

Urban Land Cover/Land Use Change Detection in National Capital Region (NCR) Delhi: A Study of Faridabad District

Madan MOHAN, India

Key words: Spatial Data, Change Detection, Urbanisation, and Sustainable Development

SUMMARY

The spatial information from the remote sensing satellites provides more effective solution for sustainable environment and urban development. There is a general consensus that the development of spatial data infrastructure (DSI) is a key to sustainable land management with economic and urban development. The National Capital Region (NCR) Delhi was created in 1985 in view of the decongestion of Delhi by developing ring towns in the adjoining areas and relocating economic activities. In spite of the long gestation period, there has been no worth development in the ring towns of NCR Delhi region lying in the Faridabad district. The urban economies are expected to be the engines of economic growth in terms of productivity and developments. So, the economic activity diffusion from centre to periphery has been largely responsible for economic growth and urban development. The cheap land is one of the important factors which have been largely responsible for the dispersal of urban settlements and industries from Delhi to Faridabad district. Based on the dynamic of urban land cover / land use analysis for the different periods a number of land management strategies have been formulated as the spatial growth of urban centers and the diffusion of economic activities in the Faridabad district.

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1. INTRODUCTION

Urban land cover / land use changes are very dynamic in nature and have to be monitored at regular intervals for sustainable environment development. Remote Sensing data is very useful because of its synoptic view, repetitive coverage and real time data acquisition. The digital data in form of satellite imageries, therefore, enable to accurately compute various land cover / land use categories and helps in maintaining the spatial data infrastructure (SDI) which is very essential for monitoring urban expansion and change detections studies (Lo, 1981; Mukherjee, 1987; and Quarmby & Cushine, 1989). In other words, the remote sensing satellite data in multiresolution and multispectral means to provide spatial information for land cover / land use at different levels for various aspects as built-up land, agricultural land, forests, wastelands and water bodies etc. So, the land cover / land use maps prepared using multirate and multispectral data provides different levels of spatial information which are used in change detection studies (Burrough, 1986).

The Urban planners formulated the concept of National Capital Region (NCR) Delhi in the first Master Plan of Delhi in 1962. The main objective of NCR Delhi region creation was to decongest Delhi by diffusing the population pressure towards ring towns. Thereafter, the NCR Delhi region came into existence in 1985, when some surrounding districts became part of it. Later on, the NCR Planning Board formulated a Regional Plan 2001 which provides a model for sustainable urban and economic development. This plan has to achieve its objectives through an inter-related policy framework in context to socio-economic and environment development parameters such as the population re-distribution, settlement patterns, regional land cover / land use patterns, economic activities, infrastructural facilities and environmental factors etc. So, the NCR Delhi region comprises by the National Capital Territory (NCT) Delhi and the delineated area of the surrounding states of Haryana, Uttar Pradesh, and Rajasthan as is shown in the Figure 1. The entire NCR Delhi region spread over an area of around 30,242 sq. kms. Out of this, the Haryana (7 districts) account the largest area of 13,413 sq. kms. Likewise, the Uttar Pradesh (5 districts) and Rajasthan (partly 1 district) account for an area of 10,853 and 4,493 sq. kms. respectively. While the National Capital Territory (NCT) Delhi (9-districts) account for 1,483 sq. kms. area of the NCR Delhi region.

The urban land cover / land use patterns has been found change in the National Capital Region (NCR) Delhi over the periods. Similarly, there has been existed diverse urban land cover / land use patterns in the Faridabad district of the NCR Delhi region during 1981 to 2001. For instance, considerable level tracts of land happen to be in and around Faridabad which is located between a Ridge in the west and River Yamuna in the east. Beside this, the land is very cheap as compared to Delhi where the price of land has recently gone very high. This is one of

the important factor which may have been largely responsible for the dispersal of urban settlements and industries from Delhi to Faridabad. However, the Faridabad district is forming a part of the NCR Delhi region. The region was created with a view to curtail migration to the Delhi city by developing the adjoining areas and relocating economic activities, thus supporting the lateral growth taking place in Delhi. The urban economies are expected to be the engines of economic growth in terms of productivity and developments. So, the economic activities diffusion from centre to periphery has to be adequate enough to accommodate such growth.

2. OBJECTIVES

The main objectives of the study were as follows:

- i to analyse the urban land cover and existing land use changes;
- ii to examine the urbanisation impact on the land cover / land use changes; and
- iii to explore the suitable strategies for sustainable environment and urban development.

