhi is compared with other NCR sub-regions in graph 5.27 below.

Graph 5.27 Percentage of Slum Population in NCR



5.7 Summary of the Assessment of Urban Peri-urban Interaction Determinants:

- **Population and urban growth**: The study has identified that there is high and uneven distribution of population growth in NCR that significantly changed the size of the population from nearly 20 million in 1981 to 37 million in 2001. There is also uneven population distribution in the Region with high concentration in Delhi and UP. Another aspect of population dynamism in the Region is the rapid urbanization which resulted in 56.25% urban (more than 10% growth in the period 1981-01). These two size and sectoral population changes greatly affect both urban peri-urban interactions and the interactions among sub-regions.
- **Sub-region wise economic disparities**: The per capita incomes of the sub-regions greatly vary from Rs 13,262 in UP to 61,676 in Delhi (2006). Obviously; this remarkable variation in per capita implies maximum difference in living standards of the people of the sub-regions and further implies much have to be done to bring about integrated and sustainable regional development in the Region. If the income variation continues to grow, the intended goal of the Regional Plan will be at its stake and the attraction and movement of people towards Delhi will grow parallel instead of dispersing population outside Delhi and reducing the prevailing pressure on the City. Similarly, the economic disparities are reflected on the proportion of population below poverty line that range from 14.0% in Haryana and Delhi to 32.9% in UP as well as in employment levels ranging from 304 per 1000 persons in UP to 332 per 1000 persons in urban Delhi. Another clear indicator of the economic disparities is the origin and destination of migrants. 40% of the migrants (1991-01) to Delhi are from UP and 37.6% of them have economic reasons.

  This **determinant** provides clear answers to the **question what types of interactions** in the Region? Here; two distinct types of interactions (tertiary and primary levels) predominate the others. Delhi; with 83% of GDP from service sector, high per capita income, and high consumption level has predominantly

tertiary level urban peri-urban interaction. On the other hand; UP with 43% of GDP from agricultural sector that mostly depend on subsistence and small-scale activities and lower per capita income has predominantly primary level urban peri-urban interaction.

- **Distribution of workers**: Large numbers of secondary and tertiary NCR workers are concentrated in Delhi, nearly 62% of NCR trade and commerce workers. However; 48% of cultivators and 58% of agricultural laborers of NCR are found in UP Sub-region. The percentage of cultivators and agricultural laborers has significantly decreased from 43% in 1971 to nearly 30% in 2001. On the other hand; the service sector of NCR has increased from 53% in 1971 to 65% in 2001. Generally speaking, the situation indicates that the urban peri-urban workforce interactions in Delhi largely depend on tertiary and secondary sectors while in UP on primary sector.
- **Land utilization in NCR**: Major land use changes and interactions are observed on the two land use categories, namely, agricultural and non-agricultural lands. The total irrigable area in NCR (2001) is 61% while the total non-agricultural use (built-up) is 14.22%. The agricultural land has declined from 78.94% in 1986 to 60.85% in 2001, while the non-agricultural (built-up) land increased from 2.9% in 1986 to 14.22% in 2001. These distinct expanding of the built-up area on the one hand, and the retreating trend of the agricultural land on the other demonstrate an interesting urban peri-urban land use interactions. These in turn enhance the urban peri-urban population and workforce interactions in NCR.
- **Infrastructure provision in NCR**: In physical infrastructure; provision of road and railway networks, energy supply, and distribution of telecommunication services are considered. Generally, the researcher has observed that there is moderate road and railway access which facilitates the urban peri-urban interaction in the Region. Among sub-regions, Delhi has better transport service than the others with 19,223 km road length per 1000 km^2 and 2.06 km road length per 1000

population. NCR has remarkable progresses in telecommunication service provision which greatly support the urban peri-urban interactions.

In social infrastructure, only education and health services are considered in the study. Except in some packages; the available social infrastructure provisions in NCR do not meet the norms stated by the Regional Plan. These short-falls will influence the urban peri-urban interactions in the Region. With these limitations; however, Delhi has comparatively better provision of primary and higher education services and enjoys better literacy rate (81.82%) in the Region.

- **Provision of basic civic amenities in NCR**: The researcher has attempted to assess the level of six major types of basic civic amenities like drinking water, electric light, separate kitchen, bath room, latrine, and drainage facilities in NCR. Delhi (97.24%), Haryana (80.92%) and UP (98.45%) have relatively good coverage of drinking water and drainage facility. Delhi (92.84%) and Haryana (83.31%) also have good coverage of electric light. Others such as separate kitchen, bath room, and latrine facilities are unsatisfactory and some of them below average. The absence of these necessities will affect the urban peri-urban interactions in the Region and may force people leave their places permanently and migrate to areas where they get such amenities.
- **Shelter provision in NCR**: There is a little gap between the total number of households and total number of census housing units in the Region. However; the total slum population in the sub-regions; except Rajasthan, is significant. The slum population in Haryana is 35.41%, in UP 27.06% and in NCT-Delhi 18% respectively. This implies that significant portion of the total housing stock of the Region is poor in quality. Housing is one of the three basic necessities of man that makes people remain in their original location and interact with their neighbor localities. However; people who lack adequate shelter will not stay and interact in their original locations. It is in this way that shelter determines the urban peri-urban interactions in the Region.

CHAPTER 6: URBAN PERI-URBAN INTERACTION IN NATIONAL CAPITAL REGION

6.1 Delhi and its Sphere of Influence

Literally, the sphere of influence refers to the area under the influence of city planning in which the city can expand its future territory when ever necessary. The area gets continuous planning, investment, infrastructure, and other necessary assistance from the city. Such assistance helps the sphere of influence to be more urban and reduces future costs of possible expansion (incorporation). It also minimizes prevailing city population pressure and traffic congestion. Coming to the Indian cases, we find similar circumstances like "to achieve a rational growth of Delhi which has been expanding in a most haphazard way, it is necessary to plan this whole area as a composite unit and have integrated and balanced overall program of development. The Ring Towns must be developed not only to deflect some of the population that would otherwise come into Delhi and jeopardize the planned growth of Delhi, but also to help these towns to grow in a planned way (NCR Plan, 2004)."

The areas have to cooperate in planning and regulating of growth in their territory. Future decisions on proposed big and strategic investment projects in the areas should take the City's (Delhi) planning objectives into consideration. Like-wise, the Planning Board of the National Capital Region has the right to control and regulate the developments in the areas falling under the Region.

The Planning Board (established in 1985) also has the right to conduct studies on the feasibility of strategic investment projects and road standards to make them consistent with the Delhi development standards, to prepare the development plan for the National Capital Region and for coordinating and monitoring the implementation of such a plan and for evolving harmonized policies for the control of land uses and

development of infrastructure in the National Capital Region so as to avoid any haphazard development in the Region (NCR Plan, 2004).

The sphere of influence is important benchmark, because it defines the primary area within which urban development is to be encouraged. The sphere of influence helps like general plans, serves as essential planning tool to combat urban sprawl and provide well planned and efficient urban development patterns.

The major purposes of this part of the study are short-listed as follows:

- assess the strength of the influence of Delhi on each settlement area falling under its sphere of influence through the distribution of gravitational fields;
- distinguish the geometric characteristic features of the urban sphere of influence;
- articulate the factors determining the changes of the urban spheres of influence and the role of distance decay effect;
- calculate the distribution of gravitational fields and draw the corresponding distribution map of gravitational field; and,
- determine the urban sphere of influence and its implication in NCR through the help of spatial indicators.

The gravity model is employed to calculate the gravitational fields and measure the strength of the city influence. The total gravitational field for urban influence force is calculated by the following formula:

$$Fi = \sum_{j=1} \frac{Pj}{Dij^2}$$

Where, Fi= total gravitational field for i^{th} gravitational settlement,

Pj= city's total urban population; and,

Dij= the distance between gravitational settlement i and city j.

6.1.1 Nature of Data

The types of data employed to assess Delhi sphere of influence include both statistical (population) and spatial (distance) data tabulated for the four National Capital Region sub-regions. However; economic data can also be used to assess city sphere of influence. Population data are collected from Census of India 2001. Tahsil level data of both factors are taken to calculate the gravitational fields and measure the strength of the City influence. The total urban population of Delhi divided by the square of the distance between urban Delhi and the respective settlement area (destination) gives the gravitational field of that particular settlement area. Therefore; the gravitational field of a given settlement area is determined through the interplay of population and distance factors.

6.1.2. Tahsil Level Distribution of Delhi (City) Gravitational Fields in NCR

It has been explained in the preceding parts that the National Capital Region has four constituent areas; namely, the National Capital Territory of Delhi (NCT), Haryana Sub-region, Uttar Pradesh Sub-region, and the Rajasthan Sub-region. Tahsil level city gravitational fields are calculated for each sub-region. . Assuming a moderate transport network in NCR, the Researcher has taken 2 as a value of **b**. The Researcher also used field (ground) distances to calculate the gravitational fields.

The Sub-region Haryana comprises seven districts and twenty seven tahsils. The relative location of the districts and tahsils to the city of Delhi greatly affects the strength of the sphere influence. Comparisons are made among the tahsils of Haryana. Tahsil level distribution of gravitational fields of the Sub-region is given in the table below.

Table 6.1: Haryana Sub-region tahsil level distribution of city gravitational fields

District	Tahsil	Tahsil Population	Delhi Total Urban Population	Distance (km)	Gravitational Fields (p/km^2)
Faridabad	Faridabad	115698	12819761	29	15243
	Ballabgarh	435150	12819761	38	8878
	Palwal	404130	12819761	60	3561
	Hathin	203881	12819761	64	3130
	Hodal	221142	12819761	89	1618
Dist. Total	-	-	-	-	32430
Gurgaon	Gurgaon	380154	12819761	27	17585
	Pataudi	100890	12819761	68	2772
	Taoru	123182	12819761	70	2616
	Sohna	140620	12819761	57	3946
	Nuh	212834	12819761	76	2219
	Punahana	206758	12819761	100	1282
	Ferozepur Jhirk	243828	12819761	111	1040
Dist. Total	-	-	-	-	31460
Rewari	Rewari	418898	12819761	88	1655
	Bawal	110549	12819761	94	1451
	Kosli	110991	12819761	103	1208
Dist. Total	-	-	-	-	4314
Jhajar	Jhajar	343114	12819761	63	3230
	Beri	135260	12819761	77	2162
	Bahadurgarh	370014	12819761	34	11090
Dist. Total	-	-	-	-	16482
Rohtak	Rohtak	447326	12819761	76	2219
	Maham	181326	12819761	110	1059
Dist. Total	-	-	-	-	3278
Sonipat	Sonipat	378097	12819761	49	5339

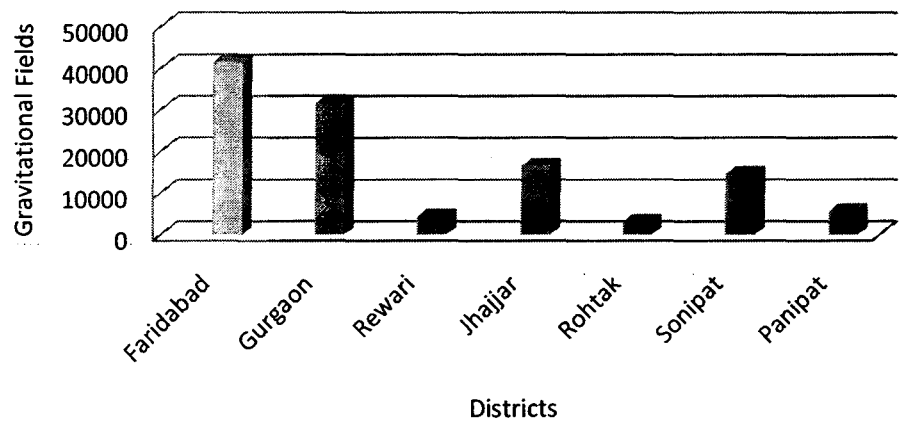
	Kharkhoda	160083	12819761	59	3683
	Gohana	339666	12819761	104	1185
	Ganaur	175833	12819761	58	3811
Dist. Total	-	-	-	-	10,703
Panipat	Panipat	234850	12819761	88	1655
	Israna	121992	12819761	92	1515
	Samalkha	248449	12819761	72	2473
Dist. Total	-	-	-	-	5643
Sub.R.Total	-	-	-	-	104,310

Source: Census of India, 2001.

Delhi's strength of influence is higher in tahsils such as Faridabad, and Gurgaon, with gravitational fields of 15,243, and 17,585p/km^2, respectively (see table 6.1). It has relatively medium strength of influence in tahsils like Bahadurgarh and Ballabgarh with gravitational fields 11,090 and 8875p/km^2. However; the city has lower strength of influence in all other tahsils of Haryana Sub-region with lower than 6,000 gravitational fields respectively.

The two major factors determining the strength of city influence are the population size and the distance factors. Table 6.1 above indicates that the gravitational fields decrease as the distances of the tahsils from the center of the City increase. It is not easy to display all the gravitational fields of all tahsils on the same graph; instead, the researcher has condensed into district level and produced Graph 6.1 below in order to visualize the distribution of Delhi gravitational fields in Haryana sub-region.

Graph 6.1: Distribution of Delhi Gravitational Fields in Haryana Sub-region Tahsils Aggregated to their Districts



Similar to the case of Haryana Sub-region, the distribution of Delhi gravitational fields is unevenly distributed through out the tahsils and districts of Uttar Pradesh Sub-region through the interplay of City population and distance from the center of the City. The strength of influence of the City; therefore, decreases from center to the periphery. Here comparisons have been made among tahsils of UP Sub-region. Table 6.2 below accounts about the distribution of the City gravitational fields on each particular location and indicates the strength of city influence.

Table 6.2: Tahsil level distribution of Delhi gravitational fields in Uttar Pradesh Sub-region

District	Tahsil	Tahsil Population	Delhi Total Urban Population	Distance (km)	Gravitational Fields (p/km^2)
Meerut	Meerut	604641	12819761	69	2692
	Mawana	686899	12819761	103	1208
	Sardhana	505616	12819761	89	1618
Dist. Total	-	-	-	-	5,518
Ghaziabad	Ghaziabad	387320	12819761	27	17585
	Hapur	774007	12819761	61	3445
	Modinagar	555054	12819761	50	5128
	Garhmukteshwar	331122	12819761	94	1451
Dist. Total	-	-	-	-	27,609
Baghpat	Baghpat	142720	12819761	40	8012
	Khekada	323087	12819761	29	15243
	Baraut	650007	12819761	68	2772
Dist. Total	-	-	-	-	23,527
Bulandshahr	Bulandshahr	495977	12819761	96	1391
	Siana	471001	12819761	109	1079
	Debai	380648	12819761	157	520
	Shikarpur	381958	12819761	117	937
	Khurja	400932	12819761	102	1232
	Anupshahr	300743	12819761	137	683
Dist. Total	-	-	-	-	5,842
Gautam B. N.	Dadri	292329	12819761	43	6933
	Jewar	258979	12819761	86	1733
Dist.Total	-	-	-	-	8,666
Total	-	-	-	-	71,162

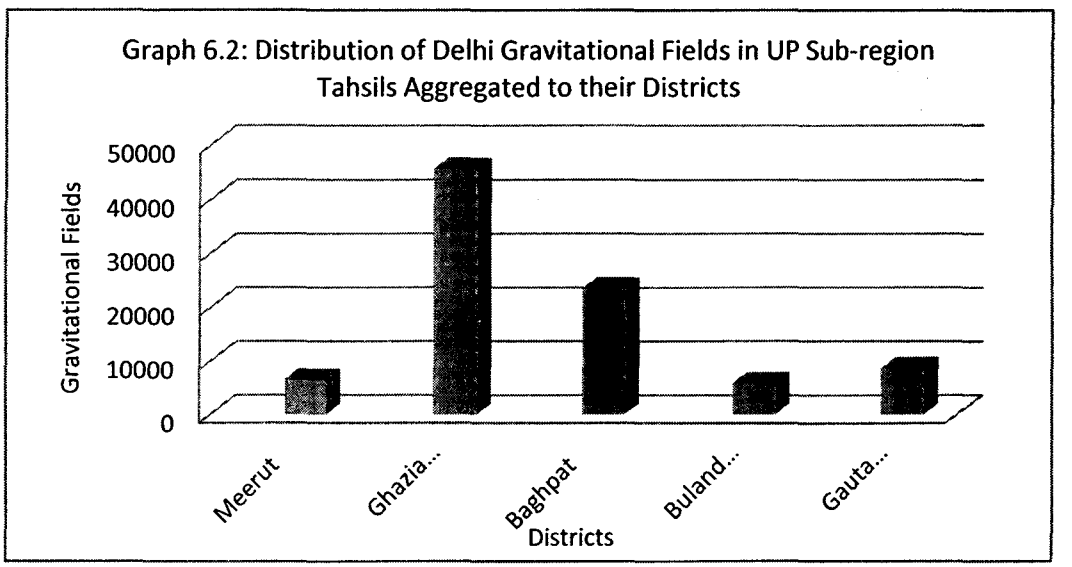
Source: Census of India, 2001.

The total City gravitational field in Uttar Pradesh Sub-region is 71,162 P/km^2. This is obviously less than the total City gravitational field in Haryana Sub-region despite the population of Uttar Pradesh Sub-region is by far greater than that of Haryana. Table 6.2 above helps understand that the difference comes from the effect of the distance factor.

Taking the gravitational fields and the strengths and weaknesses of the sphere of influence, we observe clear variations among the tahsils of the Sub-region ranging from 520p/km^2 in Debai to 17,585p/km^2 in Ghaziabad. The situation is also observed among the districts of the Sub-region.

The City gravitational fields are relatively higher in tahsils such as Ghaziabad and Khekada to indicate moderately strong City sphere of influence. On the other hand, tahsils like Debai (520 p/km^2), Anupshahr (683 p/km^2), and, Shikarpur (937p/km^2) have lower City gravitational fields showing weak City sphere of influence. Graph 6.2 below could further illustrate the situation of City gravitational field and the strength of sphere of influence in UP Sub-region.

Graph 6.2: Distribution of Delhi Gravitational Fields in UP Sub-region
Tahsils Aggregated to their Districts



It has been attempted to calculate the gravitational fields of urban Delhi on its rural tahsils (settlements) in order to make intra-sub-region comparisons. It has also been given due consideration for the comparison of gravitational fields and strength of the

sphere of influence among the rural tahsils of NCT-Delhi and the tahsils in other Sub-regions of NCR.

An interesting pattern of Delhi gravitational fields and spheres of influence is that decreasing simultaneously with distance from the urban Delhi to the outer tahsils of the NCR. Table 6.3 presents the urban Delhi gravitational fields in NCT-Delhi rural tahsils.

Table 6.3: Tahsil level distribution of urban Delhi gravitational fields in NCT Delhi Sub-region

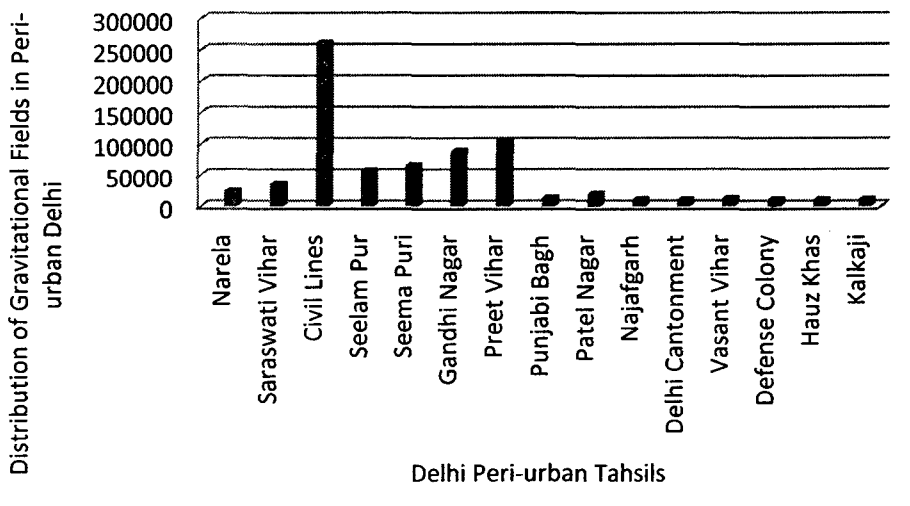
District	Tahsil	Tahsil Total Population	Delhi Total Urban Population	Distance (km)	Gravitational Fields (p/km^2)
North-West	Narela	148594	12819761	32	12519
	Saraswati Vihar	115520	12819761	16	50077
North	Civil lines	46586	12819761	7	261628
North-East	Seelam Pur	38375	12819761	11	105948
	Seema Puri	103153	12819761	16	50077
East	Gandhi Nagar	6663	12819761	11	105948
	Preet Vihar	11460	12819761	9	158268
West	Punjabi Bagh	76351	12819761	11	105948
	Patel Nagar	8953	12819761	7	261627
South-West	Najafgarh	167607	12819761	31	13340
	Delhi Cantonment	22405	12819761	13	75856
	Vasant Vihar	34662	12819761	12	89026
South	Defense Colony	33389	12819761	8	200308
	Hauz Khas	99,667	12819761	10	128197
	Kalkaji	51574	12819761	13	75856
S.R Total	-	964,959	-	-	1,694,623

Source: Census of India, 2001.

