Land-Use Dynamics of Peri-Urban Areas of Metropolitan Cities with Special Focus on Delhi

Nanda Dulal Das

Abstract Post-reform period has experienced increased flow of investment towards development of infrastructure around the large metropolitan cities in India. This has led to expansion of urban centres over the peripheral land-use classes which include productive croplands. This study seeks to find out the extent of growth of urban areas in the periphery of seven largest metropolitan cities in India and consumption of farmland by the process, with a special focus on Delhi. A trend of growing urban area is evident around almost all the metropolitan cities in the post-reform period. Though the cultivable area around the metropolitan cities has decreased in the post-reform period, the increase in net sown area in those areas signify more judicial utilization of land in the post-reform period in the peripheries of large urban centres. Though the growth of built-up area around Delhi metropolis has not followed any set pattern targeting consumption of any specific kinds of land for its expansion, large tracts of cultivable lands have disappeared in the process, despite the fact that wastelands or unutilized land remain which could have been converted for urban-centric land use. It has also been argued in this study that impact of conversion is more in areas closer to the urban centres and vice versa. A significantly high degree of negative correlation exists between the built-up area and distance from the city centre of Delhi. The analysis reveals that this process has been fairly prominent around the metropolitan city of Delhi.

Keywords Land-use dynamics · Peri-Urban · Metropolitan city · Centre-Periphery · Crop and wasteland

N.D. Das (✉)
Government Sector, Pune, India
e-mail: nandadulaldas@gmail.com

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Introduction

The process of economic reforms after 1991 has caused an intensification of private investment, especially Foreign Direct Investment (FDI) that is getting drawn towards the large urban centres. In the period between 1991 and 2004, Delhi and Mumbai together accounted for over 42 % of total incoming FDI. The concentration of high proportion of FDI saturates the urban core within a short period and is soon manifested in the outward dispersal of investment and urban infrastructure (Goldar 2007). Similar phenomena have been observed in the Class-I cities in China in recent years (Zhao et al. 2003). This "urban bias" also bends the public policies in favour of secondary and tertiary activities (Kydd 2002). Thus, urban areas grow at an unprecedented rate over an area previously occupied primarily by farming activities (Harvey and Clark 1965; Blobaum 1974; Hart 1976; Plaut 1980; Pachauri 1986; Alig and Healy 1987; Young 1999; Lopez et al. 2001). The emergence and continuous expansion of peri-urban regions is more of a recent phenomenon in India unlike the west, and thus, literature that seek to understand the dynamics of peri-urban land uses in India is not very extensive.[1] The increasing pressure on agricultural land particularly around the urban fringe could have some positive externalities for the area that remain under agriculture by enhancing investments and thereby increasing yield and altering the cropping pattern towards a high value combination due to presence of urban demand in its proximity (Gillies and Mittlebach 1958). However, loss of multi-cropped land with its associated impact on livelihood bases are a matter of concern, particularly if the urban processes fail to generate additional employment adequate to make up for such losses (Lal 2001). Thus understanding the dynamics of land-use changes is of crucial importance. The focus of the present study is to analyze the interactions between the agricultural and non-agricultural lands around Delhi metropolitan city in comparison to other large metropolitan cities in India between the pre-reform and post-reform period.

Focus, Data and Concepts

This study hypothesizes that increasing pressure of building infrastructure and built-up area around the large metropolitan centres in the post-reform period would be reflected in the loss of productive cropland in the peripheries of urban

[1]The dynamic interface at the periphery of urban boundary is characterized by gradually changing land-use from agricultural to other non-agricultural uses, changing populations, changing use of natural resources and changing processes of waste generation, etc. Changing population pressure and subsequent technological change and their impact on the dynamics of agricultural land-use has been extensively researched by some scholars (Boserup 1965). In the Indian context, peri-urban dynamics are recently being studied in detail (Shaw 2005; Sridharan 2006).

centres. The effect is expected to be more prominent in the areas closer to the urban centre. This study also assumes that with increasing pressure of urban expansion on the periphery and productive cropland, unproductive lands like wastelands would have been judiciously used in the post-reform period. Hence, this study seeks to find out the extent of conversion of different land-use classes into built-up area in a comparative perspective between the pre-reform and the post-reform period, in the peripheries of the large metropolitan centres with a special focus on the capital city of Delhi. To look into the urban-growth concentration around the large metropolitan cities in comparison to their respective larger regional perspectives, two specific sets are chosen. Districts around metropolitan (DAM) cities are chosen to represent the first set, i.e., urban periphery and the respective States have been chosen as the second set representing the larger regional backdrop.[2] To capture the impact of urban-growth phenomena, the extent of change in cultivable land area vis-à-vis area under non-agricultural use in the DAM and the respective states has been analysed in the pre-reform and post-reform period.[3] Seven large urban centres have been chosen for presenting a broad intra-regional and inter-regional pattern with a more detailed analysis of the peripheries of Delhi (Fig. 1).[4]

For the case study of the periphery of Delhi metropolitan region, a few community development (CD) Blocks have been extracted from the DAMs and within these Blocks; all the constituent villages have been studied (Fig. 2). Besides considering the loss of cultivable lands owing to increasing non-agricultural area, the extent of judicious utilization of wastelands in the periphery has also been looked in detail. The pattern of interaction among the different land-use classes has been analyzed to portray the "urban effect" in the peripheral region with the increasing distance from the urban centre. While the broader comparative analysis of the seven metropolitan centres is done based on the data published by the directorate of Economics and Statistics, the detailed analysis of Delhi is based on satellite images pertaining to two time periods, the data bases being of 1989-Landsat TM and 2006-IRS P-6, LISS-3. Numerous studies using the techniques of remote sensing and GIS have proven the phenomenon of cropland loss in the peri-urban areas effectively (Fazal 2000). Efforts have been made to classify the land utilization of the study region into standard land-use categories using satellite imagery

[2]Gurgaon, Sonepat, Jajjhar, Rohtak, Faridabad in Haryana and Ghaziabad in Uttar Pradesh; Thane and Raigad in Maharashtra; Haora, Hugli, N & S 24 Pargana in West Bengal; Chengalpattu-MGR and Thiruvallur in Tamilnadu; Rangareddy in Andhra Pradesh; Bangalore Rural in Karnataka; Kheda, Mahesana and Gandhinagar in Gujarat.

[3]For this dataset of Dept. of Agriculture & Cooperation (DAC) of the Ministry of Agriculture has been used. Triennium averages for 1978–'81, 1988–'91 and 1998–2001 have been used to reduce short-term fluctuations.

[4]Seven largest metropolitan cities according to the 2001 census have been selected for the study, namely, Mumbai, Kolkata, Delhi, Chennai, Hyderabad, Bangalore and Ahmadabad and respective states have also been chosen to represent the larger regional setting around the metropolitan cities.