3. DATABASE AND METHODOLOGY

The present study is based on the remote sensing spatial data as well as the non-spatial data available from the various sources for different periods. The Indian Remote Sensing Satellite IRS 1C and 1D multiresolution sensors as Panchromatic (PAN) and Linear Imaging Self Scanner (LISS-III) imageries with ground resolution of 5.8 and 23.5 meters respectively have been acquired for two periods for the study area. So, the spatial digital data is comparatively more useful than other methods of data collection especially for urban land cover / land use change detection studies.

The analogue scanned images of the Survey of India (SOI) toposheets on the scale of 1:50,000 and 1:25,000 have also been used for the study area. Whereas the non-spatial data as agricultural land, forests and wastelands have been obtained from the various sources as the Statistical Abstract of Haryana, Faridabad District Census Handbook and Faridabad District Gazetteers, etc. Thus, the present study has been supported by the primary sources of data generated through the extensive field verification survey as well as the literature survey of the records of the Department of Urban Development and Poverty Alleviation Ministry, Faridabad Forest Department, Faridabad Development Authority, Haryana Urban Development Authority (HUDA) and Master Plans of Delhi and Faridabad.

The Geographic Information System (GIS) and Remote Sensing (RS) tools have been applied to find out the land cover / land use changes over periods in the Faridabad district. Such as the Arc/Info, ArcView, GeoMedia and ERDAS have been used for geographical analysis, integration, and presentation of the spatial and non-spatial data for land cover / land use change detection. So, these tools are more effective for monitoring and modeling for urban land cover / land use changes as well as for the sustainable environment and urban development in the Faridabad district.

4. STUDY AREA

The Faridabad district lies between the latitudes 27° 51' 15" and 28° 30' 52" north and the longitudes 77° 04' 39" and 77° 32' 50" east. The Faridabad as a district came into existence on the map of Haryana on the 15th August, 1979 as the 12th district of the State, carved out from the Gurgaon district (Singh, 1985). Faridabad district is bounded by Delhi on the north, Gurgaon district of Haryana State on the west, Gautam Budh nagar district on the east and Mathura district in the south of Uttar Pradesh State. Faridabad district spreads over an area of 2,151 sq. kms. Out of this only 59 sq. kms. area is under forest which comprises 2.83 per cent of the total geographical area. The River Yamuna flows all along the entire eastern boundary from north to south separating the district from the Uttar Pradesh State. Delhi-Mathura National Highway No. 2 i.e. the Shershah Suri Marg passes from north to south direction through the centre of the Faridabad district. Faridabad city is about 32 kms. away from Delhi. It has a railway station on the Delhi-Mathura double track broad-gauge line of the central railways. The district has sub-tropical continental monsoon type of climate. The rainfall distribution is relatively satisfactory and is mainly concentrated during the monsoon period only.

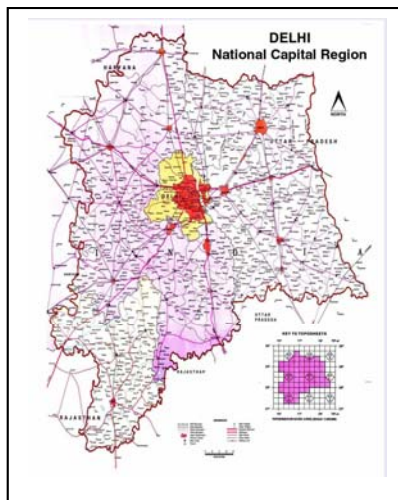


Figure 1



Figure 2

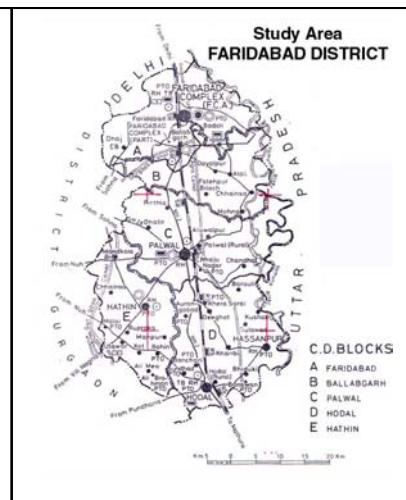


Figure 3

The Faridabad district is sub-divided into five tahsils namely, Faridabad, Ballabgarh, Palwal, Hathin and Hodal as shown in the Figure 3. Whereas there are six communities development blocks viz., the Faridabad, Ballabgarh, Palwal, Hodal, Hathin and Tilpat in the district. There were 439 villages in which 414 are inhabited villages and the rest 35 villages merged in towns in 1991. Moreover, there were 474 villages out of which 25 are uninhabited and 40 villages have been urbanised in 2001. All these villages fall within the boundary of the Faridabad Municipal Administration (FMA). The Faridabad district has 6 towns of different size class of population which altogether constituted 55.63 per cent of the total population in 2001. In January, 1972 the towns of Ballabgarh, Faridabad Old and Faridabad Township were included in the Faridabad Complex Administration (FCA). The FCA was constituted to promote the planned development of the district particularly on the urban-industrial side. So, the FCA was

