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**POPULATION DISTRIBUTION, GROWTH
AND SOCIO-ECONOMIC SPATIAL PATTERNS IN DELHI**

Findings from the 1991 census data

by

Véronique DUPONT* and Arup MITRA**

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* ORSTOM (French Institute of Scientific Research for Development through Co-operation, Dept. Societies, Urbanisation, Development, 213 Rue La Fayette, 75 480 Paris cedex, France) and visiting scholar at the Institute of Economic Growth (University Enclave, Delhi 110 007, India).

** Institute of Economic Growth (University Enclave, Delhi 110 007, India).

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1. INTRODUCTION

The emergence of large metropolises with several millions of inhabitants raises crucial and specific problems in terms of urban administration. Given the ineluctable spread of such agglomerations, understanding the spatial pattern of population distribution and growth, as well as the socio-economic differentiation of the urban space, seems an indispensable prerequisite for any attempt at town planning. For example, the provision of adequate urban services, and to start with housing, would require a detailed knowledge of the population characteristics according to its residential location within the agglomeration; the planning of an appropriate system of transportation responding to the needs of the daily commuters should rely on a preliminary study of the residential spatial pattern of the different segments of the working force as related to the location of the various urban economic activities and main sources of employment.

These introductory remarks particularly apply to the case of a capital city like Delhi, whose population reached 8.4 million in 1991. Moreover, among the twelve Indian metropolises having population over one million in 1981, Delhi is the one which has experienced the highest demographic growth over the last decades: 5.1% per year from 1951 to 1961, 4.5% to 4.6% from 1961 to 1981, and 3.9% per year between 1981 and 1991. Despite their slow down, such rhythms of demographic expansion obviously compound the task of town planners. Delhi also bears the distinction of being the Indian city where new ideas of town planning were launched after the Independence, and where the first Master Plan was elaborated and implemented since 1962.

Whereas one can find a good number of publications analysing town planning and urban policies in Delhi¹, or relating to housing problems², as well as case studies of some specific urban areas³ or specific sections of the urban population⁴, surprisingly it seems to be a lack of studies which would analyse thoroughly the demographic and socio-

¹ see: OLDENBURG, 1978; MISHRA, SARMA, 1979; RIBEIRO, 1981; DATTA, CHAKRAVARTY, 1981; BHAGWAN, 1983; JAIN, 1990; BILLAND, 1992

² see: TRIVEDI, 1980; SINGH, 1989; ALI, 1990; PUGH, 1990; GUPTA & al., 1993.

³ see: JAGMOHAN, 1975; MAJUMDAR P. & MAJUMDAR I, 1978; MERHA, 1979; GUPTA R.C., 1985.

⁴ See for example T.K. MAJUMDAR's study (1983) which focus on the low-income migrant communities living in *jhuggis-jhompris* and includes a spatial approach with maps showing the location of the settlements according to various characteristics of their population.

economic characteristics of the population in relation to its spatial distribution within the space of the whole urban agglomeration. Even the remarkable study of Greater Delhi conducted in 1956-57 by Rao and Desai (1965), and based on a huge sample survey of 80,000 persons all over Delhi, does not deal with the spatial dimension of the dynamics and characteristics of the urban population. In fact, very little use has been done of the census data in a systematic way to analyse the spatial and economic structure of Delhi, and the rare published studies of urban morphology based on census data refer to the 1951, 1961 and 1971 censuses. For instance Sudesh Nangia's "Study in Settlement Geography" of Delhi Metropolitan Region (1976) includes a spatial analysis of the variations of population density and growth, and of other population characteristics in 1951 and 1961, according to the distance from the city. "Delhi. Capital City" by Asok Mitra (1970) comprises a brief description of the spatial distribution of the population according to some socio-demographic characteristics in 1961. In a more elaborated statistical study based on a factor analysis of the 1971 census data, John Brush (1986) highlights the pattern of growth and the socio-economic structure of the Delhi urban area (see below).

Thus, apart from a very few and already dated cases, the ecological pattern of Delhi has been studied essentially in terms of physical differentiation and morphology, including the spatial distribution of various economic establishments, and sometimes references to the pattern of densities⁵. Development about socio-spatial differentiation, whenever covered, rely on direct observation of the urban landscape, inferences from the pattern of housing and *a priori* knowledge of the city, eventually documented by information from case studies in specific localities, but without being supported by extensive and updated population statistics.

Nevertheless, studies on Delhi usually stress the strong differentiation in the spatial organisation of the capital. Hence, Mitra (1970: 8) underlined first of all the lack of integration between the old city and New Delhi, as the result of a deliberate and planned segregation: after the capital of the British India was transferred from Calcutta to Delhi in 1911, "the new capital site was designed to recognize as few physical links as possible with the old city"(p. 8), and he later concluded: "The problem of Delhi as a capital city today is a problem of integration" (p. 48). More than twenty years later, this dual structure is still prominent, and directly inspired the title of a recent publication: "Delhi: the tale of two cities" (VHAI, 1993).

⁵ among others see: SUNDARAM, 1978; Delhi Development Authority, 1981; *Delhi Vikas Varta*, 1985; United Nations, 1986; NAGPAUL, 1988; JAIN, 1990; PUGH, 1990; DIWAKAR, QURESH, 1993.

Other authors rather emphasize a more complex internal structure, not only marked by the city's different historic periods, but also by the post-independence efforts of urban planning as well as endogenous forces.

Thus for Sundaram (1978: 116) Delhi "is not one city, but really a number of cities linked together, each of which, however, is quite separate in character, origin and function" ; more recently Pugh starts his chapter devoted to Delhi by this statement: "Delhi comprises several cities joined somewhat loosely together" (p. 173), and again in the conclusion insists on the "several contrasting cities or urban areas" which differentiate its total geographical spread" (p. 198). Further, with reference to the various American ecological models of cities, Nagpaul (1988) identifies the pattern of multiple nuclei development as the most relevant model to explain the urban configuration of Delhi (p. 187) ; this author also points out the pattern of mixed use of land as "perhaps Delhi's most prominent ecological characteristic".

With a similar concern for confronting the observation with the proposed models of urban morphology, the pre-modern pattern of Asian towns as well as its applications to contemporary Indian cities require mention. According to the traditional pattern proposed by Sjoberg (1960) for pre-modern Asian towns, the urban morphology reflected a model of socially stratified societies, with the high status people concentrated in the centre of the town where most economic activities (arts and trade, commerce) as well as the seat of political power were also located, and with the low status people confined to the urban periphery. As pointed out by Brush (1977), various empirical studies show how this type of urban structure has survived into the present time in many Indian cities. However, this author, among others (Rao, 1983 ; Schenk, 1986), also underlined that this pre-industrial urban pattern cannot apply strictly to the recent urban development in India, which proves to be more complex. In particular, the development of "industrializing and tertiarizing belts or strips along transport axes" (Rao, 1983:174), and a recent tendency of the urban elite to move to peripheral residential areas, have disturbed the traditional indigenous pattern as well as the dual structure inherited from the colonial British rule.

With reference to this traditional model and to the new processes at work, Brush (1986) demonstrates that, in the Delhi of 1971, "there are inner zones of old upper-class concentration and outer zones of recent upper-class expansion", while "population of lower class is confined either to congested areas of the Delhi urban core and its immediate vicinity or in lesser numbers to the peripheral sectors and rural fringes" (p. 148). Hence "the urban core (...) retains features which reflect traditional preference of the elite for central locations, while current growth towards the peripheries parallels the geographical pattern of so-called Western urbanisation (p. 149)".

It remains to be seen to which extent the present socio-spatial structure of Delhi can be comprehended in these terms, how the processes identified have evolved over the last two decades, and whether new trends have emerged.

Following this brief review, a consensus seems to emerge on the prevalence in Delhi of the phenomenon of population differentiation according to residential zones: yet, the process of residential and social segregation is more often *a priori* acknowledged or presumed than demonstrated, and there is a lack of statistical evidence and indicators to appraise the current stage of evolution in the spatial structure of Delhi's population. Our study intends to be a contribution to fill this gap.

With the urbanisation issues initially mentioned in view, the objective of this paper is threefold:

- to provide an original set of reference maps describing the differential spatial pattern of population distribution and growth in Delhi, on the basis of the 1991 census data, and then to analyze this pattern with reference to the models and processes quoted;
- to identify the variables which seem to generate the highest degree of residential segregation, and also to reveal forms of privileged associations between population groups identified by their socio-economic characteristics and certain areas;
- to analyse the residential pattern of the different categories of workers in relation with the location of the main economic activities, in order to detect patterns of close association between work place and residence, or on the contrary patterns of separation.

2. SOURCE OF DATA AND METHODOLOGY

Before the presentation of our findings, the source of data and their limitations, as well as the methodology followed, should be briefly discussed.

Available data and variables

The data used for this study are issued from the 1991 Primary Census Abstract of Delhi Union Territory, published in the District Census Handbook of Delhi, and released for the first time on floppies. This provides the distribution per sex of the total population and of the following sub-populations: population below age 7, literates in the population aged 7 and above, scheduled castes population (there is no schedule tribe identified in Delhi Union Territory), total main workers, marginal workers and non-workers, and main workers according to 9 industrial categories. These population figures are available

at the village level in rural areas, and at the level of the charge (the so-called census statistical division) in urban areas.

Other census tables which will provide much more detailed information on the characteristics of the population (social and cultural tables, economic tables, migration tables, etc.), were not yet published at the time of the preparation of this paper. Anyhow, all these tables will not be broken up at the charge level in urban areas, hence not allowing any analysis of intra-urban spatial differentiation, which is highly regrettable for a metropolis with the size of Delhi. In particular, there will be no possibility of analysing the impact of migration on the structuring of the urban space, and hence the interactions between mobilities and residential segregation.

Although no direct and specific data regarding the distribution of socio-economic statuses are available at the level of detailed spatial division from the census publications, it is possible to derive some useful indicators in order to approach the socio-economic structure of the urban space. The percentage of scheduled castes population (the lowest social group identified for specific public benefits) and the percentages of male and female literates/illiterates (in the population aged 7 and above) can be used as proximates for social ranking, and to identify the spatial distribution of the most underprivileged socio-economic groups.

Regarding the 9 industrial categories for main workers, apart from the first two that distinguish cultivators and agricultural labourers (which is however more meaningful for rural studies than for a study of a big metropolis like Delhi), these refer to the sector of employment, and can be hence very heterogeneous in terms of occupation and labour status. For example, the category "trade and commerce" includes big businessmen as well as petty street vendors, and the category "other services" includes jobs in public administration, private professionals, as well as personal services.

Another basic indicator to study the demographic configuration of the urban space, is the residential density. In the census reports published for Delhi, the area measurements are given for each village and census town, but not at the charge level in the urban areas. The areas of the different urban charges were estimated on the basis of a previously digitized map of the urban agglomeration showing its census divisions, and gross residential densities by census charge hence estimated.

Being based on the data from a single census, 1991, this study can only apprehend the socio-economic differentiation of the urban space at one point in time. However, in order

to supplement this static appraisal with some elements of the population dynamics, two other variables were also introduced for the analysis: the annual rate of growth between 1981 and 1991, and the ratio of children aged 0 to 6 years to female population, as an indicator of fertility.

The 1981-91 annual (exponential) growth rate for each census charge and census town was computed as per the 1991 boundaries, with the necessary adjustments to take into account the changes that have occurred in the number of census divisions and in the boundaries of some of them, due to the sub-division of certain 1981 charges, and the incorporation of certain 1981 census towns and villages into the Delhi urban agglomeration.

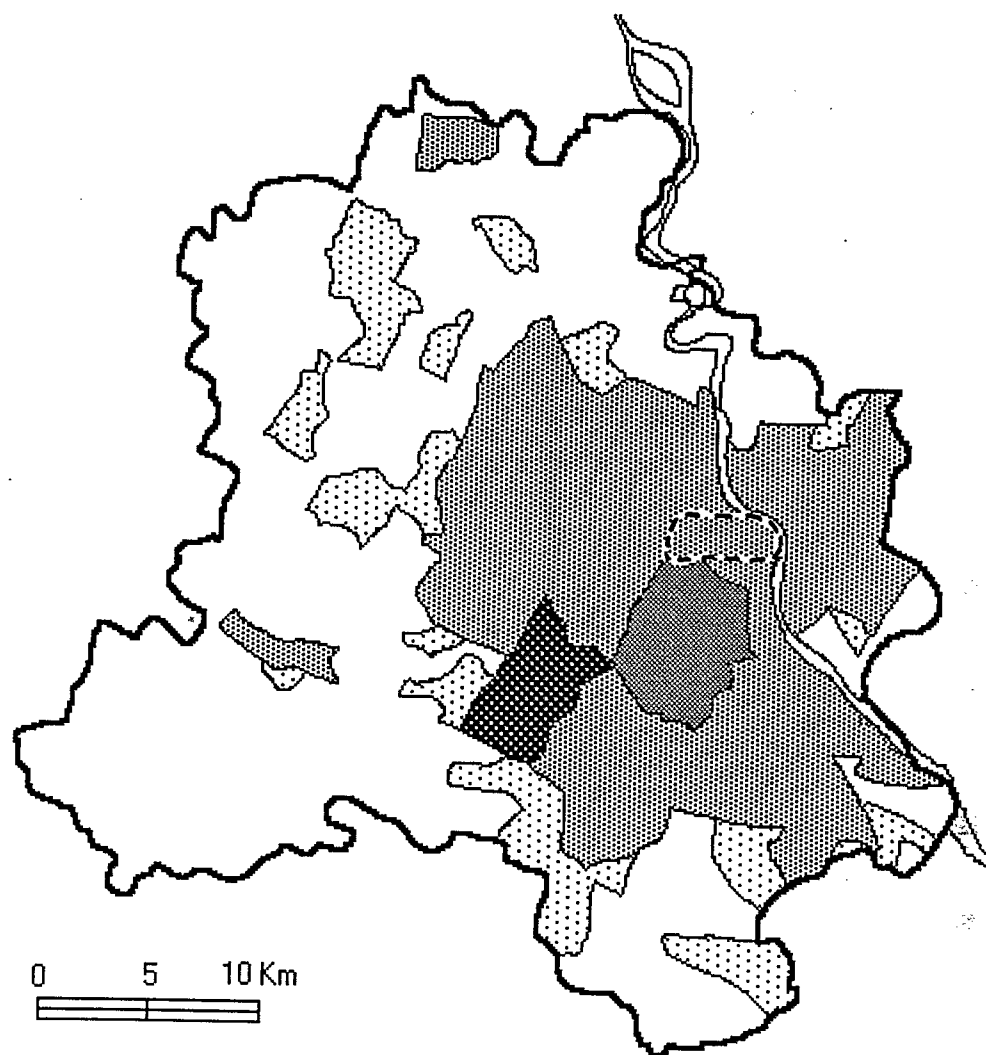
Space of reference and spatial unit of analysis

Although this study focuses on the demographic and socio-economic structure of the urban space, the space of reference is that of the entire Delhi Union Territory - and not only its urban agglomeration -, in order precisely to evaluate the differential pattern between the urban agglomeration proper, its immediate rural hinterland and the towns of the hinterland.

As mentioned above, the spatial units of analysis are the census charges or the census towns. In 1991, Delhi Urban Agglomeration comprised Delhi (Municipal Corporation) divided into 110 charges, New-Delhi divided into 9 charges, Delhi Cantonment accounting for a single charge, and 23 census towns, each one representing one charge. The Union Territory includes 6 other census towns outside the urban agglomeration. The remaining rural area, which accounts for only 10 per cent of the total population, was considered as a single zone for the purpose of our study. The distribution of the population among the main components of the Delhi Union Territory is given in Table 1, while Map 1 shows the boundaries of their respective areas.