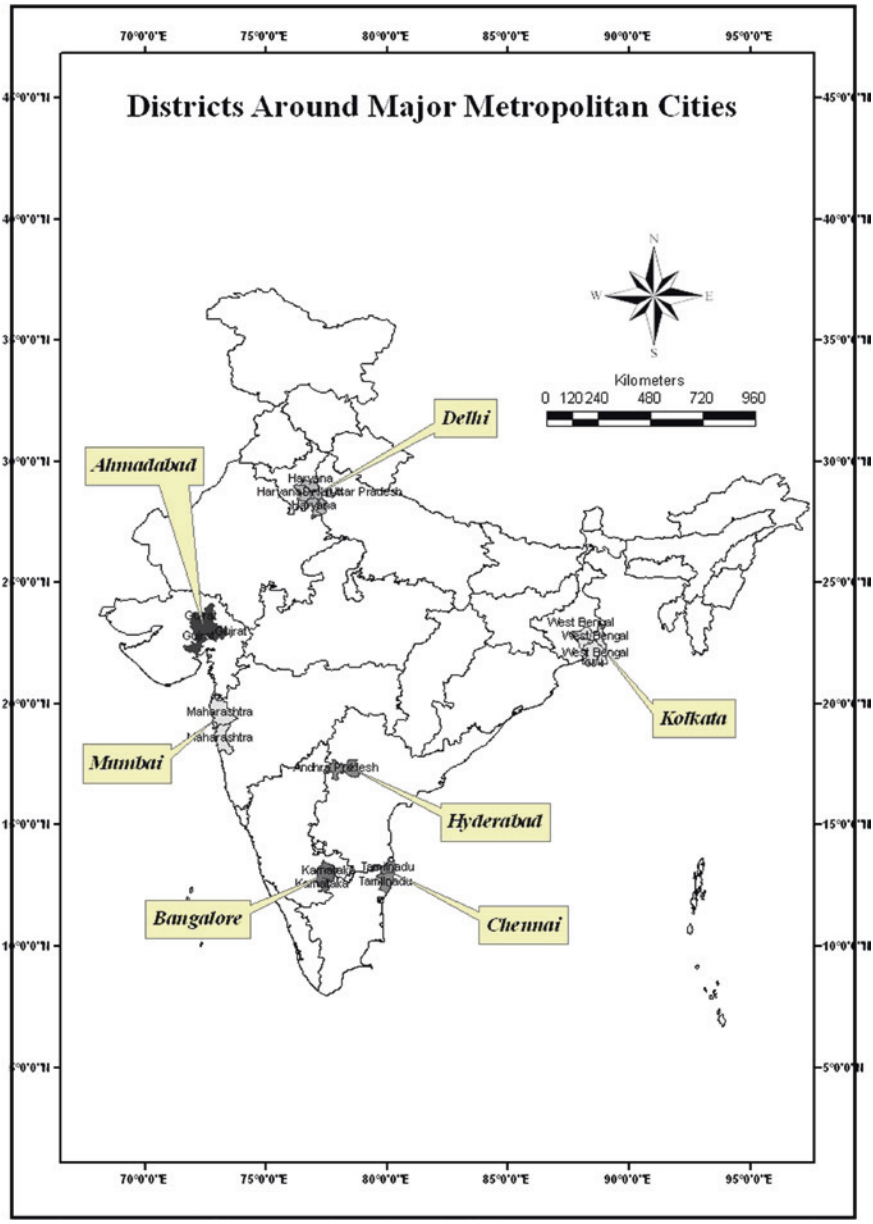

Fig. 1 Selected districts around the seven large metropolitan cities in India

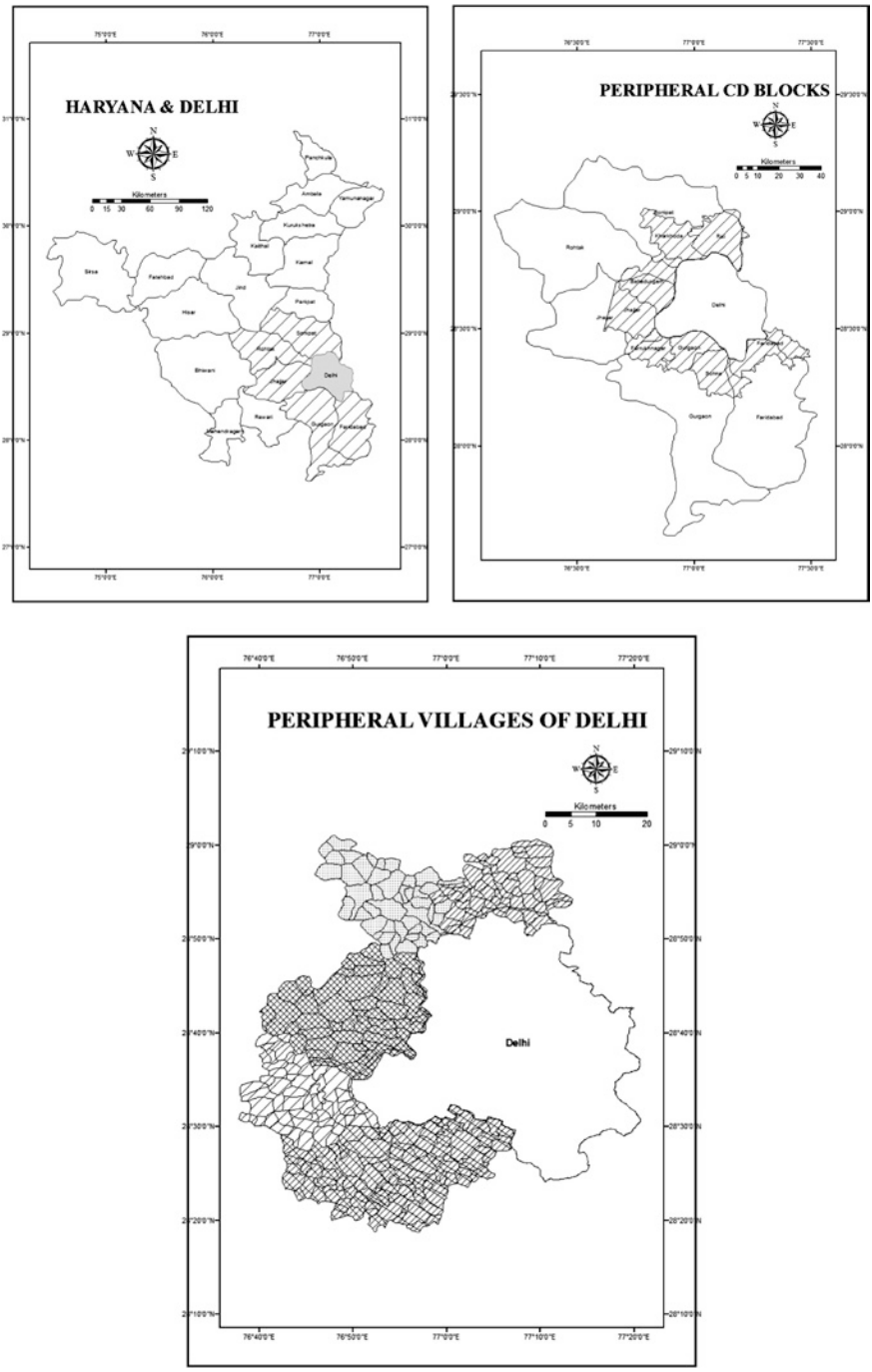

Fig. 2 Study area for microscopic analysis in the peripheral blocks and villages around Delhi (in the Haryana side)

(Anderson et al. 1976). Change detection between the two satellite imageries of two different years has been done using 'change vector study' (Coupin and Bauer 1996). The impact of land acquisition around Delhi on livelihood of farmers has been substantiated with field observations through an exploratory survey in a few villages around Delhi.