As per table 6.3 above; almost all rural tahsils of the NCT-Delhi have greater urban gravitational fields and corresponding strong spheres of influence. These results mainly belong to the distance factor. NCT-Delhi tahsils with the highest urban gravitational fields and strongest urban spheres of influence include Civil Lines and Patel Nagar with 261,628p/km^2 each, Defense Colony (200300p/km^2), Preet Vihar (158,268p/km^2), Hauz Khas (128197p/km^2), Gandhi Nagar (105948p/km^2), Seelam Pur (105948p/km^2), Punjabi Bagh (105948p/km^2), and Vasant Vihar (89026p/km^2). The lowest scores in the NCT-Delhi tahsils are more than the average scores of the tahsils in other Sub-regions.

Comparisons are interesting not only at tahsil and district levels; but also, at Sub-region levels. The total urban gravitational fields in the respective Sub-regions include the rural NCT-Delhi (1,694,623p/km^2), Haryana Sub-region (104,310p/km^2), Uttar Pradesh Sub-region (71,162p/km^2), and Rajasthan Sub-region (7,218p/km^2). These results give a clear picture of core-periphery decreasing patterns. The urban gravitational fields in all NCT-Delhi rural tahsils are depicted on Graph 6.3 as follows.

Graph 6.3: Distribution of Urban Delhi Gravitational Fields in NCT-Delhi Peri-urban Tahsils (p/km)



Tahsil level urban gravitational fields for Alwar district (Rajasthan Sub-region) are separately calculated to make intra-sub-region comparisons. The geographical location of Alwar district is far beyond the other districts of the National Capital Region. As a

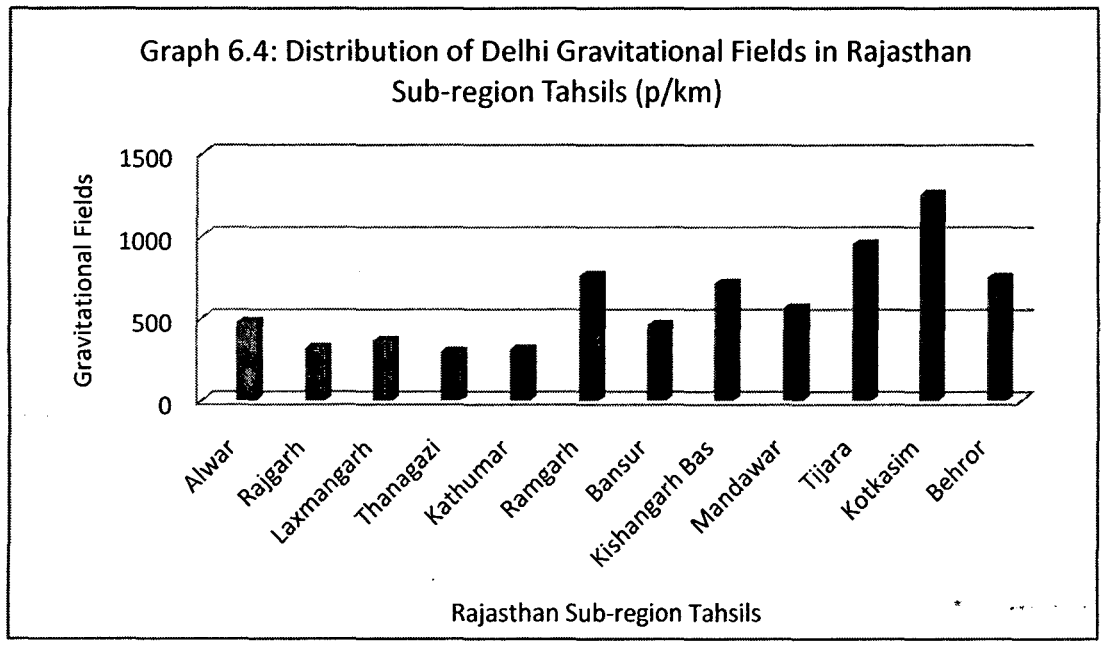
result of its distant location, the urban gravitational fields of the district are by far lower than in other districts of NCR referring weak urban sphere of influence. Table 6.4 below is portrayed to give further explanations on the distribution of urban gravitational fields in all tahsils of Alwar district (Rajasthan Sub-region).

Table 6.4: Tahsil level distribution of Delhi gravitational fields in Rajasthan Sub-region, 2001

District	Tahsil	Tahsil Population	Delhi Total Urban Population	Distance (km)	Gravitational Fields (p/km^2)
Alwar	Alwar	568530	12819761	164	477
	Rajgarh	306226	12819761	200	320
	Laxmangarh	241708	12819761	188	363
	Thanagazi	189977	12819761	208	296
	Kathumar	206685	12819761	203	311
	Ramgarh	201757	12819761	130	759
	Bansur	214351	12819761	167	460
	Kishangarh B.	161629	12819761	134	713
	Mandawar	197582	12819761	151	562
	Tijara	280772	12819761	116	953
	Kotkasim	117687	12819761	101	1257
	Behror	305688	12819761	131	747
Total	-	-	-	-	7218

Source: Census of India, 2001.

With the exception of Kotkasim (1257p/km^2), all other tahsils of Rajasthan Sub-region have lower urban gravitational fields and weak city sphere of influence which is attributed to the long distance from urban Delhi (see table 6.4). All tahsils, except Kotkasim, have gravitational fields less than 1000. Graph 6.4 is expected give adequate information about the distribution of urban gravitational fields in Rajasthan Sub-region.


Graph 6.4: Distribution of Delhi Gravitational Fields in Rajasthan Sub-region Tahsils (p/km)
Gravitational Fields
1500
1000
500
0
Alwar
Rajgarh
Laxmangarh
Thanagazi
Kathumar
Ramgarh
Bansur
Kishangarh Bas
Mandawar
Tijara
Kotkasim
Behror
Rajasthan Sub-region Tahsils

6.1.3 Correlation Test: Delhi Sphere of Influence and Distance from City-center

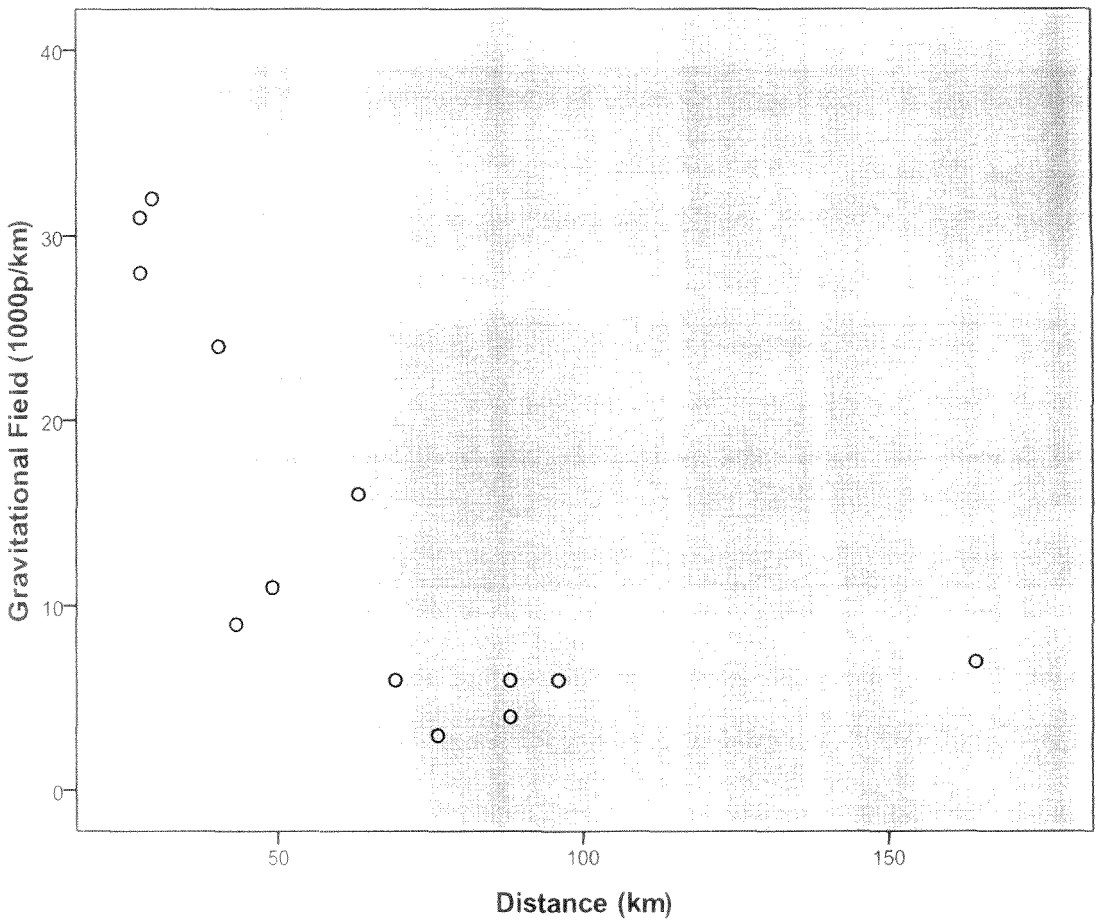
Karl Pearson's Product Moment Correlation Coefficient (using SPSS) is employed to test whether there exists a direct correlation between city sphere of influence measured by the distribution of city gravitational fields in the National Capital Region and the distance variables. Since the result remains unchanged, the gravitational field of each settlement is divided by 1,000 to make the computation easy. Distances are measured in km from city-center (Delhi) to district headquarters of the National Capital Region.

Table 6.5: Relationship between Delhi strength of sphere of influence in NCR and distance from city-center to district headquarters

S.No	Districts/Sub-region	Distance(km) (x)	Gravitational Fields(p/km^2) (y)
1	NCT-Delhi	12	1695
2	Gurgaon	27	31
3	Ghaziabad	27	28
4	Faridabad	29	32
5	Baghpat	40	24
6	Gautam B. N.	43	9
7	Sonipat	49	11
8	Jhajjar	63	16
9	Meerut	69	6
10	Rohtak	76	3
11	Panipat	88	6
12	Rewari	88	4
13	Bulandshahr	96	6
14	Alwar	164	7

Sources: Compiled from census of India, 2001

6.1 Scatter plot showing distance and gravitational field variables



Correlations between distance from city-center and gravitational fields in NCR

		Distance (km)	Gravitational Field (1000p/km2)
Distance (km)	Pearson Correlation	1	-.691**
	Sig. (2-tailed)		.009
	N	13	13
Gravitational Field (1000p/km2)	Pearson Correlation	-.691**	1
	Sig. (2-tailed)	.009	
	N	13	13

**. Correlation is significant at the 0.01 level (2-tailed).

The tabulated value of t for 11(13-2) degree of freedom is 3.11 at 1% 2.20 at 5% and 1.80 at 10% levels of significance. The computed value (3.1704) of t (significance test of correlation coefficient) is greater than the1%, 5% and 10% tabulated value of t. Hence; the correlation coefficient is significant at 1% level. Note that Delhi is an outlayer and not considered in the computation.

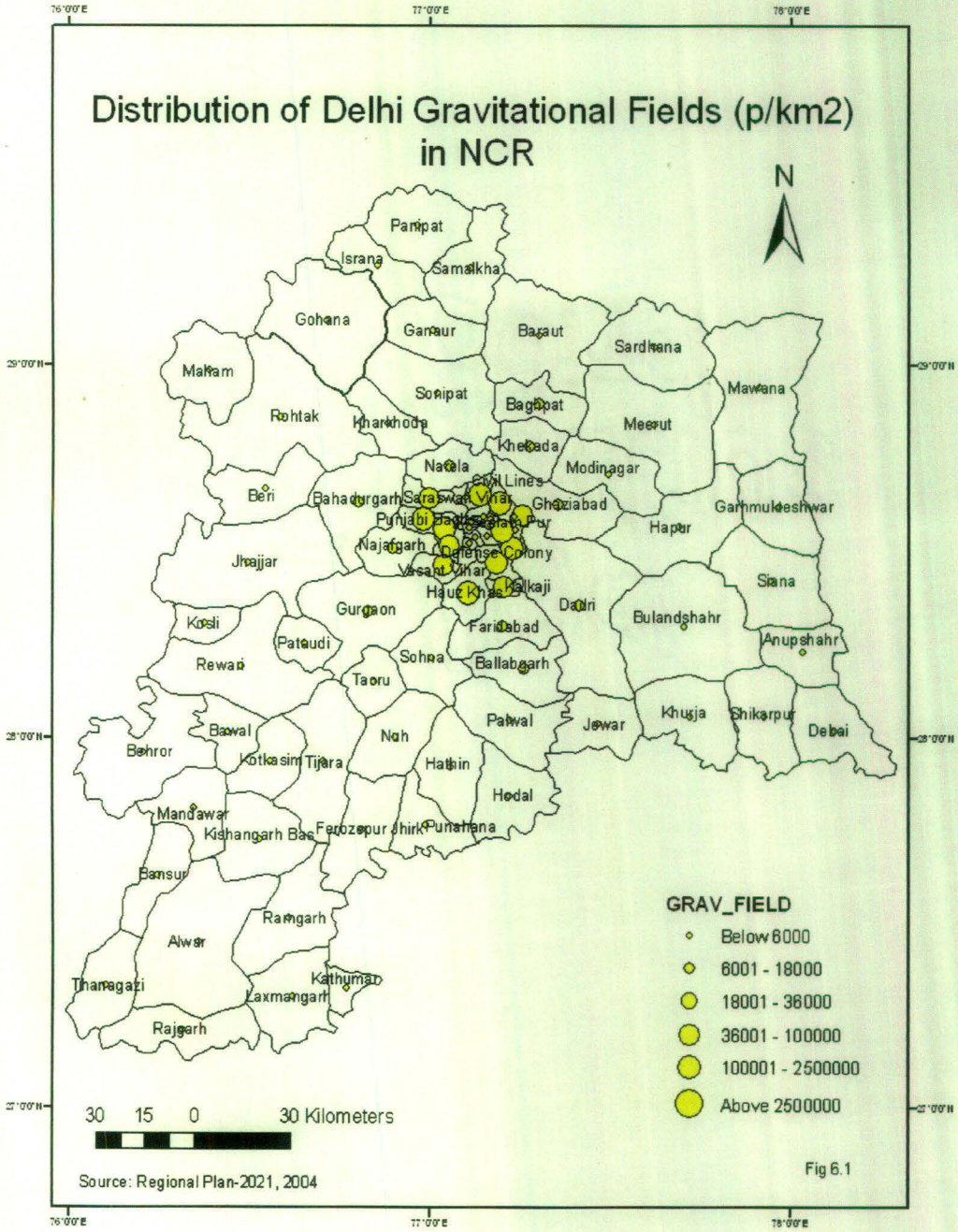
The computed result shows that there exists strong inverse relationship between the city sphere of influence and the distance from city-center towards the district headquarters in the National Capital Region. This indicates as distance increases from city-center to the periphery, the strength of city sphere of influence decreases.

6.1.4 Application of ArcGIS to Show City Sphere of Influence

ArcGIS is used to show high-accuracy spatial distribution pattern of urban gravitational fields for 84 NCR tahsils. The urban influence strength for a given tahsil (settlement) is measured by the computed gravitational field value. A city sphere of influence is represented by a circular area (point proportional). The strength of the sphere of influence is; therefore, represented by the size (volume) of the circular area. Towns located at the same distance will have the same city influence. City sphere of influence decreases with distance from city-center to the periphery.

6.1.5 Jenks Classification (Natural Breaks)

Classes are based on natural groupings inherent in the data. ArcMap identifies break points by picking the class breaks that best group similar values and maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values.


Distribution of Delhi Gravitational Fields (p/km2) in NCR
N
Panipat
Israna
Samalkha
Gohana
Ganaur
Baraut
Sardhana
Mawana
Meerut
Sonipat
Baghpat
Rohtak
Kharkhoda
Khekada
Modinagar
Nangla
Civil Lines
Beri
Bahadurgarh
Saraswati Vihar
Ghaziabad
Garhmukteshwar
Punjabi Bagh
Hapur
Najafgarh
Defense Colony
Jhajjar
Vasant Vihar
Siana
Hauz Khas
Kalkaji
Dadri
Gurgaon
Bulandshahr
Kosli
Faridabad
Anupshahr
Pataudi
Rewari
Sohna
Ballabgarh
Taoru
Palwal
Jewar
Khurja
Shikarpur
Debai
Bawal
Nuh
Behror
Kotkasim
Tijara
Hathin
Hodal
Mandawar
Kishangarh Bas
Ferozepur Jhirk
Punahana
Bansur
Ramgarh
Alwar
Kathumar
Thanagazi
Laxmangarh
Rajgarh
GRAV_FIELD
Below 6000
6001 - 18000
18001 - 36000
36001 - 100000
100001 - 2500000
Above 2500000
30 15 0 30 Kilometers
Source: Regional Plan-2021, 2004
Fig 6.1

6.1.6 Spatial Data Analysis

The distribution of urban gravitational fields in the National Capital Region is a function of the urban population and the distance separating the City (Delhi) and a given settlement area in NCR. This directly implies that the strength of urban influence increases with the development of transport infrastructure. The improvement in transport networks reduces the friction of distance and increases the strength of influence. Liang (2008) stresses on the role of distance decay index as: "with the development of transportation in the real world, the friction of distance is reducing and the distance decay index is declining."

The strength of City influence on its neighboring settlements can increase or decrease in accordance with the traffic development situations. The development of modern transportation can increase the inward force to the distant settlements and help to form an integrated social and economic development in the National Capital Region.

City influence domains are circular mosaic in the real world (Liang, 2008). Similarly, the City gravitational fields are represented in circular mosaics as indicated in **Fig. 6.1** above. The size of the circular features decreases as one moves from the center of the City to the periphery indicating the declining of the strength of the sphere of influence with distance.

Towns located around (near to) Delhi have high gravitational field values **(see Fig.6.1)** showing strong city influence while towns located at the periphery have lower gravitational field values indicating weak city influence.

The distribution of gravitational fields **(Fig. 6.1)** illustrates, unlike to the assumptions stated in Central Place Theory (Christaller, 1933) referring uniform distribution of towns, the spatial distribution of towns in the National Capital Region has no geometric regularity. Hence, the strength of influence for each town (settlement) varies accordingly. However, towns locating at the same distance from Delhi may have the same gravitational field.

The distribution map of urban gravitational fields in the National Capital Region has the following major advantages:

- Distinguishes the characteristic features of the distribution of urban gravitational fields;

- Enables to identify high-value areas of the National Capital Region. Liang (2008) accounts about the importance of the distribution map of urban gravitational fields in identifying such areas as:"Through calculating the gravitational field of cities, the high-value area of urban gravitational field can be defined, which can further be utilized to do spatial clustering analysis for the cities and to define the core areas for city group;"

- Helps to identify urban clusters such as the Central-NCR towns with high gravitational field values;

- Can be used in spatial clustering analysis to determine the structure and spatial distribution of NCR towns;

- May assist as a major tool in formulating appropriate urban development planning in the National Capital Region. Liang (2008) argues about the role of gravitational field in urban development planning. "The city gravitational field can be used in urban development planning to determine the City's development axis and potential development axis. The distribution of weak gravitational field can serve as an indicator for urban planning and designing agencies to establish new cities in accordance with the principle of gap-filling."