Map 1

Delhi Union Territory: urban and rural areas in 1991



- boundaries of Delhi Union Territory
- New-Delhi
- ▨ Delhi Cantonment
- ▤ Delhi (Municipal Corporation)
- ▧ Census Towns
- Rural Areas
- Walled city and its extension
- ~ River Yamuna

Based upon the map of Delhi in *Census of India 1991*,
District Delhi, District Census Handbook

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Table 1. Delhi Union Territory: population and area in 1991

		POPULATION		AREA	
		Nbr.	%	Sq. km	%
Delhi U. A.	Delhi (M.C)	7206704	76.50	431.09	29.07
	New-Delhi	301297	3.20	42.74	2.88
	Cantonment	94393	1.00	42.97	2.90
	Census towns in U.A	816690	8.67	107.48	7.25
Census towns	out of U.A.	52541	0.56	61.06	4.12
Rural area		949019	10.07	797.66	53.79
Total		9420644	100.00	1483.00	100.00
Delhi U.A.		8419084	89.37	624.28	42.10
Total urban		8471625	89.93	685.34	46.21
Total rural		949019	10.07	797.66	53.79
Total		9420644	100.00	1483.00	100.00

Source: 1991 census

Methods of analysis

Several types of analysis have been combined to study the spatial pattern of population distribution and growth, and the socio-economic differentiation of the urban space of Delhi.

First, a set of maps has been designed to show the spatial differentiation of the selected indicators and population characteristics. Various size classes pertaining to each of the variables have been constructed on the basis of frequency distribution. All these size classes have been represented by different shades and charges falling into different size classes have been shaded accordingly in the maps.

This descriptive approach is supported by measures of concentration and dispersion, and supplemented by a statistical analysis of the correlation coefficients of the different variables, in order to reveal privileged forms of associations. The interpretation however requires particular caution, since the analysis is carried out at the charge level; therefore the associations detected do not necessarily imply similar associations of the corresponding characteristics at the household or individual levels, due to possible internal heterogeneity of the charges. A factor analysis and a cluster analysis eventually attempt to bring out meaningful synthetic patterns of spatial organisation.

3. PATTERN OF POPULATION DISTRIBUTION AND GROWTH

This section deals with the spatial pattern of population density and growth in Delhi urban agglomeration and hinterland; the analysis also includes two other indicators of population dynamics, namely child-women ratio and sex ratio, and further examines the interactions among those variables.

Population density

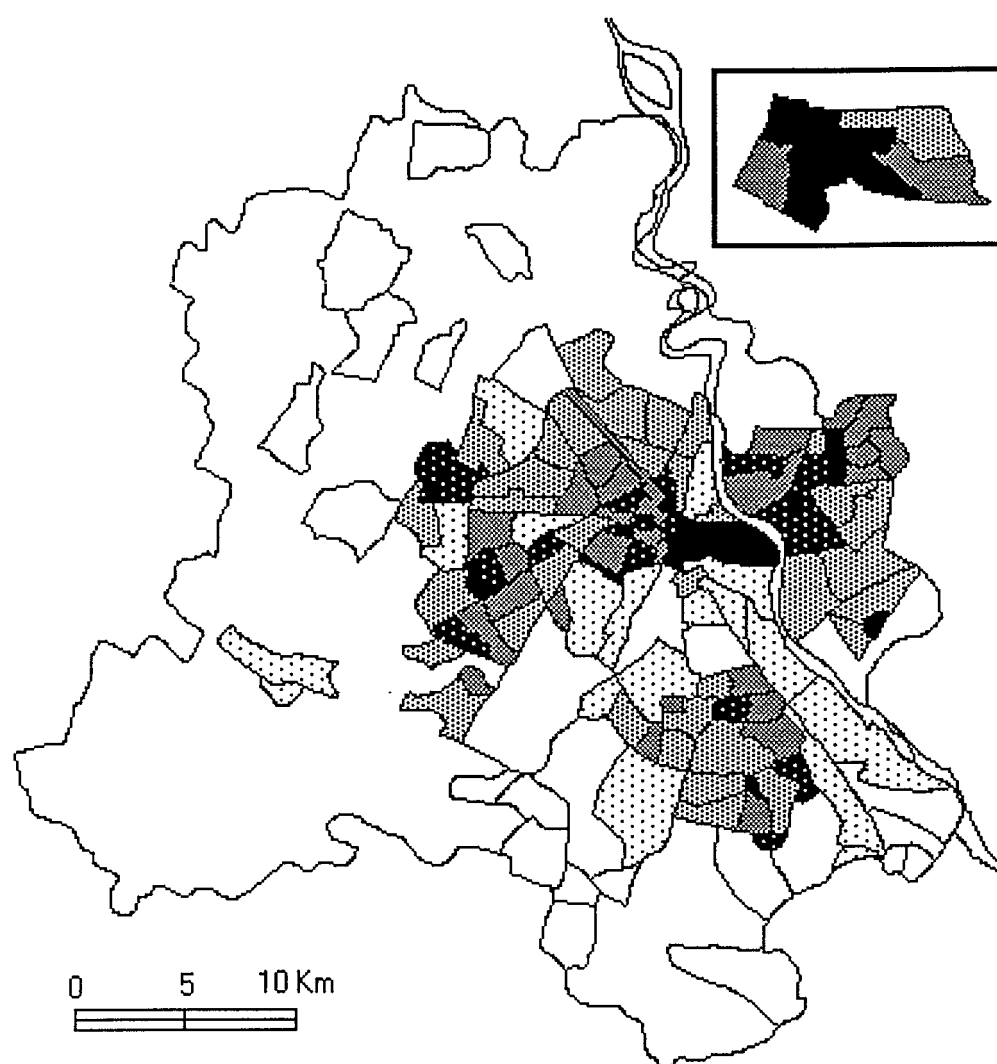
In 1991 the Union Territory of Delhi had an average population density of 63.5 person per hectare, rising to 135 in the Delhi urban agglomeration as a whole. As shown in Map 2, the pattern of population density exhibits heavy concentration of population in certain urban pockets, and relatively sparse population in others, these wide variations of the densities being also reflected by a high value of the coefficient of variation (108 per cent). Thus, almost half of the total urban population is concentrated in 66 census charges (out of 149) accounting for only 18 per cent of the total urban area. The highest densities are registered in Old Delhi, the walled city dating back to the Mughals; there the average density is 560 persons per hectare, with a maximum of 1660 in one charge. The old city comprises also a high concentration of commercial and small-scale industrial activities, showing a mixed land use pattern typical of traditional Indian cities. Densities are also high in Shahdara, in the northeast across the river Yamuna, which received a major influx of refugees from Pakistan after the Partition and developed as a satellite town of Delhi. On the other hand New Delhi has a density of only 70 persons per hectare, with a minimum of 35 in one charge; further, Delhi cantonment, which includes military land and the international Airport, records an even lower density of 22 persons per hectare. The classical model of population density gradients, characterized by high densities in the urban core, and a sharp decline towards the periphery, and whose "original causes (...) can be summed up in three words: protection, prestige, and proximity" (Brush, 1961:65), has largely survived in Delhi. Yet, some pockets of high population density are also noticeable in the western sector and in the south^{east}.

Rate of population growth

The pattern of growth in Delhi between 1981 and 1991 was "clearly centrifugal" (Map 3), hence in continuation with the trend already highlighted by Brush (1986: 127) for the 1961-71 decade. Noteworthy, this centrifugal trend extends beyond the limits of the urban agglomeration, since the population growth between 1981 and 1991 was faster in the rural hinterland than in Delhi urban agglomeration: 9.6 per cent per year as against 3.8

Map 2

Population density in different zones of Delhi Union Territory in 1991



Population density in 1991 (number of inhabitants per hectare)

	4 to 49		200 to 299
	50 to 99		300 to 499
	100 to 199		500 to 1700

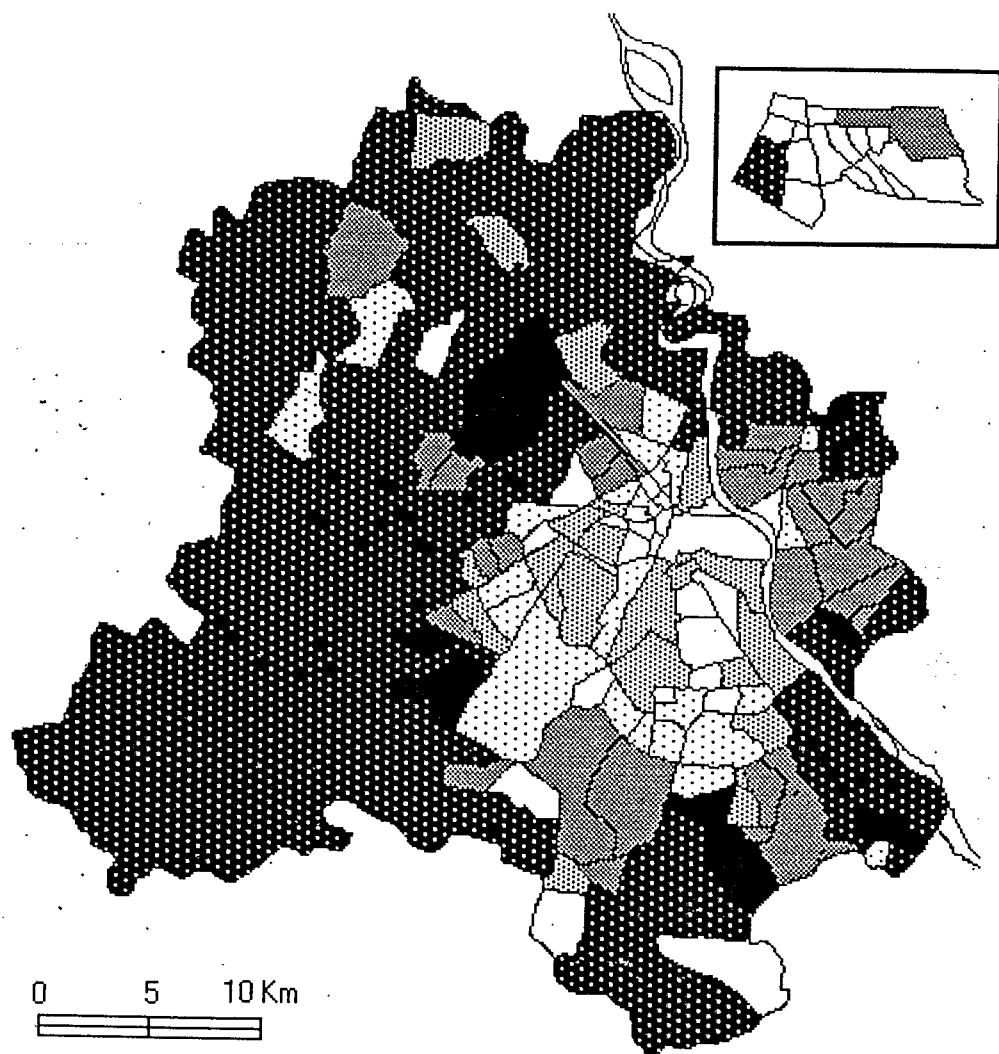
Average for Delhi Union Territory: 63.5

Based on 1991 Census data

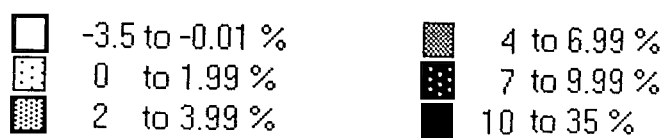
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Map 3

Annual growth rate of the population from 1981 to 1991 in different zones of Delhi Union Territory



Annual growth rate of the population from
1981 to 1991 (in percentage)



Average for Delhi Union Territory: 4.24%

Based on 1991 Census data

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per cent respectively (within the boundaries of the urban agglomeration and the rural area as per in 1991). As already noticed by Bose (1993:160) "this reflects the spillover of urban Delhi". These figures should be compared to the annual rate of natural growth during the same period, that is approximately 2.1 per cent in Delhi Union Territory, which hence indicates the correlative importance of net in-migration. It appears that the rural hinterland has attracted a large number of migrants, coming from other States, or who left the Delhi urban agglomeration in search of less congested and/or cheaper places to stay.

A more detailed examination of the differential pattern of growth within the urban agglomeration shows considerable variations (the coefficient of variation reaches 136 per cent). Absolute decrease in population, indicating important net out-migration, has occurred in the old city and some adjoining charges, which as seen above correspond to a highly densely populated area. The population deconcentration in the urban core, which was first revealed by the 1971 census (Brush, 1986) is still under process. But the population has also declined in some parts of New Delhi where population densities were quite low. On the other hand, the highest growth rates were recorded in certain charges of the outskirts, with annual rates above 10 per cent, up to a maximum of 35 per cent (in Rohini). Two distinct processes could generate the particularly rapid growth of the peripheral urban zones: new in-migrants coming from other States or - in lower proportion - from Delhi hinterland and who found such areas more accessible to settle down; and natives of Delhi or migrants of longer standing living previously in inner zones of the urban agglomeration, and who moved to new residential sites. However, specific surveys would be required in order to evaluate the respective contribution of the two types of population moves.

In order to understand better the logic of the spatial pattern of population growth, it is interesting to test statistically the relationship between growth rate and density: the two variables are negatively related although the extent of association is moderate (correlation coefficient = -0.292). Nevertheless, this suggests that high population densities tend to act as a deterrent for new dwellers, or tend even to induce exit moves towards less crowded areas.

Beyond that, the pattern of population distribution and growth should be related to the land-use pattern, availability and price of land or residential house, accessibility to employment opportunities and urban services. If, as already mentioned, this last factor contributes to explain the centripetal force of the past, the actual centrifugal tendency is certainly associated to the scarcity of land for new residential constructions and its

consequent appreciating value in the central areas, whereas the less congested peripheral zones can provide more affordable housing possibilities, or more accessible sites to squatter. For example many housing societies have set up residential colonies in east Delhi in the trans-Yamuna area. Besides, the tremendous increase of private means of transportation in the capital has allowed the development of residential colonies, including posh ones, in the urban fringes, especially in the south, for those who can afford the price of daily commuting by car to distant work place. Although with very mitigated results, the Delhi Development Authority, in charge of the implementation of the Master Plan and of land development, has been striving to decongest the old city and to clear the capital of squatter settlements by relocating them in organised "resettlement colonies", far out from the city centre, in the east across the Yamuna river, or to the west and south (Pugh, 1990: 176).