Dynamics of Land-Use in the Periphery of Large Metropolitan Cities

Several cities have witnessed a spill-over effect of urbanization around its peripheries in the post-reform period. This is more prominent around Hyderabad, Chennai, Delhi adjacent to Haryana and also Bangalore (Table 1).[5] Thus, the southern cities seem to have responded to the reform in a manner that was expected along with the areas adjacent to Delhi.

The peripheral areas have generally experienced higher increase in non-agricultural area that are faster than the respective states in the post-reform period. The only exceptions are Kolkata and Mumbai. The DAM of Chennai has experienced highest proportional increase of area under non-agricultural use (AUNAU) in the post-reform period than any other cities under consideration and this trend is consistent with the amount of investment it drew in the post-reform period.[6] This has happened despite the fact that it is having a base of AUNAU that is significantly higher than the other cities.

Several important patterns emerge out from the analysis of change in shares of net sown area (NSA) and total cultivable land (TCL) in the pre-and post-reform periods.[7] In most of the cases, proportion of both NSA and TCL is higher in the states than in the DAMs in both the pre-reform and post-reform period. Majority of the peripheries of metropolitan cities have improved in terms of extent of net sown area in the post-reform period in contrast to the pre-reform period. These are the same cities that had witnessed a decline in the extent of NSA in the pre-reform period. In contrast, periphery of Mumbai, Delhi (on the Haryana side) had registered a greater increase in NSA in the pre-reform period in comparison to the later period. Except for Hyderabad and Mumbai, peripheries of most of the other cities experienced continued decrease in proportion of total cultivable land (TCL), a process which had started from before the reforms. In spite of some increase in NSA in the post-reform period in many cases, none of them could revert back to their

[5]In 1989, 'Bangalore Rural' district was carved out from Bangalore and thus data for Bangalore Rural district was not available in 1981 separately.

[6]Source: Data from CAPEX, CMIE (Centre for Monitoring the Indian Economy), February 2005. (as presented in Shaw et al. 2006).

[7]Cultivable Land has been calculated by summing up the areas under Culturable Wasteland, Current Fallow Land and Fallow Other than Current Fallow Land and Net Sown Area; especially the lands having potentiality of producing agricultural crops.

Table 1 Decadal Percentages of AUNAU, NSA and TCL in the DAMs and respective states (1980–2000) (% to reporting area)

		Mum	MH	Kol	W.B.	Del	Har	Del	U.P.	Hyd	A.P.	Chen	T.N.	Bang	KNT	Ahm	Guj
AUNAU	('80)	6.4	3.4	21.5	14.3	10.8	8.5	12.1	7.5	9.2	7.8	23.7	13.2	NA	5.5	9.4	5.7
	('90)	7.8	3.6	24.3	18.4	11.1	6.9	14.1	8.2	10.1	8.4	25.4	14.0	7.5	6.2	9.9	5.9
	('00)	8.5	4.3	25.6	20.0	14.4	8.4	15.3	8.6	11.6	9.5	30.6	15.1	9.9	6.8	10.0	6.0
NSA	('80)	27.8	59.0	53.3	62.6	74.3	81.8	73.1	57.9	42.2	39.6	40.5	45.7	NA	53.4	75.4	50.9
	('90)	33.0	60.0	48.1	60.3	77.6	81.2	71.1	57.9	39.5	40.2	36.2	43.0	52.3	55.3	72.6	49.7
	('00)	32.0	57.5	49.9	61.5	75.4	81.0	71.7	59.0	39.7	39.7	36.9	42.1	51.0	54.5	74.9	50.7
TCL	('80)	38.1	67.8	54.7	68.7	83.7	86.3	82.0	68.2	65.9	56.5	59.5	63.9	NA	65.2	81.6	66.1
	('90)	45.1	69.7	52.6	66.5	82.9	86.0	80.7	68.1	66.4	57.4	58.9	63.2	61.5	66.0	80.6	65.6
	('00)	41.8	68.7	51.4	65.4	81.4	86.1	80.4	68.0	66.6	56.8	54.7	61.9	60.9	66.2	80.4	65.8

Source Calculated from the land-utilization statistics of Directorate of Economics and Statistics, Ministry of Agriculture, GOI. [Abbreviations: AUNAU-Area under Non-Agricultural Use, NSA-Net Sown Area, TCL-Total Cultivable Land]

position of 1980. Thus, there was a net outflow of area under plough in those cases compared to the 1980s However, generally speaking, a decrease in total cultivable land on one hand and increase in NSA, on the other, in the post-reform period around many of the large metropolitan cities indicates better utilization of limited stock of agricultural land in the post-reform period. This general trend, however, needs to be studied in greater details, because the exact dynamics of urban expansion and the resultant land use changes cannot be understood by looking at the net inflows and outflows.

This section reveals to us that frequently, peripheries of all metropolitan cities have been more rooted to the larger regions in which they are located, rather than taking on a monolithic urban 'metropolitan' character. The difference in the patterns of land use changes in the large cities located in different regional contexts reveal that the geographical contexts and the socio-cultural and regional economic contexts are important in shaping these changes.

Dynamics of Land-Use in the Periphery of Delhi: A Detailed Analysis

Delhi has experienced a multipolar urbanization with Gurgaon and Faridabad merging with Delhi in terms of urban area expansion. From the analysis done in the earlier section, the peripheries of Delhi have the unique feature of experiencing a decline in both the net sown area and total cultivable land in the post-reform period. Also, Delhi is surrounded by multi-cropped productive area, both in Haryana and Western Uttar Pradesh. These characteristics make Delhi an ideal case to explore in greater depth.

The nature of transfer of land from one land-use class to another cannot be understood clearly from the analysis in the previous section. Use of satellite imageries of two periods for Delhi's peripheries has enabled change detection with higher certainty. The status of land utilization in the post-reform period (up to 2006), in the delineated study area, shows that none of the CD Blocks studied here is having more than 40 % of double-cropped area. Expectedly, in Gurgaon, total net sown area accounts for only 50 % (within which only 20 % are double cropped) and area under built-up use is reasonably higher than any other blocks under consideration. On the other hand, the block of Jhajjar possesses a great prospect for future growth of built-up area as proportion of built-up area is among the lowest and it is also having over 5 % of wasteland which presents a possibility of future expansion of built-up area at lesser costs than any other blocks.

The summary of land-use categories as derived from satellite data has been shown in Table 2. This provides us with the existing pattern of land utilization. An effort to address the question of how have different land-use classes been converted to built-up area in the post-reform period has been made by comparing the available imageries of Kharif seasons between 1989 and 2006. The following paragraphs give a detailed analysis of such conversion process.