earlier known as the Faridabad-Ballabgarh Complex is located in the Faridabad tahsil. There are three towns namely the Hassanpur, Hodal and Palwal in the Palwal tahsil. The Hathin Tahsil has one town namely the Hathin. The Tilpat as a census town came into existence in 2001.

5. LAND COVER / LAND USE CHANGES

The land cover / land use thematic maps have been prepared using the Survey of India digital analogue topographic sheets and the remote sensing satellite imageries. The land use has been classified into the three levels in details as is suggested in the manual of National Remote Sensing Agency (NRSA) for the NCR Delhi region (NRSA, 1989).

5.1 NCR Delhi Region

The land cover / land use statistics for the National Capital Region (NCR) Delhi is presented in the Table 1. The cultivated land is accounted a large proportion of 79.53 per cent area in the NCR Delhi region. Whereas the built-up land is comprises by about 8.72 per cent of the total geographical area. The wasteland is accounted for about 6.63 per cent. A small proportion of 4.02 per cent area is under forest in the entire NCR Delhi region.

Table 1: Land Cover/Land Use in NCR Delhi Region

Category	Area (in sq. kms.)	% to Total Area
Built-up land	2635.87	8.72
Cultivated land	24052.63	79.53
Forests	1214.36	4.02
Wasteland	2004.25	6.63
Others	334.89	1.11
<i>Total</i>	<i>30242.00</i>	<i>100.00</i>

Source: National Capital Region Planning Board, 1999

So, there are lots of prospects for the urban development process in the NCR Delhi region. Because plenty of cheap agricultural land is available for building construction which cause to increase land value that can be used for the financing of the urban development.

5.2 Faridabad District

5.2.1 Cultivated Land

The Faridabad district is by and large formed by the plain area. The River Yamuna is flowing all along its eastern boundary. It has formed a flood plain area. Such as, there is a narrow tract of land all along the Yamuna River which is quite different from the remaining plain area. The former is known as 'Khadar'. It is also know as the low lying flood plain where the newer alluvium is found deposited. Whereas the latter is know as 'Bhangar'. It is an upland plain

which is made by the older alluvium. The Khadar is generally three to five kilometers wide and is subjected to flood during the rainy season. When the floods recede there find considerable fine silt which is easy to plough. The soil in the flood plain area retains adequate moisture even after the rainy season and is particularly good for cultivation (Ahuja, 1983).

Table 2: Land Cover / Land Use in Faridabad District: 1980-81 to 2000-01

Classification	1980-81	1990-91	2000-01	1980-81	1990-91	2000-01
	Area (in '000 hectares)			% to Total Geographical Area		
1. Land Not Available for Cultivation:	38	42	39	17.84	20.19	18.40
i.Land put to non-agricultural uses	29	34	30	13.62	16.35	14.15
ii.Barren and unculturable land	9	8	9	4.22	3.85	4.25
2. Other Uncultivated Land:	3	2	3	1.41	0.96	1.41
i.Permanent pasture & other grazing lands	3	2	3	1.41	0.96	1.41
ii.Land under misc. tree and groves	-	-	-	-	-	-
iii.Culturable waste	-	-	-	-	-	-
3. Fallow land	1	1	1	0.47	0.48	0.47
4. Net Sown Area	167	157	163	78.40	75.48	76.89
5. Forests	4	6	6	1.88	2.89	2.83
<i>Total Geographical Area</i>	<i>213</i>	<i>208</i>	<i>212</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>

Source: Statistical Abstract of Haryana: 1980-81 to 2000-01.

By and large, there have been no major land use changes in the Faridabad district over the periods as is evidenced by the Table 2. The large area is devoted to the cultivation which constituted around 76.89 per cent as net sown area of the total geographical area during 2000-01. This proportion was comparatively little low than that the preceding period 1980-81. Whereas the land not available for cultivation accounted for 18.40 per cent in 2000-01. It is constituted by the land put to non-agricultural usages of 14.15 per cent as well as the barren and unculturable land of 4.25 per cent. Besides this, the other uncultivated land and fellow land are forming a negligible proportion of 1.41 and 0.47 per cent respectively. Likewise, there is a small proportion of 2.83 per cent as forest area in 2000-01 which is little high than the preceding period of 1980-81. However, the land use statistics presented above shows that the majority of land is under cultivation in which there has been no more changes occurred over periods in the Faridabad district.