Child-women ratio

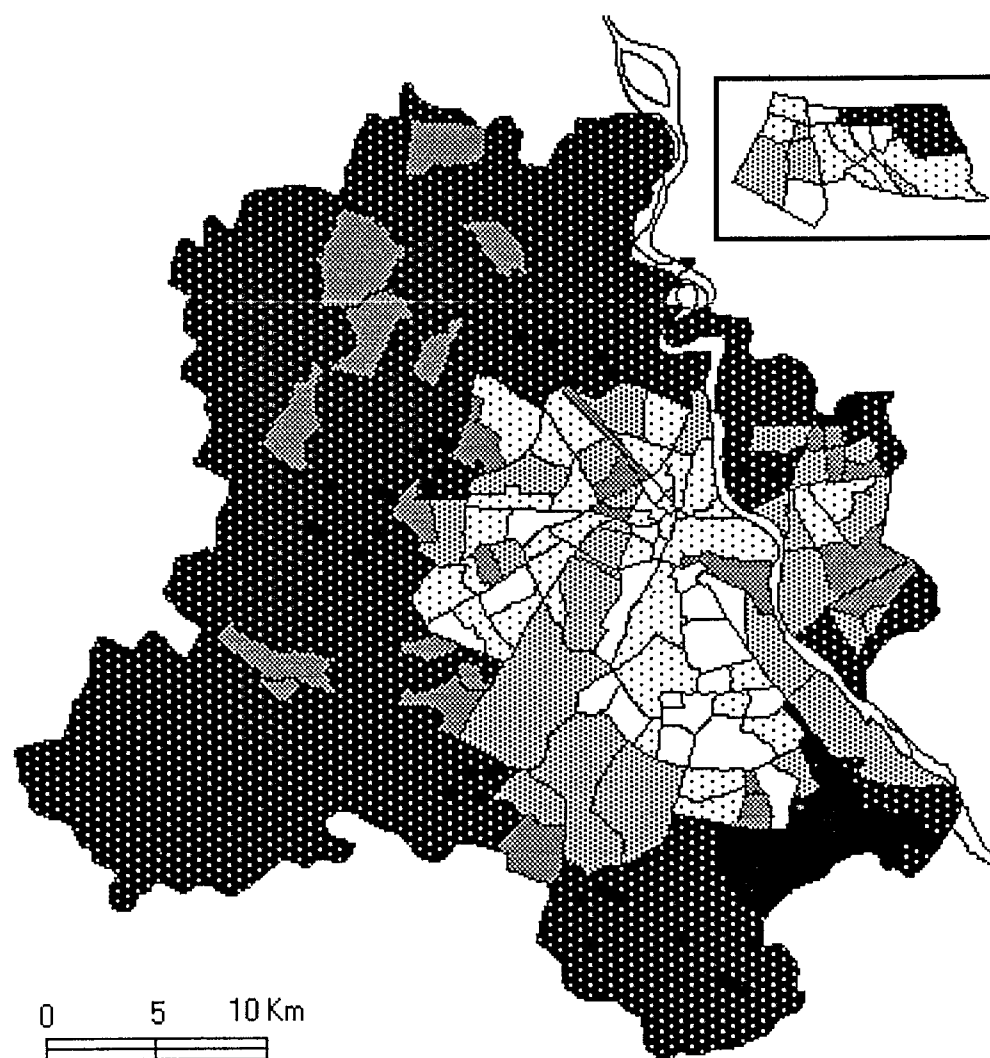
The spatial differentiation of child-women ratio, another indicator of population dynamics, shows also a centrifugal pattern, with higher values generally found in the outskirts of the urban agglomeration, in the towns of the hinterland and in rural areas (Map 4). However, there is no systematic correspondence between the charges of more rapid population growth and those with higher child-women ratio - and reciprocally.

Sex ratio

The sex ratio of the total population of Delhi Union Territory was 827 females for 1000 males in 1991, with, on the average, a lower ratio in the rural area (807) than in the urban area (830). This is consistent with the already observed differential pattern of population growth between rural and urban Delhi - more rapid in the former than in the latter -, in the sense that very marked imbalanced sex ratios in favour of males usually indicate important male dominated in-migration. The variations of the sex ratio inside the urban agglomeration exhibit however a more complex pattern (Map 5). Admittedly, sex-ratio of the population appears to be high in certain charges where rate of growth of population and the child-women ratio have been low or moderate, like in most part of the old city; reciprocally it appears to be low in certain charges of fast growing population, in particular in the southeast of Delhi, more precisely in and around the Okhla industrial zone which must have attracted large numbers of male migrant workers. Yet, there is no systematic inverse association between sex ratio and growth rate at the charge level, and some notable exceptions could be pointed out. For example, in Delhi cantonment where population growth has been very slow (1 per cent per year), the sex ratio is the minimum

Map 4

Children / female population ratio in different zones of Delhi Union Territory in 1991



Ratio of children aged 0 to 6 years to female population (in percentage)

□ 20 to 29.99 %	▨ 40 to 44.99 %
▤ 30 to 34.99 %	▩ 45 to 49.99 %
▧ 35 to 39.99 %	■ 50 to 59.99 %

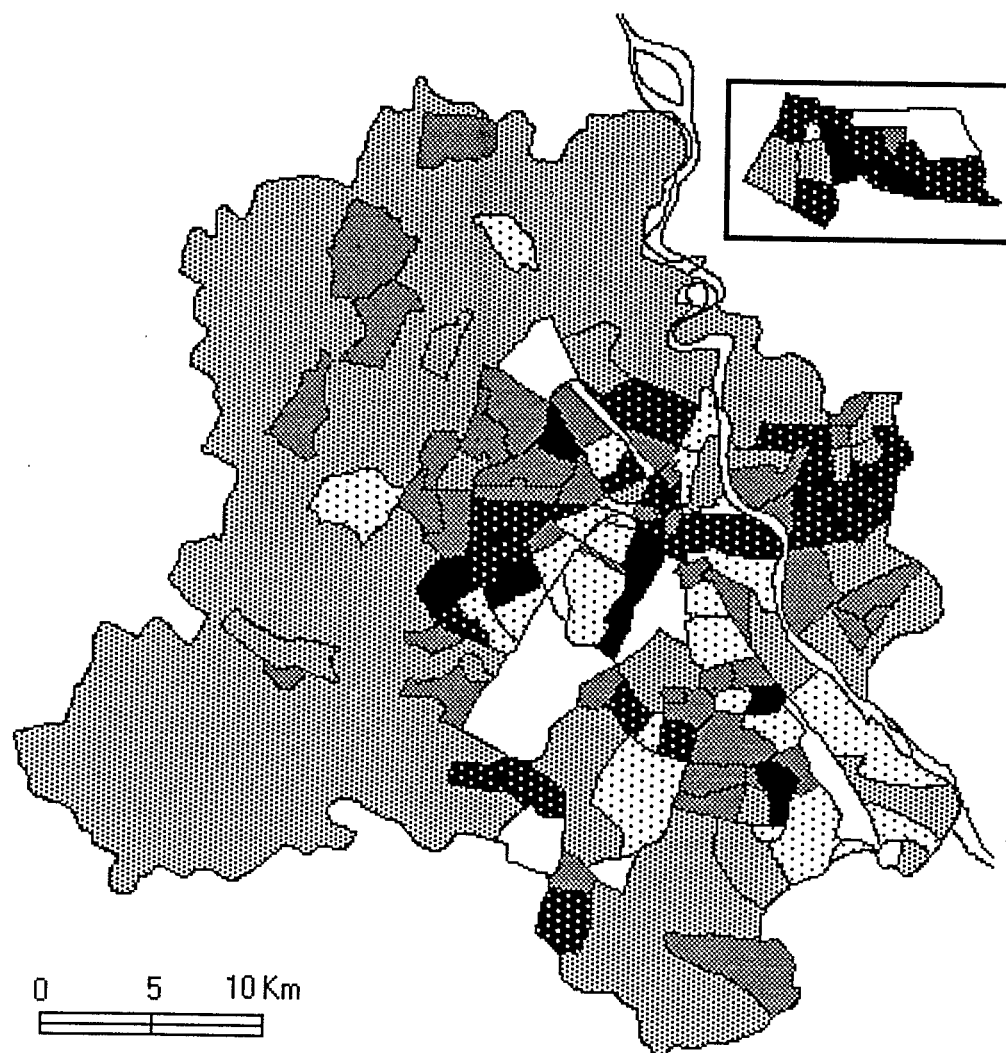
Average for Delhi Union Territory: 37.29%

Based on 1991 Census data

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Map 5

Sex ratio of total population in different zones of Delhi Union Territory in 1991



Number of females for 1000 males among
total population in 1991



Average for Delhi Union Territory: 827.30

Based on 1991 Census data

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recorded (638), due to partial occupancy by military quarters. The charge of New Delhi containing the presidential estate and the Parliament is also atypical by its very low sex ratio (785) associated with moderate population growth (2.6 per cent per year). Specific land use hence influences the sex ratio of the population. Further, the combination of high sex ratio and sustained rate of population growth above the rate of natural increase, like in certain charges of Northeast Delhi, could indicate a pattern of growth based on relatively sex-wise balanced in-migration and family moves from other zones of the urban agglomeration.

4. PATTERN OF SOCIAL AND RESIDENTIAL SEGREGATION

The social differentiation of the urban space is approached here by analysing the percentages of scheduled castes population and of illiterates/literates across charges in Delhi. These variables are then related to the demographic indicators analysed above, in order to detect possible meaningful associations between the spatial pattern of population dynamics and the characteristics of the population.

Scheduled castes population

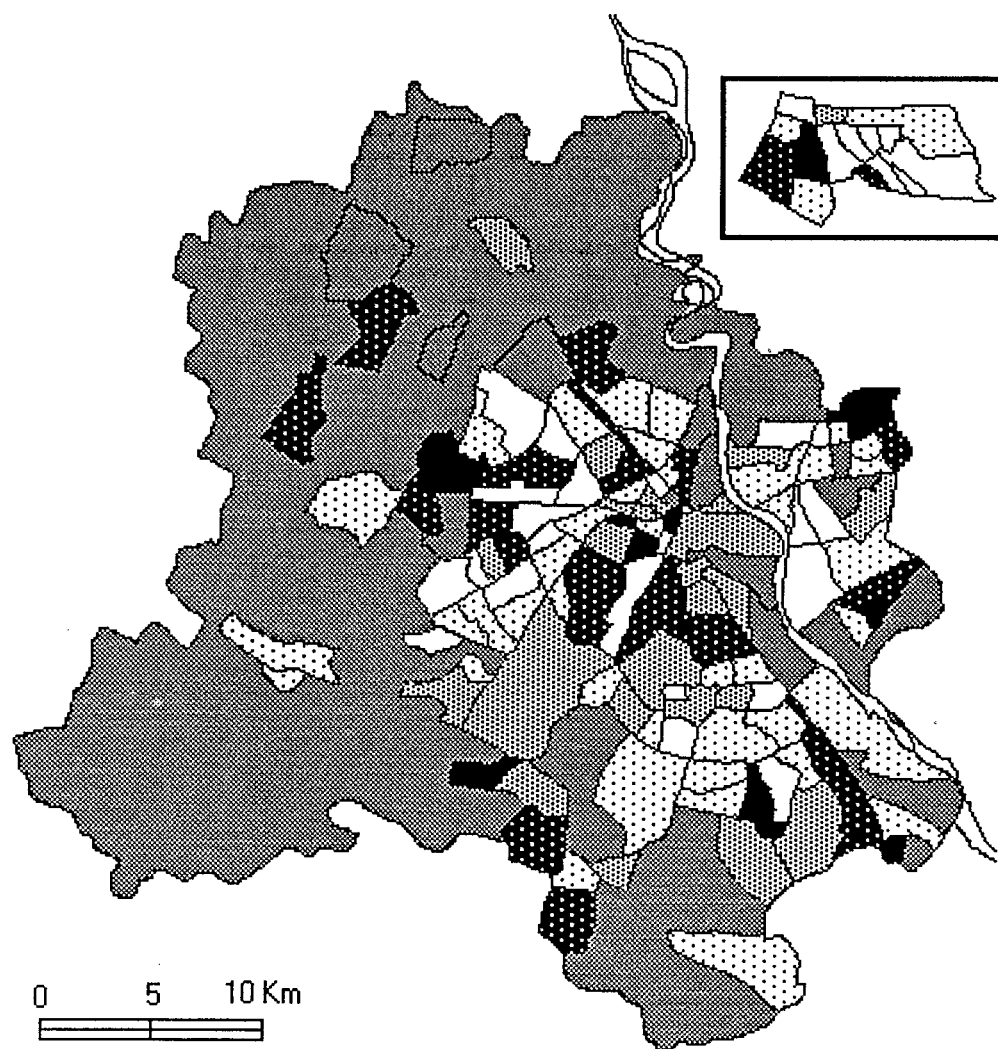
The percentage of scheduled castes in the total population of Delhi Union Territory in 1991 was 19 per cent, with small difference between the rural and urban areas on the average (22 per cent as against 19 per cent respectively). Nevertheless, within the urban area, the percentage of scheduled castes population varies considerably, from less than 5 per cent in certain charges, up to a maximum of 56 per cent (Map 6). Moreover, half of the scheduled castes population is concentrated in 40 census charges whose corresponding share in the total urban population is only 27 per cent. This indicates the persistence of social ostracism manifested in terms of spatial segregation. The pockets showing high percentages of scheduled castes are not however concentrated in a same geographical sector of the urban agglomeration; they are rather scattered, some being located in the central area, including certain charges of Old Delhi as well as New Delhi, and others in the peripheral zones.

Literates and illiterates

As usually observed elsewhere in India, the prevalence of illiteracy is higher in rural Delhi than in urban Delhi (33 per cent of illiterates against 24 per cent respectively); it is also higher among females than among males, and the difference between the two sub-

Map 6

Percentage of scheduled castes in total population in different zones of Delhi Union Territory in 1991



Percentage of scheduled castes in total population in 1991



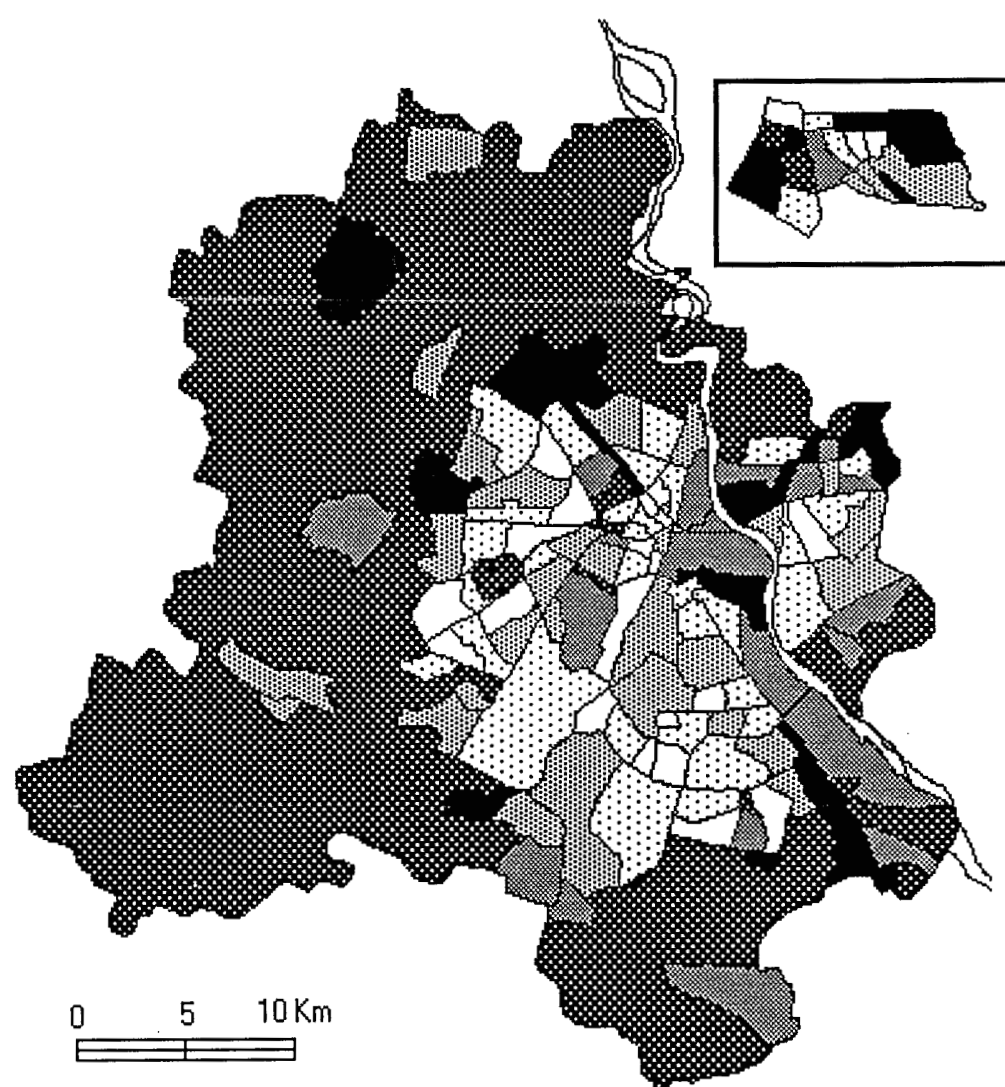
Average for Delhi Union Territory: 19.05%

Based on 1991 Census data

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Map 7

Percentage of illiterates in different zones of Delhi Union Territory in 1991



Percentage of illiterates in population aged 7 years and above in 1991



Average for Delhi Union Territory: 24.71 %

Based on 1991 Census data

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populations is more marked in rural areas than in urban areas (48 per cent of illiterates among females against 22 per cent among males in rural Delhi, as compared to 32 per cent and 18 per cent respectively in urban Delhi).