Table 2 Percentage of areas under different land-use/land cover classes in CD Blocks (2006)

CD Block	Area (ha)	DCA	SCA	BUA	Vegetation	Wasteland	Water	Dry and sandy soil
Rai	27,373	39.8	9.9	32.0	15.5	1.6	2.4	0.1
Kharkhoda	30,355	36.4	18.6	27.7	12.5	3.1	1.5	0.2
Bahadurgarh	48,838	32.0	21.6	32.7	9.3	3.9	2.6	0.3
Jhajjar	30,534	31.6	38.7	19.4	2.5	5.1	1.0	1.8
Farrukhnagar	29,004	35.3	44.8	12.4	3.0	2.2	0.7	0.8
Gurgaon	27,795	20.2	30.6	33.2	7.4	2.7	4.8	1.1

Source Table generated from the land-use classification operation using two satellite imageries (IRS P-6 LISS-3 Path-96 Row-51) of 12/02/2006 (Rabi) and 10/10/2006 (Kharif) ,respectively and overlaying of maps of the six blocks of Haryana surrounding Delhi. The administrative boundaries of the districts and CD blocks have been taken from the Town and Village Directory of the Census of India (1991). N.B. DCA and SCA stand for double-and single-cropped area, respectively, while BUA stands for built-up area (Figures generated from supervised classification of satellite imagery)

The possibility of change detection between two periods of time is possible partially as imagery of two Kharif growing seasons are available (1989 & 2006). After performing supervised imagery-classification, overlaying and change detection techniques have been used for the analysis. To grasp the process of conversion more accurately, a comparison of different types of classes, which were converted into built-up area between 1989 and 2006, has been shown in terms of amount of area consumed from a village and also the percentage of one particular land-use/cover class converted to the built-up use in the respective villages (Figs. 3 and 4). Among all the peripheral blocks of Delhi, Gurgaon has experienced tremendous growth of area under built-up category and land-use types being consumed for the purpose of built-up area is quite diverse and extensive. The Case of Bahadurgarh block is almost similar to that of Gurgaon. Field study confirms high level of growth of built-up area in the post-reform period in both the blocks, especially around the cities of Gurgaon and Bahadurgarh.

Statistical analysis points to few prominent features of land conversion. First, land from almost all the land-use classes have been more or less converted into urban use. Second, land-use units occupying larger area (more than 100 ha) were converted mainly from uses like cropped area, seasonal fallow, vegetative cover other than agriculture and wasteland. Third, the overall conversion, irrespective of land-use classes, however, has happened mainly for the smaller units of use (Table 3). Thus, individual housing has probably outweighed large scale acquisition of land by Government and private owners.

Further, we could see that no one land-use class dominated in the process of conversion. Croplands, both cropped land and seasonal fallow combined, alone account for about 29 % of total conversion. Loss of area under croplands to the extent of 30–40 % has taken place in many villages, which is a matter of concern given its potential impact on those dependent on agriculture.

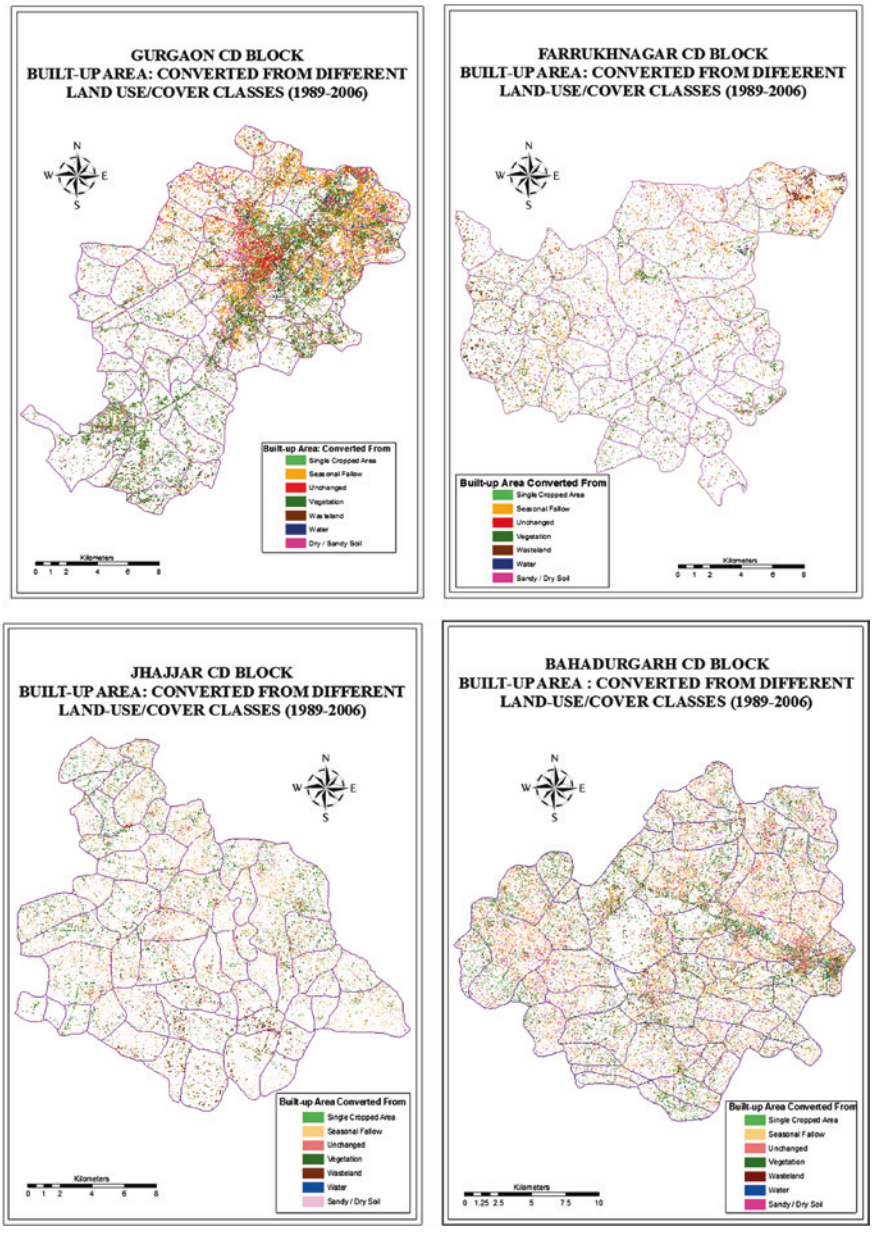

Fig. 3 Conversion of different land-use/cover classes to Built-up Area (1989–2006). (CD Blocks of Gurgaon, Farrukhnagar, Bahadurgarh and Jhajjar clockwise from the *top left*)

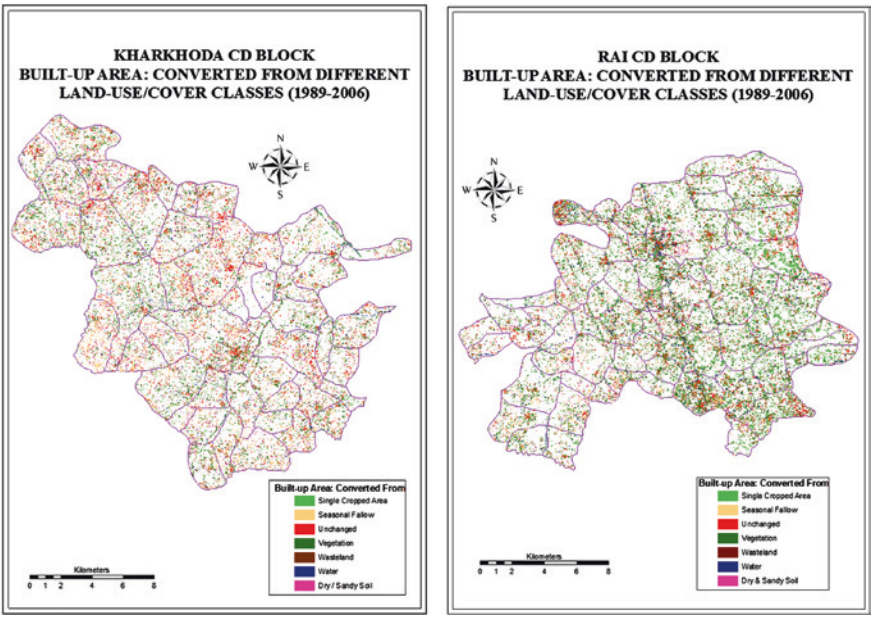

Fig. 4 Conversion of different land-use/cover classes to Built-up Area (1989–2006). (CD Blocks of Kharokhoda and Rai)