5.2.2 Forests Land Cover

Though there are no thick forests, yet there is an area of 59 sq. kms. classified as forests area in 2000-01. Forests areas in the district are largely all along the rail, road and canal strips. A number of forest products are extracted in the form of round timber, wood-pulp, bamboo, fuel,

fodder and grass, gum and resin and fruits etc. All these forest products are forming useful raw materials for the forest-based industries. The status of forest cover and its classification for the Faridabad district is presented in the Table 3.

Table 3: Forests Land Cover Classification: 1980-81 to 2000-01

Classification	Forest Area					
	(in sq.kms.)			(in per cent)		
	1980-81	1990-91	2000-01	1980-81	1990-91	2000-01
1. State forests:	32	32	33	53.33	56.14	55.93
i. Reserved	3	3	3	5.00	5.26	5.08
ii. Protected	27	28	28	45.00	49.13	47.46
iii. Others	2	1	2	3.33	1.75	3.39
2. Private Forests:	28	25	26	46.67	43.86	44.07
i. Closed under Indian forest Act.	-	-	-	-	-	-
ii. Closed under landPreservationAct	28	25	26	46.67	43.86	44.07
<i>Total Forest Area</i>	<i>60</i>	<i>57</i>	<i>59</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>

Source: Statistical Abstracts of Haryana: 1980-81 to 2000-01.

In general, there has been no increase in forest cover in Faridabad district over the periods as is evidenced by the Table 3. The State forest is accounted for 55.93 per cent in 2000-01. Out of this, a major proportion of 47.46 per cent is constituted as the protected forest. The reserved forest and other forest types constituted about 5.08 and 3.39 per cent respectively. Moreover, the area under the private forest was 44.07 per cent which is closed under Indian Forest Act. However, there is a need to increase forests cover because it can playing an important role in the land protection and sustainable environment development (Raghav, 1988).

5.2.3 Built-up Land

5.2.3.1 Urban Residential Complexes

There are about six urban residential complexes as the Faridabad, Hassanpur, Hathin, Hodal, Palwal and Tilpat towns in the Faridabad district. All these urban residential complexes are found widely spread on both sides of the Delhi-Mathura National Highway-2 (NH-2). The urban residential complexes altogether accounted for an area of 207.88 sq. kms. There has been continuous increase in the urban population from 7,41,310 persons in 1991 to 12,220,194 persons in 2001. In other words, the high growth of urban population of 81.43 per cent and 64.60 per cent is recorded during 1981-91 and 1991-01 respectively. The density of population was 1,966 in 1981 which increased to 3,566 persons per sq. km. in 1991. Furthermore, it was increased to 5,970 persons per sq. km. in 2001. However, it is noteworthy to mention that the National Capital Region (NCR) Planning Board was constituted in 1985 about two decades ago to develop the ring towns in the neighboring States with a view to decongesting Delhi. But during these decades nothing worthwhile has been done. Thus, the entire Faridabad's urban complexes are developed in a planned way on modern town planning lines by the Haryana Urban Development Authority (HUDA).

5.2.3.2 Industrial Complexes

The Faridabad district is being essentially developed as an industrial area; a railway line has been laid down right through its center so as to be serviceable to all the industrial units established there. The original industrial area was 240 acres divided into plots of various sizes varying from below 1 acre to about 10 acres. There is easy availability of the major infrastructural facilities as the land, labour, power, raw materials, machinery, market, transport and financial assistance etc. for the establishment of various types of factory industries throughout the Faridabad district (Gupta, 1971). There are now about 15,000 small, medium and large industries providing direct and indirect employment to nearly half a million people and ranks 9th largest industrial estate in Asia. Many international / multinational companies like Whirlpool, Goodyear, Larsen & Toubro, Asia Brown Boveri, GKN Invel, Woodward Governor, Castrol besides Escorts, Eicher, Cutler Hammer, Hyderabad Asbestos, Nuchem are operating in the district. It is lamentable that the residents of Faridabad are still inhaling the polluted air emitting out of the blazing chimneys of the Faridabad Thermal Power Plant and the factories. So, there is a need to develop green sectors within the industrial complexes in order to have sustainability of the environment.