Within the urban area, the population of illiterates is far from being equally distributed : around half of the illiterate population is concentrated in 60 census charges which account altogether for only 35 per cent of the total urban population. The percentage of illiterates across the different charges displays a wide range, from a minimum of 9 per cent to a maximum of 57 per cent (Map 7). The charges showing particularly high percentages of illiterates are located either in the old core of the city, or in peripheral areas, with stretches corresponding to industrial zones (Okhla in southeast, along Grand-Trunk Road and near Vazirpur in northwest). On the other hand, New-Delhi, Delhi cantonment and most part of south Delhi (barring some peripheral charges and the southeastern area along the western bank of the Yamuna) are inhabited by populations more literate than the average. Yet some charges with particularly low percentages of illiterates are also found in other sectors of the urban agglomeration, sometimes adjoining charges which conversely present strong concentration of illiterates. This is especially the case in Old Delhi, where pockets with minimum percentages of illiterates (around 10 per cent) border the charge with the maximum score in all Delhi (57 per cent of illiterates). The pattern described above does not entail significant variations when literacy rates are examined separately for female and male populations.

As it has been already highlighted in the case of the scheduled castes population, the spatial distribution of illiterates reveals a spatial pattern of "local concentration cum global dispersion", though less distinct than in the former case. Since these two attributes help to identify the lower socio-economic strata, their residential spatial pattern could be related to another observation made by Nagpaul (1988: 189): "a striking feature of Delhi is that even planned localities, posh or middle-class, contain a large number of temporary structures established haphazardly where domestic and lower-class workers live". It can be also interpreted as a manifestation of what Schenk (1986: 183) has identified as the "two seemingly contradictory societal forces upon the socio-spatial structure of urban residence: (a) the aim to reside in socially-homogeneous areas, and (b) the aim and the need to maintain relations of dependency". The first principle would explain the existence of lower-class clusters, while the second would account (to some extent) for the proximity between some of these clusters and certain upper- and middle-class residential areas, the inhabitants of the former providing services to those of the latter.

Interrelationships between demographic and social variables

An examination of the interrelationships among the above demographic and social variables is important both from analytical and political viewpoint.

A preliminary comparison of the maps shows that literacy rates of the population (Map 7) tend to be high in those charges where rate of population growth and child-women ratio have been low or moderate (Maps 3 & 4). The statistical analysis of the correlation coefficients corroborates the above trends of association. With a rise in female literacy both population growth rate and child-women ratio seem to decline. Particularly, the coefficient of correlation between child-women ratio and female literacy is considerably high ($r = -0.89$). The female-male ratio of the population is also positively associated with both female and male literacy, the correlation coefficients being 0.4 and 0.35 respectively. Quite interestingly, charges with higher female-male ratio are likely to have lower child-women ratio ($r = -0.41$) suggesting that with a rise in the percentage of women in total population, the fertility rate tends to decline. All this would advocate the importance of female literacy in controlling the natural increase of population and generating a more balanced sex ratio.

Although not so easily discernible on the maps, the percentage of scheduled castes population is positively associated to child-women ratio ($r = 0.45$). In relation to literacy, it appears to have a rather opposite pattern, evidenced by negative correlation coefficients ($r = -0.45$ and -0.60 with respect to male and female literacy rate respectively). All this conforms further to the phenomenon of socio-spatial differentiation, also manifested in terms of differences in demographic and development indicators.

5. ECONOMIC STRUCTURE

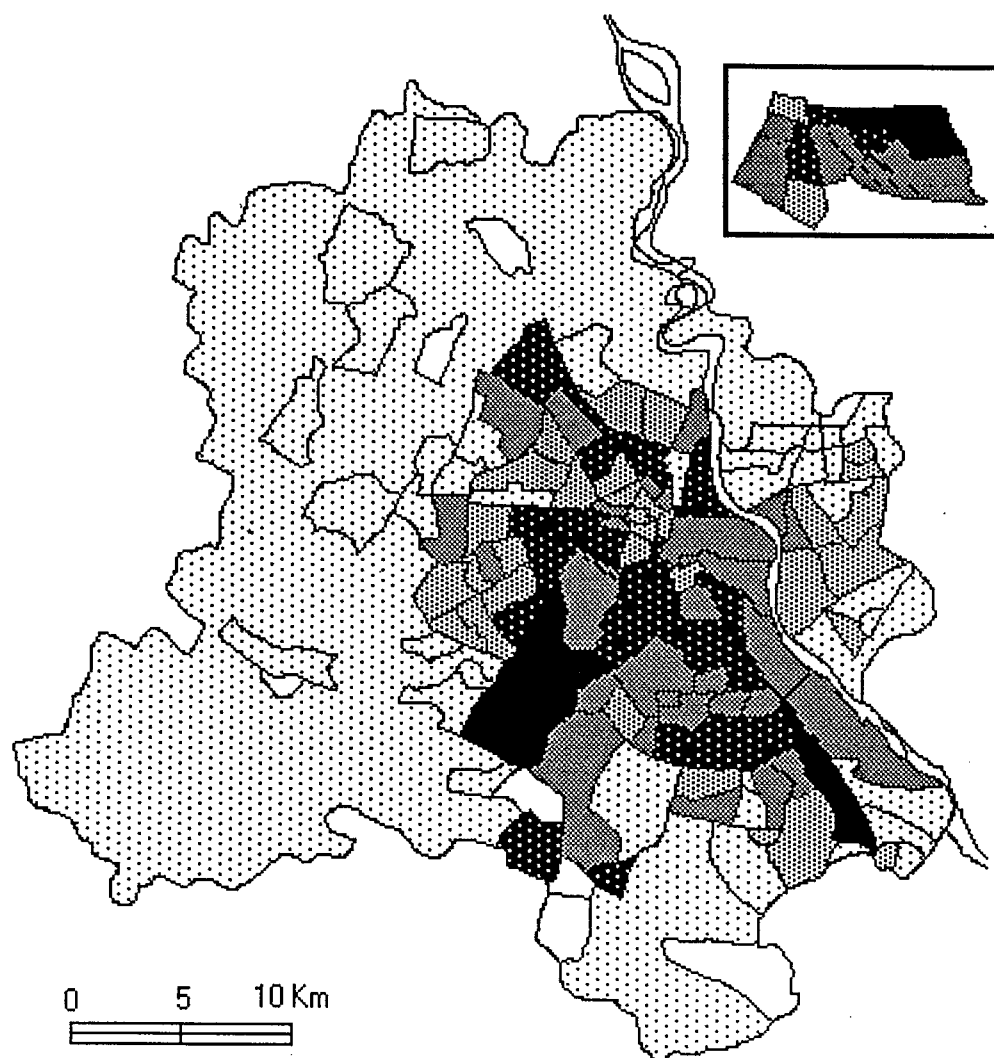
This section examines the economic structure of Delhi, the variations of the work force participation rates as well as the pattern of spatial distribution of the workers according to their industrial category. This will be also related, on the one hand, to the land-use pattern and, on the other, to literacy and other social and demographic characteristics.

Work force participation rate

For the male population, the average work force participation rate in Delhi U.T. in 1991 was 52 per cent, with a coefficient of variation across charges which appears to be quite

Map 8

Percentage of total main workers in male population in different zones of Delhi Union Territory in 1991



Percentage of total main workers in male population in 1991



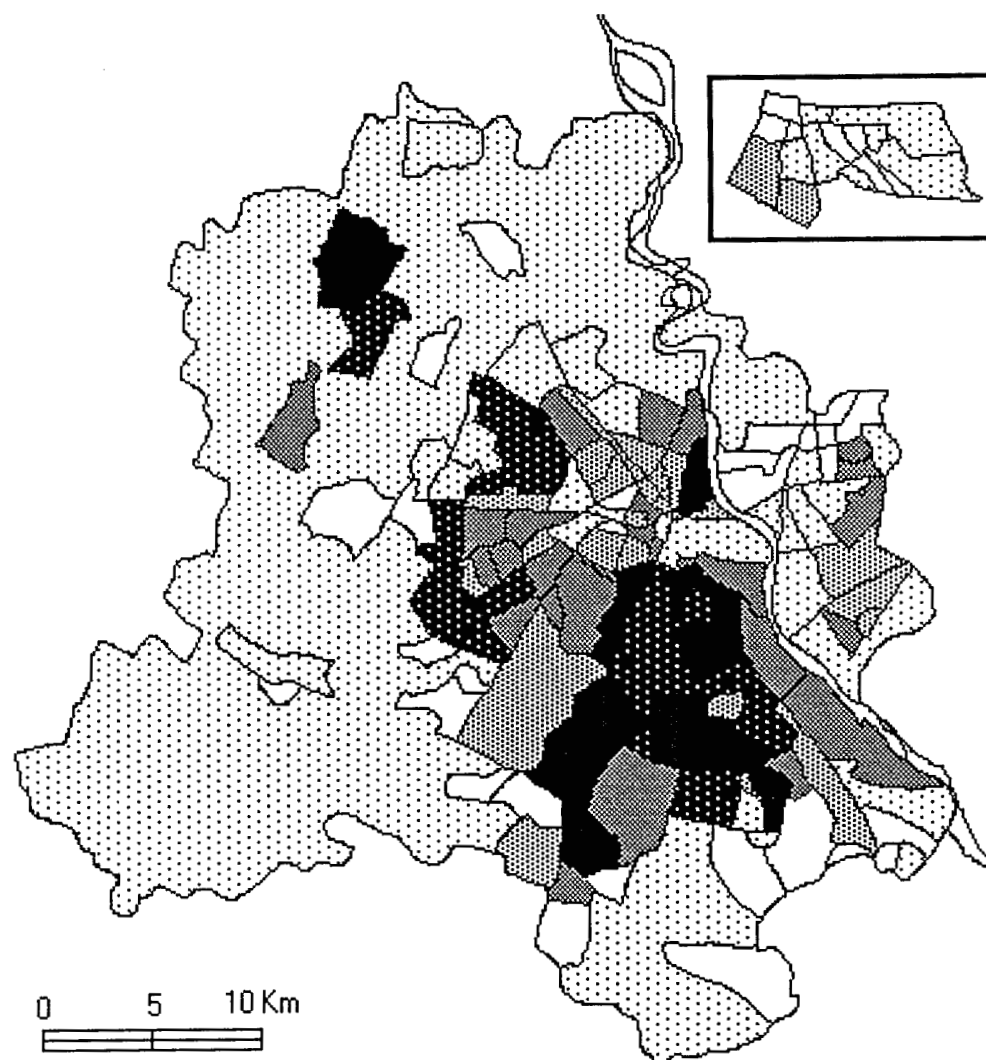
Average for Delhi Union Territory: 51.61%

Based on 1991 Census data

IEG-ORSTOM

Map 9

Percentage of total main workers in female population in different zones of Delhi Union Territory in 1991



Percentage of total main workers in female population in 1991



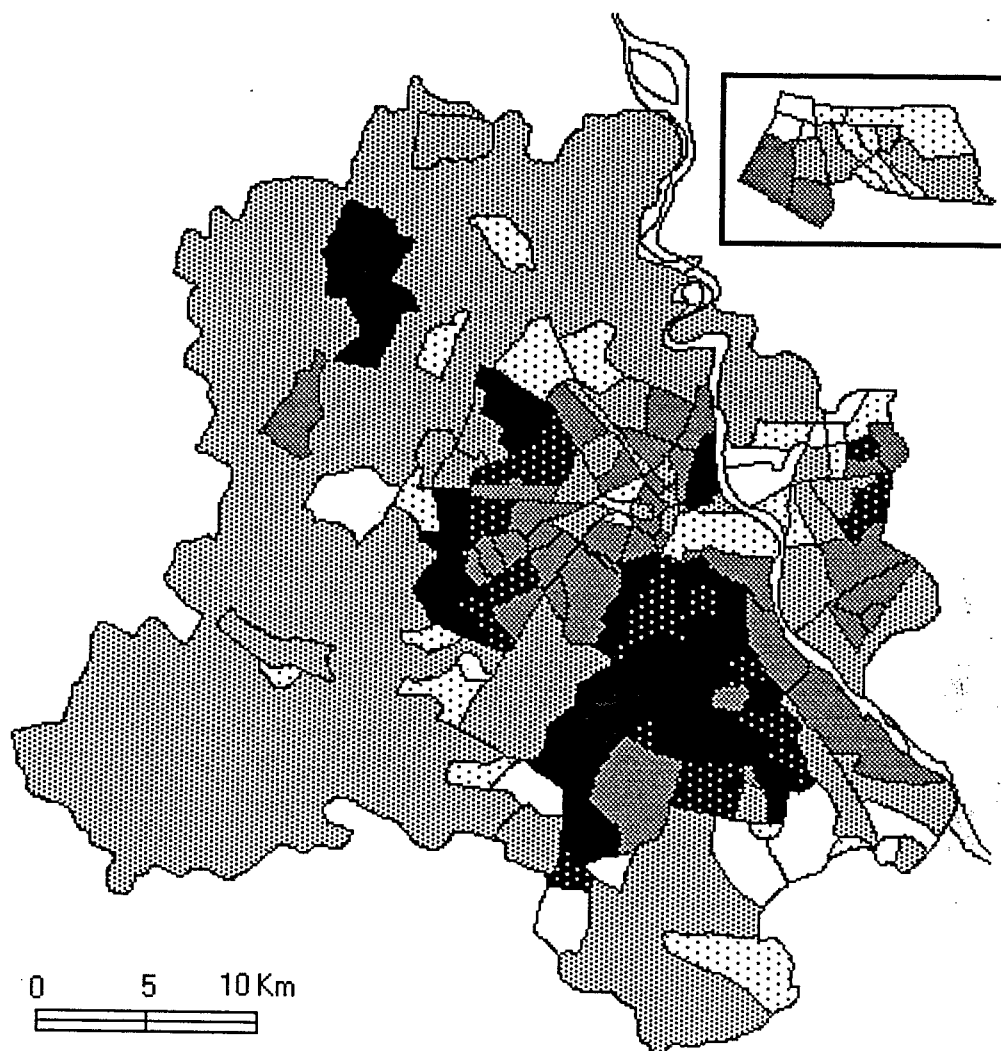
Average for Delhi Union Territory: 7.21%

Based on 1991 Census data

IEG-ORSTOM

Map 10

Sex ratio of main working population in different zones of Delhi Union Territory in 1991



Number of female main workers for 1000
male main workers in 1991

0 to 49.99	100 to 149.99
50 to 74.99	150 to 199.99
75 to 99.99	200 to 299.99

Average for Delhi Union Territory: 115.53

Based on 1991 Census data

IEG-ORSTOM

low (7.8 per cent). All the census towns except two, either located at the periphery of the urban agglomeration or in its hinterland, recorded participation rates below the average, with a minimum of 39 per cent. East Delhi is also remarkable for lower or moderate participation rates. At the other extreme, the highest work force participation rates, 61 to 62 per cent, were recorded in two industrial areas (Naraina in the west and Okhla in the southeast), one charge of Old-Delhi and Delhi cantonment, hence in zones presenting varied land use (Map 8).