Table 3 Area-wise conversion of major land-use/cover types into built-up area in different peripheral CD blocks of Delhi (1989–2006)

			Area converted to built-up area (%)						Total (%)
			1.00	2.00	3.00	4.00	5.00	6.00	
Built-up area converted from	Cropped area	% of changed cases	63.8	17.8	10.9	6.6	0.9	0.0	100.0
		% of total conversion	**9.1**	2.5	1.6	0.9	0.1	0.0	**14.3**
	Seasonal fallow	% of changed cases	33.5	15.6	24.4	18.2	5.7	**2.6**	100.0
		% of total conversion	**4.8**	2.3	**3.5**	2.6	0.8	0.4	**14.4**
	Wasteland	% of total conversion	90.4	6.1	2.6	0.9	0.0	0.0	100.0
		% of total conversion	**12.8**	0.9	.4	0.1	0.0	0.0	**14.1**

Source Table generated from the land-use classification operation using two satellite imageries (IRS P-6 LISS-3 Path-96 Row-51) of 10/10/2006 (Kharif) and Landsat TM Path-147, Row-40 of 09/10/1989 (Kharif), respectively and overlaying of these classified imageries along with maps of the six blocks of Haryana surrounding Delhi to obtain change detection between different classes. The administrative boundaries of the districts and CD blocks have been taken from the Town and Village Directory of the Census of India (1991). N.B.: Column title marked as 1.00, 2.00, 3.00, 4.00, 5.00, and 6.00 represent the area of a single land-use converted from a single village and their absolute values are −10 ha and less, 10–20, 20–40, 40–100, 100–200 and 200 ha and more, respectively. All the figures are approximate

The study also finds that among the different blocks in the periphery of Delhi metropolitan area, there was a large area under wastelands still unaffected that could have been converted in the post-reform period and at the aggregate level, loss of cropland could have been restricted. There are also some blocks where even extensive croplands' conversion could not feed the rapid urban-growth experiences in the post-reform period. Table 4 and Fig. 5 gave the extent of croplands that could have been saved had wastelands been converted to urban use. While the limitation that the distribution of wasteland may not fit into the land demands for built-up area extension is understood, the argument that the intrusion on farmland is inevitable due to lack of availability of any other kinds of land gets discounted.

Dynamics of Land-Use with Increasing Distance from Urban Centre of Delhi

To identify the effect of metropolitan expansion on the land-use pattern of the villages in the peripheral blocks of Delhi, owing to the higher investment made in the post-reform period, different buffer areas at increasing distances from the urban centre have been delineated and the phenomena of conversion of productive cropland and other important land-use classes have been considered. The areas so delineated have been shown in Fig. 6a. Following paragraphs focuses on the process of land-use change that had actually happened to those villages in the state of changing demand for land with increasing distance from the urban centre.

Table 4 Extent of converted croplands and remaining wastelands in the periphery of Delhi in the post-reform period (1989–2006) (Area in hectares)

CD blocks	Converted croplands	Remaining wastelands	Croplands (that could have been saved)
Bahadurgarh	6362	2188	4174
Farrukhnagar	871	2376	−1504 (No cropland conversion was needed)
Gurgaon	2843	786	2057
Jhajjar	1981	2819	−838 (No cropland conversion was needed)
Kharkhoda	2818	1021	1797
Rai	2719	418	2301

Source Table generated from the land-use classification operation using two satellite imageries (IRS P-6 LISS-3 Path-96 Row-51) of 10/10/2006 (Kharif) and Landsat TM Path-147, Row-40 of 09/10/1989 (Kharif), respectively and overlaying of these classified imageries along with maps of the six blocks of Haryana surrounding Delhi to obtain change detection between different classes. The administrative boundaries of the districts and CD blocks have been taken from the Town and Village Directory of the Census of India (1991)