6.2 Urban-Urban Population Interactions in National Capital Region

Population Interaction among NCT-Delhi and other Class I Towns in NCR

The interactions among different urban centers can take place in different ways and for various reasons. People and resources are not evenly distributed in all places. Therefore, people could move from place to place for economic, social, cultural, or political purposes. Governments have greater role in the distribution of urban population through different mechanisms like employment and regulatory systems. People prefer places having better employment opportunities, better housing or basic civic amenities, better provision of health and education services. It is in this way that the urban-urban or urban-peri-urban interaction take place.

The total number of urban-urban interactions is usually measured in gravity model. Adequate literature exists on the development and use of the model. Walter Isard (1998) states about the advantage of the model as, "we can estimate the expected total number of trips for every possible combination of originating sub-area and terminating sub-area. Thus we obtain for the metropolitan region a set of expected or hypothetical trip volumes (total number of trips) between sub-areas". The total population interaction between places (towns) i and j is; therefore, computed by the following gravity formula:

$$\sum_{i=1}^{n} Iij = k \sum_{i=1}^{n} \frac{PiPj}{dij^{b}}$$

Where, k = constant,

b = distance friction coefficient,

I_{ij} = total interaction between place i and j,

P_i = population of place i,

P_j = population of place j; and,

d_{ij} = distance between places i and j.

Waugh (2009) argues "The interaction model in geography is based up on the idea that as the size of one or both of the towns increase, there will also be an increase in movement between them. The further apart the two towns are, however, the less will be the movement between them." Aslam (2002) stated that the choice of exponent b to the distance is a difficult problem. Many investigators have proposed the value of b either unity or two. Assuming a moderate transport network in NCR, the Researcher has taken **2** as a value of **b**. This is also applied in calculating gravitational fields, urban peri-urban population interaction, and urban peri-urban workforce interaction in NCR. The Researcher used field (ground) distances to calculate all types of interactions.

The types of data used to calculate the urban-urban interaction in NCR are population and distance (spatial) data of the fifteen towns of National Capital Region. However; economic data can also be used in place of population to calculate the urban-urban potential interaction. Population data are collected for all towns from Census of India 2001. Ground distances between NCT-Delhi and other towns are also identified using map my India. Therefore; the population interaction between NCT-Delhi and any other particular town in NCR is determined by population and distance factors. Table 6.6 is provided to illustrate the size or strength of population interaction among NCT-Delhi and other NCR urban centers.

Table 6.6: Population interaction among NCT-Delhi and other class I towns of the NCR

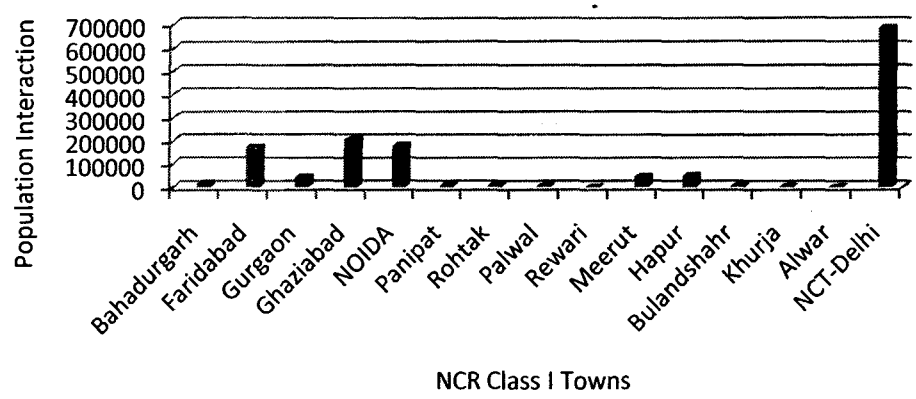
S. No	Name of Towns	Population (2001)	NCT-Delhi Total Population (2001)	Distance (km)	Interaction (Lakh p^2/km^2)
1	Delhi	13782976	13782976	12	684462
2	Bahadurgarh	131924	13782976	33	16,697
3	Faridabad	1054981	13782976	29	172899
4	Gurgaon	229243	13782976	27	43342
5	Ghaziabad	1089180	13782976	27	205928
6	NOIDA	293908	13782976	15	180041
7	Panipat	353983	13782976	88	6300
8	Rohtak	294537	13782976	76	7028
9	Palwal	100528	13782976	61	3724
10	Rewari	100946	13782976	88	1797
11	Meerut	1167399	13782976	69	33795
12	Hapur	211987	13782976	61	7852
13	Bulandshahr	176256	13782976	96	2636
14	Khurja	98403	13782976	102	1304
15	Alwar	265850	13782976	164	1362
	NCR Total	37033214	-	-	1423946

Source: Census of India, 2001.

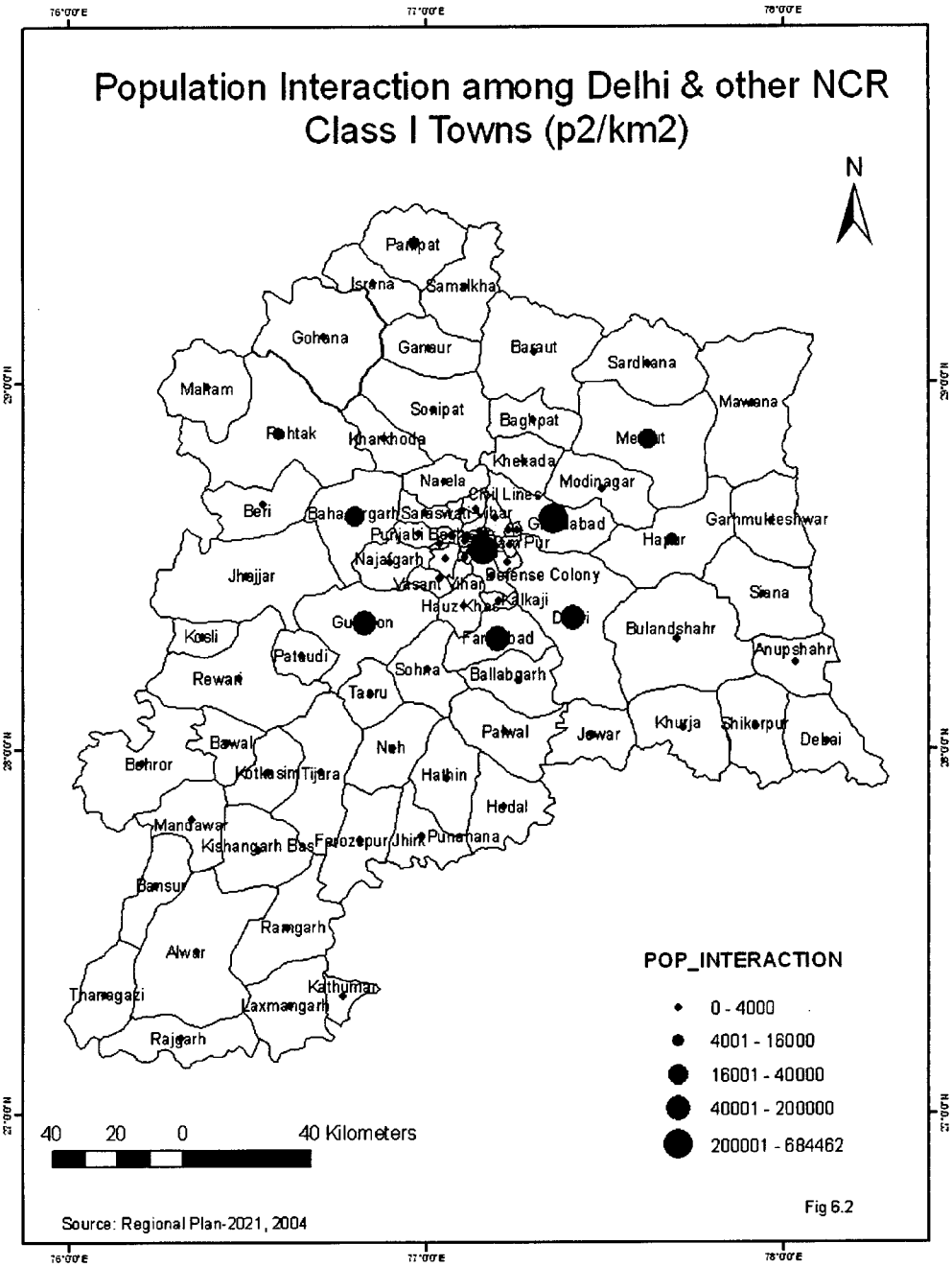
The NCT-Delhi has the highest potential interaction among urban centers of the Region. Other NCR urban centers such as Ghaziabad (205,928p^2/km^2), NOIDA (180041p^2/km^2), and Faridabad (172,899p^2/km^2) have the highest strength of interaction due to their proximity to the City center and their population size. Gurgaon, Meerut and Bahadurgarh are also urban centers having the next higher strength of interaction for similar reasons. On the other hand, urban centers Khurja, Alwar, Rewari and Bulandshahr have weak interaction with the City (Delhi) which might belong to their

distant locations and small population size. Graph 6.5 will further visualize the strength of interaction among NCT-Delhi and the other NCR urban centers.

Graph 6.5: Population Interaction among NCT-Delhi and other Class I Towns (in lakh)



It has been mentioned that the urban-urban interaction takes place among different urban centers, urban social groups, manufacturing and services, etc. It also involves the flows of people, workers, goods and services. The urban-urban interaction is useful for various purposes such as strengthening trade activities, exchange of goods and services, mobilize labor, finance and other material resources from surplus to scarce areas, technology transfer, and getting employment opportunities.


Population Interaction among Delhi & other NCR
Class I Towns (p2/km2)
N
Panipat
Israna
Samalkha
Gohana
Ganaur
Baraut
Sardhana
Maham
Somipat
Baghpat
Mawana
Rohtak
Kharkhoda
Meerut
Khekada
Narela
Modinagar
Civil Lines
Beri
Saraswati Vihar
Garhmukteshwar
Najafgarh
Hapur
Jhajjar
Defense Colony
Vasant Vihar
Siana
Kalkaji
Hauz Khas
Bulandshahr
Kosli
Anupshahr
Pataudi
Rewari
Sohna
Ballabgarh
Taoru
Palwal
Jewar
Khurja
Shikarpur
Bawal
Nuh
Behror
Kotkasim
Tijara
Hathin
Hodal
Mandawar
Kishangarh Bas
Ferozepur Jhirka
Punahana
Bansur
Ramgarh
Alwar
Kathumar
Tharagazi
Laxmangarh
Rajgarh
POP_INTERACTION
0 - 4000
4001 - 16000
16001 - 40000
40001 - 200000
200001 - 684462
40 20 0 40 Kilometers
Source: Regional Plan-2021, 2004
Fig 6.2

Using ArcGIS; the researcher has analyzed the urban-urban population interaction in the National Capital Region **(see Fig 6.2).** Only fifteen major cities and towns recognized by the Regional Plan are taken into consideration. ArcGIS identified cities with various levels of urban-urban interactions. Based on **Fig 6.2**, the urban-urban population interactions of NCR are grouped under five levels ranging from lakh 1304p^2/km^2 (Khurja) to lakh 684462p^2/km^2 (Delhi). Urban centers having the highest interaction range from lakh 200,001 to 684,462p^2/km^2, while towns having the lowest urban-urban population interaction range from 0 to lakh 4000 p^2/km^2 respectively. Cities (towns) with the highest urban-urban population interactions include Delhi (lakh 684,462p^2/km^2), Ghaziabad (lakh 205,928 p^2/km^2), NOIDA (lakh 180,004p^2/km^2), and Faridabad (lakh 172,899p^2/km^2) respectively. These cities have high population size and comparatively shorter distances. Cities (towns) with comparatively moderate urban-urban interactions are Gurgaon (lakh 43342p^2/km^2), and Meerut (lakh 33795p^2/km^2.Towns with weak urban-urban population interactions; on the other hand, represent majority of NCR urban centers ranging from lakh 1304-16697p^2/km^2. However; these interactions may not be considered as weak when compared to the urban peri-urban population interactions in NCR. The towns with weak urban-urban interaction have relatively small population size and located far away from Delhi.

Fig 6.2 demonstrates that Delhi dominates the urban-urban population interaction and has greater role on the process of sustainable and integrated development in NCR. Towns with lower urban-urban population interaction are assumed to have lesser role to bring about an integrated development in the Region. The computed data and **Fig 6.2** indicate that there is a decreasing pattern of urban-urban population interaction as one moves from city -center (Delhi) to the periphery.

6.3 Urban Peri-urban Population Interaction in National Capital Region

Rural-urban relationships and the rural-urban transformation processes are best understood from a viewpoint of economic history. It is necessary to trace and understand the history of the relationships between towns and their surrounding agricultural areas. These relationships are the basis for urban peri-urban interactions. Taking the economic aspects, urban per-urban relationships exist mainly due to:

- Rural users of urban services,
- Rural consumers of urban products; and,
- Urban users or consumers of rural products and services.

The United Nations Human Settlements Program, UN-Habitat (2002) states that the rural-urban relations are always historically bound and shaped by specific geographic, economic, social and political factors that must not be ignored in an attempt at generalizing analysis and model construction. Nevertheless, it is also useful and necessary to undertake broad and sometimes rather abstract studies of urbanization, in order to focus on rural-urban interactions, over time and in specific regions.

The UN-Habitat (2002); further, forwards that development takes place in the form of three interrelated processes of transformation – from predominantly rural to predominantly urban economic base, from high-level demographic equilibrium to low-level equilibrium, and from mainly primary-sector employment to mainly secondary and tertiary-sector employment. The trouble with uneven development is that those three processes of transformation rarely are in tune. Thus demographic transition typically jumps ahead of economic transition and especially, balanced rural-urban development.

6.3.1 Tahsil Level Urban Peri-urban Population Interaction in Haryana Sub-region

It has been noted that the urban per-urban population interactions take place for various purposes and for mutual benefits. The economic, social, administrative (political), and cultural interactions may come for front among other types. The rural people; for example, use the urban centers as market places for their products. They also get support services such as production inputs, repair services, credits, information, technology, and innovations to increase their productivity. The rural places usually get administrative and infrastructure provision services from their respective urban centers. On the other hand; the urban centers get their food crops (supply), raw materials for their processing industries, and market for their non-agricultural products from peri-urban (rural) areas. The urban peri-urban interdependency is not limited to the above issues; but extends to numerous multi-purpose interaction aspects.

The urban peri-urban population interaction in Haryana Sub-region mainly depends on the facts listed above. This part mainly stresses on the tahsil level population interactions among the urban centers and their neighboring peri-urban areas in the sub-region. The strength and the level of population interaction among the two spatial entities are clearly presented in table 6.7 below.

Table 6.7: Haryana Sub-region tahsil level urban peri-urban population interaction

Districts	Tahsils	Total Pop. (2001)	Nearest Town Center	Total Urban Population	Distance (km)	Interaction (LakhP^2/km^2)
Faridabad	Faridabad (Tilpat)	115698	Faridabad	812275	10	9398
	Ballabgarh	435150	Faridabad	812275	10	35346
	Palwal	404130	Faridabad	812275	30	3647
	Hathin	203881	Faridabad	812275	46	783
	Hodal	221142	Faridabad	812275	57	553
Dist. total	-	2193276	-	-	-	49,727
Gurgaon	Gurgaon (Jharsa)	380154	Gurgaon	249403	14	4837
	Pataudi	100890	Gurgaon	249403	30	280

	Taoru	123182	Gurgaon	249403	37	224
	Sohna	140620	Gurgaon	249403	24	609
	Nuh	212834	Gurgaon	249403	45	262
	Punahuna	206758	Gurgaon	249403	88	67
	Ferozepur Jhirk	243828	Gurgaon	249403	83	88
Dist. total	-	1657669	-	-	-	6,367
Rewari	Rewari (Dharuhera)	418898	Rewari	124289	15	2314
	Bawal	110549	Rewari	124289	16	537
	Kosli	110991	Rewari	124289	32	135
Dist. total	-	764727	-	-	-	2,986
Jhajjar	Jhajjar (Kablana)	343114	Jhajjar	39004	9	1652
	Beri	135260	Jhajjar	39004	9	651
	Bahadurgarh	370014	Jhajjar	39004	29	172
Dist. total	-	887392	-	-	-	2475
Rohtak	Rohtak (Kalanaur)	447326	Rohtak	311384	21	3159
	Maham	181326	Rohtak	311384	32	551
Dist. total	-	940036	-	-	-	3710
Sonipat	Sonipat (Rohat)	378097	Sonipat	225151	9	10,510
	Kharkhoda	160083	Sonipat	225151	19	998
	Gohana	339666	Sonipat	225151	35	624
	Ganaur	175833	Sonipat	225151	16	1546
Dist. total	-	1278830	-	-	-	13,678
Panipat	Panipat (Madlauda)	234850	Panipat	362047	19	2,355
	Israna	121992	Panipat	362047	17	1528
	Samalkha	248449	Panipat	362047	19	2492
Dist. total	-	967338	-	-	-	6,375
S.R total	-	8689263	-	-	-	85,318

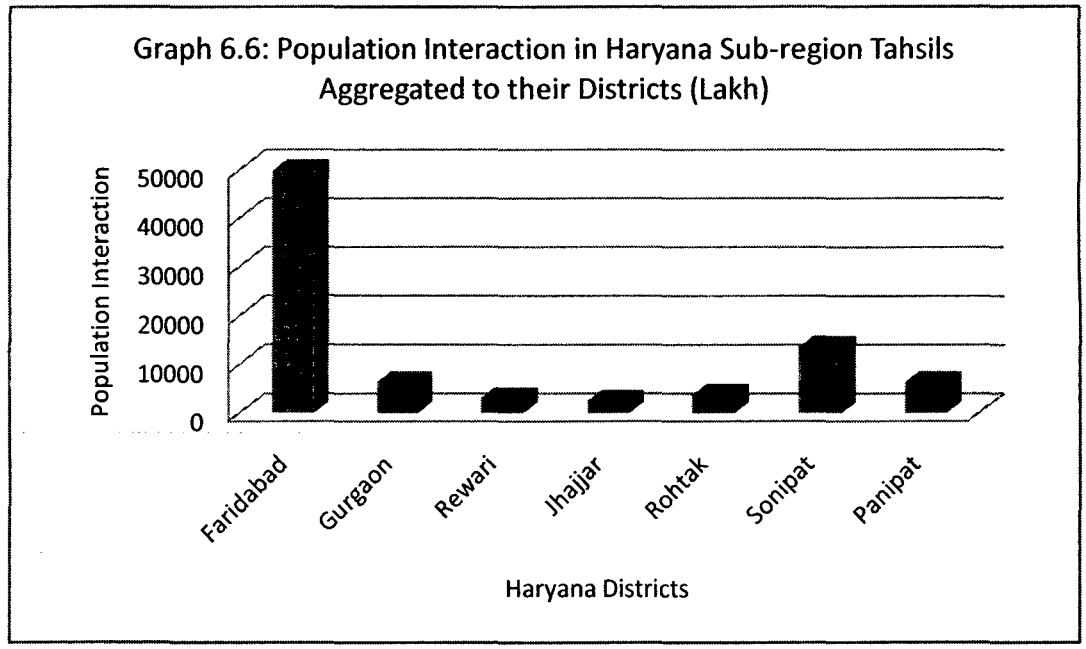
Source: Census of India, 2001.

The urban peri-urban interaction is directly proportional to the population of two places (urban and peri-urban) under consideration and inversely proportional to the square of the distance separating them.

The urban peri-urban population interaction in Haryana Sub-region is; therefore, subject to the interplay of the two factors. The results of tahsil level urban peri-urban population interactions are given in table 6.7 above. These results vary from the highest interaction score being lakh35,346p^2/km^2 between the town of Faridabad and tahsil Ballabgarh to the smallest interaction score being Lakh67p^2/km^2 between the town of Gurgaon and tahsil Punahana.

