IIMB-WP N0. 587

WORKING PAPER NO: 587

Residential Segregation Patterns in Indian Metros

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Year of Publication – April 2019

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Abstract

We present the first ever neighbourhood-scale portrait of caste-based residential segregation in Indian cities. Using 2011 enumeration block (EB) level census data for five major cities in India – Bengaluru, Chennai, Delhi, Kolkata, and Mumbai – we show how patterns of caste-based urban residential segregation operate in contemporary India. We also present the first visual snapshot of caste-based residential segregation in an Indian city using georeferenced EB level data for Bengaluru.

Keywords: Caste Segregation; Residential Segregation; Geo-coded Enumeration Block; Indian National Census

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ABSTRACT

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This paper is derived from of an earlier working paper titled "Isolated by Caste: Neighbourhood-Scale Residential Segregation in Indian Metros."

Introduction

Extant studies of residential segregation in urban India use the ward as the principal unit of empirical analysis (Sidhwani, 2015; Singh, Vithayathil, & Pradhan, 2019a; Vithayathil & Singh, 2012). Vithayathil & Singh (2012) use ward level data (Census 2001) to find that caste- based residential segregation is more pronounced than segregation by socio-economic status. A similar study by Sidhwani (2015), showed that the percentage of Dalits and Adivasis in a neighborhood was correlated to the quality of public good provisioning. A recent longitudinal study by Singh, Vithayathil, & Pradhan (2019) using 2001 and 2011 census, showed that residential segregation persisted or worsened in 60 percent of Indian cities. One the most serious limitations of all these studies is that they use ward as their unit of analysis, and this might underreport the intensity of residential segregation in Indian cities. Even when a ward is diverse in terms of caste composition, the communities are often highly segregated within a ward. In Bengaluru for example, upper caste neighborhoods are often abutted by highly dense lower caste settlements. Thus even when spatially proximate, the social distance between these neighborhoods can be very high (Shaw 2012). Clustering can happen even at a micro streel-level, with households from two different castes occupying adjoining streets, or even two different sides of the same street. Hence, the ideal unit of analysis must be still smaller – say a street. Given the compact spatial spread of an urban census enumeration block, we argue that that they represent a good proxy for neighbourhoods.

We provide robust evidence for intra-ward segregation for five metropolitan cities of India – Delhi, Mumbai, Kolkata, Chennai and Bangalore. Of these five cities, we are also able to visually demonstrate such segregation for Bengaluru using geo-referenced enumeration block level data. To the best of our knowledge, this paper is the first ever attempt to use enumeration block (EB) data (released in 2015) to study caste-based residential segregation in India, and also provide a visual portrait of micro-level intra-ward segregation.

Ward and Census Enumeration Block (EB)

The limitations of using ward as the spatial unit of urban segregation analysis is well-documented. The average population in an urban ward can vary from 1500 to 6000 for small statutory towns and municipalities. In larger metropolitan cities, ward size may vary from 30,000 to 200,000 (R. N. Prasad 2006). Hence for studying neighborhood level segregation, a ward is not the most useful spatial unit of analysis. A census enumeration block (or sub-block, that we advocate as a more appropriate neighbourhood proxy in this paper) has around 100-125 households with a population of 650-700 (Socio-Economic and Caste Census 2011). Figures 1 and 2 illustrate the limitations of using ward level data as a proxy for neighbourhood residential segregation. Even without accounting for social groups, these maps show substantive intra-ward variation in distribution of people in Bengaluru. The maps show how the EBs within a ward are heterogeneous even in terms of aggregate population numbers.