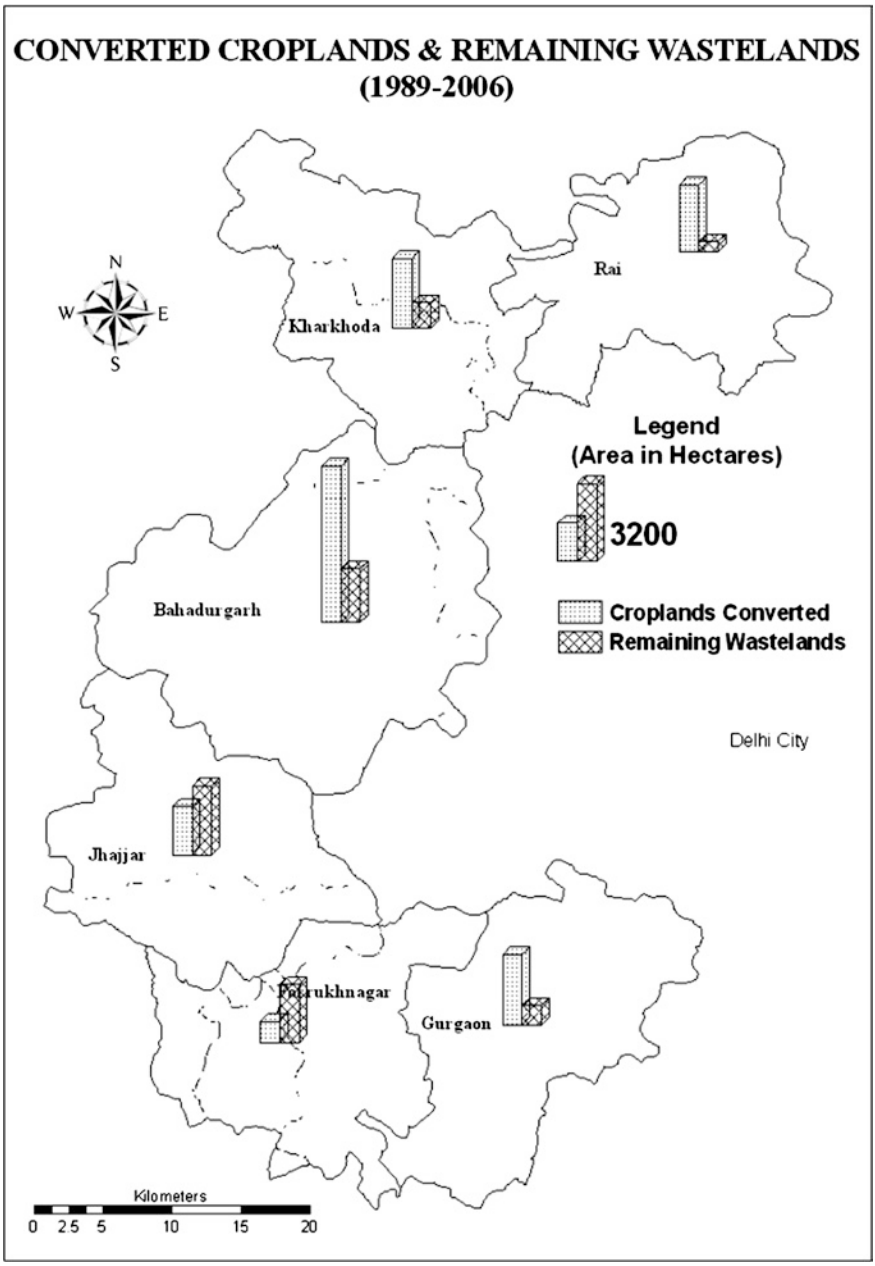

Fig. 5 Extent of remaining wastelands and converted croplands in the post-reform period in the periphery of Delhi

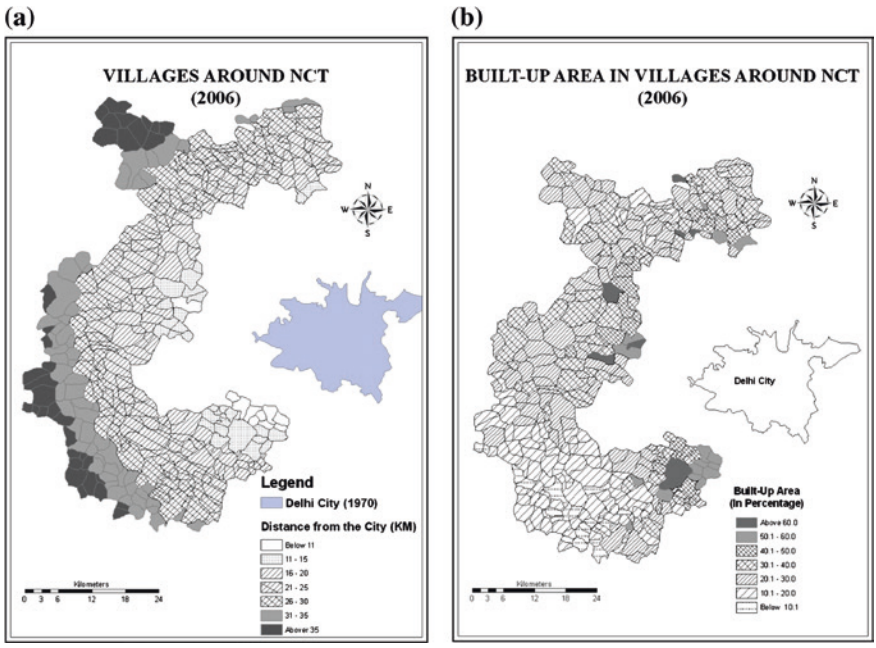

Fig. 6 **a** Villages at different distances (shown in *different colour*) from the urban centre of Delhi and **b** present status (2006) of built-up area in the villages

As the map of built-up area suggests that the concentration of area under this use increases as distance from urban centre declines (Fig. 6b). It can be observed that wherever the city centre approaches the villages' boundary, the occurrence of built-up area is significantly high; most of the villages having more than 60 % of built-up area within them are located within 20 km from the city centre and the villages with lower percentage of built-up area within them are reasonably far away from the city centre. There exists a significantly high degree of negative correlation between the built-up area and distance from the city centre. It implies that with increasing distance from the city centre of Delhi, the percentage of built-up area in the villages' decreases and vice versa. It supports the very basics of this study which assumes that increased level of investment in the post-reform period in and around large metropolitan centres will necessitate enhancement of infrastructure and other developmental activities what would be reflected in the expansion of built-up area in the periphery of large urban metropolitan centres. The foregoing analysis reveals that this process has been fairly prominent around the metropolitan city of Delhi.

Analyzing the present distribution of built-up area does not serve our purpose completely as long as we do not look into the process of transfer of land from different uses, especially from cropland, to built-up area during the period 1989–2006. Such transfer tells about the rationale of land-use change processes as a reflection of local land-use decisions and motives of different players involved.

As far as the conversion of single-cropped area is concerned, the percentage change of single-cropped area, between the two periods, into built-up area has been considered here in correlation with changing distance from the city centre (Table 5 and Fig. 7a).[8] A fair degree of significant negative correlation is found between these two land-use classes. High proportion of conversion of cropped area into built-up area occurring closer to the urban area has left meagre amount of available total stock of cultivable land in the nearby villages to the urban centre. Similar kind of phenomena has been found in a study around the urban centres of Mumbai, Kolkata and Delhi (Chadha et al. 2004).

To have a better understanding of the phenomena, percentage loss in single-cropped area to built-up area has been extracted and analyzed in relation with distance with the distance centre. Table 5 suggests that highest number of villages where higher percentage of single-cropped area has been converted into built-up area lie nearest to the urban centre and vice versa. It is found that higher number of villages where low to moderate level conversion to built-up area has happened lie between 25 and 35 km from the city centre. However, if we extend the analysis to the conversion of seasonal fallow land, a higher level of correlation is found between the percentage change in area under seasonal fallow and distance from the city centre. In this case also, villages experiencing higher percentage of conversion are found in the closest three belts of the city centre. Thus, one thing becomes very clear here, i.e. increasing built-up area has not worked in the rationale of saving precious croplands for the future. There exists significant negative correlation (−0.480) between these two variables (seasonal fallow/single cropped land and distance from the city centre). Figure 7a, b gives a clear understanding of the process.

The rationale of sustainable land-use practice can be viewed from one more perspective, i.e. how the wastelands were used in the process of conversion with increasing distance from the city centre. There exists again a significant negative correlation (−0.493) of higher degree between the level of conversion of wasteland and their distance from the city centre. With increasing distance from the city centre there is again a trend of lower proportion of conversion. Highest proportions of wastelands conversion in villages are concentrated within the distance of 20 km from the city centre (See Fig. 8). This partly shows that urban pressure has worked well in many peripheral villages to convert large plots of wastelands into built-up area and this satisfies our assumption.

When we look at the proportion of different classes that were converted to built-up area with increasing distance from the city centre in the post-reform period (1989–2006), we see that seasonal fallow lands contributed highly in the villages

[8]These farmland areas, as has been found in the kharif season imagery of 1989, could also possibly be considered as double-cropland area and also what has been seen as fallow lands in the 1989 imagery, can be considered as single cropped area here to ease the analysis. During our field survey to some of the villages in and around Delhi, it was found that, lands may remain fallow in the Kharif season if it is actually there; otherwise what has been cultivated in the Kharif season, in all the cases those were cultivated in the rabi season also. Thus, this assumption is backed by evidences from field study.