Taking sub-region level comparisons (comparisons within the sub-region); there are highest urban peri-urban population interactions in tahsils such as Ballabgarh (lakh 35,346p^2/km^2), Faridabad (lakh 9,398p^2/km^2), Sonipat (lakh 10,510p^2/km^2), Gurgaon (lakh 4,837p^2/km^2) and their corresponding urban areas. Tahsils like Bawal (lakh 3647p^2/km^2), Rewari (lakh 2314p2/km^2), Jhajjar (lakh 1652p^2/km^2), Rohtak (lakh 3159p^2/km^2), Ganaur (lakh 1546p^2/km^2), Samalkha (lakh 2492p^2/km^2) and their respective urban centers also have significant scores of urban peri-urban population interaction. On the other hand; tahsils such as Punahana (lakh 67p^2/km^2), Ferozepur Jhirk (lakh 88p^2/km^2), Kosli (lakh 135p^2/km^2), Bahadurgarh (lakh 172p^2/km^2), Taoru (lakh 224p^2/km^2), Nuh (lakh 262p^2/km^2), Pataudi (lakh 280p^2/km^2), and their corresponding urban centers have lower urban peri-urban population interaction scores. Graph 6.6

provides additional information on the strengths (scores) of urban peri-urban population interaction in tahsils and their respective urban centers in Haryana Sub-region.



6.3.2 Tahsil Level Urban Peri-urban Population Interaction in Uttar Pradesh Sub-region

The Uttar Pradesh Sub-region has high population size second to the NCT-Delhi which has greater role for high urban peri-urban population interaction. Similar to the facts discussed in Haryana Sub-region, the population interaction in UP takes place for various purposes and mutual benefits.

The strength of urban peri-urban population interaction is greatly determined by the population size and quality of existing transport networks. High quality (improved) transport networks generate high population interaction. Because, the peri-urban (rural) people can get easy access to supply their agricultural products to the urban centers, and in turn buy their consumption goods and services. On the other hand, the urban people would be encouraged to produce more non-agricultural goods and services for their rural customers. It would be better see the strength of urban peri-urban population interaction in Uttar Pradesh Sub-region from table 6.8 below.

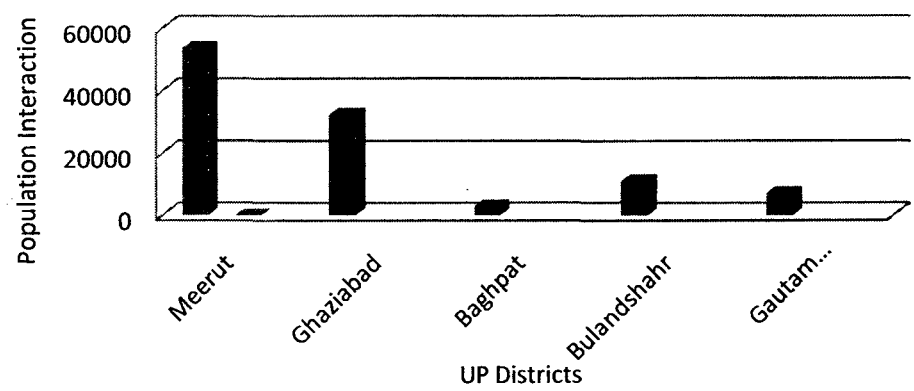
Table 6.8: Uttar Pradesh Sub-region tahsil level urban peri-urban population interaction

Districts	Tahsils	Total Population	Nearest Urban center	Total Urban Population	Distance (km)	Population Interaction (LakhP^2/km^2)
Meerut	Meerut (Aminagar)	604641	Meerut	1208805	16	28,505
	Mawana	686899	Meerut	1208805	26	12283
	Sardhana		Meerut	1208805	22	12628
Dist. total	-	3005961	-	-	-	53,462
Ghaziabad	Ghaziabad (Loni)	387320	Ghaziabad	1243054	20	12036
	Hapur	774007	Ghaziabad	1243054	34	8323
	Modinagar	555054	Ghaziabad	1243054	25	11039
	Garhmukteshwar	331122	Ghaziabad	1243054	70	840
Dist. total	-	3290557	-	-	-	32238
Baghpat	Baghpat (Aminagar Sarai)	142720	Baghpat	48788	17	240
	Khekada	323087	Baghpat	48788	10	1576
	Baraut	650007	Baghpat	48788	18	979
Dist. total	-	1164602	-	-	-	2,795
Bulandshahr	Bulandshahr (Gulaothi)	495977	Bulandshahr	239200	21	2,690
	Siana	471001	Bulandshahr	239200	32	1100
	Debai	380648	Bulandshahr	239200	51	350
	Shikarpur	381958	Bulandshahr	239200	22	1888
	Khurja	400932	Bulandshahr	239200	19	2657
	Anupshahr	300743	Bulandshahr	239200	40	450
Dist. total	-	2923290	-	-	-	10,810
Gautam B. N.	Gautam B. N. (dankaur)	258979	Noida	303252	32	767
	Dadri	387810	Noida	303252	14	6000
	Jewar	250566	Noida	303252	60	211
Dist. total	-	1200607	-	-	-	6,978
S.R total	-	11,785,017	-	-	-	104,608

Source: Census of India, 2001.

There are high urban peri-urban population interactions in many tahsils of Uttar Pradesh Sub-region which could be attributed to their access (proximity) to their neighboring urban centers and their population size. For example; tahsils Meerut (lakh 28,505p^2/km^2), Sardhana (lakh 12,628p^2/km^2), Mawana (lakh 12,283p^2/km^2), Ghaziabad (lakh 12,036p^2/km^2), Modinagar (lakh 11,039p^2/km^2), Hapur (lakh 8,323p^2/km^2), and, Dadri (lakh 6,000p^2/km^2) have comparatively high interactions with their neighboring urban areas; while tahsils Bulandshahr (lakh 2,690p^2/km^2), Khurja (lakh 2,657p^2/km^2), Shikarpur(lakh 1,888p^2/km^2), Khekada (lakh 1,576p^2/km^2), and Siana (lakh 1,100p^2/km^2) have moderate urban peri-urban interactions with their corresponding urban centers. However; tahsils such as Jewar (lakh 211p^2/km^2), Baghpat (lakh 240p^2/km^2), Debai (lakh 350p^2/km^2), and Anupshahr (lakh 450p^2/km^2) generate lower urban peri-urban interactions with their respective urban centers. The urban peri-urban population interaction scores in UP sub-region are depicted in Graph 6.7 below to indicate the strength of interaction among the two spatial entities.

Graph 6.7: Population Interaction in UP Sub-region Tahsils Aggregated to their Districts (Lakh)



6.3.3 Tahsil Level NCT-Delhi Sub-region Urban Peri-urban Population Interaction

The urban peri-urban interaction in the National Capital Territory of Delhi is very high and much more complex than the other sub-regions of the National Capital Region. It

refers to the interaction between the urban Delhi and the peri-urban areas of the NCT-Delhi.

The NCT-Delhi has the highest population size among the four sub-regions of NCR. Delhi serves as a huge market for the peri-urban agricultural and other products. It also serves as an outlet to other internal and external markets. Evidences indicate that there is a growing need for encouraging peri-urban agriculture in the NCT-Delhi for ensuring food and nutritional security of the urban people and helping the farmers in the rural areas to retain their traditional livelihood and reduce the consequences (impacts) of rapid urbanization leading to shrink the landholdings and leaving poor families economically insecure.

The Peri-urban agriculture can have several opportunities due to proximity and good connectivity to the urban markets. Many of the urban consumers demand high value, safe and nutritious fruits, vegetables, flower, dairy products, meat and poultry products which can increase the income of farmers in peri-urban areas of NCT-Delhi.

There is also a growing environmental concern which could be taken as part of the urban peri-urban interaction. This issue has to be properly addressed and mitigated to create conducive environment for sustainable agriculture in the peri-urban areas. The urban peri-urban environmental issue is very wide to cover in this study. The researcher; therefore, recommends the issue to be studied separately by other researchers. It is attempted to indicate the strength of the urban peri-urban population interaction in the National Capital Territory of Delhi through the help of table 6.9 as follows.

Table 6.9: Tahsil level NCT-Delhi Sub-region urban peri-urban population interaction

Districts	Tahsils	Total Population	Nearest Urban center	Total Population	Distance (km)	Population Interaction (Lakh p^2/km^2)
North-West	Narela	148594	Urban Delhi	12819761	32	18603
	Saraswati Vihar	115520	Urban Delhi	12819761	16	57849
Dist. total	-	264114	-	-	-	76,452
North	Civil lines	46586	Urban Delhi	12819761	7	121,882
Dist. total	-	46586	-	-	-	121,882
North-East	Seelam Pur	38375	Urban Delhi	12819761	11	40658
	Seema Puri	103153	Urban Delhi	12819761	16	51656
Dist.total	-	141,528	-	-	-	92314
East	Gandhi Nagar	6663	Urban Delhi	12819761	11	7059
	Preet Vihar	11460	Urban Delhi	12819761	9	18138
Dist.total	-	18123	-	-	-	25197
West	Punjabi Bagh	76351	Urban Delhi	12819761	11	80893
	Patel Nagar	8953	Urban Delhi	12819761	7	23424
Dist. total	-	85304	-	-	-	104317
South-West	Najafgarh	167607	Urban Delhi	12819761	31	22359
	Delhi Cantonment	22405	Urban Delhi	12819761	13	16996
	Vasant Vihar	34662	Urban Delhi	12819761	12	30858
Dist. total	-	224674	-	-	-	70213
South	Defense Colony	33389	Urban Delhi	12819761	8	66881
	Hauz Khas	99654	Urban Delhi	12819761	10	127754
	Kalkaji	51571	Urban Delhi	12819761	13	39120
Dist.total	-	184,614	-	-	-	233755
S.R Total	-	964,943	-	-	-	724,130

Source: Census of India, 2001.

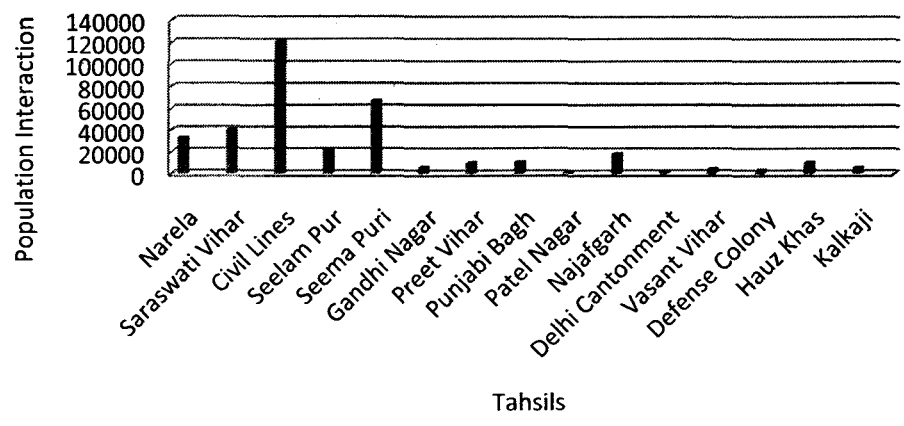
The urban peri-urban interaction scores of the four sub-regions of the National Capital Region correspond to the population size of the sub-regions. The NCT-Delhi with the

highest population size and comparatively shorter distances has the highest urban peri-urban population interaction (lakh 724,130p^2/km^2) in NCR.

Comparisons have been made among the urban peri-urban areas of the NCT-Delhi Sub-region. Taking the particular tahsils into consideration, Hauz Khas (lakh 127,754p^2/km^2), Civil lines (lakh 121,882p^2/km^2), Punjabi Bagh (lakh 80 893p^2/km^2), Defense Colony (lakh 66,881p^2/km^2), Saraswati Vihar (lakh 57,849p^2/km^2), Seema Puri (lakh 51,656p^2/km^2), Seelam Pur (lakh 40,658p^2/km^2), and Kalkaji (lakh 39,120p^2/km^2) have the highest urban peri-urban population in the NCT-Delhi. Other tahsils like Vasant Vihar (lakh 30,858p^2/km^2), Patel Nagar (lakh 23,424p/km^2), Najafgarh (22,359 p^2/km^2), Narela (lakh 18,603p^2/km^2), Preet Vihar (lakh18,138p^2/km^2), and Delhi Cantonment (lakh 16,996 p^2/km^2) have moderate scores of urban peri-urban population interaction. A tahsil with relatively lower urban peri-urban population interaction includes Gandhi Nagar (lakh 7,059 p^2/km^2). The lower interaction scores in NCT-Delhi are in the category of moderate ones in other sub-regions.

Generally speaking, the strength of urban peri-urban population interaction is very high in NCT-Delhi due to high population size, short distances, and improved transport networks. Graph 6.8 is employed to give additional information on the NCT-Delhi interaction scores.

Graph 6.8: Population Interaction in NCT-Delhi Sub-region
Tahsils (Lakh)



6.3.4 Tahsil Level Urban Peri-urban Population Interaction in Rajasthan Sub-region

The urban peri-urban population interaction in Rajasthan Sub-region is likely to be smaller than in the others. Because; the population size and density of Alwar district is relatively lower than in the other sub-regions. Furthermore; 85% (Census of India, 2001) of the population of the district live in rural areas and a great majority of the population practices agriculture and other primary activities like mining. Trade and manufacturing activities are lower than in other sub-regions.

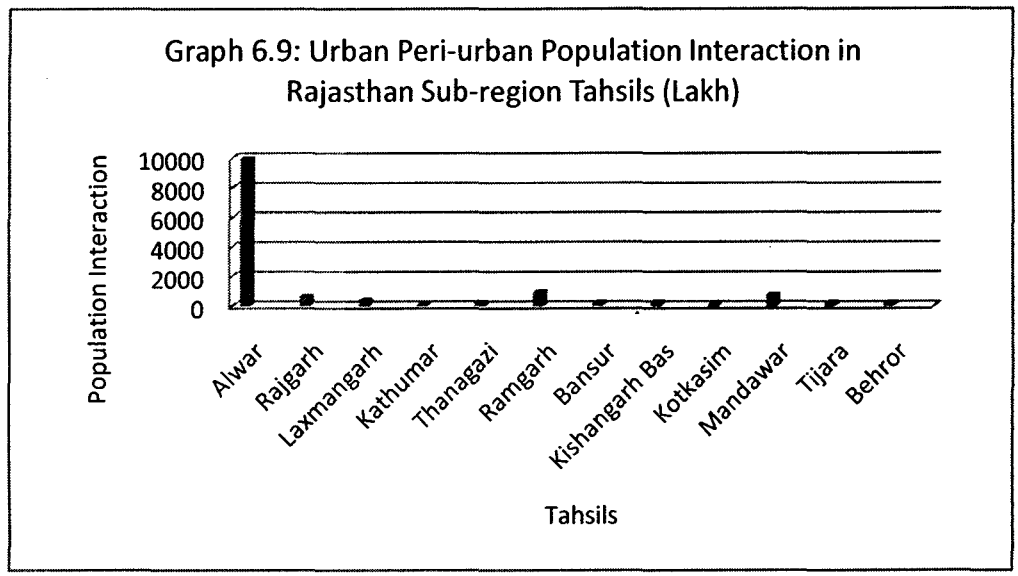
The strength of urban peri-urban population interaction in the district could also be affected by the maximum distance between the tahsils and their respective urban center. All the tahsils' head quarters (except Alwar, Ramgarh and Mandawar) are located far away from their respective urban centers. Table 6.10 provides supportive evidences favoring the reasons affecting the urban peri-urban population interaction in Rajasthan sub-region.

Table 6.10: Rajasthan Sub-region tahsil level urban peri-urban population interaction

District	Tahsils	Total Rural Population	Nearest Urban center	Total Urban Population	Distance (km)	Population Interaction (Lakhp^2/km^2)
Alwar	Alwar (Umren)	302327(rural)	Alwar	266203	9	9,936
	Rajgarh	306226	Alwar	266203	36	629
	Laxmangarh	241708	Alwar	266203	40	402
	Thanagazi	189977	Alwar	266203	46	239
	Kathumar	206685	Alwar	266203	77	93
	Ramgarh	201757	Alwar	266203	24	932
	Bansur	214351	Alwar	266203	50	228
	Kishangarh Bas	161629	Alwar	266203	40	269
	Mandawar	197582	Alwar	266203	27	721
	Tijara	280772	Alwar	266203	55	247
	Kotkasim	117687	Alwar	266203	50	125
	Behror	305688	Alwar	266203	60	226
Dist.total	-	2726689	-	-	-	14,047
S.R total	-	2726689	-	-	-	14,047

Source: Census of India, 2001.

Table 6.10 indicates that only Alwar (tahsil) has relatively high urban peri-urban interaction with a total score of lakh 9,936p^2/km^2. All other tahsils have lower strength of interaction which is attributed to their location from their respective urban center. Tahsils such as Kathumar, Kotkasim, Behror, Bansur, and Thanagazi have even the lowest interaction scores. See Graph 6.9 for additional information.



Correlation Test: Population Interaction and Distance from City-Center

Karl Pearson's Product Moment Correlation Coefficient (using SPSS) is employed to prove whether there exists a direct correlation between urban peri-urban population interaction in the National Capital Region and the distance variables. Since the result remains unchanged, the scale of population interaction is changed dividing each value by 1,000,000. Distances are measured in km from city-center (Delhi) towards district headquarters of the National Capital Region.