5.2.3.3 Historical Buildings and Monuments

There are found a number of historical buildings and monuments which are in ruins in different part of the Faridabad district. For instance, the Sheikh Farid built a fort, a tank and a mosque which are in ruins. For instance, the town Ballabgarh was founded by one Ballabab Singh, the son of a poverty-stricken cultivator. The fort in the town is said to have been built by Balram, and possibly the name may be a corruption of Balramgarh. The township boundary was laid out by Raja Bahadur Singh of Ballabgarh. It still bears the trace of his careful planning - quadrangular market-places, wells at cross-roads and a large garden which was named Dilkusha. A 'chhatri' (Canopy) and a 'pucca' (Masonry) tank were constructed by the widow of Anrudh Singh, Raja of Ballabgarh till 1818. The fort, the tank and the 'chhatri' are still there (Ahuja, 1983).

5.2.4 Transport Network and Other Infrastructures

Faridabad district has well connected network of road, rail and electricity. All the villages of the district are connected by metalled roads as well as electricity since 1970. Faridabad is well connected with other parts of the country by rail and road. The broad gauge railway line of the central railways passes through the district. The Delhi-Mathura National Highway-2 (NH-2) also passes through the middle while connecting to Faridabad, Ballabgarh, Palwal and Hodal towns of the district. There area about 6 telephone exchanges and about 126 post offices in the district.

5.2.5 Water Bodies – River and Lakes

The perennial River Yamuna flows all along the eastern boundary of the Faridabad District. There are number of lakes and reservoirs such as the Suraj Kund and Badkhal Lake. The Suraj Kund is close to Delhi. In other words, it is about 18 kms. away from the Tughlaqabad which is located in south Delhi. It is a water tank which resembles to the Roman amphitheatre. It consists of a semi-circular stepped stone embankment to impound rain water from the hills. It's bed is about 130 meters in diameter. Almost touching it is a fresh water pond called Pea Cock lake surrounded by hillocks.

The Badkhal Lake nestling amidst rocks to the west of Faridabad Old and northwest of Faridabad township. Badkhal lake is about 32 kms. away from Delhi and 3.5 kms. away from Delhi-Mathura National Highway-2 (NH-2). The rain water harvest is done by joining toes of the two hillocks and by constructing a check dam which is 644.5 meters long and 6 meters wide. Thus, a beautiful lake was created on one side of the check dam while the rock remnants of the Aravalli Range on the other side presented a beautiful picturesque. The rocks and ridges surrounding the lake provide natural landscape with greenery of trees and shrubs. So, both the Suraj Kund and Badkhal Lake are connected through a six kilometers inner forest road.

6. DYNAMICS OF LAND USE IN URBAN CENTERS

There are six urban centers which are located all over the Faridabad district. They are playing a counter-productive role in the economic progress since the inception of Faridabad as a separate district. It is important to mention that the Faridabad and Palwal towns are to be developed as urban-industrial complexes as is evidenced by the Table 2. Besides this, there will also be provision for the other infrastructural facilities development as is laid down in the master plans for both the towns.

Table 2: Proposed Land Use Plan for Faridabad and Palwal Towns: 2011

Category	Faridabad		Palwal	
	Area (km ²)	% to Total	Area (km ²)	% to Total
Residential	77.95	49.72	12.06	43.80
Commercial	7.73	4.93	2.37	8.60
Industrial	31.36	20.00	5.71	20.73
Institutional	5.30	3.38	1.72	6.25
Transport & Communication	15.54	9.91	2.74	9.95
Open Space & Parks	4.42	2.82	2.49	9.04
Public Utilities	1.55	0.99	0.45	1.63
Others	12.95	8.26	-	-
<i>Total</i>	<i>156.79</i>	<i>100.00</i>	<i>27.53</i>	<i>100.00</i>

Source: Master Plans of Faridabad and Palwal.

Therefore, it is obligatory to mention about the existed land use pattern for all urban centers which are widely located in different parts of the Faridabad district.

6.1 Faridabad City

The Faridabad as a town is known to have been founded in 1607 A.D. by Shaikh Farid, treasurer of Jahangir, with the objective of protecting the highway which passed through the town. In January, 1972 the towns of Ballabgarh, Faridabad Old and Faridabad Township were included in the ‘Faridabad Complex Administration’ (FCA). The FCA was constituted to promote the planned development of the region particularly on the urban-industrial side. Faridabad city is virtually a suburb of Delhi. It is located about 11.26 to 32.19 kms. away from Delhi, and 1.61 to 6.44 kms. from the Old Town of Faridabad. Faridabad urban residential complex spreads over an area of 187.27 sq. kms. on the western side of the Delhi-Mathura National Highway-2 (NH-2). The entire Faridabad city is developed in a planned way on modern town planning lines. The Master Plan of Faridabad provides for 56 sectors out of which 27 are residential.