On the other hand, the female work force participation rate is very low, 7 per cent on the average, with a coefficient of variation as high as 52.8 per cent. Subsequently, the female workers account for only 12 per cent of the total work force. Since the coefficient of variation of the work force participation rate among males is very low as compared to that of females, the variations of the sex ratio of the working population across charges follow the variations of the female work force participation rate, the two corresponding maps revealing almost similar patterns (Maps 9 & 10). While in certain census towns of the urban periphery, the female work force participation rates are even less than 1 per cent, they reach 14 to 17 per cent in some other charges located essentially in New-Delhi, south-Delhi, and in the Civil Lines to the north. The pattern across charges appears to be mixed in the western and north-western zones of the urban agglomeration, whereas Old Delhi and East Delhi are conspicuous by their lower participation rates. All this further suggests that female workers are mostly concentrated in certain parts of the city: in fact about half of them reside in 47 urban charges corresponding to only 31 per cent of the total urban female population.

In relation to literacy, it may be noted that charges with higher female literacy rates tend to correspond to higher work participation rates among females, ³ barring however East Delhi and Old Delhi. The analysis of correlation coefficients corroborates the suggested positive association among the females ($r = 0.43$), while it reveals a negative association among male, though rather low ($r = -0.32$)⁶

Usually scheduled castes are said to have higher work participation rates (see Mitra, 1992) since the incidence of poverty among them is high and those who are poor are less likely to remain unemployed for long. The pattern observed at the charge level in Delhi does not, however, bring out evidence to support this thesis. Charges with higher percentages of scheduled castes population tend on the contrary to record lower or average work force participation rates, for both males and females. The expected positive

⁶ To compute these correlation coefficients, the work force participation rates have been recalculated for the population aged 7 and above, like for the literacy rates.

correspondence between the two variables is only detectable in a few charges, the most meaningful examples being found in some parts of Old Delhi and in the industrial zone of Okhla, where both the percentages of scheduled castes and the male work force participation rates are significantly high. The coefficient of correlations computed across all urban charges turn out to be negative, though, admittedly, very low⁷. But this unexpected association could be partly due to an effect of heterogeneity of the charges, since the association can be observed only at the charge level, and not at the household one.

Employment structure

A preliminary presentation of the outlines of the economic structure of Delhi Union Territory as a whole will help to replace the detailed analysis at the charge level in its contextual background (Table 2).

Table 2. Delhi Union Territory: Percentage distribution of main workers by industrial category in 1991

Industrial category	Males	Females	Total
agriculture, livestock, mining, quarrying	2.86	2.67	2.84
household industry	1.40	1.50	1.41
manufacturing non hh ind.	24.69	10.48	23.22
construction	8.00	60.9	7.80
trade, commerce	25.22	12.54	23.91
transport, communication	8.90	3.13	8.30
other services	28.93	63.59	32.52
Total	100.00	100.00	100.00
Total number of workers	2660967	307410	2968377

Source: 1991 census

In 1991 almost one third of the total (main) working population was engaged in community, social and personal services, which reflects the role of Delhi as the national capital with major administrative functions. The public sector is Delhi's largest employer⁸. Then the two most equally important employment sectors appear to be 'trade

⁷ r being -0.02 and -0.13 among males and females respectively. Here also the work force participation rates have been recalculated for the population aged 7 and above, in order to neutralize the effect of different proportions of young children (virtually all non workers) between scheduled caste population and others, as suggested by the positive association between the percentage of scheduled caste population and the child-women ratio.

⁸ See United Nations (1986: 14): In 1981, the public sector employed more than half a million persons (542,000 or 28 per cent of the work force). Corresponding figures for the 1991 census were not yet published at the time of the writing of this paper.

and commerce' and 'non-household manufacturing and processing industry', which occupied respectively 24 per cent and 23 per cent of the work force. This is to be related to the long-standing place of Delhi as a chief trade centre for north-west India, and to its increasing role as an industrial centre.

Regarding first the rural/urban differentiation of the employment structure, what should be underlined is not the expected higher share of the primary sector in rural Delhi (19 per cent as against 1.3 per cent in urban Delhi)⁹, but the fact that, by Indian standards, this share remains remarkably low. In 1991, the primary sector occupied 83 per cent of the all-India rural population, and still 15 per cent of the urban population. Hence, the areas in Delhi U.T. still qualified as rural exhibit a sectorial employment structure which resembles more to that of urban areas. This again reveals a process of metropolisation around the capital, already noticed in terms of population growth, and now corroborated in terms of economic characteristics.

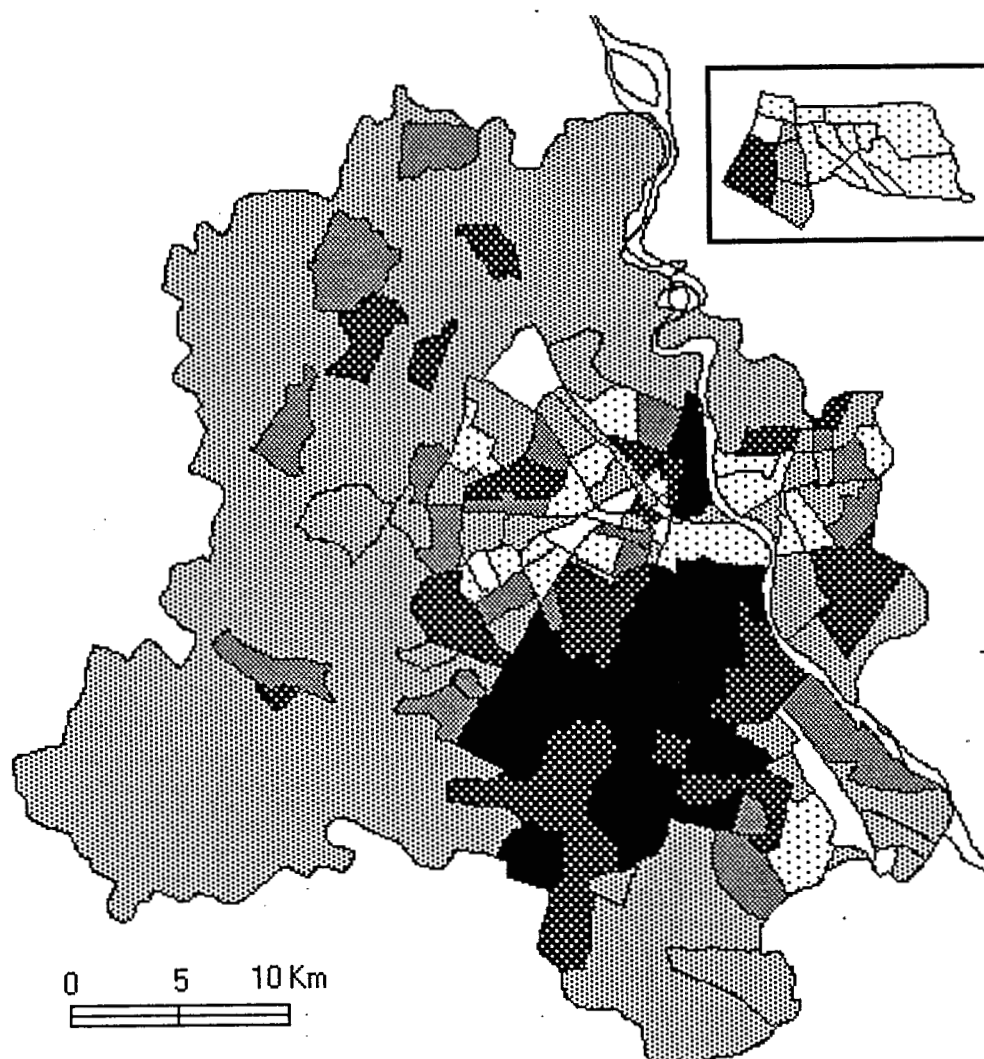
To analyse the intra-urban differentiation of the employment structure, the focus will be on the major three economic functions of the capital, administrative, commercial and industrial. A first look at the maps showing the respective percentages of workers in 'community, social and personal services' (here after: 'services'; Map 11), 'trade and commerce' (Map 12) and 'non-household manufacturing and processing industries' (here after: 'manufacturing industries'; Map 14) reveals very distinctive patterns.

The charges with higher proportions of workers in services are mostly concentrated in the southern half of the agglomeration (southeast excluded) - (Map 11). In particular, the proportions range between 58 per cent and 77 per cent in New-Delhi, and reach a maximum of 84 per cent in Delhi Cantonment (which comprises army quarters). Many colonies were constructed in the ^{South} ~~northern~~ part of the town to provide housing for the very large numbers of government employees; they have engendered a pattern of residential segregation, not only between the latter and the other workers, but also among the government employees themselves since they were supplied with different categories of housing according to their official status and range of income. This specific feature of the urban landscape, and its consequences in terms of segregation along socio-economic lines, has been already underlined in studies on Delhi (Sundaram, 1978: 121; Nagpaul, 1988: 188), and even qualified as "salaried apartheid" by Mitra (1970, also quoted by Nagpaul, 1988: 188).

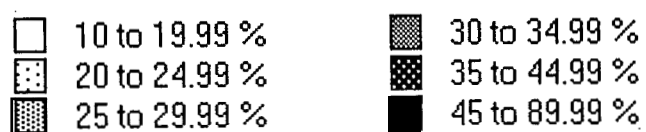
⁹ This is mainly at the expenses of 'trade and commerce' (13 per cent of the rural workers), and - to a lesser extent - of 'community, social and personal services' (27 per cent of the rural workers).

Map 11

Percentage of workers in other services among total main workers in different zones of Delhi Union Territory in 1991



Percentage of workers in other services among total main workers in 1991



Average for Delhi Union Territory: 32.52 %

Based on 1991 Census data

IEG-ORSTOM

Another striking example in New-Delhi of residential clusters for specific types of employees in services is Chanakyapuri with its concentration of foreign embassies. In the north, one charge is also remarkable, that corresponding to the Civil Lines, with its land-use pattern inherited from the British colonisation, and showing 50 per cent of workers in services.

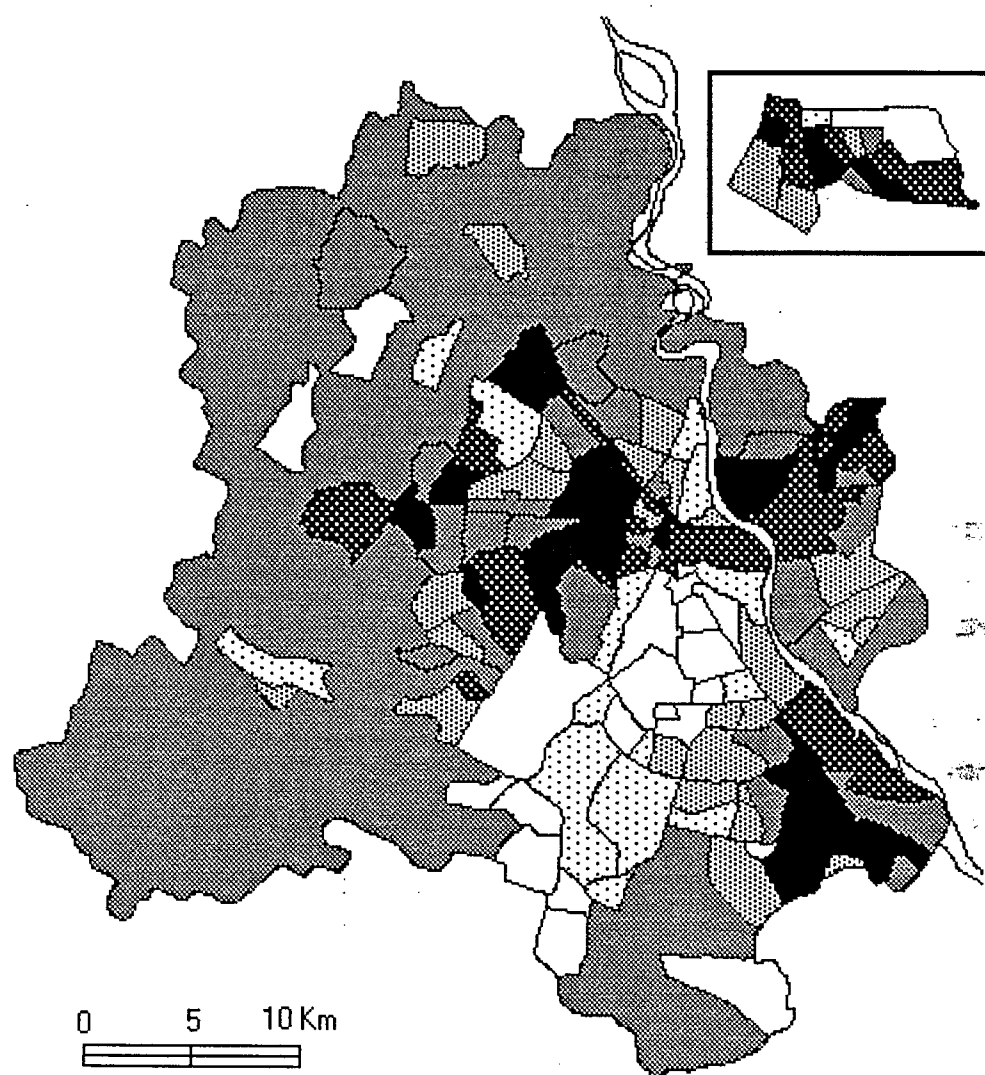
The pattern of spatial concentration of the workers in manufacturing industries is almost the opposite of the preceding one (Map 12): the charges with higher proportions of such workers are located in the northern half of the urban agglomeration, as well as in the southeast, in areas having lower proportions of workers in services; and reciprocally. Hence all charges in New-Delhi as well as Delhi cantonment have less than 10 per cent of workers in manufacturing. The coefficient of correlation further verifies the negative association between the two variables, quite evident in the case of male workers ($r = -0.75$).

The share of manufacturing industries appears to have a very high degree of variation, from 2.5 per cent up to 47 per cent (see also Table A1 in appendix). What is more interesting here is to examine the location of the charges having higher proportion of workers in manufacturing industries in relation to the location of the main industrial areas, which reveals a good congruence. Thus, there are important concentrations of industrial workers in the southeast around the large planned Okhla industrial estate; in the west along Najafgarh road, in Naraina, along Rothak road, and in Wazirpur and around; in the northwest along Grand Trunk Karnal road; in the east in Shahdara. Lastly, in Old Delhi, pockets with high proportions of industrial workers correspond not only to the many small-scale industrial units set up in that area, but also to the location of some large ones like the Delhi Cloth Mill, Delhi Flour Mill and Birla Mills. As rightly pointed out by Nagpaul (1986: 189), although "several attempts have been made to relocate some of the old industries functioning in congested parts of Old Delhi", "even today large industrial units (...) continue to function in the most thickly populated residential areas". In connection to this feature, it can be noted that the correlation coefficients reveal a positive association between population densities and the proportions of workers in manufacturing industries across charges (r being 0.35 and 0.3 in the case of males and females respectively).