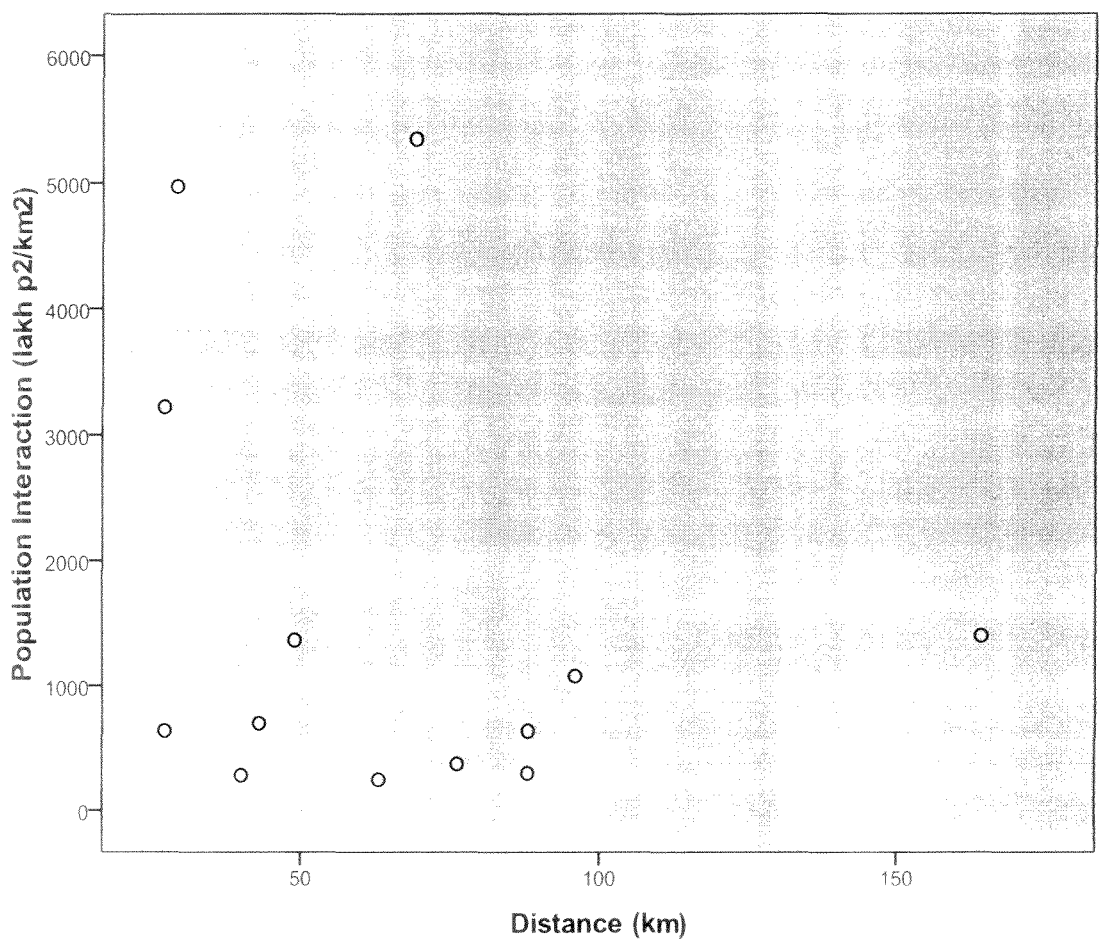
Table 6.11: Relationship between urban peri-urban population interaction in NCR and distance from city-center to district headquarters

S.No	Districts/Sub-region	Distance(km) (x)	Population Interaction (000,000) (y)
1	NCT-Delhi	12	72413
2	Gurgaon	27	637
3	Ghaziabad	27	3224
4	Faridabad	29	4973
5	Baghpat	40	280

6	Gautam Buddha N.	43	698
7	Sonipat	49	1368
8	Jhajjar	63	248
9	Meerut	69	5346
10	Rohtak	76	371
11	Panipat	88	638
12	Rewari	88	299
13	Bulandshahr	96	1081
14	Alwar	164	1405

Source: Compiled from Census of India

6.2 Scatter plot showing distance and population interaction variables

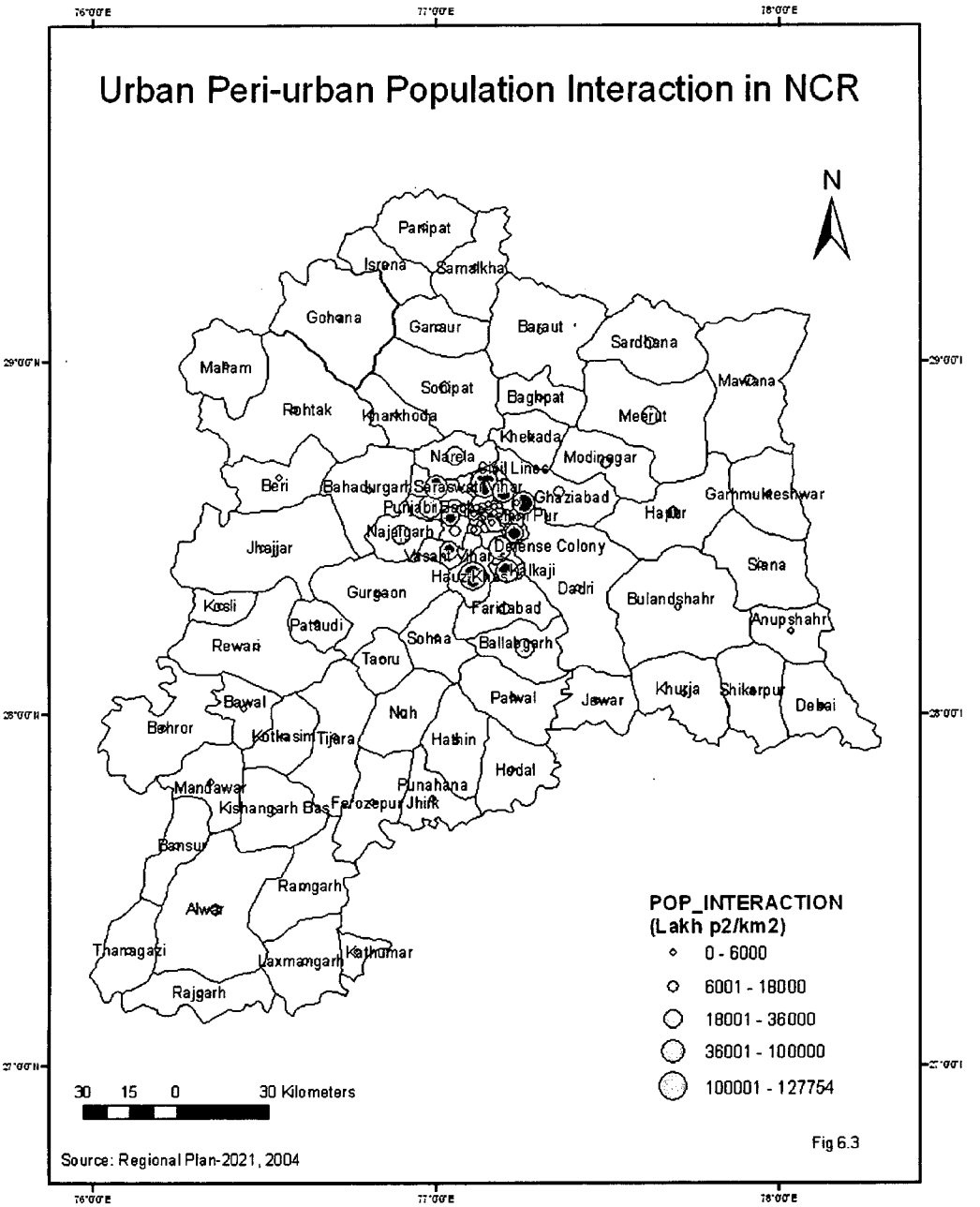


Correlations between distance from city-center and population interaction in NCR

		Distance (km)	Population Interaction (lakh p2/km2)
Distance (km)	Pearson Correlation	1	-.213
	Sig. (2-tailed)		.486
	N	13	13
Population Interaction (lakh p2/km2)	Pearson Correlation	-.213	1
	Sig. (2-tailed)	.486	
	N	13	13

The tabulated value of t for 11(13-2) degree of freedom is 3.11 at 1% 2.20 at 5% and 1.80 at 10% levels of significance. The computed value (0.723) of t (significance test of correlation coefficient) is less than even the 10% tabulated value of t. Hence; the correlation coefficient is insignificant. Note that Delhi is an outlayer and not considered in the computation. The size (area) and total population of the outer districts also distort the pattern (regularity) of relationships. For example; Alwar with a total area of 7,829 sq.km (nealy the size of other three districts) and total population of 2,990,862 (2001) which resulted in comparatively higher combined urban peri-urban population interaction greatly distorts the expected pattern of relationship.

Although it is weak and insignificant, the computed result gives insight that there exists inverse relationship between urban peri-urban poulation interaction and the distance from city-center towards the districize t headquarters in the National Capital Region. This implies as distance increases from city-center to the periphery, the strength of urban peri-urban population interaction decreases.


Urban Peri-urban Population Interaction in NCR
N
Panipat
Israna
Samalkha
Gohana
Ganaur
Baraut
Sardhana
Maham
Sonipat
Baghpat
Mawana
Rohtak
Kharkhoda
Meerut
Khekada
Narela
Civil Lines
Modinagar
Beri
Bahadurgarh
Saraswati Vihar
Ghaziabad
Garhmukteshwar
Punjabi Bagh
Hapur
Najafgarh
Jhajjar
Defense Colony
Siana
Vasant Vihar
Nilkaji
Gurgaon
Dadri
Bulandshahr
Kosli
Faridabad
Anupshahr
Pataudi
Rewari
Sohna
Ballabgarh
Taoru
Bawal
Patwal
Jewar
Khurja
Shikarpur
Delhai
Behror
Nuh
Kotkasim
Tijara
Hathin
Hodal
Mandawar
Punahana
Kishangarh Bas
Ferozepur Jhirk
Bansur
Ramgarh
Alwar
POP_INTERACTION
(Lakh p2/km2)
0 - 6000
6001 - 18000
18001 - 36000
36001 - 100000
100001 - 127754
Thanagazi
Laxmangarh
Kathumar
Rajgarh
30 15 0 30 Kilometers
Fig 6.3
Source: Regional Plan-2021, 2004

The urban peri-urban interactions involve the flows of people, workers, goods and services. They also take place between sectors such as agriculture, manufacturing and services and improve the livelihood of the people living in both urban and peri-urban areas. The urban peri-urban interactions are important to bring about integrated and balanced economic development. Isolated rural settlements can not be benefited from urban products and services. On the other hand; urban settlements having no interaction with their respective rural areas will not get agricultural and other rural products necessary for life.

The urban peri-urban interaction can take place at different levels and among various urban and peri-urban social groups. However; it has a vital role in the livelihood strategies of the poor groups of both urban and peri-urban areas. Low-income rural people often depend on urban-based non-farm jobs, while low-income urban dwellers usually work on seasonal farm jobs.

Taking these issues into consideration; the researcher has analyzed the urban peri-urban population interaction in the National Capital Region. Using ARCGIS **(see Fig. 6.3),** tahsils (areas) with various levels of urban peri-urban interactions are identified. Accordingly, the urban peri-urban population interactions of NCR are grouped under five levels ranging from lakh $93p^2/km^2$ (Kathumar tahsil) to lakh $127,754p^2/km^2$ (Hauz Khas tahsil). Places having the highest urban peri-urban interaction range from lakh $100,000\text{-}127,754p^2/km^2$, while places having the lowest urban peri-urban population interaction range from 0-Lakh $6000p^2/km^2$. Places with the highest urban peri-urban population interactions include tahsils Hauz-Khas (lakh $127,754p^2/km^2$) and Civil Lines (lakh $121,882p^2/km^2$) located at the immediate adjoining of the highly populated and entirely urbanized tahsils of Delhi. Places with the next highest interactions are tahsils Punjabi Bagh (lakh $80,893p^2/km^2$), Defense Colony (lakh $66,881p^2/km^2$), Saraswati Vihar, (lakh $57,849p^2/km^2$), and Seema Puri (lakh $51,656p^2/km^2$), respectively. Tahsils with the lowest urban peri-urban population interactions; however, represent majority of NCR tahsils and range from 0-Lakh $6000p^2/km^2$.

Generally speaking; places (tahsils) with highest urban peri-urban population interaction imply that they have better progress on the process of sustainable and integrated development in NCR. Tahsils with lowest urban peri-urban population interactions have lower progress in bringing about an integrated development in the Region. The computed data and **Fig 6.3** indicate that there is no uniform distribution of urban peri-urban population interactions in the National Capital Region.

6.4 Urban Peri-urban Workforce Interaction in National Capital Region

Before starting discussions about the workforce interaction, it is necessary to make the terms such as work, workforce, labor-force, workers, main workers, marginal workers, and non-workers clear. Based on the Indian National Sample Survey, NSS 55th round (1999), the term workforce refers to the persons gain fully employed in economic activities as self-employed, salary /wage paid, etc. This includes agricultural and non-agricultural activities, seasonal and perennial, regular and casual employment. It is generally used to describe those working for a single company or industry, but, can also apply to a geographic region like a city, country, state, etc. The term generally excludes the employers or managers, and implies those involved in manual labour.

The term workforce should not be confusing with the labourforce. The workforce refers to only those that are willing and available for work, while the term labourforce usually refers to the total number of persons classified as "employed" or "unemployed". The labourforce is a broader concept and comprises the workforce participation. Concerning to this, Mankiw (1997) states that the term labourforce is defined as the sum of employed and unemployed persons (16 years and older) during the reference period.

As per the Census of India 1981 (last updated in 2000), the terms work, main workers, marginal workers, and non-workers are defined as follows:

I. **Work**: was defined as participation in any economically productive activity. Such participation is physical or mental in nature. Work involves

not only actual work but also effective supervision and direction of work. According to this definition, the entire population has been classified into three main categories: main workers, marginal workers, and non-workers.

II. **Main workers**: were those who had worked for the major part of the year preceding the date of enumeration or, those who were engaged in any economically productive activity for 183 days (six months) or more during the year.

III. **Marginal Workers**: were those who worked any time at all in the year preceding the date of enumeration; did not work for a major part of the year, or those who worked for less than 183 days (six months).

IV. **Non-Workers**: were those who had not worked any time at all in the year preceding the date of enumeration. Generally, the status of workers is clearly determined by their extent of workforce participation.

Although, workers are classified into different categories, the total workers (main + marginal workers) are taken into consideration in the subsequent discussions. The objective of this part of the study is to assess the urban peri-urban workforce participation and urban peri-urban workforce interaction in National Capital Region. To calculate the urban peri-urban workforce interaction, the researcher considered the workforce of a given urban-center, its corresponding peri-urban area, and the relative distance separating the two geographic entities. The gravity model applied to calculate the population interaction is used to compute and estimate the total number of urban peri-urban workforce interactions (trips) in NCR as follows:

$$\sum_{i=1}^{n} Iij = k \sum_{i=1}^{n} \frac{PiPj}{dij^{b}}$$

Where, k = constant,

b = distance friction coefficient

I_{ij} = total interaction between places i and j,

P_i = population of place i,

P_j = population of places j,

D_{ij} = distance between places i and j.

6.4.1 Haryana Sub-region Tahsil Level Trend of Workforce Participation

The workforce participation refers to the number of working persons in a country. In relation to this, the National Sample Survey (NSS 60th round, 2004) of India defined the **Workforce Participation Rate** as the number of persons employed per thousand persons. This can also be calculated as the number of persons employed per hundred people.

This part of the study examines the trend of workforce participation in Haryana Sub-region taking both the percentage of workforce participation and the absolute number of total workers for the decade 1991-2001. Table 6.12 presents tahsil level trend of the rate of workforce participation in the Sub-region.

Table 6.12: Haryana Sub-region tahsil level trend of workforce participation

District	Tahsil	1991			2001		
		Total Population	Total Workers	%(1981-91)	Total Population	Total Workers	%(1991-01)
Faridabad	Faridabad	557781	166769	29.90	927973	295751	31.87
	Ballabgarh	301661	86199	28.57	436150	152468	34.96
	Palwal	467237	145038	30.04	404130	153164	37.89
	Hathin	150561	50152	33.31	203881	90606	44.44
	Hodal	-	-	30.80	221142	105060	47.51
Dist. Total	-	1477240	448158	30.68	2193276	797049	36.34
Gurgaon	Gurgaon	519065	149961	28.89	629557	233621	37.11
	Pataudi	84019	22885	27.24	100890	37773	37.44

	Taoru	-	-	-	123182	52350	42.49
	Sohna	-	-	-	140620	53554	38.08
	Nuh	231753	90473	39.04	212834	85454	40.15
	Punahana	-	-	-	206758	71281	34.47
	Ferozepur	311253	104124	33.45	243828	96515	39.58
Dist. Total	-	1146090	367443	32.06	1657669	630548	38.03
Rewari	Rewari	439697	123198	28.02	543187	222380	40.94
	Bawal	87630	24537	28.00	110549	53808	48.67
	Kosli	95924	25192	26.26	110991	57823	52.09
Dist.Total	-	623251	172927	27.75	764727	334011	43.68
Jhajjar	Jhajjar	448429	133565	29.79	382118	175086	45.82
	Beri	-	-	-	135260	50122	37.05
	Bahadurgarh	258635	84788	32.78	370014	168319	45.48
Dist. Total	-	707064	218353	30.88	887392	393527	44.34
Rohtak	Rohtak	620366	180041	29.02	940036	371696	39.54
	Maham	171521	59666	34.79	181326	85901	47.37
Dist. Total	-	791887	239707	30.27	1121362	457597	40.80
Sonipat	Sonipat	602766	183557	30.45	603243	234359	38.84
	Kharkhoda	-	-	-	160083	75206	46.97
	Gohana	309635	110163	35.58	339666	133813	39.39
	Ganaur	152100	47845	31.46	175838	80198	45.61
Dist. Total	-	1064501	341565	32.07	1278830	523576	40.94
Panipat	Panipat	677157	114625	16.93	596897	228852	38.34
	Israna	-	-	-	121992	55824	45.76
	Samalkha	-	-	-	248449	99522	40.06
Dist. Total	-	677157	114625	16.93	967338	384198	39.72
S.R Total	-	6824401	1902778	27.88	8689263	3520506	40.51

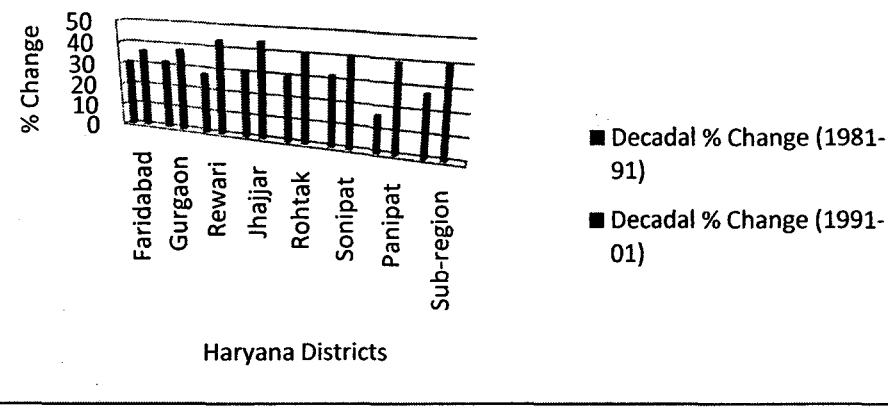
Source: Census of India 1991 and 2001.

The workforce participation in all tahsils of Haryana Sub-region shows an increasing trend. However, the percentage increase varies from 25.83% in tahsil Kosli to 1.11% in

tahsil Nuh. The tahsils having the highest increase in workforce participation rate include Kosli (25.83%), Panipat (21.41%), Bawal (20.67%), Hodal (16.71%), and Jhajjar (16.03%) respectively. Tahsils Ganaur (14.15%), Rewari (12.92%), Bahadurgarh (12.70%), and Maham (12.58%) have moderate increase in workforce participation rate, while tahsils Nuh (1.11%), Faridabad (1.90%), Gohana (3.81%), and Ballabgarh (6.39) show a slight increasing rate of participation.

Graph 6.10 is employed to illustrate the rate of trend of workforce participation in Haryana Sub-region.

Graph 6.10: Trend of Workforce Participation in Haryana Sub-region Tahsils Aggregated to their Districts



6.4.2 Haryana Sub-region Tahsil Level Urban Peri-urban Workforce Interaction

Work is the central purpose for the urban per-urban workforce interactions to take place. The urban peri-urban workforce interactions are based on mutual benefits. The rural (peri-urban) workers may interact among themselves on the process of production of agricultural products. However; this part stresses on the interaction of peri-urban workers with their respective urban workers mainly on the production and processes of selling and purchasing of their products in different market places. The interaction may also take place in the provision of support services such as production inputs, repair services, credits, information, technology, and innovations to increase their productivity. Urban workers produce various non-agricultural products and provide the peri-urban

workers and other rural people with various consumer goods and services as well as various agricultural implements. The urban peri-urban workforce interaction can also be expressed through the movement (shifting) of workers from one sector to another. Generally, the urban peri-urban workforce interdependency is not limited only to the above issues; but also extends to numerous multi-purpose interaction aspects.

The urban peri-urban workforce interaction in Haryana Sub-region mainly depends on the facts listed above at various levels. This part; however, stresses on the tahsil level workforce interactions among the urban centers and their neighboring peri-urban areas in the Sub-region. The strength and the level of workforce interaction among the two spatial entities are clearly presented in table 6.13 below.