Table 5 Percentages of double and single-cropped area converted to BUA in villages with increasing distance from the city centre

			Percentage of double cropped area (DCA) and single-cropped area (SCA) consumed (%)					Total (%)
			1.00	2.00	3.00	4.00	5.00	
Distance from the city centre (in km)	10	Percentage of DCA	0.0	18.2	18.2	18.2	***45.5***	100.0
		Percentage of SCA	0.0	0.0	9.1	**27.3**	**63.6**	100.0
	15	Percentage of DCA	6.9	34.5	24.1	20.7	13.8	100.0
		Percentage of SCA	0.0	27.6	31.0	10.3	***31.0***	100.0
	20	Percentage of DCA	10.3	31.0	51.7	3.4	3.4	100.0
		Percentage of SCA	8.8	26.3	***40.4***	14.0	10.5	100.0
	25	Percentage of DCA	30.0	***45.0***	18.8	6.3	0.0	100.0
		Percentage of SCA	24.4	***32.6***	***30.2***	12.8	0.0	100.0
	30	Percentage of DCA	***29.3***	***50.7***	14.7	5.3	0.0	100.0
		Percentage of SCA	23.0	***44.6***	***29.7***	2.7	0.0	100.0
	35	Percentage of DCA	**42.4**	**42.4**	13.6	1.7	0.0	100.0
		Percentage of SCA	***35.6***	***32.2***	25.4	5.1	1.7	100.0
	40	Percentage of DCA	***39.3***	***57.1***	3.6	0.0	0.0	100.0
		Percentage of SCA	27.6	***55.2***	17.2	0.0	0.0	100.0
	45	Percentage of DCA	***28.6***	0.0	***71.4***	0.0	0.0	100.0
		Percentage of SCA	28.6	0.0	***71.4***	0.0	0.0	100.0
Total	Percentage of DCA		26.5	41.8	22.8	5.8	3.2	100.0
	Percentage of SCA		21.0	33.8	30.1	8.5	6.5	100.0

Source Same as Table 3. Besides, Maps of the villages have been taken from the Town and Village Directory of the Census of India (1991) and overlaying operation performed using GIS platform. N.B.: Column title marked as 1.00, 2.00, 3.00, 4.00 and 5.00 represent the percentage of double-/single-cropped area converted from a particular village from 1989. Figures 1, 2, 3, 4, and 5 stand for 10 % or less, 10–20, 20–30, 30–40 and 40 % or more respectively

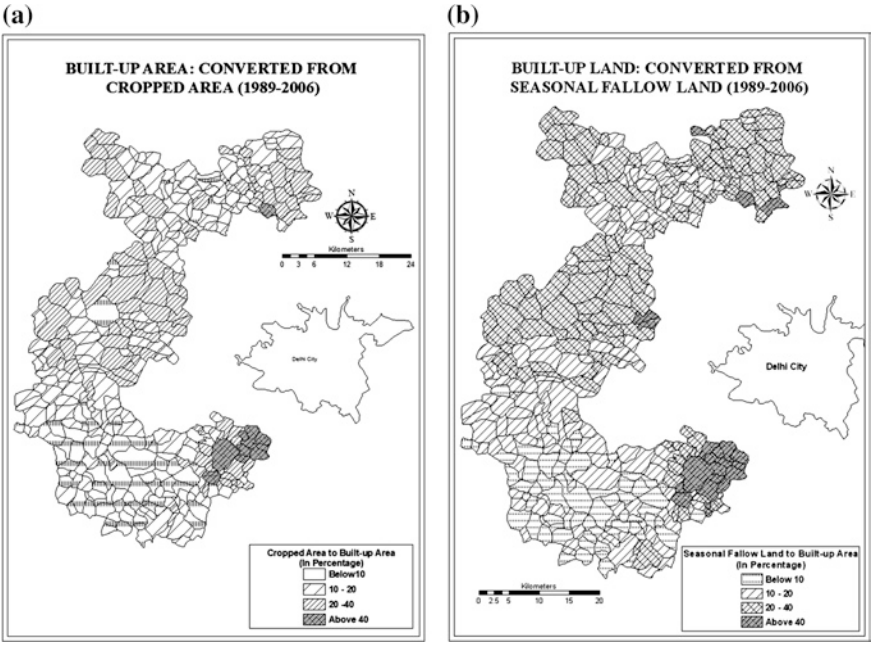

Fig. 7 **a** Percentage of cropped area converted into built-up area and **b** percentage of seasonal fallow converted into built-up area between 1989 and 2006

which were close to the urban centre or at a medium distance (20–35 km) from the urban centre. There is significant negative correlation between distance from the city centre and proportional conversion of fallow lands in the villages. However, proportion of single-cropped area converted to built-up area does not seem to be too high in the villages closer to the urban centre, and there exists a positive relationship with conversion of single-cropped area and distance from the city centre. In other words, number of villages that experienced conversion of higher proportion of double-cropped area increased with increasing distance from the urban centre. A similar kind of pattern has been seen between the conversion of wasteland and distance from the city centre. A significant positive correlation between these two phenomena exists. Figures 9a, b and 10 depicts all such phenomena clearly.

In Delhi, or for that matter in any other urban centre, land is acquired from the land-owners for any development-plan initiated by Government. In Delhi, Delhi Development Authority (DDA) is the public authority that is empowered to acquire land for different developmental purposes within the National Capital Territory (NCT). Record of DDA also shows that most of the acquisition of land took place in the north and north-westerly direction from the city centre.[9]

[9]Data collected on acquisition of land for DDA was collected from DDA Head Office, New Delhi in March, 2008.

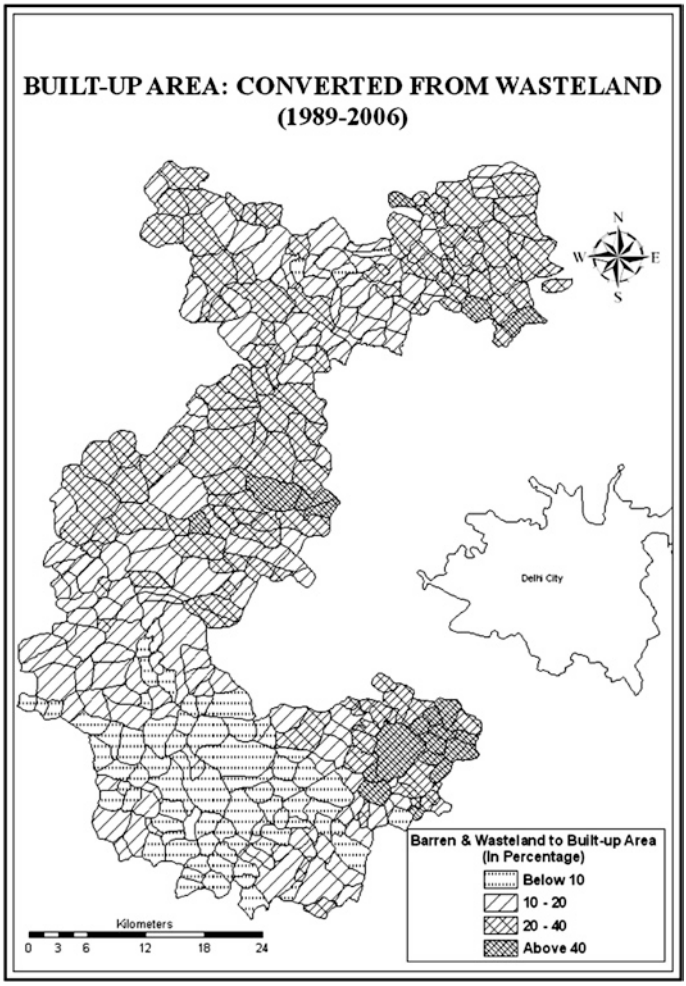

Fig. 8 Percentage of wasteland converted into Built-Up Area between 1989 and 2006

Two villages were selected in the periphery of Delhi for looking into the impact of expansion of built-up area around urban centre upon the livelihood of the farmers.[10] One of the study-villages *Rani Khera* is also located in the fast growing north-western region of Delhi. It was one among many other villages where over 10 % of village area was acquired in the post-reform period (post-1990). The second village that was selected for the study was *Manesar* village, located some 10 km away from Gurgaon city and located within Gurgaon CD Block. Over 95 % of total area of Manesar has been acquired for different projects (over 35 % in the

[10]The exploratory field-survey was conducted in the first-half of 2008.