Mention can be made here of the second component of manufacturing activities, the household industries. Though the proportion of workers in household manufacturing industries is extremely low, 1.4 per cent for the all Delhi U.T., it has a high degree of

Map 12

Percentage of workers in manufacturing and processing non-household industry among total main workers in different zones of Delhi Union Territory in 1991



Percentage of workers in manufacturing and processing non-household industry among total main workers in 1991



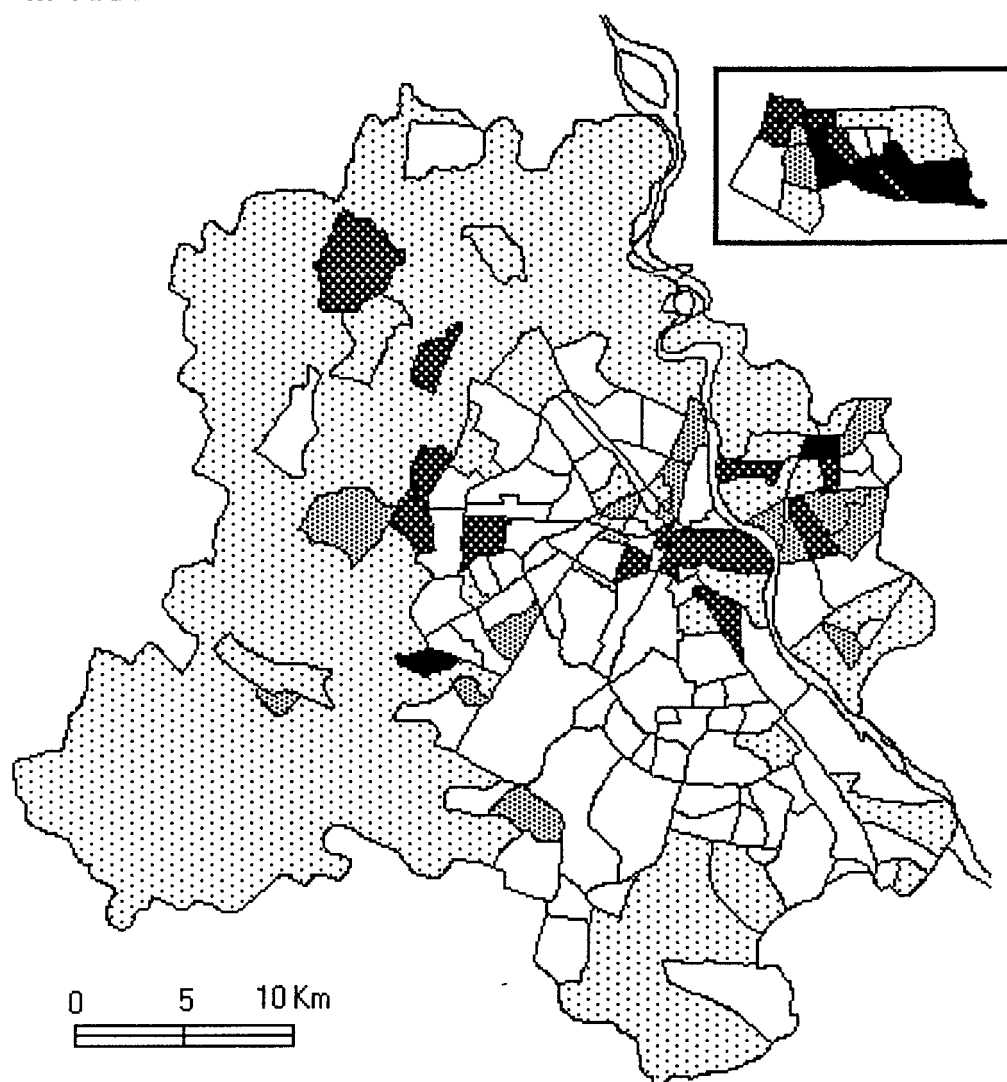
Average for Delhi Union Territory: 23.22 %

Based on 1991 Census data

IEG-ORSTOM

Map 13

Percentage of workers in household industry among total main workers in different zones of Delhi Union Territory in 1991



Percentage of workers in household industry
among total main workers in 1991

□ 0 to 0.99 %

◻ 1 to 1.99 %

◻ 2 to 2.99 %

◻ 3 to 4.99 %

◻ 5 to 13.99 %

Average for Delhi Union Territory: 1.41 %

Based on 1991 Census data

IEG-ORSTOM

variability¹⁰, indicating concentration of this type of activity mainly in certain specific pockets of the city (since by definition household industries are undertaken in the premises of the residential houses). Thus, half of the workers in household industries are concentrated in 28 charges accounting only for 16 per cent of the total work force. The point noteworthy is that most of the charges recording higher proportions of workers in household industries, between 5 and 10 per cent, are located in Old Delhi, therefore adding - although to a small extent - to the already underlined congestion of this area (Map 13).

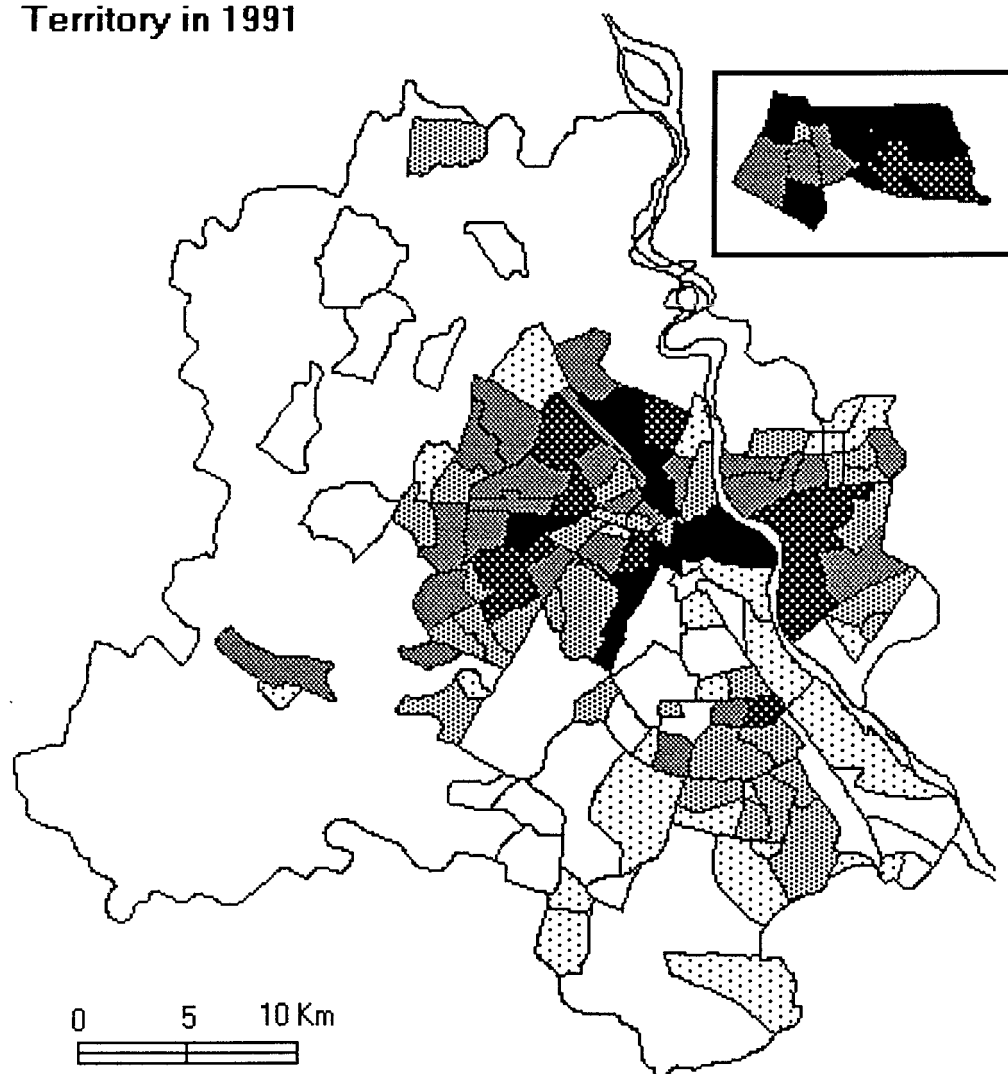
Turning now to trade and commerce, there is again a clear-cut division between the southern and northern parts of the capital, even more distinct than for services and manufacturing. The higher proportions of workers engaged in trade and commerce are found essentially in areas located north of New-Delhi and Delhi Cantonment, and in east Delhi (Map 14). The maximum shares (40 to 56 per cent of the total work force) were recorded in some charges of Old Delhi and neighbouring areas, where they are in accordance with the concentration of wholesale business and retail trade: in Chandni Chowk, Sadar Bazar, Pahar Ganj and Karol Bagh, which are also zones of very high population densities. Laxmi Nagar in the East, and Lajpat Nagar, single cluster in the south, provide other examples of concentration of both traders' residences and commercial activities, although to a lesser degree. Otherwise, there is no systematic congruence between work site and residential area as in the case of industrial workers: some major commercial complexes, like Connaught Place in New Delhi and Nerhu Place in South Delhi, are located in charges showing lower or average percentages of workers in trade and commerce.

In fact, the origin of some major residential concentrations of traders and businessmen seems to be linked to the post-partition period, 1948-50, and the massive influx into Delhi of refugees from Pakistan, essentially Punjabis and Sindhis, estimated to be about half a million (Rao & Desai, 1965). Three main refugee camps were first established in Kingsway in the north, at Tibbia College in Karol Bagh in the central area, and in Shahdara in the east across the river Yamuna; others were later constructed in the west, in Rajinder Nagar, Patel Nagar and Moti Nagar, and in the south in Lajpat Nagar (among others). All the residential areas mentioned here are conspicuous by their higher share of workers in trade and commerce; some of them also developed into flourishing shopping markets (Karol Bagh and Lajpat Nagar, as already pointed out).

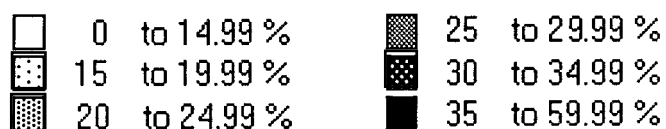
¹⁰ The coefficients of variation of household manufacturing are 125.7 per cent and 134 per cent among male and female work force respectively.

Map 14

Percentage of workers in trade and commerce among total main workers in different zones of Delhi Union Territory in 1991



Percentage of workers in trade and commerce among total main workers in 1991



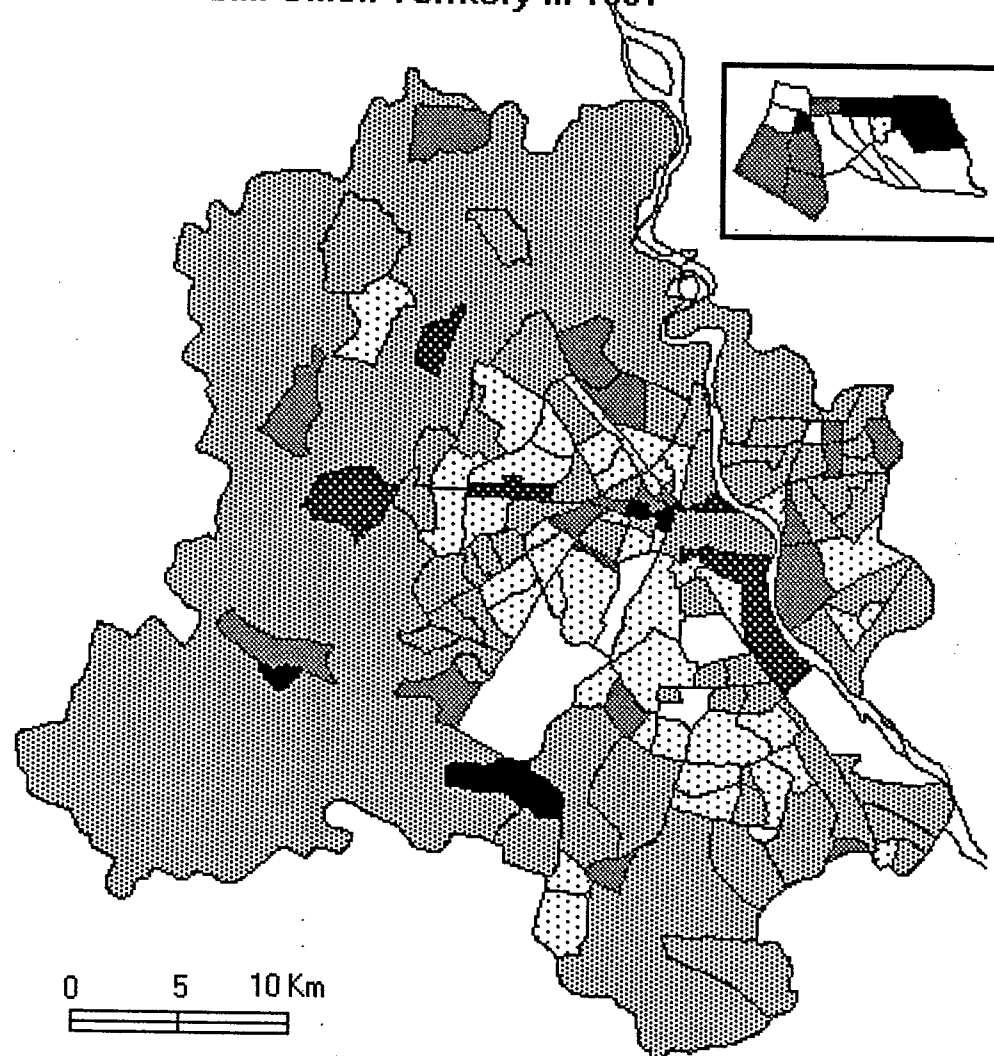
Average for Delhi Union Territory: 23.91 %

Based on 1991 Census data

IEG-ORSTOM

Map 15

Percentage of workers in transport, storage and communication among total main workers in different zones of Delhi Union Territory in 1991



Percentage of workers in transport, storage and communication among total main workers in 1991

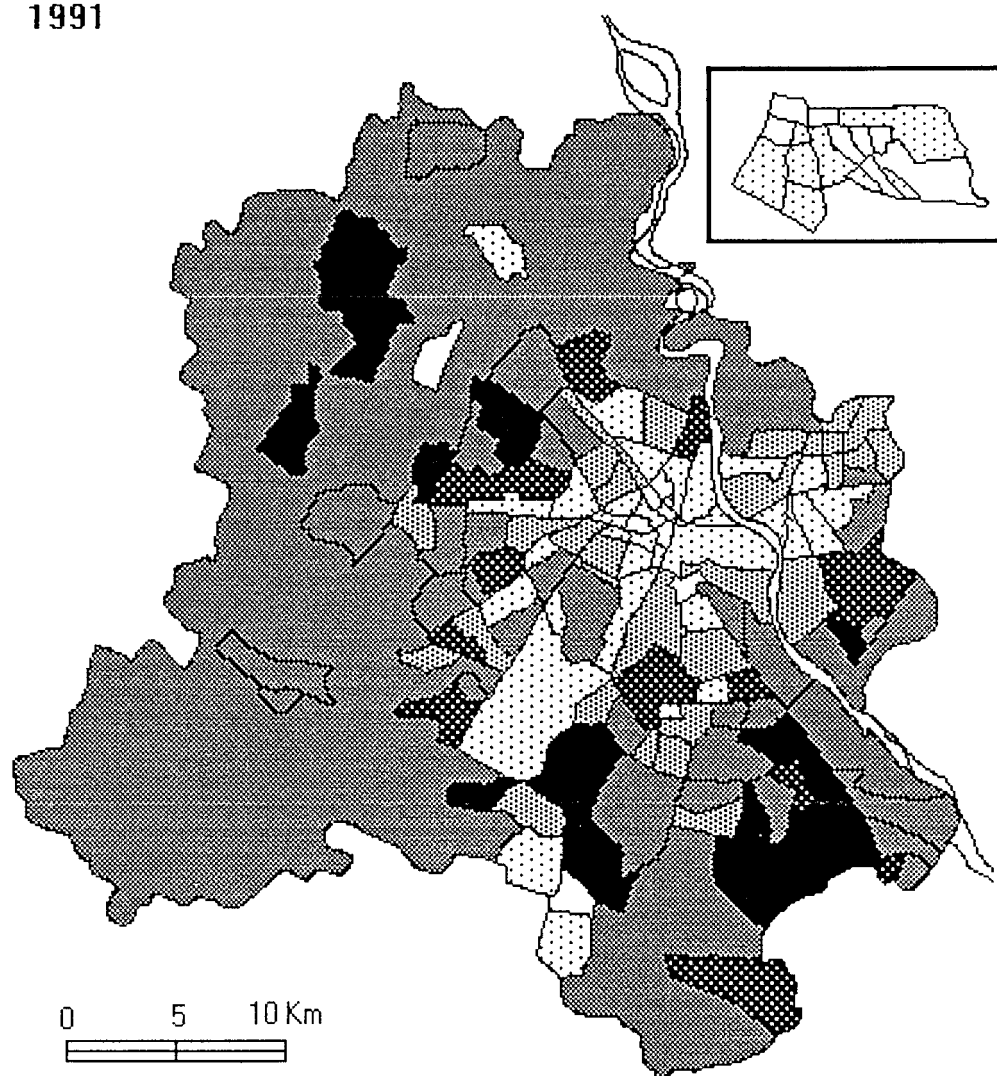


Average for Delhi Union Territory: 8.30 %

Based on 1991 Census data

IEG-ORSTOM

Percentage of workers in construction among total main workers in different zones of Delhi Union Territory in 1991



Percentage of workers in construction among total main workers in 1991



Average for Delhi Union Territory: 7.80 %

One feature of the spatial distribution of workers in transport, storage and communication can be indicated here, since these activities are partially connected to trade and commerce. The charge showing the highest proportion of such workers, that is 27 per cent of the total work force as compared to 8 per cent on the average for Delhi U.T., is once again located in Old Delhi, more precisely in Chandni Chowk (Map 15). All this highlights the complexity of the economic structure of Old Delhi, with sharp concentrations of workers engaged in manufacturing activities, trade and commerce, or still in transport, and residing in intermingling or neighbouring clusters, in the vicinity of their work place.