Table 6.13: Haryana Sub-region tahsil level urban peri-urban workforce interaction

Districts	Tahsils	Tahsil Population	Tahsil Workers	Nearest Town Center	Urban Population	Urban Workers	Distance (km)	Interaction (lakh p^2/km^2)
Faridabad	Faridabad (Tilpat)	927973	295751	Faridabad	812276	255400	10	7,553
	Ballabgarh	436150	152468	Faridabad	812276	255400	10	3,894
	Palwal	404130	153164	Faridabad	81 2276	255400	30	435
	Hathin	203881	90606	Faridabad	812276	255400	46	109
	Hodal	221142	105060	Faridabad	812276	255400	57	83
Dist. total	-	2193276	797049	-	-	-	-	12,074
Gurgaon	Gurgaon (Jharsa)	629557	233621	Gurgaon	249403	82607	14	985
	Pataudi	100890	37773	Gurgaon	249403	82607	30	35
	Taoru	123182	52350	Gurgaon	249403	82607	37	32
	Sohna	140620	53554	Gurgaon	249403	82607	24	143
	Nuh	212834	85454	Gurgaon	249403	82607	45	35
	Punahuna	206758	71281	Gurgaon	249403	82607	88	8
	Ferozepur Jhirk	243828	96515	Gurgaon	249403	82607	83	12

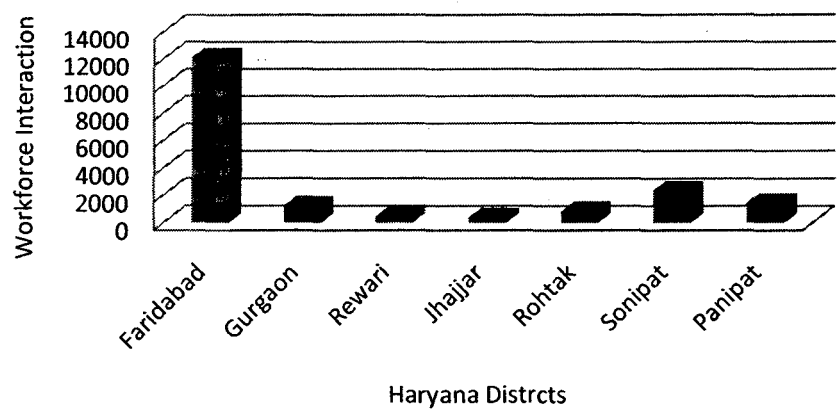
Dist. total	-	1657669	630548	-	-	-	-	1,250
Rewari	Rewari (Dharuhera)	543187	222380	Rewari	124289	36349	15	359
	Bawal	110549	53808	Rewari	124289	36349	16	76
	Kosli	110991	57823	Rewari	124289	36349	32	21
Dist. total	-	764727	334011	-	-	-	-	456
Jhajjar	Jhajjar (Kablana)	382118	175086	Jhajjar	39004	13346	9	288
	Beri	135260	50122	Jhajjar	39004	13346	9	83
	Bahadurgarh	370014	168319	Jhajajr	39004	13346	29	27
Dist. total	-	887392	393527	-	-	-	-	398
Rohtak	Rohtak (Kalanaur)	940036	371696	Rohtak	311384	92129	21	777
	Maham	181326	85901	Rohtak	311384	92129	32	77
Dist. total	-	1121362	457597	-	-	-	-	854
Sonipat	Sonipat (Rohat)	603243	234359	Sonipat	225151	66881	9	1,935
	Kharkhoda	160083	75206	Sonipat	225151	66881	19	139
	Gohana	339666	133813	Sonipat	225151	66881	35	73
	Ganaur	175838	80198	Sonipat	225151	66881	16	210
Dist. total	-	1278830	523576	-	-	-	-	2,357
Panipat	Panipat (Madlauda)	596897	228852	Panipat	362047	133139	19	844
	Israna	121992	55824	Panipat	362047	133139	17	257
	Samalkha	248449	99522	Panipat	362047	133139	19	367
Dist. total	-	967338	384198	-	-	-	-	1,468
S.R total	-	8689263	3520506	-	-	-	-	18,857

Source: Census of India, 2001.

Different urban centers and their respective peri-urban areas have various strengths of interactions. Similar to the urban peri-urban population interactions, urban peri-urban workforce interactions are greatly affected by the size of workforce and distance factors. Urban centers of Haryana Sub-region Faridabad (lakh 7,553p^2/km^2), Ballabgarh (lakh 3,894p^2/km^2), Sonipat (lakh 1,935p^2/km^2) and their neighboring peri-urban tahsils have comparatively high strengths of urban peri- urban interactions. Other urban centers such as Gurgaon (lakh 985p^2/km^2), Rohtak (lakh 777p^2/km^2), Panipat (lakh 844p^2/km^2) and their respective peri-urban areas have moderate strengths of workforce interaction. On the other hand; the rest urban areas and their corresponding peri-urban tahsils in Haryana Sub-region have weak workforce interactions. The total urban peri-urban workforce interaction of the Sub-region is lakh 18,857p^2/km^2.

Urban centers like Faridabad, Ballabgarh, Sonipat and their neighbor peri-urban areas also have high urban peri-urban population interaction. This indicates that there is close relationship with urban peri-urban workforce interaction that might be attributed to their common distance factor and their population and workforce sizes. Graph 6.11 indicates the strength of urban peri-urban workforce interactions in Haryana Sub-region.

Graph 6.11: Workforce Interaction in Haryana Sub-regionTahsils Aggregated to their Districts (Lakh)



6.4.3 Uttar Pradesh Sub-region Tahsil Level Trend of Workforce Participation

The assessment of workforce participation for different years gives the trend and status of the urban peri-urban workforce participation in Uttar Pradesh Sub-region. It indicates whether the participation is increasing or decreasing through time. Therefore; the percentages of workforce participation for the census years 1991 and 2001 are taken for comparisons. Table 6.14 is presented to compare and determine the trend of participation in the two successive census years.

Table 6.14: Uttar Pradesh Sub-region tahsil level trend of workforce participation

District	Tahsil	1991			2001		
		Total Population	Total Workers	%(1981-91)	Total Population	Total Workers	%(1991-01)
Meerut	Meerut	1398938	401257	28.68	1813446	505220	27.86
	Mawana	393788	187950	47.73	686899	231536	33.71
	Sardhana	619353	179324	28.95	505616	162884	32.21
Dist. Total	-	2412079	768531	31.86	3005961	899640	29.93
Ghaziabad	Ghaziabad	857497	260274	30.35	1630374	447669	27.46
	Hapur	638630	179324	28.08	774007	214824	27.75
	Modinagar	461870	139292	30.16	555054	167247	30.13
	Garhmukteshwar	279346	86281	30.88	331122	110881	33.48
Dist. Total	-	2237343	665171	29.73	3290557	940621	28.58
Baghpat	Baghpat	835833	245944	29.43	191508	62775	32.78
	Khekada	35191	9456	26.87	323087	103787	32.12
	Baraut	67705	17831	26.34	650007	218150	33.56
Dist. Total	-	938729	273231	29.11	1164602	384712	33.03
Bulandshahr	Bulandshahr	734102	208530	28.41	735177	280820	38.20
	Siana	444985	148560	33.38	471001	204105	43.33
	Debai	-	-	-	380648	125742	33.03
	Shikarpur	-	-	-	381958	183225	47.97

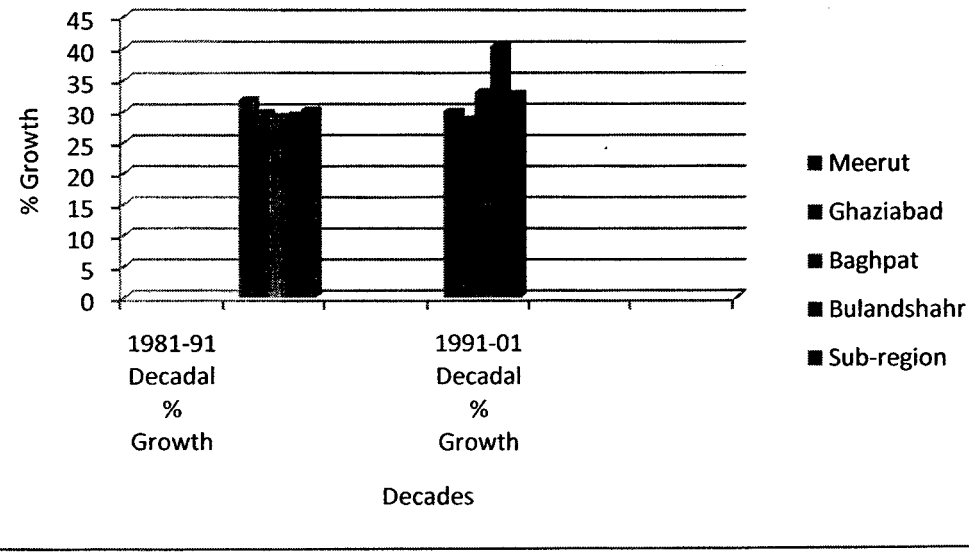
	Khurja	673102	193643	28.77	400942	147664	36.83
	Anupshahr	580028	163062	28.11	300743	137071	45.58
Dist.Total		2432217	713795	29.34	2670469	1078627	40.39
Gautam B.N.	Dadri	-	-	-	691082	244927	35.44
	Jewar	-	-	-	258979	77979	30.11
Dist. Total	-	-	-	-	950061	322906	30.11
S.R Total	-	8020368	2420728	30.18	11081650	3626506	32.73

Source: Census of India, 1991, 2001.

From table 6.14, we can observe that some five tahsils have a decreasing trend of workforce participation. These include Meerut (28.68 to 27.86%), Mawana (47.73 to 33.71%), Ghaziabad (30.35 to 27.46%), Hapur (28.08 to 27.75%), and Modinagar (30.16 to 30.13%) respectively. The other thirteen tahsils of the Sub-region; however, have an increasing trend of workforce participation.

The overall trend of participation shows an increasing trend with percentage of participation 30.18 in 1991 and 32.73 in 2001. Graph 6.12 illustrates the trend of workforce participation in Uttar Pradesh Sub-region in the two census years.

Graph 6.12: Decadal % Growth of Workforce Participation in UP Sub-region Tahsils Aggregated to their Districts



6.4.4 Uttar Pradesh Sub-region Tahsil Level Urban Peri-urban Workforce Interaction

Most of the reasons for urban peri-urban workforce interactions in the four sub-regions could approximately be similar. The peri-urban workforce interaction in the process of production of agricultural, mining, forestry, and fishery products and supplying of these products to the urban centers; on the one hand, and the urban workforce interaction in the process of production and provision of agricultural implements as well as consumer goods and services to the peri-urban tahsils could be taken among the common reasons. Therefore; what is discussed in the case of Haryana sub-region could be partially applicable for UP sub-region. The strengths of interactions; however, vary from sub-region to sub-region depending on their relative distances and size of workforces.

Despite its high population size (11,081,650), the Uttar Pradesh Sub-region has low workforce participation (3,626,506 or 32.73%) as compared to Haryana sub-region that has comparatively low population size, 8,689,263 and high workforce participation (3,520,506 or 40.51%). Table 6.15 is provided to give a clear picture of the urban peri-urban workforce interaction in UP Sub-region.

Table 6.15: Uttar Pradesh Sub-region tahsil level urban peri-urban workforce interaction

District	Tahsil	Tahsil Population	Tahsil Workers	Nearest Urban center	Urban Population	Urban Workers	Distance (km)	Interaction(lakh p^2/km^2)
Meerut	Meerut (Aminagar)	1813446	505220	Meerut	1208805	321119	16	6,337
	Mawana	686899	231536	Meerut	1208805	321119	26	849
	Sardhana	505616	162884	Meerut	1208805	321119	22	1081
Dist. total	-	3005961	899640	-	-	-	-	8,267
Ghaziabad	Ghaziabad(Loni)	1630374	447669	Ghaziabad	969538	269443	20	3,016
	Hapur	774007	214824	Ghaziabad	969538	269443	34	447

	Modinagar	555054	167247	Ghaziabad	969538	269443	25	721
	Garhmukteshwar	331122	110881	Ghaziabad	969538	269443	70	61
Dist. total	-	3290557	940621	-	-	-	-	4,245
Baghpat	Baghpat (Aminagar sarai)	191508	62775	Baghpat	48788	12516	17	27
	Khekada	323087	103787	Baghpat	48788	12516	10	130
	Baraut	650007	218150	Baghpat	48788	12516	18	84
Dist. total	-	1164602	384712	-	-	-	-	241
Bulandshahr	Bulandshahr (Gulaothi)	735177	280820	Bulandshahr	239200	63189	21	402
	Siana	471001	204105	Bulandshahr	239200	63189	32	126
	Debai	380648	125742	Bulandshahr	239200	63189	51	31
	Shikarpur	381958	183225	Bulandshahr	239200	63189	22	239
	Khurja	400942	147664	Bulandshahr	239200	63189	19	258
	Anupshahr	300743	137071	Bulandshahr	239200	63189	40	54
Dist.total	-	2670469	1078627	-	-	-	-	1,110
Gautam B.	Dadri	691082	244927	Noida	303252	105914	14	1323
	Jewar	258979	77979	Noida	303252	105914	60	23
Dist. total	-	950061	322906	-	-	-	-	1346
S.R total	-	11081650	3626506	-	-	-	-	15,209

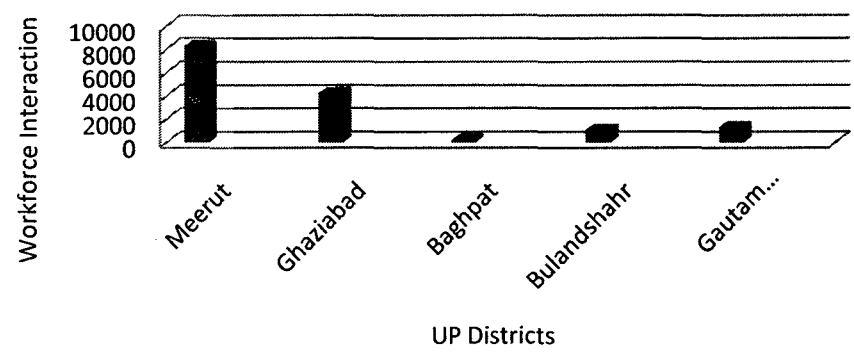
Source: Census of India, 2001.

Generally, Sub-region Uttar Pradesh has lower urban peri-urban workforce participation as compared to Haryana Sub-region. This in turn resulted in low urban peri-urban

interaction (lakh 15,209 p^2/km^2). To make comparisons among particular places in UP sub-region, tahsils such as Meerut (lakh 6,337p^2/km^2), Ghaziabad (lakh 3,016p^2/km^2), Gautam Buddha Nagar (lakh 1,323p^2/km^2), Sardhana (lakh 1,081p^2/km^2) and their corresponding urban centers have relatively high strength of urban peri-urban workforce interaction, while tahsils Mawana (lakh 849p^2/km^2), Modinagar (lakh 721p^2/km^2) and their neighboring urban centers show moderate strength of urban peri-urban workforce interaction.

Tahsils Jewar (lakh 23p^2/km^2), Baghpat (lakh 27p^2/km^2), Debai (lakh 31p^2/km^2), Anupshahr (lakh 54p^2/km^2), Garhmukteshwar (lakh 61p^2/km^2) and their corresponding urban areas generate very weak workforce interaction. Graph 6.13 below will best describe the degree of urban peri-urban interaction in UP Sub-region.

Graph 6.13: Workforce Interaction in UP Sub-region Tahsils Aggregated to their Districts (Lakh)



6.4.5 Workforce Participation in the National Capital Territory of Delhi

The National Capital Territory of Delhi has 32.80 average rate of workforce participation. This rate of participation varies with sectors, sex, districts, and tahsils of the NCT-Delhi. The workforce participation also varies with different economic activities in-which workers could be categorized as cultivators, agricultural laborers, household industry, and other workers.

This part discusses the urban peri-urban rate of workforce participation in the nine districts and 27 tahsils in NCT Delhi. The rate of workforce participation is the proportion of total workers to the respective total population. The following table (table 6.16) presents the NCT-Delhi Sub-region tahsil level rate of workforce participation in the year 2001.

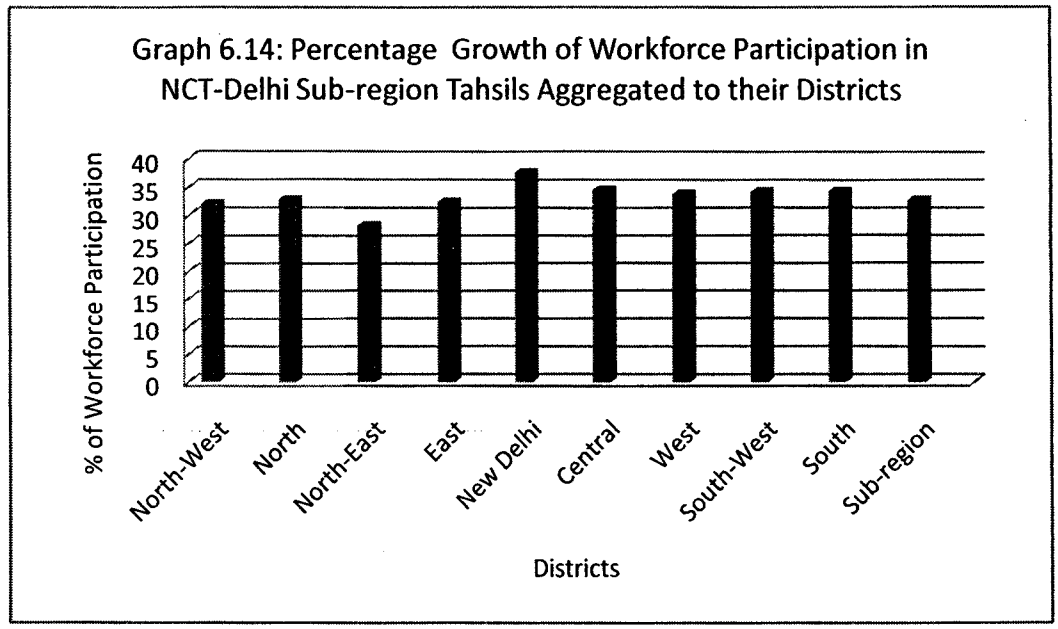
Table 6.16: NCT-Delhi Sub-region tahsil level workforce participation

District	Tahsil	2001		
		Population	Total Workers	% of Workers
North-West	Narela	497257	156688	31.51
	Saraswati Vihar	1795406	574882	32.02
	Model Town	555311	182954	32.93
District total	-	2847974	914524	32.11
North	Civil lines	525589	168822	32.12
	Sadar Bazar	133056	43991	33.06
	Kotwali	121849	43484	35.67
District total	-	780494	256297	32.84
North-East	Seelam Pur	917832	254352	27.71
	Shahdara	317570	91416	28.78
	Seema Puri	528176	153232	29.01
District total	-	1763578	499000	28.29
East	Gandhi Nagar	367292	118328	32.23
	Vivek Vihar	210881	66843	31.70
	Preet Vihar	882599	288824	32.72
District total	-	1460772	473995	32.44
New Delhi	Parliament street	58532	21161	36.15
	Connaught Place	44978	18161	40.38
	Chanakia Puri	68356	25421	37.19
District total	-	171866	64743	37.67
Central	Karol Bagh	140734	50548	35.92

	Pahar Ganj	196772	70138	35.64
	Darya Ganj	306829	102265	33.33
District total	-	644335	222951	34.60
West	Punjabi Bagh	592710	196489	33.15
	Patel Nagar	1060116	356806	33.66
	Rajouri Garden	468984	164902	35.16
District total	-	2121810	718197	33.85
South-West	Najafgarh	907222	281020	30.97
	Delhi Cantonment	306471	123557	40.32
	Vasant Vihar	536188	195949	36.54
District total	-	1749881	600526	34.32
South	Defense Colony	632284	226400	35.80
	Hauz Khas	1030497	348012	33.77
	Kalkaji	599594	202082	33.70
District total	-	2262375	776494	34.32
Sub-region Total	-	-	-	32.80

Source: Census of India, 2001.

The gap between the highest and the lowest workforce participation in NCT Delhi is smaller than that of the sub-regions Haryana and Uttar Pradesh. The rate of workforce participation in NCT-Delhi is greater than that of Uttar Pradesh and lower than that of Haryana and Rajasthan sub-regions. The NCT-Delhi tahsils Connaught Place (40.38%), Delhi Cantonment (40.32%), Chanakya Puri (37.67%), Vasant Vihar (36.54%), and Parliament Street (36.15%) have comparatively high rate of workforce participation, while tahsils like Seelam Pur (27.71%), Shahdara (28.79%), and Seema Puri (29.01%) indicate lower rate of participation. Other tahsils of the Sub-region have relatively medium rate of participation. Graph 6.14 illustrates the rate of workforce participation in tahsils of the National Capital Territory of Delhi.