The growth trends and density of population for the major urban centers of Faridabad district are presented in the Figure 4 and 5 respectively. The Faridabad town comes under the class I category constituting a population of 6.25 lakhs in 1991 which was increased to 10.55 lakhs in 2001. Besides this, there is found a large variation in the growth of population in the Faridabad city during 1901-11 to 1991-01 as is evidenced by the Figure 4. The trends of population growth over the past century or so can be divided into two parts, the point of division being 1921 and 1951. The year 1921 is called the year of the “Great Divide” because it is distinguished by earlier period with a negative population growth from a period of moderately increasing growth. The year 1951 marks the beginning a rapid population growth. The population growth has come down during 1991-01 in comparison to the previous periods which is good sign for population control. On the other hand, the Faridabad city accounts for the largest proportion of 86.46 per cent of the total urban population. The density of population was 3,444 persons per sq. kms. in 1991 which grew to 5,633 in 2001 as is evidenced by the Figure 5.

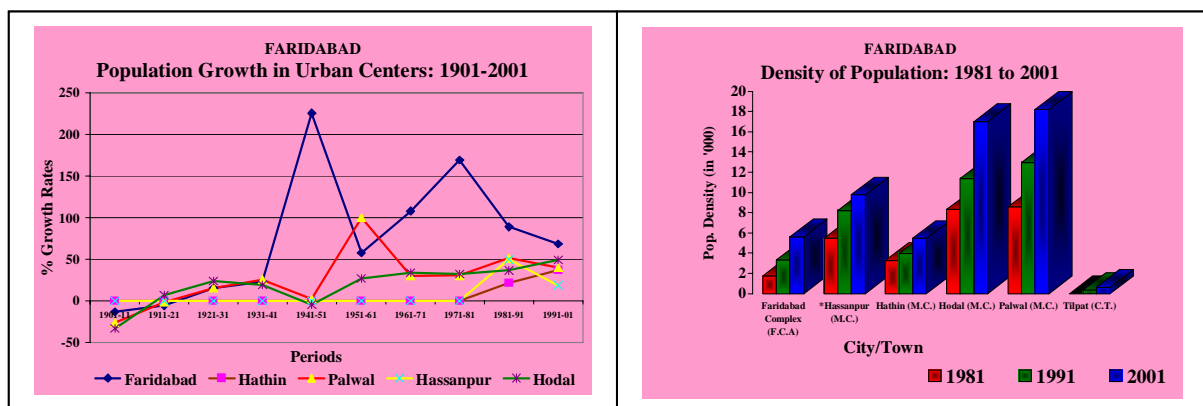


Figure 4

Figure 5

Such high density of population is influenced by the rapid pace of industrialisation and urbanisation processes (Wirth, 1938). The Faridabad city is functioning as an industrial hub for the adjoining areas as a whole. As a result, in 1992 the Faridabad City Authority (FCA) had announced an ambitious development plan for Faridabad city to create necessary infrastructure and amenities to accommodate a population of 19.75 lakhs by 2011. The Faridabad city population will grow to around 37.10 lakhs in 2021 (NCRPB, 1999a & b).

6.2 Hassanpur

The Hassanpur town is situated in the Palwal tahsil. It is 52 kms. away from the Faridabad city. The Hassanpur town is spread over an area of about one or 0.93 sq. km. It is a class V category town and has a population of 9,089 persons in 2001. The population growth of 49.83 per cent was recorded during 1981-91 in the Hassanpur town. It was comparatively low to 18.93 per cent during 1991-2001 as is evidenced by the Figure 4. The density of population was 5,494 in 1981 which increased to 8,231 persons per sq. km. in 1991. Furthermore, it was increase to 9,773 persons per sq. km. in 2001.

6.3 Hathin

The Hathin town is situated about 16 kms. west-south of Palwal on the Palwal-Hathin road. The Hathin town is spread over an area of 1.99 sq. kms. It is a class V category town with the population of 7,863 persons in 1991. It was increased to 10,913 persons in 2001. The population growth of 21.10 per cent was recorded during 1981-91 in the Hathin town. It was comparatively low to 37.51 per cent during 1991-2001 as is evidenced by the Figure 4. The density of population was 3,293 in 1981 which increased to 3,988 persons per sq. km. in 1991. Furthermore, it was increased to 5,484 persons per sq. km in 2001. Under the Mawat Development Scheme an industrial estate of 350 acres is being developed in the Hathin tahsil.