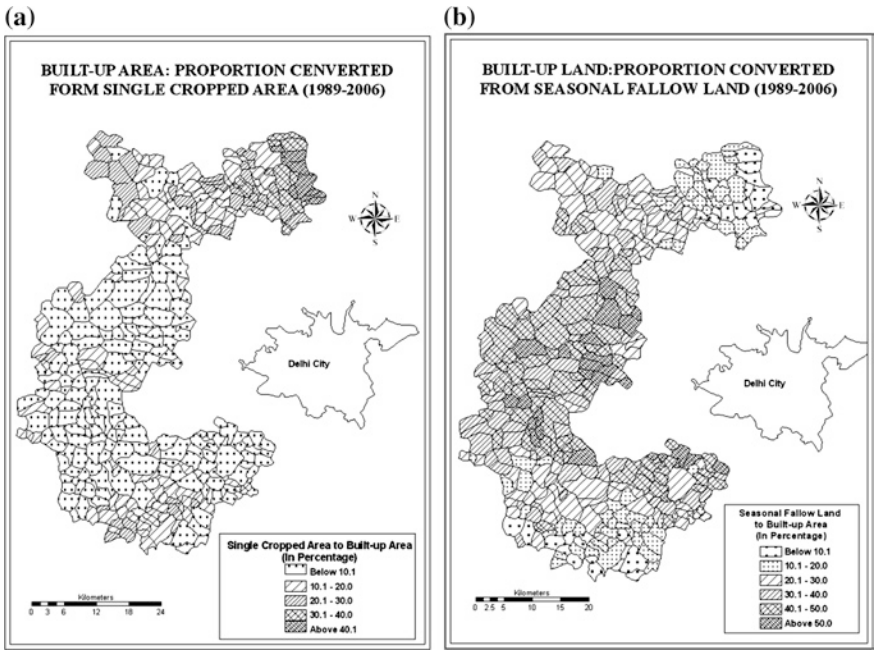

Fig. 9 **a** Proportion of single-cropped area and **b** proportion of fallow land contributed to built-up area

post-liberalization period), and acquired lands were mainly double-cropped land and barren lands.

Some observations can be brought out here as were found from the field study. First, there has been an increase in loss of cultivable land in the post-reform period, as is shown in the study based on secondary data, owing to the increased developmental activities. Second, the phenomenon of loss of cultivable land is largely found closer to the urban centre and as one move away from the centre, it becomes less persistent. Third, the growth of urban area over rural land has a clear spatial pattern; in Delhi, it has spread mainly towards the north-west and south. Fourth, although some wastelands have been converted, cultivated land was the category from which major outflows took place. With the acquisition of land, landless farmers have been affected more than the owner–farmers. In such a situation they are more desperate to find a job outside in contrast to the small owner–farmer who continued to lead a fair quality of living even after acquisition of portions of their farmlands. Lastly, there is dissatisfaction among the farmers over the whole process of acquisition and provided compensation. Lands are acquired and kept vacant for long and by the time it is put to use, the price of such land increases manifold in comparison to the actual amount paid to the farmers during acquisition. Hence, dissent amongst the affected farmers is evident. While they felt that though acquisition of land is almost inevitable, there is clearly some space for better policy so far as land acquisition and related compensation packages are concerned.

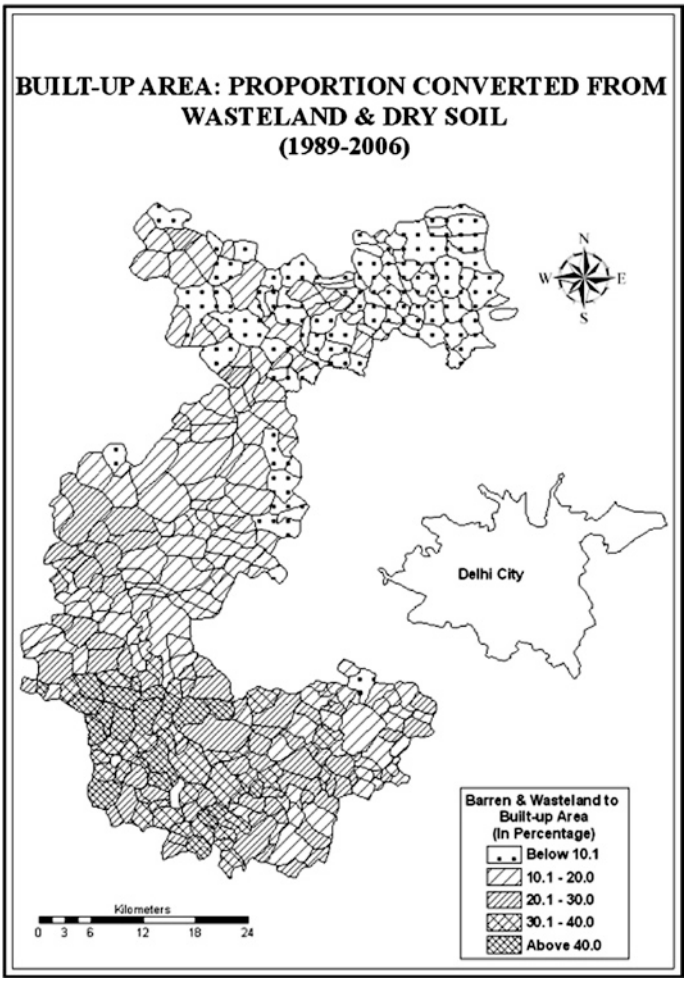

Fig. 10 Proportion of wastelands contributed to built-up area

Conclusion

In a nutshell, the complex dynamics of land utilization is quite evident around the large metropolitan cities of India. Though there are evidences that wastelands have also been used to a large extent, but the consumption of farmland is much higher and such a trend is also supported by the findings of the field work that was carried out around Delhi. The impact of conversion is more prominent on the fallow lands and single-cropped areas and closer to the urban centre of Delhi. There still remains scope for conversion of considerable amount of wastelands in the peripheral blocks of Delhi. In most of the cases government has carried out mass acquisition of farmlands for many developmental purposes. The present level of growth

that the capital city is experiencing for the last two decades is posing a substantial threat to the farmlands surrounding it. This phenomenon is resulting in not only physical transfer of lands from one use to another, but also economic deprivation of the cultivators who were dependent on such land, in the long run.

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