6.4.6 NCT Delhi Tahsil Level Urban Peri-urban Workforce Interaction

As it has been discussed in the other sub-regions of the National Capital Region, the urban peri-urban workforce interaction depends on the production and supply of primary products such as agricultural, mining, and forestry to the urban Delhi; on the one hand, and production and supply of non-agricultural products like various industrial products, provision of technology, education, and health services to the peri-urban areas on the other.

The urban peri-urban workforce interaction is also expressed in change of occupation. When the peri-urban workers earn inadequate agricultural products to support their life, they usually flow to urban Delhi and join the non-agricultural urban activities. Urban workers are also assigned in peri-urban areas as health, education, water supply, and administrative workers. Table 6.17 below gives a clear picture of the strength of urban peri-urban interaction in NCT Delhi Sub-region.

Table 6.17: NCT-Delhi Sub-region tahsil level urban peri-urban workforce interaction

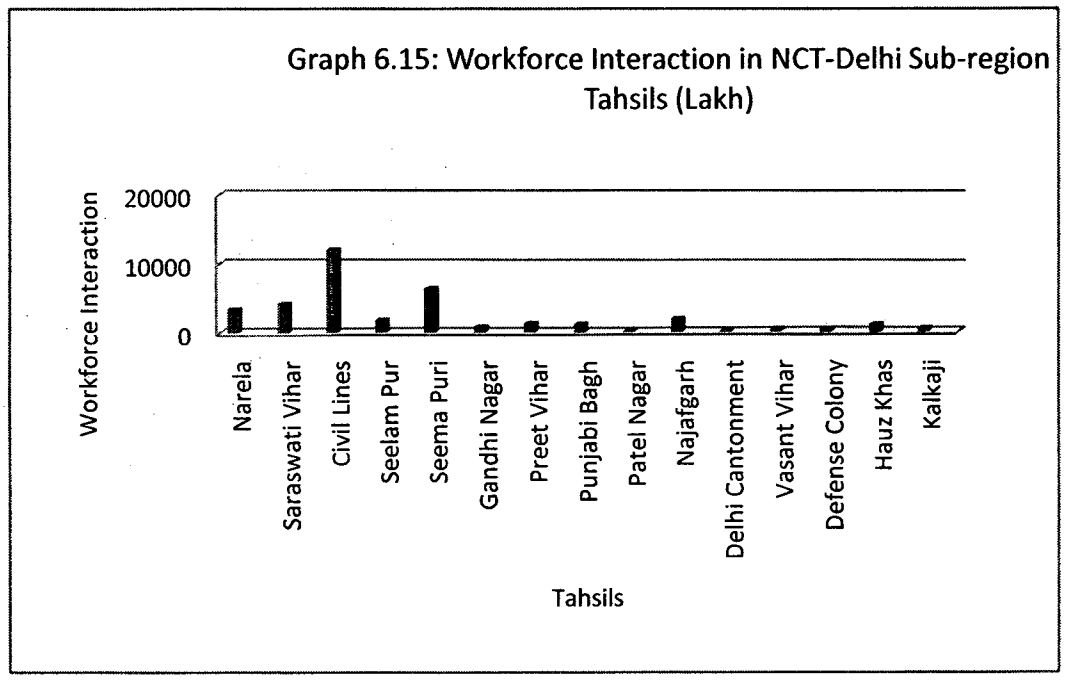
Dist.	Tahsil	Peri-urban Population	Peri-urban Workers	Nearest Urban center	Urban Population	Urban Workers	Distance (km)	Interaction (Lakh P^2/km^2)
North-W.	Narela	148594	46877	Urban Delhi	12819761	4217971	32	1931
	Saraswati Vihar	115520	36007	Urban Delhi	12819761	4217971	16	5933
Dist. total	-	264114	82884	-	-	-	-	7864
North	Civil lines	46586	14079	Urban Delhi	12819761	4217971	7	12119
Dist. total		465863	14079					12119
North-E.	Seelam Pur	38375	10281	Urban Delhi	12819761	4217971	11	3584
	Seema Puri	103153	30103	Urban Delhi	12819761	4217971	16	4960
Dist. total	-	141528	40384	-	-	-	-	8544
East	Gandhi Nagar	6663	2826	Urban Delhi	12819761	4217971	11	985
	Preet Vihar	11460	4493	Urban Delhi	12819761	4217971	9	2340
Dist. total	-	18123	7319	-	-	-	-	3325
West	Punjabi Bagh	76351	26340	Urban Delhi	12819761	4217971	11	9182
	Patel Nagar	8953	2455	Urban Delhi	12819761	4217971	7	2113
Dist. total	-	85304	28795	-	-	-	-	11295
South-W.	Najafgarh	167607	52732	Urban Delhi	12819761	4217971	31	2314
	Delhi Cantonment	22405	8812	Urban Delhi	12819761	4217971	13	2199
	Vasant Vihar	34662	12430	Urban Delhi	12819761	4217971	12	3641
Dist. total	-	224674	73974	-	-	-	-	8154
South	Defense Colony	33389	12820	Urban Delhi	12819761	4217971	8	8449
	Hauz Khas	99654	31411	Urban Delhi	12819761	4217971	10	13249
	Kalkaji	51571	17100	Urban Delhi	12819761	4217971	13	4268
Dist. total	-	184,614	61331	-	-	-	-	25966
S.R Total	-	964,943	308766	-	-	-	-	77,267

Source: Census of India, 2001.

The urban peri-urban workforce interaction in NCT Delhi is very high (lakh 77,267p^2/km^2) as compared to the other sub-regions of the National Capital Region. Of the 15 tahsils having peri-urban areas in NCT-Delhi, Hauz Khas (lakh 13,249p^2/km^2), Punjabi Bagh (lakh 9,182p^2/km^2), Defense Colony (lakh 8,449p^2/km^2), and Saraswati Vihar (lakh 5,933p^2/km^2) have high urban peri-urban workforce interactions. Those having relatively average interaction include tahsils Seema Puri (lakh 4,960p^2/km^2), Kalkaji (lakh 4,268p^2/km^2), Vasant Vihar (lakh 3,641p^2/km^2), and Seelam Pur (lakh 3,584p^2/km^2) respectively. Tahsils with the lowest workforce interaction in NCT Delhi; however, include Gandhi Nagar (lakh 985p^2/km^2), and Narela (lakh 1,931p^2/km^2).

The higher urban peri-urban workforce interaction in the NCT-Delhi than the other sub-regions of NCR is mainly attributed to the large population size of the urban Delhi and the shortest distances among the Peri-urban tahsils and the respective urban Delhi. Graph 6.15 is employed to give adequate understanding on the workforce interaction in NCT-Delhi.

Graph 6.15: Workforce Interaction in NCT-Delhi Sub-region Tahsils (Lakh)



6.4.7 Trend of Workforce Participation in Rajasthan Sub-region

Rajasthan Sub-region contributes the smallest portion (8.08%) to the total population of the National Capital Region. However; it constitutes 23.32% of the total area of NCR.

Rajasthan Sub-region has predominantly agricultural economy and is the least urbanized among the NCR sub-regions. But; the workforce participation is higher than the other sub-regions. The table below (table 6.18) reflects the trend of workforce participation in Rajasthan Sub-region.

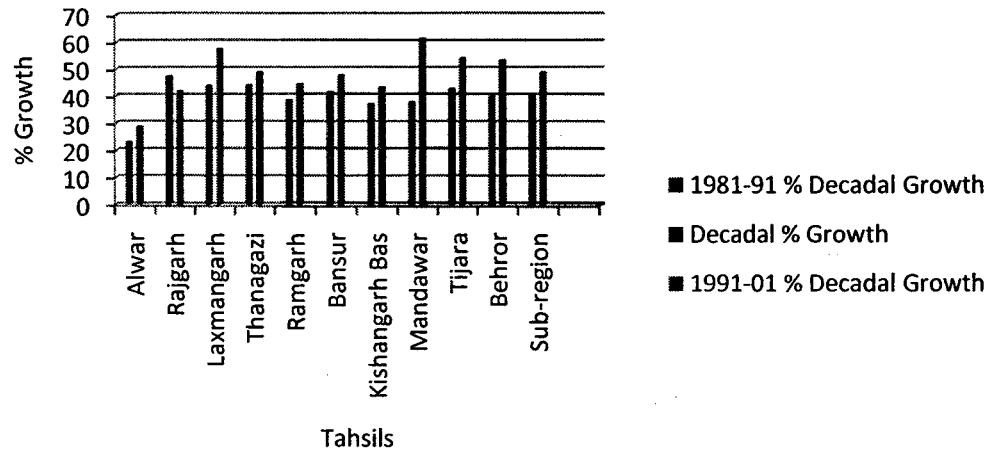
Table 6.18: Tahsil level trend of workforce participation in Rajasthan Sub-region

District	Tahsils	1991			2001		
		Total Population	Total Workers	% of Workers	Total Pop.	Total Workers	% of Workers
Alwar	Alwar	432952	100244	23.15	568530	163014	28.67
	Raigarh	238519	113130	47.43	306226	128119	41.83
	Laxmangarh	354847	155670	43.86	241708	138836	57.44
	Thanagazi	144119	63632	44.15	189977	93125	49.02
	Kathumar	-	-	-	206685	105906	51.24
	Ramgarh	149796	57582	38.44	201757	89705	44.46
	Bansur	163582	67875	41.49	214351	102401	47.77
	Kishangarh B.	217264	80822	37.19	161629	69840	43.21
	Mandawar	162010	61216	37.78	197582	121213	61.35
	Tijara	181877	77592	42.66	280772	151716	54.04
	Kotkasim	-	-	-	117687	60181	51.14
	Behror	251614	100244	39.84	305688	163014	53.32
Dist. T.	-	2296580	927116	40.36	2992892	1458686	48.73
S.R T.	-	2296580	927116	40.36	2992892	1458686	48.73

Source: Census of India, 2001.

All tahsils of Rajasthan Sub-region; except, Rajgarh which declined from 47.43% to 41.83%, show an increasing trend of workforce participation. At the same time; all the tahsils; except, Alwar (28.67%) have workforce participation greater than 40%. Among others, Mandawar (61.35%), Laxmangarh (57.44%), Tijara (54.04%), and Behror (53.32%) have the highest workforce participation. The average workforce participations in the Census years of 1991 (40.36%) and 2001(48.73%) show an increasing trend. Rajasthan Sub-region has the highest workforce participation than the other sub-regions of the National Capital Region. Graph 6.16 illustrates the trend of workforce participation in the Sub-region.

Graph 6.16: Decadal Growth of Workforce Participation in Rajasthan Sub-region Tahsils



6.4.8 Rajasthan Sub-region Tahsil Level Urban Peri-urban Workforce Interaction

The workforce interactions in Rajasthan Sub-region are intended on several purposes. Similar the reasons in other sub-regions, these interactions take place on the process of production and provision of rural (agricultural) products to the urban centers; on the one hand, and on the process of production and provision of urban products to the peri-urban areas on the other. These also include the movement of workers from rural to urban and sometimes from urban to rural areas which mostly resulted in change of occupation.

The slow process of urbanization in Rajasthan Sub-region can have a significant influence on the urban peri-urban workforce interactions to take place. The following table (table 6.19) gives adequate information on the strength of workforce interaction in Rajasthan Sub-region.

Table 6.19: Rajasthan Sub-region tahsil level urban peri-urban workforce interaction

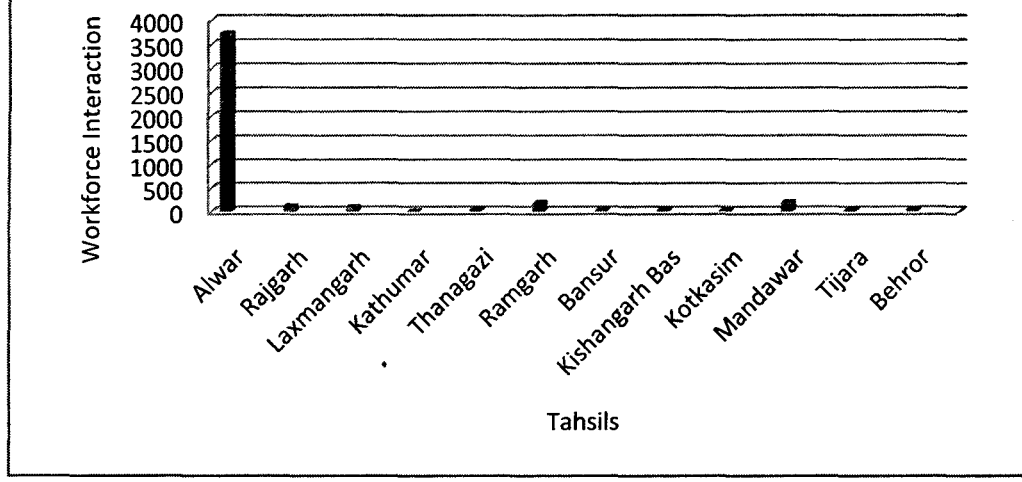
District	Tahsils	Total Pop.	Total Peri-Urban Workers	Nearest Urban center	Total Urban Pop.	Total Urban Workers	Distance (km)	Interaction (Lakh p^2/km^2)
Alwar	Alwar (Umren)	302327 (rural)	234630	Alwar	266203	128801	9	3,731
	Raigarh	306226	128119	Alwar	266203	128801	36	127
	Laxmangarh	241708	138836	Alwar	266203	128801	40	112
	Thanagazi	189977	93125	Alwar	266203	128801	46	57
	Kathumar	206685	105906	Alwar	266203	128801	77	23
	Ramgarh	201757	89705	Alwar	266203	128801	24	201
	Bansur	214351	102401	Alwar	266203	128801	50	53
	Kishangarh B.	161629	69840	Alwar	266203	128801	40	56
	Mandawar	197582	121213	Alwar	266203	128801	27	214
	Tijara	280772	151716	Alwar	266203	128801	55	65
	Kotkasim	117687	60181	Alwar	266203	128801	50	31
	Behror	305688	163014	Alwar	266203	128801	60	58
D.total	-	2992892	1458686	-	-	-	-	4,728
S.R total	-	2992892	1458686	-	-	-	-	4728

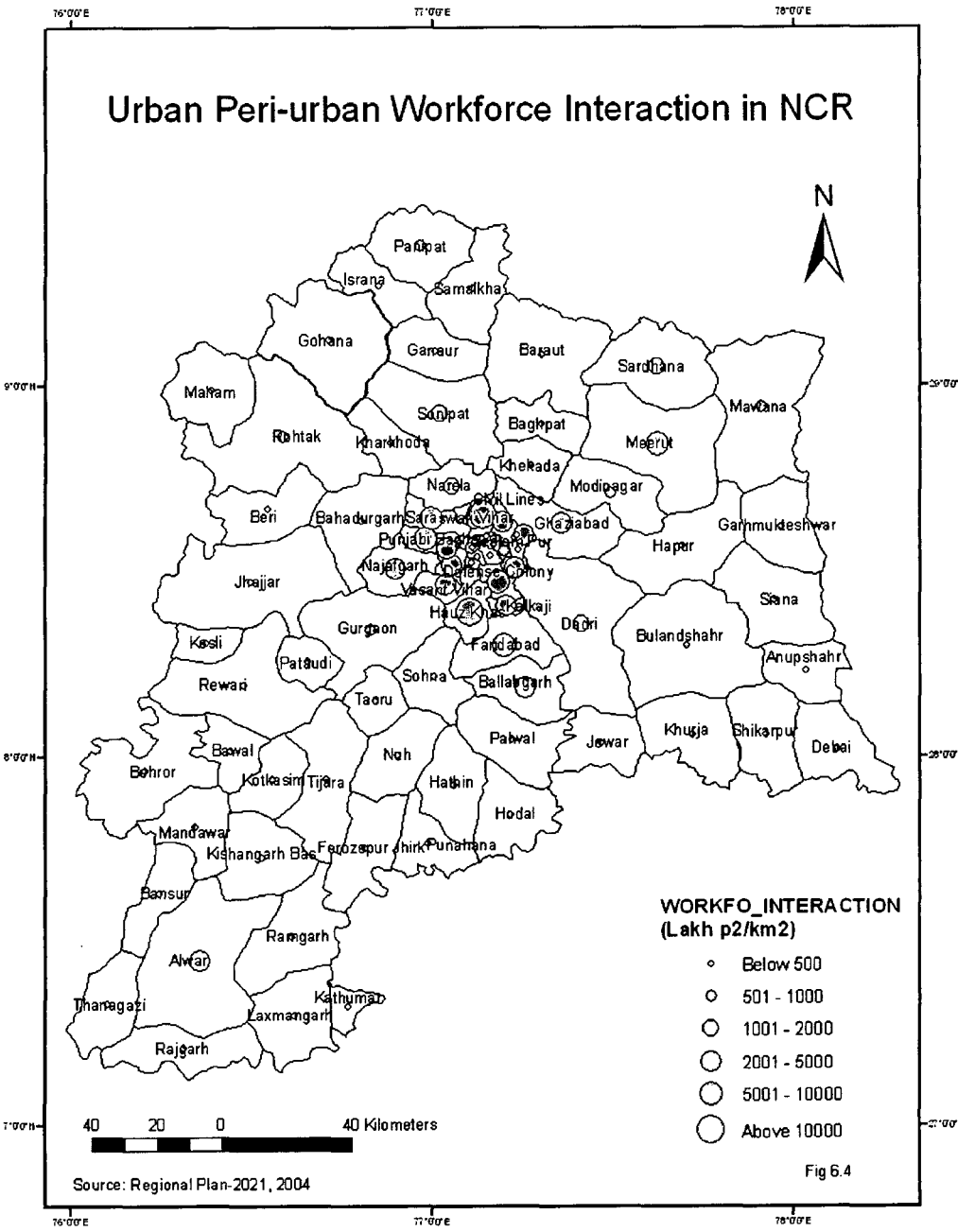
Source: Census of India, 2001.

Of all the tahsils of Rajasthan Sub-region, only Alwar has comparatively moderate (lakh 3,731p^2/km^2) urban peri-urban workforce interaction. All others do not even close to the average of the tahsils in other sub-regions. Tahsils Kathumar (lakh 23p^2/km^2), and Kotkasim (lakh 31p^2/km^2) have the lowest urban peri-urban workforce interactions in this Sub-region.

The reasons for the weak workforce interaction in Rajasthan Sub-region are related to the small population size of the urban centers and their relative peri-urban tahsils as well as the long distances between the two spatial entities. Graph 6.17 is presented to demonstrate the strength of interaction among the urban and peri-urban workers of Rajasthan Sub-region.

Graph 6.17: Urban Peri-urban Workforce Interaction in Rajasthan Sub-region Tahsils (Lakh)




Urban Peri-urban Workforce Interaction in NCR
N
Panipat
Israna
Samalkha
Gohana
Garaur
Baraut
Sardhana
Mawana
Maham
Sonipat
Baghpat
Rohtak
Kharkhoda
Meerut
Khekada
Narela
Modinagar
Civil Lines
Beri
Bahadurgarh
Ghaziabad
Garhmukteshwar
Hapur
Jhajjar
Najafgarh
Defence Colony
Siana
Gurgaon
Dadri
Bulandshahr
Kasli
Faridabad
Anupshahr
Pataudi
Sohna
Ballabgarh
Rewari
Taoru
Palwal
Jewar
Khurja
Shikarpur
Debai
Bawal
Nuh
Bohror
Kotkasim
Tijara
Hathin
Hodal
Mandawar
Kishangarh Bas
Ferozepur Jhirk
Punahana
Bansur
Ramgarh
Alwar
Thanagazi
Kathumar
Laxmangarh
Rajgarh
40 20 0 40 Kilometers
WORKFO_INTERACTION
(Lakh p2/km2)
Below 500
501 - 1000
1001 - 2000
2001 - 5000
5001 - 10000
Above 10000
Fig 6.4
Source: Regional Plan-2021, 2004

It has been noted that the peri-urban areas are mostly characterized by strong urban influence for various purposes, such as supply of farm products, and supply of low-skilled workers to fill existing labor gaps. These areas also suffer from shortages of adequate farm lands and risks of urban expansion and pollution. Drechsel (1999) argues that "there is a growing tendency toward more intensive production systems that better satisfy the increasing urban demand in peri-urban than in rural areas. Often, larger urban centers have conspicuous inner and outer zones where cultivation of food crops and market gardening are being pursued vigorously." Since peri-urban agriculture is highly profitable, farmers who can invest on agricultural intensification can squeeze out the small-scale farming. As a result wage agricultural labour often becomes more important than the small-scale farming attracting workers from both urban and peri-urban areas. This process ensures the urban peri-urban workforce interactions.