6.4 Hodal

The Hodal town is a small town on the Delhi-Mathura National Highway-2 (NH-2) and lies at a distance of about 87 kms. from Delhi. The oldest part of the town is on the hill formed by the debris of a still older habitation. The town is situated about 72 kms. to the south-east of Gurgaon. Hodal town is a class III category town covering an area of 2.25 sq. kms. It has a population of 25,626 persons in 1991 which was increased to 38,306 persons in 2001. The population growth was increased over the periods as is evidenced by the Figure 4. For instance, the population growth of 36.74 per cent was recorded by the Hodal town during 1981-91. It was increased to 49.48 per cent during 1991-2001. The density of population was 8,329 in 1981 which increased to 11,389 persons per sq. km. in 1991. Furthermore, it was increase to 17,025 persons per sq. km. in 2001. During the reign of Suraj Mal of Bharatpur, many significant buildings were created such as the fine old serai, a baoli and masonry tank which are now in ruins. The tank and temple are situated at about a kilometer from the town. A plenty of cheap land is easily available for the establishment of factory industries here. It is strategically placed for industrial units which could depend for fuel needs on the Mathura Refinery.

6.5 Palwal

The Palwal town is located about 25 kms. away from Faridabad on the Delhi-Mathura National Highway-2 (NH-2). It is about 61 kms. away from Delhi. It has railway station on the Delhi-Mathura broad-gauge line of the central railways. The Palwal town stretches over an area of 5.52 sq. kms. It is a class II category town with a population of 71,637 persons in 1991 which was grown to 1,00,528 persons in 2001. However, it is estimated the Palwal town population will grow to 124.008 lakhs in 2021. It is significant to mention that the population growth rate fluctuated over the periods as is evidenced by the Figure 4. Such as the population growth of 51.26 per cent was recorded during 1981-91. It was decreased to 40.33 per cent during 1991-2001. The density of population was 8,574 in 1981 which was increased to 12,978 persons per sq. km. in 1991. Furthermore, it was increase to 18,212 persons per sq. km. in 2001. It is noteworthy to mention that an old fort which was constructed during Mughal period now in ruins. Jama Masjid which appears to date back to 1210 A.D. is also in ruins. There are also found ruins of Idgah of Shihab-ud-Din which date back to 1211 A.D. There is a Rural Industrial Estate (RIE) which spreads over an area of 22,000 sq. yards and is divided into two parts - one located at Sohna and the other at Palwal.

6.6 Tilpat

The Tilpat as a census town came into existence in 2001. It is a class V category town with the population of 6,377 persons in 2001. It spreads over an area of around 9.92 sq. kms. It has recorded the density of population of 643 persons per sq. km. in 2001.

7. CONCLUSIONS AND SUGGESTIONS

The urban land cover and existing land use have been dynamic in nature over the periods in the Faridabad district. There are number of implications of urbanisation on the land cover / land use changes as the landscape's physiological destruction, illegal land encroachment and shrinkage of forests cover etc. The Master Plans have been there for a very long time now, and despite this long gestation period, there has been no worth development in the Faridabad district. Due to rapid increase in population, the land values have gone high in and around Faridabad city. The district's urban centers must grow in harmony to share the population pressure on the Faridabad city. So, it is expected that during the urban development process the agricultural land converted into the built-up land result to increase in land value which can be used for financing of the urban development. Spatial regional planning in general and land cover / land use planning in particular are important tools to guide the sustainable urban and environment development. In lieu of this, the land readjustment is a very elegant and viable economic way for urban development and urban redevelopment. Land readjustment is able to equalise the advantages and disadvantages of urban planning and to finance greater parts of the costs of urban development. In order to achieve sustainability, industrial and urban growth is economical desirable. Consequently, there is a need for the development of spatial data infrastructure (SDI) which play an important role in the decision making process for the spatial

growth of urban centers and the diffusion of economic activities for the sustainable environment and urban development.