Lastly, the spatial distribution of workers in construction across different charges exhibits a centrifugal pattern, with very low proportions of construction workers among total work force in the urban core, and the higher ones in some charges scattered in the peripheral zones¹¹ (Map 16).

6. LOOKING FOR SYNTHETIC PATTERNS

Attempts are made in this section to bring out synthetic patterns of spatial organisation through factor analysis and cluster analysis.

Factor analysis

This analysis aims at revealing the most meaningful combinations of variables or 'factors' which structure the pattern of living places in Delhi. The factor analysis applied to the 22 variables selected in this study reveals seven factors, which together account for about 79 per cent of the variance occurring among the 149 urban charges¹² (see Table A3 in appendix). These factors are examined below.

Factor 1 shows strong negative association of high literacy for both males and females with child-women ratio and with the percentage of scheduled castes population. The negative factor loading of the latter two variables imply that they are positively associated with each other. In other words, child-women ratio tends to increase with a rise in the proportion of population belonging to lower castes across charges. Both male and female work force participation rates are positively associated with literacy and negatively with

¹¹ The percentage of workers in construction among total work force has a high degree of variability, the coefficients of variation being 69.1 and 149 per cent among males and females respectively.

¹² A methodological note on factor analysis is presented in appendix.

child-women ratio and the percentage of scheduled castes population. The sex ratio of both total population and work force is again positively related to literacy. This factor which explains about 24 per cent of the total variance can be considered as an indicator of demographic characteristics and social status.

Factor 2, on the other hand, explaining about 20 per cent of the variance, indicates the importance of the economic sector of employment in structuring the pattern of living places. Non-household manufacturing and community, social and personal services are negatively associated with each other. Further, population density and non-household manufacturing reveal a positive relationship between them.

Factor 3 explaining around 10 per cent of the total variance indicates a positive association between the percentages of male and female work force engaged in household manufacturing. Both household manufacturing in factor 3 and non-household manufacturing in factor 2 are weakly associated with literacy.

The rest of the four factors together explain only 24 per cent of the total variance.

To sum up the most significant features, this factor analysis corroborates on the one hand a positive association between fertility and incidence of lower socio-economic strata, and, on the other, a spatial dissociation of the residential places according to the employment sector, especially between manufacturing and services.

Cluster analysis

This analysis aims at identifying homogeneous groups of urban charges or clusters¹³. Here we wished to test the significance of an urban structure conforming to geographical divisions. For this purpose, we distinguished 9 *a priori* broad zones corresponding to : (1) Old-Delhi; (2) New-Delhi and Delhi Cantonment; (3) central sector (comprising Pusa Institute and delimited by Ring Road to the west, Delhi cantonment border to the south, New-Delhi border to the east, and Najafgarh drain and railway line to the north); (4) northern sector; (5) western sector; (6) South Delhi; (7) East Delhi (across the Yamuna); (8) census towns located in the northern part of Delhi U.T; (9) census towns located in the southern part of Delhi U.T. Then cluster analysis was carried out on the 22 variables under consideration in order to determine the important clusters to which the 149 census charges of urban Delhi belong, and to verify to which extent these coincide with the 9

¹³ A short methodological note on cluster analysis is presented in appendix.

broad zones identified above. Table A4 (in appendix) gives the mean and standard deviation of the 22 variables for the charges belonging to each cluster, along with the number of charges included.

An examination of the characteristics of each cluster and their location map (Map 17) suggests that, barring the case of a single charge cluster (number 3), the other 8 clusters can be re-grouped into 6 main clusters on the basis of their similarities, as explained below.

The largest group comprises of 53 charges, after merging cluster 2 (8 charges) with cluster 1. It is characterized by distinct demographic features, namely low residential density and rapid population growth as well as higher child/women ratio, associated with a higher incidence of lower socio-economic strata (manifested by higher percentages of scheduled castes and illiterates). This group includes the majority of the census towns, either located in the hinterland or being part of the urban agglomeration, and more generally a large part of the urban periphery, hence corresponding to zones where urbanisation is of recent origin. However, a few inner charges also belong to this group.

As mentioned above, cluster 3 corresponds to a single charge, a census town of the hinterland with an atypical employment structure marked by an extremely high percentage of workers in construction.

More interestingly and in accordance with our *a priori* spatial differentiation, New Delhi and Delhi cantonment constitute one cluster (number 4) which exhibits a very distinct pattern: very low residential density and extremely low population growth, for a highly literate population, allowing larger female work force participation, in the context of an employment structure dominated by government services. This cluster can be further identified as the area whose urban landscape is marked on the one hand by urbanisation of colonial origin and, on the other, by the impact of the post-independence State through extensive construction of Government residential colonies.

Cluster 5, which includes 28 charges, covers a large part of South Delhi as well as some charges in West, Central and North Delhi, but excluding East Delhi and Old Delhi. The demographic characteristics of this cluster indicate somewhat lower residential density and lower population growth. It seems to be inhabited by population belonging to relatively higher socio-economic strata, as suggested by very low percentages of

scheduled caste and illiterates, and with an employment structure marked by a higher incidence of trade and commerce.

Cluster 6 includes 17 charges, rather scattered in Central and Old Delhi, and with a strip in East Delhi. The residential density in this cluster is twice as high as the average, associated with very low population growth, indicating net out-migration, and with also lower child/women ratio. Another notable characteristic is the higher incidence of industrial workers.

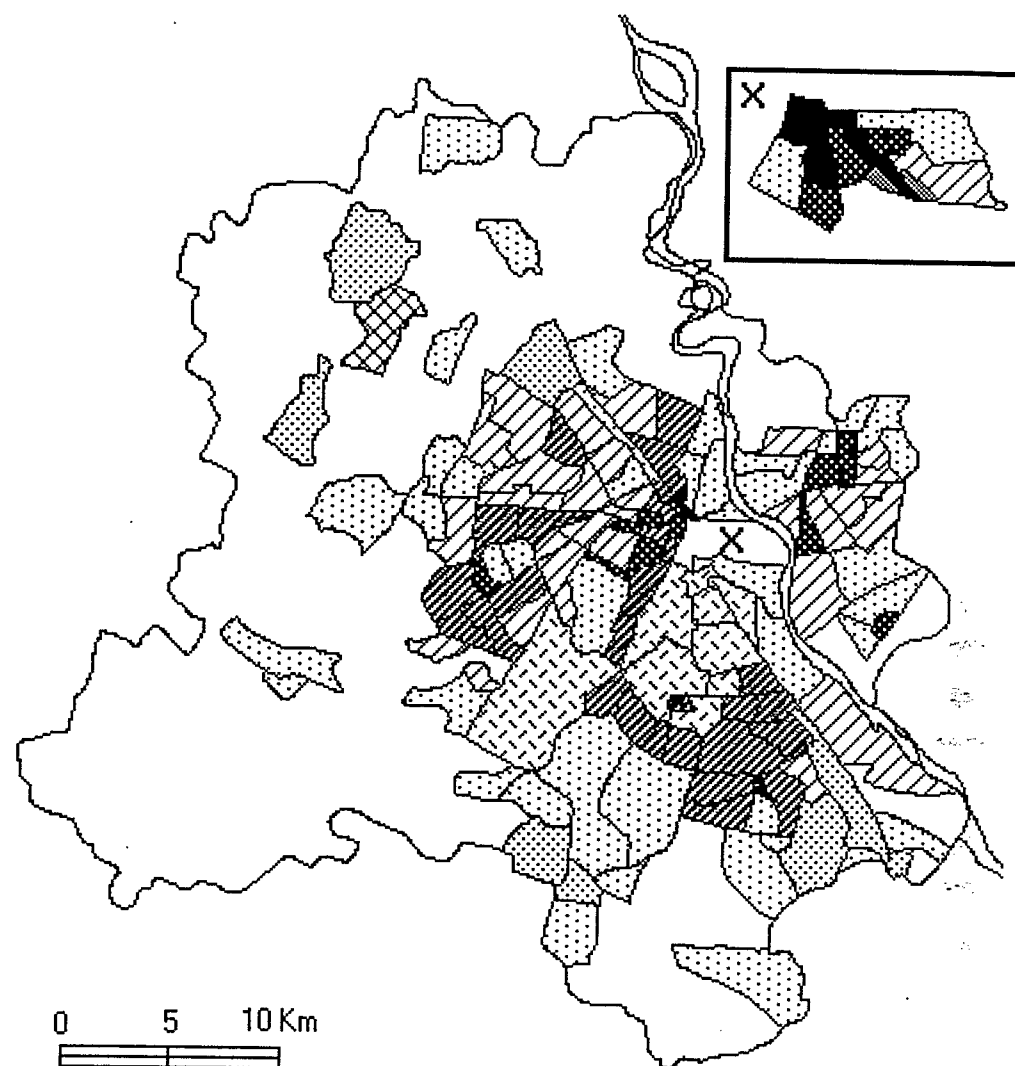
Cluster 7, with 30 charges, covers large parts of West, Northwest and East Delhi, as well as one zone in the southeast. The lower socio-economic strata seem to be under-represented, as suggested by very low percentage of scheduled caste and higher literacy rates, while the employment structure is characterized by higher proportions of workers in manufacturing activities as well as in trade and commerce.

The last group is a small one, formed by the combination of cluster 8 (2 charges) and cluster 9 (9 charges), both exhibiting similar location and population characteristics. This combined cluster has a well defined demographic and socio-economic structure, and is moreover essentially concentrated in a single geographical zone, in Old-Delhi. It is first distinguishable by its extremely high residential density associated with negative population growth and lower child-women ratio. In terms of employment structure, population in this cluster also appears to be more industrialized, and highly commercialized.

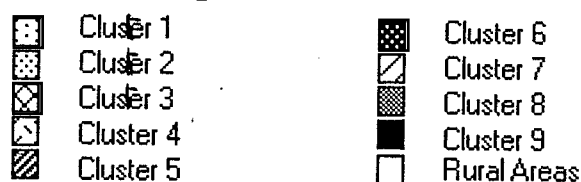
Following this analysis, it appears that the pattern of spatial organisation revealed by the cluster analysis does not conform to a mere geographical division; nevertheless, as also shown above, the different clusters do have meaningful locational characteristics. The most striking example is provided by New-Delhi and Delhi cantonment, falling into a single cluster. The other main geographical sectors correspond to a combination of two or three clusters, excluding others. Old-Delhi, however, manifests a more complex pattern, with 4 main types of cluster being represented, including one exclusive type, but all of them having one common economic characteristic: under-representation of services. Thus, the different geographical sectors of Delhi Urban Agglomeration still exhibit distinct demographic and socio-economic structure.

Map 17

Distribution of the census charges of Delhi Union Territory in 1991 into nine clusters



The nine clusters identified by cluster analysis based on 22 demographic, social and economic variables in the 149 census charges



Based on 1991 Census data

IEG-ORSTOM

7. SUMMARY OF MAIN FINDINGS

This paper has examined population distribution, growth and socio-economic spatial patterns in Delhi, on the basis of the 1991 census data.

The pattern of population density gradients is broadly in accordance with the classical model characterized by high densities in the urban centre, and decreasing values towards the periphery, whereas the population growth rate follows a clearly centrifugal pattern. Furthermore, population growth in rural hinterland proved to be higher than in Delhi urban agglomeration, indicating the diffusion of the urbanisation process.

The social differentiation of the urban space in Delhi highlights the persistence of segregation corresponding to traditional caste-based ostracism, as well as a spatial distribution of the lower socio-economic strata according to a pattern of 'local concentration cum global dispersion'. Hence clusters with especially high proportions of scheduled castes population can be identified, though rather scattered within the Delhi urban agglomeration, while other areas are conspicuous by their marginal percentage. Illiteracy also generates an unequal distribution of living places in the urban space, with strong concentration of illiterate population in some specific census divisions, especially in the core of the old city or in peripheral areas with stretches corresponding to industrial zones.

The employment structure of the population in rural areas of the Union Territory reflects the urbanisation process at work in the city's hinterland. In the urban agglomeration, the three main economic functions of the capital, administrative, commercial and industrial, have generated very distinct residential patterns for the concerned workers with a broad division between the southern and northern parts. The workers employed in community, social and personal services are more concentrated in the south, whereas workers in trade and commerce or in manufacturing industries are represented in higher proportions in the north. The preferential location of the residences of the former is to be related to the construction in this part of the city of many housing colonies by the government for its employees, which has further engendered a high degree of residential segregation based on income and status. In Old Delhi and its close vicinity, living places and work sites of the traders intermingle, while elsewhere there is no systematic correspondence; some major residential concentrations of traders and businessmen appear to be linked to the location of the refugee camps established after the partition. On the other hand, there is a good congruence between the industrial zones and the main concentrations of industrial workers' living places.

The Old City deserves a special mention, for its extremely high population densities, notwithstanding their decreasing trend, associated with a notorious concentration of

commercial and manufacturing enterprises, despite repeated attempts of the Delhi Administration to decongest this area.

The factor analysis further corroborates the significance of two main 'factors' in the structuring of the pattern of population distribution in Delhi's urban space: the first one indicates the combined effect of demographic characteristics and social status, and the second one the impact of the employment sector. The cluster analysis substantiates with evidence the location of different types of growth patterns with distinct demographic, social and economic characteristics across urban Delhi.

The pattern of spatial organisation which eventually emerges from this study of Delhi proves to be multifaceted. It is first deeply marked by the different historic periods, from the Mughal rule to the British rule, the trauma of Partition, as well as by the impact of the independent Government, through its efforts of town planning and in asserting the status of Delhi as a capital city. All these factors not only contributed to shape the urban landscape, but have also influenced the socio-economic composition of the population residing in various localities. Endogenous forces are also clearly manifested, conforming to the laws of the real-estate market, or to the search of a better proximity between place of residence and place of work; furthermore these forces can work against the attempts of the Delhi Administration to regulate the development of the capital.