The urban peri-urban workforce interaction in the National Capital Region is a manifestation of peri-urban workforce participation in the process of production and supply of farm products to satisfy the demand of urban centers on the one hand; and, urban workforce participation in the production and supply of non-farm products (goods) and services required by the peri-urban people on the other. Surplus peri-urban workers may involve in available urban activities or vice versa.

Findings show that the urban peri-urban workforce interactions greatly vary throughout the tahsils of the National Capital Region. Using ARCGIS **(see Fig. 6.4)** tahsils having various levels of workforce interaction are identified. Based on the tahsil level map of NCR (Fig.6.4), the urban peri-urban workforce interactions are categorized under five levels ranging from 0 to lakh 13,249p^2/km^2. Accordingly, places having highest urban peri-urban workforce interactions range from lakh 5,000p^2/km^2 -13,249p^2/km^2; while places having the lowest interactions range from 0-lakh 500p^2/km^2.

Tahsils having the highest workforce interaction include Hauz Khas (lakh 13,249p^2/km^2), Punjabi Bagh (lakh 9,182p^2/km^2), Defense Colony (lakh 8,449p^2/km^2), Faridabad (lakh 7,553p^2/km^2), Meerut (lakh 6,337p^2/km^2), and Saraswati Vihar (lakh 5,933p^2/km^2)

respectively. These are the tahsils within the NCT-Delhi or districts having million cities which resulted in high interaction. The map **(Fig. 6.4)** indicates tahsils Seema Puri (lakh 4,960p^2/km^2), Kalkaji (lakh 4,268p^2/km^2), Ballabgarh (lakh 3,894p^2/km^2), Alwar (lakh 3,731p^2/km^2), Vasant Vihar (lakh 3,641p^2/km^2), Seelam Pur (lakh 3,584p^2/km^2), and Ghaziabad (lakh 3,016p^2/km^2) are the second highest in workforce interaction. However; most of the tahsils of the National Capital Region fall under relatively lower urban peri-urban workforce interaction ranging from 0-lakh 500p^2/km^2.

Tahsils with high population (workers) and shortest distance to their head quarters have highest urban peri-urban workforce interaction. On the other hand; tahsils having low population (workers) concentration and longest relative distance to their head quarters have weak urban peri-urban workforce interaction. Similar to the urban peri-urban population interaction, there exists uneven distribution of urban peri-urban workforce interaction in National Capital Region.

CHAPTER 7: CONCLUSIONS AND POLICY INPUTS

7.1 Conclusions

A rapid population growth in both urban and peri-urban areas of the National Capital Region is one of the major determinants of urban peri-urban interaction. A high population concentration in some areas could face material resource limitations to meet the minimum basic needs while other areas may still constrain with human resources. As a result; people move (migrate) from scarce areas to resource areas. The formation and planning of NCR is with the intention of solving the problems of rapid population growth and pressure in Delhi through ensuring a balanced and planned development leading to dispersal of economic activities and immigrants to the neighboring peri-urban areas having adequate space and land resources. The unique characteristic features supporting the issue under discussion are the growing trend (table 5.1) in the percentage share of population in NCT-Delhi Sub-region on the one hand, and the declining trend in the percentage share of population in UP, Haryana, and Rajasthan sub-regions on the other. Another driving force for the urban peri-urban interaction in NCR is the unequal distribution of population among sectors which resulted in a continuous high rate of urbanization and a continuous decreasing trend in the proportion of the peri-urban population.

The economic disparities among sub-regions are among the major determinants of urban peri-urban interactions. These disparities are reflected in weak urban peri-urban interactions and poor center-periphery relationships. It has been attempted to address the disparities using the data in table 5.9. There are significant economic differences among sub-regions and are increasing from year to year. For instance; the per capita income of the NCT-Delhi Sub-region (Rs. 61,676) in the year 2006 is more than four times that of the Uttar Pradesh (Rs. 13,262) in the same year. The NCR sub-regions, UP and Rajasthan, have lower per capita income (Rs. 13,262 and 17,863) than the national average Rs. 23,222.

The second factor taken to investigate the economic disparities is the proportion of population below poverty line. Although it has certain problems for its accuracy, this measure can serve as economic and social indicator. Table 5.10 indicates that there exist clear relationships between the proportion of population below poverty line and the average per capita of the sub-regions. Delhi and Haryana sub-regions with highest average per capita income have lower proportion of population below poverty line (14.7% and 14.0%) while UP sub-region with lowest per capita income has the highest proportion of population below poverty line (32.8%). We have seen that economic disparities can limit the urban peri-urban interactions for business, trade, investment, and other purposes.

Economic disparities among sub-regions can encourage other forms of urban peri-urban interaction expressed by urban-ward migration. People flow from scarce areas to areas having high opportunities. Here, the unique situations are the relationships between sub-regions per capita income, unemployment, and migration to urban centers. Sub-regions such as UP with lower per capita income have high rate of unemployment and high urban-ward (Delhi) migration while sub-regions having higher per capita income have comparatively lower rate of unemployment and migration to Delhi.

The distribution of workers by sector in NCR can affect the urban peri-urban interaction in some ways. The service sector in NCR is rapidly growing. It is attracting and shifting workers mainly from the primary rural sector. It has been proved (table 5.18) that there exists a decreasing trend in both cultivators and agricultural laborers throughout the three decades (1971-01) while trade, commerce and others enjoy a rapid increasing trend.

The study has given due emphasis to land utilization as well as to the extent of land use changes from agricultural to non-agricultural (built-up) lands which could be taken (assumed) as best explanatory for urban peri-urban interaction in NCR. The built-up area in NCR (table 5.21) had grown from 2.94% to 7.85% in the years 1986-1999 indicating 4.91% growth in 13 years. However; within the years 1999-2001, the built-up area had

rapidly grown to 14.22%, nearly double within two years. On the other hand, the agricultural land area declined from 78.94% to 71.62% in the years 1986-1999 and further sharply declined to 60.85% in 2001. Land use change in NCR decreases as one moves from city-center (Delhi) to the periphery.

The National Capital Region has a well designed road and rail transport network system that favors strong urban peri-urban interaction. The road network of NCR shows convergence of five National High Ways in Delhi and two National High Ways in Ghaziabad. On the other hand; the Rapid-Regional Rail Network connects the regional towns among each other and with Delhi.

There is power infrastructure shortage in the Region. However; there is adequate coverage of telecommunication facility in NCR. Access to telephone facility promotes collaborative work in business activities, sharing information and scientific studies.

The development of education infrastructure plays a key role in strengthening urban peri-urban interaction. The norms and standards of the Regional Plan are considered to assess the status of the provision of educational facilities in NCR. With the exception of primary school facilities, all sub-regions and districts of NCR are below the norms of the Regional Plan. Excluding the NCT-Delhi, the literacy rate in NCR is not encouraging. Districts such as Gautam Buddha Nagar and Meerut have literacy rates 57.6% and 58% which are below the national average (64.84%).

There is unequal distribution of health care infrastructure in NCR. Except hospital facilities in Delhi, the status of health care infrastructure in NCR is below the norms and standards stated by the Regional Plan. The difference in provision and distribution of health care infrastructure in NCR is resulted in significant difference in life expectancy in the sub-regions.

Provision and distribution of drinking water and drainage facility; except Rajasthan, are encouraging (above 80%). The supply of electric light in NCT-Delhi (92.84%) and Haryana

(83.31%) sub-regions is also encouraging. However; supply of separate kitchen, bath room and latrine facility is unsatisfactory in all sub-regions of NCR.

Shelter as one of the basic needs of man largely determines the urban peri-urban interaction. People need safe and affordable housing. When the number of houses in NCR is compared with the number of households, the existing gap is not very wide. However; when housing amenities considered, they have critical problems ranging large number of the houses into slum standard. Hence; the slum population of NCR is 21.87%.

Comparisons concerning urban Delhi gravitational fields and sphere of influence have been made not only at tahsil and district levels; but also, at Sub-region levels. The total urban gravitational fields in the respective Sub-regions include the rural NCT-Delhi (1,694,623p/km^2), Haryana Sub-region (104,310p/km^2), Uttar Pradesh Sub-region (71,162p/km^2), and Rajasthan Sub-region (7,218p/km^2). These results give a clear picture of core-periphery decreasing patterns.

The strength of City influence on its neighboring settlements can increase or decrease in accordance with the traffic development situations. The development of modern transportation can increase the inward force to the distant settlements and help to form an integrated social and economic development in the National Capital Region.

City gravitational fields are represented in circular mosaics as indicated in Fig. 6.1. The size of the circular features decreases as one moves from the center of the City to the periphery indicating the declining of the strength of the sphere of influence with distance.

The distribution of gravitational fields illustrates, unlike to the assumptions stated in Central Place Theory (Christaller, 1933) referring uniform distribution of towns, the spatial distribution of towns in the National Capital Region has no geometric regularity. Hence, the strength of influence for each town (settlement) varies accordingly.

The urban-urban interaction is a function of the total population of two given urban centers (towns) and the distance separating them. As a result, the NCR urban centers

Ghaziabad (lakh 172, 899p^2/km^2), NIDA (lakh 180,041p^2/km^2), and Faridabad (lakh 172, 899p^2/km^2) have the highest strength of interaction due to their proximity to the city-center (Delhi) and their high population size. On the other hand; urban centers Alwar (lakh 1,362p^2/km^2), Rewari (lakh 1,797p^2/km^2), and Bulandshahr (lakh 2,636p^2/km^2) have weak interaction with Delhi (City) for their distant locations and comparatively small population size.

Rural-urban relationships and the rural-urban transformation processes are best understood from a viewpoint of past economic and social transformations. It is necessary to trace and understand the history of the relationships between towns and their surrounding agricultural areas. These relationships are the basis for urban peri-urban interactions. The urban per-urban relationships usually come to exist mainly when rural consumers demand the urban goods and services. Similarly, the relationships develop when urban consumers demand rural products and services.

Evidences indicate that there is a growing need to encourage peri-urban agriculture to ensure food and nutritional security of urban people and helping farmers in rural areas to retain their traditional livelihood and reduce the consequences (impacts) of rapid urbanization leading to shrink the landholdings leaving poor families economically insecure.

The researcher has analyzed the urban peri-urban population interaction in the National Capital Region. Using ArcGIS **(Fig. 6.3),** tahsils (areas) with various levels of urban peri-urban interactions are identified. Accordingly, the urban peri-urban population interactions of NCR are grouped under five levels ranging from lakh 93p^2/km^2 (Kathumar tahsil) to lakh 127,754p^2/km^2 (Hauz Khas tahsil). Places having the highest urban peri-urban interaction range from lakh 100,000-127,754p^2/km^2, while places having the lowest urban peri-urban population interaction range from 0-lakh 6,000p^2/km^2. Places with the highest urban peri-urban population interactions include tahsils Hauz Khas (lakh 127,754p^2/km^2) and Civil Lines (lakh 121,882p^2/km^2) located at the immediate adjoining of the highly populated and entirely urbanized tahsils of Delhi.

Tahsils like Punjabi Bagh (lakh 80,893p^2/km^2), Defense Colony (lakh 66,881p^2/km^2), Saraswati Vihar, (lakh 57,849p^2/km^2), and Seema Puri (lakh 51,656p^2/km^2) fall under the category of moderate urban peri-urban population interaction. However; tahsils with the lowest urban peri-urban population interactions represent majority of NCR tahsils ranging from 0-lakh 6,000p^2/km^2.

Generally speaking; places (tahsils) with highest urban peri-urban population interaction imply that they have better progress on the process to bring about sustainable and integrated development in NCR. Tahsils with lowest urban peri-urban population interactions are expected to have lower progress in bringing about an integrated development in the Region.

Intensive large farming systems and wage agricultural labour often become more important in peri-urban areas than the small-scale farming attracting workers from both urban and peri-urban areas. These systems enhance the urban peri-urban workforce interactions.

The urban peri-urban workforce interaction in the National Capital Region is a result of peri-urban workforce participation in the process of production and supply of farm products to satisfy the demand of urban centers; and, urban workforce participation in the production and supply of non-farm products and services required by the peri-urban people. Surplus peri-urban workers may involve in available urban activities or vice versa.

Based on the tahsil level map of NCR **(Fig.6.4),** the urban peri-urban workforce interactions are categorized under five levels ranging from 0 to lakh 13,249p^2/km^2. Accordingly, places having highest urban peri-urban workforce interactions range from lakh 5,000p^2/km^2 -13,249p^2/km^2; while places having the lowest interaction range from 0-lakh 500p^2/km^2.

Tahsils having the highest workforce interaction include Hauz Khas (lakh 13,249p^2/km^2), Punjabi Bagh (lakh 9,182p^2/km^2), Defense Colony (lakh 8,449p^2/km^2), Faridabad (lakh

7,553p^2/km^2), Meerut (lakh 6,337p^2/km^2), and Saraswati Vihar (lakh 5,933p^2/km^2) respectively. The map **(Fig. 6.4)** indicates tahsils Seema Puri (lakh 4,960p^2/km^2), Kalkaji (lakh 4,268p^2/km^2), Ballabgarh (lakh 3,894p^2/km^2), Alwar (lakh 3,731p^2/km^2), Vasant Vihar (lakh 3,641p^2/km^2), Seelam Pur (lakh 3,584p^2/km^2), and Ghaziabad (lakh 3,016p^2/km^2) are the second highest in workforce interaction. However; most of the tahsils of the National Capital Region fall under lower urban peri-urban workforce interaction ranging from 0-lakh 500p/km^2.

Tahsils with high population (workers) and shortest distance to their head quarters have highest urban peri-urban workforce interaction. On the other hand; tahsils having low population (workers) concentration and longest relative distance to their head quarters have weak urban peri-urban workforce interaction.

Generally, there is high urban peri-urban population interaction in National Capital Region. As per the results obtained from the assessment of the determinants of urban peri-urban interaction, significant portion of the NCR population has either one or both of the problems such as unemployment, poverty, lack of access to land, poor access to infrastructure and social services, poor access to basic civic amenities, and poor quality of shelter provision. The interaction generated under this situation is poverty driven interaction and has less contribution to ensure the intended sustainable regional development. Therefore, such urban peri-urban interaction has to be changed into fully market (business)-based interaction that brings about the required integrated and sustainable regional development. The urban peri-urban workforce interaction in NCR is lower as compared to developed countries. Certain policy interventions are required to promote the workforce participation and interaction so as to contribute significant role in the overall sustainable regional development.

7.2 Policy Inputs

The researcher has identified and analyzed some major determinant factors that enhance or hamper the process of urban peri-urban interaction. Some of them can be considered as interactions; but, still determine other forms of interactions. The researcher has also identified the real problems of the determinants and the urban peri-urban interactions and forwards the following recommendations:

- To reduce migration to Delhi, effective development works have to be done at the origin of migrants: The burden of rapid population growth and pressure created by huge number of migrants to Delhi could be solved (blocked) at grass root levels through improving the living standard of the migrants at their original location. Creating new metropolitan cities around (outside) Delhi and dispersing economic activities and migrants could be taken as one of the solutions. The fruits of the NCR Plan such as the wonderful world-class real estate and infrastructure developments currently under going in Central NCR towns (DMA) particularly in Ghaziabad, NOIDA, Faridabad and Gurgaon are encouraging results. Despite their remarkable progresses, these types of interventions can even more attract migrants flow toward cities. Some time in the near future, these new metropolitan cities may also need other diversion towns around them. Therefore; the current efforts should be supplemented by effective development works at the origin of migrants.

- Changing poverty driven interaction into market (business)-oriented urban peri-urban interactions: The share of migration in population growth of Delhi is about 41%. This is very high and is one aspect of urban peri-urban interaction in NCR. This type of interaction takes place when people lack the basic necessities at home and forced to move towards urban centers Therefore; such type of interaction can be taken as poverty driven interaction. This is not the right interaction and has to be changed into market (business)-oriented through introducing development schemes at the origin of migrants and enabling them

produce their basic needs and interact in the process of buying and selling products in their neighboring urban centers.

- Reducing economic disparities among NCR sub-regions: It has been noted that there are significant economic disparities which can be expressed through certain measures such as per capita income, percentage of population below poverty level; and percentage of unemployment in the sub-regions. The differences are growing from time to time creating undesired city (Delhi) ward migration. These situations greatly hamper the right track to achieve the intended integrated and sustainable regional development. Therefore; measures have to be taken to bring about balanced regional development through introducing policy interventions favoring the weak sub-regions.

- Harmonizing land use policy inline with rapid land use change in NCR: Land is a precious resource where everything takes place on it. A fair distribution of farm lands in the peri-urban areas of NCR may retain farmers in their localities and ensure a steady (stable) urban-ward movement of people. The study has investigated that there has been rapid land use change, particularly from agricultural land to built-up land witnessing high urban peri-urban land use interaction in the Region. Hence; land use policy reforms that accommodate the prevailing rapid land use changes are essential to entertain all forms of investments and ensure the desired sustainable regional development.

- Promote the distribution of infrastructure in NCR: Though they are under progress, the National Capital Region has a well designed road and railway networks. The status of the provision of telecommunication infrastructure is also quite encouraging. However; as per the data in the Regional Plan 2021 (2004), there is significant short-fall of energy supply in NCR. Of course; it is difficult to realize effective production and distribution of goods and services without adequate energy supply. Weak production and distribution of goods and services implies weak producer-consumer interaction or urban peri-urban interaction.

Promoting and distribution of firm energy supply is; therefore, one of the primary tasks of the NCR concerned bodies. Energy production and distribution is costly and requires high technology; but, can be accomplished through the involvement of Federal Government.

- Improve the distribution of social services: Improved provision of educational and health care services is a determinant factor to develop healthy and productive human resource in the Region. These infrastructure types enable people use appropriate technology to improve their performances. Despite their advantages, education and health care coverage is not encouraging in several areas of NCR. Improving the distribution of health care and educational facilities could be realized through the involvement of all stakeholders in National Capital Region.

- Improve the distribution of basic civic amenities in NCR: Except drinking water and electric light supply; the distribution of basic civic amenities in NCR is unsatisfactory. Lack of basic civic amenities is one of the factors that push people to leave their original places and move to other areas. However; the distribution of civic amenities can be improved through active participation of local, regional and central governments and the community as well.

- Improve the status of shelter provision in NCR: When the total number of houses in NCR is compared with the total number of households in the Region, the short-fall is lower. However; there is high proportion of slum population witnessing that the quality of houses is very low and not livable. This situation can force people leave their places and migrate to other areas. This problem requires slum up-grading policy intervention.

- Promote the urban peri-urban interaction through improving the interaction determinants underpinned above: Generally, there is high urban peri-urban population interaction in NCR; but, the interaction is left with certain distances

to take the right track or to be fully market (business)-based interaction that brings about integrated and sustainable regional development. The urban peri-urban workforce interaction in NCR is low as compared to developed countries. Certain policy interventions are required to promote the workforce participation and interaction so as to contribute significant role in the overall sustainable regional development.

- Amend the Regional Plan organizational structure and enhance the plan implementation: The implementation of comprehensive Plans like Regional Plan 2021 requires fully empowered single administrative organ which is accountable for all duties and responsibilities regarding the plan implementation. This administrative body should have the power to discharge all types of managerial, technical and financial decisions. The researcher has no adequate information about the progress of NCR Plan implementation. However; in principle and experiences, plans should be managed, supervised (monitored) and evaluated through single administrative body. At present; the NCR Plan is under implementation through the technical wing of NCR Planning Board and various departments of the four NCR sub-regions (participating states) which are accountable to their respective states. Such organizational structure could be constrained with coordination, resource mobilization, managing and supervision, monitoring and evaluation, and multiple accountability problems. Amending the Regional Plan organizational structure would; therefore, enhance the efficiency of plan implementation and realize healthy urban peri-urban interaction that ensures integrated and sustainable regional development.

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