REFERENCES

- Ahuja, S. (1983) *Faridabad - Haryana District Gazetteers*, Chandigarh, Haryana Gazetteers Organisation, Revenue Department.
- Burrough, P.A. (1986) *Principles of Geographic Information System for Land Resource Assessment*, Oxford, Clarendon Press.
- Census of India (1981 & 1991) *Faridabad - District Census Handbook - Village and Town Directory and Primary Census Abstract*, Part - XIII - A & B, Series – 6 & 8, Haryana.
- Census of India (2001) *Haryana – Provisional Population Totals, Paper 2 of 2001*, Chandigarh, Directorate of Census Operations, Haryana.
- ESO, P.D. (1993) *Statistical Abstract of Haryana: 1980-81 to 2000-01*, Chandigarh, Economic and statistical Organisation, Planning Department, Government of Haryana.
- Gupta, S.L. (1967) “Faridabad: A Study in Industrial Growth”, *The Indian Geographical Journal*, Vol. XLII, No. 1 & 2, pp. 22-28.
- Lo, C.P. (1981) “Land Use Mapping of Hong Kong From Landsat Images: An Evaluation”, *International Journal of Remote Sensing*, Vol. 2, No. 3, pp. 231-251.
- Mukherjee, S. (1987) “Landuse Maps for Conservation of Ecosystems”, *Geographical Review of India*, Vol. XLIX, No. 3, pp. 23-28.
- NCRPB (1999a) *Delhi 1999: A Fact Sheet*, New Delhi, National Capital Region Planning Board, Ministry of Urban Development and Poverty Alleviation, India Habitat Centre, Lodhi Road.
- NCRPB (1999b) *National Capital Region Directory*, New Delhi, National Capital Region Planning Board, Ministry of Urban Development and Poverty Alleviation, India Habitat Centre, Lodhi Road.
- NRSA (1989) *Manual of Nationwide Land Use / Land Cover Mapping Using Satellite Imagery*, National Remote Sensing Agency, Hyderabad.
- Quarmby, N.A. and Cushine, J.L. (1989) “Monitoring Urban Land Cover Changes at the Urban Fringe From SPOT HRV Imagery in South East England” *International Journal of Remote Sensing*, Vol. 10, No. 6, pp. 231-251.
- Raghav, K.S. (1988) “Suggested Landuse and Afforestation of Waste-land in the North-Eastern Part of the Aravalli Hill Gaps”, *Annals of Arid Zone*, Vol. 27, No. 1, pp. 47-56.
- Singh, N. (1985) “The Development Process and Urbanisation in Newly Organised State: A Case Study of Haryana”, *Population Geography*, Vol. VII, Nos. 1 & 2, pp. 49-59.
- Wirth, L. (1938) “Urbanisation as a way of life”, *American Journal of Sociology*, Vol. 44, pp. 11.

BIOGRAPHICAL NOTES

I am Lecturer in the Department of Geography, Faculty of Natural Sciences, Jamia Millia Islamia (Central University), New Delhi. I have authored for a book on the theme of 'Ecology and Development', which has published in India in January 2000. I have also contributed by publication of number of research papers, which have been appeared in several reputed journals both at the national and international levels on the issues of Ecology and Development, Climate Change, Spatial Data for Environment Management, and GIS and Remote Sensing Application for Mapping and Modeling of Social Life Styles. I am the life member of the professional societies – the National Association of Geographer, India (NAGI); and the Association of Population Geographers of India (APGI); and the associate member of the Boovigyan Vikas Foundation (Foundation for Earth Sciences Development), New Delhi, India.

I had participated in the international conferences as the XIXth ISPRS Congress Amsterdam 2000, The Netherlands on the theme of "Geoinformation for All"; the Vth ICORG 2001 International Conference, Hyderabad, India, on the theme of "Spatial Information Technology"; the XXII FIG 2002 International Congress on the theme of "Geomatics and Property Valuation for Global Sustainable Development", Washington, D.C. United States of America; the FIG Working Week 2003 and 125 Anniversary of FIG Congress, main theme was "Still on the Frontline", Paris, France; and the XXth ISPRS Congress 2004 on the theme of "Bridging-Continents", Istanbul, Turkey.

I have traveled and visited a number of foreign countries: the Royal Netherlands (Holland), Amsterdam in 2000; the United States of America (USA), Washington, D.C. in 2002; the France, Paris in 2003 and the Turkey, Istanbul in 2004.

CONTACTS

Dr. Madan Mohan
Jamia Millia Islamia (Central University)
Department of Geography, Faculty of Natural Sciences, Jamia Millia
Islamia (Central University), New Delhi – 110 025
INDIA.
Tel. +91 11 2601 1290 (Res.)
+91 11 2683 1717 Ext. 342 (Off.)
Mobile +91 11 9871088798
Fax +91 11 2698 0229 (Off.)
Email roshnlal@ndb.vsnl.net.in, drmdnmohan@yahoo.com
Website www.jmi.nic.in