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APPENDIX

Methodological note on factor analysis

In factor analysis each variable is expressed as a linear function of several factors. If X_i is a standardised variable, it may be expressed in terms of k number of factors, $f_1, f_2,$

..... f_k :

$$X_i = \sum_{j=1}^k \lambda_{ij} f_j + e_i$$

where, $i = 1, 2, \dots, p$

and $k \leq p$.

λ_{ij} in the linear model are regarded as factor loading and e_i a random error. It resembles the multiple regression model, but the basic difference between them is that the factors $f_1, \dots, f_k$ are unobservable whereas in a multiple regression model we have the observed values as independent variables. In factor analysis, the factors are the hypothetical constants which can only be estimated from the observed data. The number of factors produced can be as many as the number of variables. In other words, only the significant factors, i.e., the factors with eigen values or latent roots greater than 1, are taken into account.

Eigen value is computed as the column-wise sum of the square of the factor loadings of all variables on a given factor. If there are p number of variables as said before, eigen value of the j th factor, E_j will be

$$E_j = \sum_{i=1}^p \lambda_{ij}^2$$

Eigen value is a measure of the amount of variation accounted for by a factor.

Communalities, C_i , on the other hand, is the row-wise sum of the square of the factor loadings of a given variable on all factors indicating the relative amount of variance of each variable being measured by the significant factors

$$C_i = \sum_{j=1}^k \lambda_{ij}^2$$

The sum of all eigen values for all factors equals the number of variables under consideration (in our case 22). Therefore, eigen values greater than unity are usually taken to be significant. Thereafter, the unrotated factor structure is rotated by means of the "varimax" rotation technique and the factor loadings can be interpreted.

Methodological note on cluster analysis

Following the SPSS programme applied here, "cluster analysis produces hierarchical clusters of items (here the 149 census charges) based on their dissimilarities or similarities on one or more variables" (in this study 22 variables are taken into consideration). "The cluster procedure involves four steps:

- First Cluster obtains distance measures of similarities between or distances separating initial clusters (individuals or variables being clustered).
- Second, it combines the two nearest clusters to form a new cluster.
- Third, it recomputes similarities or distances of existing clusters to the new cluster.
- Finally it returns to the second step until all items are combined in one cluster.

The process yields a hierarchy of cluster solutions, ranging from one overall cluster to as many as there are cases. (...) Within each level, the clusters are disjoint (each item belongs to only one cluster)" (*SPSS Reference Guide*).

Here the solution corresponding to 9 clusters has been considered, in order to compare them to the 9 broad zones as identified on *a priori* basis according to their geographical location.

The distance between census charges was estimated by the squared Euclidean distance, and the 'average linkage between groups' method used for clustering.

Note on Tables A1, A2, A3 & A4.

Abbreviations for the 22 variables

SCST: percentage of scheduled castes in total population
 MWPR: percentage of total main workers in male population
 FWPR: percentage of total main workers in female population
 CHEF: children/female population ratio = Ratio of children aged 0 to 6 years to female population (in percentage)
 M5A: percentage of workers in household industry among total male main workers
 M5B: percentage of workers in manufacturing and processing non-household industry among total male main workers
 M6: percentage of workers in construction among total male main workers
 M7: percentage of workers in trade and commerce among total male main workers
 M8: percentage of workers in transport, storage and communication among total male main workers
 M9: percentage of workers in other services among total male main workers
 F5A: percentage of workers in household industry among total female main workers
 F5B: percentage of workers in manufacturing and processing non-household industry among total female main workers
 F6: percentage of workers in construction among total female main workers
 F7: percentage of workers in trade and commerce among total female main workers
 F8: percentage of workers in transport, storage and communication among total female main workers
 F9: percentage of workers in other services among total female main workers
 F-MPOP: sex ratio of total population = number of females for 100 males
 F-MWOR: sex ratio of main working population = number of female main workers for 100 male main workers
 MLIT: male literacy rate = percentage of literates in male population aged 7 years and above
 FLIT: female literacy rate = percentage of literates in female population aged 7 years and above
 ROG: annual (exponential) rate of growth of the population from 1981 to 1991 (in percentage)
 DENSITY: gross population density in 1991 = number of inhabitants per hectare (in Table A4, DENSITY = number of inhabitants per 10 ares)

Other abbreviations

S.T. : standard deviation
 EIGEN VAL: Eigen value
 % V. Exp.: percentage of the variance explained

Source of the data

The 22 variables have been computed on the basis of the 1991 census data at the charge level (149 urban charges including census towns); 1981 census data were also used for ROG :

- *Census of India 1981, Series-28 Delhi, District Census Handbook, Village and Townwise Primary Census Abstract.*
- *Census of India 1991, Series - 31 Delhi, District Delhi, District Census Handbook, Village and Townwise Primary Census Abstract.*

Table A1: Coefficients of Variation

Variable	Coefficient of Variation
SCST	.594
MWPR	.078
FWPR	.527
CHEF	.204
M5A	1.25
M5B	.434
M6	.690
M7	.385
M8	.396
M9	.433
F5A	1.34
F5B	.575
F6	1.49
F7	.443
F8	.651
F9	.200
F-MPOP	.063
F-MWOR	.529
MLIT	.096
FLIT	.185
ROG	1.36
DENSITY	1.08

TABLE A2 CORRELATION COEFFICIENTS

	SCST	WMPR	FWPR	CHEF	M5A	M5B	M6	M7	M8	M9	F5A	F5B	F6	F7	F8	F9	F-MPOP	F-MWOR	MLIT	FLIT	ROG	DENSITY
SCST	1	-0.20	-0.16	0.45	-0.07	-0.02	0.29	-0.36	0.15	0.09	-0.02	0.22	0.22	-0.01	-0.28	-0.26	-0.22	-0.16	-0.45	-0.60	0.02	0.07
WMPR		1	0.37	-0.47	-0.16	0.14	-0.17	0.30	-0.18	0.01	-0.15	0.07	-0.08	0.35	0.21	0.07	-0.32	0.22	-0.01	0.37	-0.21	0.14
FWPR			1	-0.56	-0.39	-0.43	0.11	-0.09	-0.20	0.53	-0.47	-0.30	0.16	-0.03	0.18	0.18	0.10	0.98	0.32	0.47	-0.06	-0.30
CHEF				1	0.004	0.14	0.46	-0.49	0.25	-0.16	0.07	0.27	0.33	-0.13	-0.45	-0.48	-0.41	-0.55	-0.61	-0.89	0.47	-0.23
M5A					1	0.25	-0.24	0.09	-0.14	-0.23	0.73	0.11	-0.19	-0.22	-0.11	0.06	0.28	-0.36	-0.14	-0.06	-0.14	0.41
M5B						1	-0.22	0.35	-0.13	-0.75	0.21	0.71	-0.18	0.31	0.01	-0.20	0.46	-0.44	-0.21	-0.09	0.06	0.35
M6							1	-0.46	0.02	0.06	-0.26	0.08	0.74	-0.09	-0.25	-0.35	-0.18	0.13	-0.26	-0.41	0.41	-0.30
M7								1	-0.16	-0.58	0.14	0.09	-0.39	0.58	0.18	0.09	0.44	-0.07	0.20	0.50	-0.26	0.46
M8									1	-0.11	0.02	0.05	-0.03	-0.01	0.29	-0.11	-0.17	-0.19	-0.26	-0.27	0.09	-0.16
M9										1	-0.25	-0.50	0.04	-0.42	0.0003	0.38	-0.23	0.49	0.24	0.10	-0.02	-0.37
F5A											1	0.18	-0.23	-0.17	-0.19	-0.04	0.23	-0.45	-0.15	-0.12	-0.10	0.50
F5B												1	-0.04	0.21	-0.08	-0.42	-0.06	-0.30	-0.30	-0.29	0.07	0.30
F6													1	-0.21	-0.22	-0.53	-0.20	0.17	-0.21	-0.34	0.20	-0.28
F7														1	0.09	-0.15	0.05	-0.05	-0.09	0.12	-0.06	0.19
F8															1	0.15	0.07	0.17	0.40	0.48	-0.11	0.01
F9																1	0.21	0.15	0.38	0.48	-0.14	-0.01
F-MPOP																	1	0.25	0.35	0.40	-0.12	0.34
F-MWOR																		1	0.35	0.47	-0.04	-0.28
MLIT																			1	0.82	-0.11	-0.11
FLIT																				1	-0.23	0.09
ROG																					1	-0.29
DENSITY																						1

Table A3_ Results from Factor Analysis (Factor loadings)

Variables	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SCST	-0.76	-0.10	0.08	0.18	0.18	0.04	0.05
MWPR	0.28	0.20	0.27	-0.03	0.45	-0.66	-0.16
FWPR	0.47	-0.46	0.43	0.36	0.31	-0.13	-0.16
CHEF	-0.75	0.13	-0.10	0.18	-0.58	-0.03	0.06
M5A	-0.01	0.15	-0.84	-0.10	0.12	0.11	-0.13
M5B	0.01	0.85	-0.17	-0.08	-0.07	-0.15	-0.10
M6	-0.28	-0.14	0.21	0.68	-0.33	0.09	-0.10
M7	0.35	0.58	0.15	-0.34	0.37	0.31	-0.10
M8	-0.26	-0.02	0.07	-0.04	-0.07	0.04	0.87
M9	0.04	-0.90	0.09	-0.02	0.03	-0.23	-0.09
F5A	-0.12	0.19	-0.80	-0.15	0.15	0.14	-0.03
F5B	-0.19	0.69	-0.15	0.16	0.04	-0.21	0.04
F6	-0.17	-0.10	0.08	0.85	-0.16	-0.03	-0.07
F7	-0.05	0.57	0.59	-0.20	0.25	0.10	-0.05
F8	0.56	0.05	0.09	-0.06	0.14	-0.12	0.66
F9	0.33	-0.42	-0.01	-0.64	0.04	0.05	-0.13
F-MPOP	0.38	0.09	-0.17	0.00	0.22	0.81	-0.11
F-MWOR	0.48	-0.46	0.40	0.40	0.29	0.05	-0.14
MLIT	0.78	-0.23	0.06	-0.16	-0.06	0.19	-0.01
FLIT	0.89	-0.06	0.13	-0.22	0.25	0.07	-0.07
ROG	-0.03	0.09	0.12	0.20	-0.74	0.03	-0.05
DENSITY	-0.06	0.42	-0.38	-0.15	0.56	0.19	-0.12
EIGEN VAL	5.34	4.48	2.37	1.65	1.47	1.12	1.04
% V.Exp.	24.30	20.40	10.80	7.50	6.70	5.10	4.70

Table A4: Results from Cluster Analysis

Variable		Cluster									
		1	2	3	4	5	6	7	8	9	Total
	count	45	8	1	9	28	17	30	2	9	149
SCST	mean	24.5	24.5	25.1	18.4	11.3	20.1	12.7	18.9	23.3	18.6
	S.D.	11.3	7.8		4.5	5.2	14.7	5.2	15.8	16.4	11.1
MWPR	mean	49.3	51.5	45.5	55.2	53.3	52.0	52.9	52.7	53.2	51.8
	S.D.	4.5	6.6		3.1	2.1	3.0	3.3	0.3	2.4	4.1
FWPR	mean	5.5	7.0	11.2	13.5	11.3	5.3	7.1	3.6	4.2	7.4
	S.D.	3.2	4.0		2.8	2.8	1.6	2.8	0.9	1.5	3.9
CHEF	mean	43.0	48.2	44.0	30.1	28.8	33.5	36.4	34.0	33.4	36.7
	S.D.	5.6	5.5		3.4	3.3	5.7	3.5	3.3	4.3	7.5
M5A	mean	1.5	0.8	1.2	0.9	0.5	2.6	1.4	5.1	3.4	1.5
	S.D.	2.1	0.9		1.3	0.7	2.0	1.6	2.4	2.3	1.9
M5B	mean	20.9	23.8	3.5	5.6	19.4	28.6	30.6	32.4	27.5	23.1
	S.D.	8.3	18.0		1.8	5.8	5.8	7.0	9.6	7.4	10.1
M6	mean	10.1	11.8	28.8	5.6	7.3	4.2	7.0	4.0	4.1	7.8
	S.D.	5.8	6.1		2.9	3.3	2.7	4.4	1.3	5.4	5.4
M7	mean	21.3	13.9	6.7	12.2	30.6	30.8	28.5	37.0	35.3	25.6
	S.D.	7.1	6.6		4.4	8.3	10.5	5.4	3.2	10.2	9.9
M8	mean	10.8	1.6	6.7	6.5	8.1	10.1	8.3	4.5	8.1	9.1
	S.D.	4.4	9.1		2.1	1.8	4.4	2.1	0.3	4.7	3.6
M9	mean	30.6	27.8	39.2	68.1	33.4	23.3	23.3	16.3	21.1	30.2
	S.D.	7.3	12.0		7.9	10.9	5.5	5.3	2.9	6.0	13.1
F5A	mean	2.6	1.2	0.2	1.2	0.5	4.0	1.7	7.8	8.1	2.4
	S.D.	2.8	1.5		2.4	0.6	4.0	2.3	3.8	5.0	3.2
F5B	mean	9.9	15.1	0.2	2.8	8.0	11.9	10.9	16.2	13.1	10.0
	S.D.	6.8	10.1		1.4	2.5	3.6	3.9	3.0	5.2	5.8
F6	mean	6.7	19.7	82.9	4.4	4.6	1.6	4.7	0.5	2.3	6.0
	S.D.	5.6	13.4		2.8	3.0	1.5	5.3	0.5	3.3	9.0
F7	mean	12.5	9.2	0.0	7.0	14.4	13.5	13.1	12.3	13.8	12.6
	S.D.	7.0	9.1		1.5	3.3	5.6	3.0	6.0	3.8	5.6
F8	mean	2.8	1.4	0.2	3.4	4.0	4.3	3.8	2.3	2.5	3.1
	S.D.	1.3	1.1		1.9	1.2	3.1	2.3	0.3	1.6	2.0
F9	mean	62.4	30.8	14.7	80.9	68.2	64.2	65.2	60.1	60.0	63.2
	S.D.	11.1	11.0		5.6	4.1	4.7	7.1	6.5	6.2	12.7
F-M POP	mean	81.0	76.0	83.0	79.1	85.7	85.4	82.8	89.6	85.7	82.8
	S.D.	4.6	7.4		6.9	4.5	3.3	3.8	1.4	3.4	5.3
F-M WOR	mean	8.8	11.2	20.5	19.9	18.3	8.8	11.1	6.1	6.8	11.8
	S.D.	4.6	8.0		5.7	4.9	2.8	4.3	1.5	2.7	6.2
MLIT	mean	77.1	76.1	77.6	88.0	89.5	83.9	84.2	75.2	79.2	82.3
	S.D.	8.8	5.7		3.1	2.9	5.7	4.9	9.9	6.7	7.9
FLIT	mean	56.6	48.1	52.4	74.9	81.1	71.2	72.5	65.3	67.7	67.5
	S.D.	9.6	7.1		4.1	4.8	8.9	5.0	7.9	9.4	12.5
ROG	mean	5.60	5.27	1.49	0.73	2.61	1.07	6.69	-0.25	-0.60	3.95
	S.D.	4.1	3.1		1.7	5.2	3.8	7.4	0.3	2.0	5.4
DENSI TY	mean	14.07	3.20	0.83	7.78	20.85	53.73	20.97	161.11	103.01	27.55
	S.D.	11.5	2.4		5.0	7.6	10.7	8.7	6.8	13.1	29.8