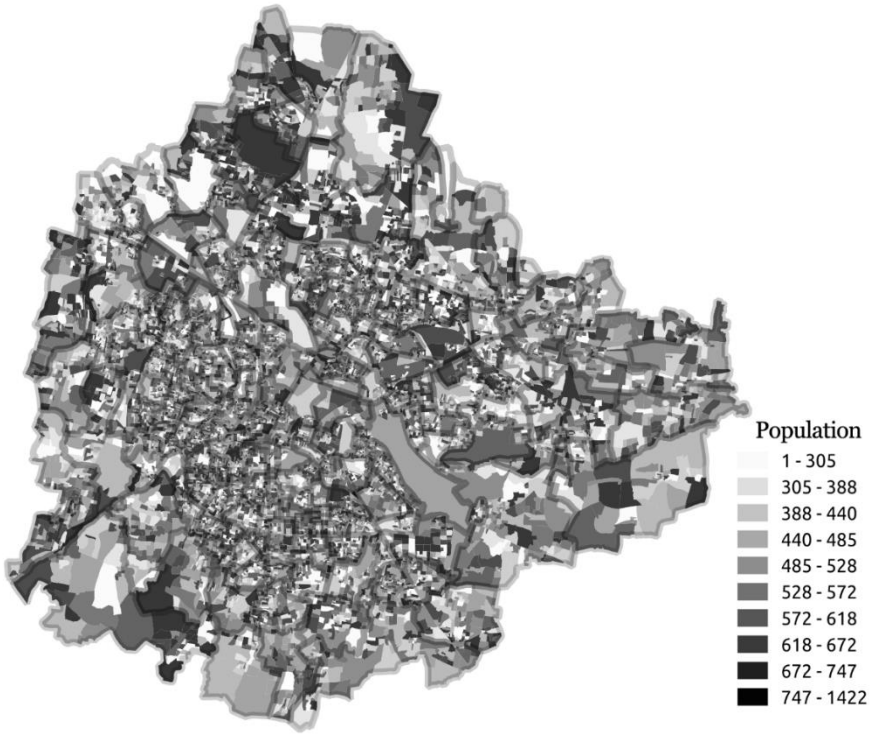


Figure 1: Bengaluru Enumeration Block level Population Map. Uniform ward-level population has been the staple of urban policy analysis in India. This map for Bengaluru shows how there is significant intra-ward variation in population. The population numbers, ward boundaries, and block boundaries are all from Census of India (2011). Also cf. Figure-2 and Figure-3.

Figure 2: Variation of population within wards in Bengaluru. This figure simply magnifies a particular portion of Figure-1 to better illustrate ward boundaries and thus intra-ward variation in populations.

Using EB data, and comparing it with ward level information, this paper shows why the usage of ward as a unit to study spatial segregation grossly understates the true extent of caste-based residential segregation in urban India. The remainder of the paper is organized as follows. In the following section, we discuss our data and the methodology, and more rigorously defend the census enumeration block as the appropriate spatial unit of analysis for studying residential segregation. Following an analytical discussion of our key results, we present India's first ever visual map of residential segregation using enumeration block map for the city of Bengaluru, before concluding with object lessons for research as well as policy.

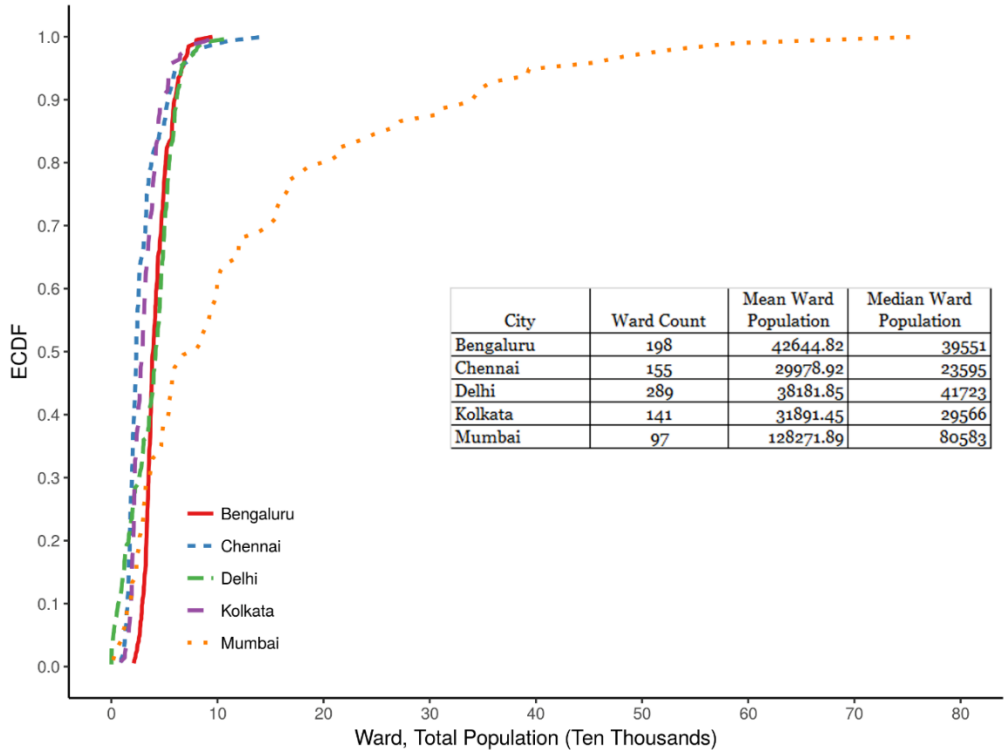
2. Data and Methodology

This paper uses data from Census of India 2011 which gives total population (Male and Female) and Scheduled Caste and Tribe population for every enumeration block within a urban ward.[1] As discussed in the introductory section, a census enumeration block (or sub-block) has around 100-125 households with a population of 650-700. In this paper, we present data for four traditional metropolitan cities of India – Chennai, Delhi, Kolkata and Mumbai along with Bengaluru. Inset tables in Figure 3 list the mean and median ward and block size for these five major urban cities. Clearly, ward sizes vary across cities making them incomparable, but the mean block level size is consistent across all the cities. Figure 3 gives empirical cumulative distribution function (ECDF) plots for block and ward population sizes for all the five cities that we study in this paper. ECDF block population plots of different cities overlap unlike ward plots – denoting comparable block sizes across cities. Table 1 gives total population, and percentage of SC, ST population. For purpose of this paper, we have combined SC and ST population – a standard practice in quantitative studies of urban segregation in India. Since only population numbers are made available at the enumeration block level, we are unable to study segregation based on socio-economic indicators (class variables), or do a comparative analysis of urban amenities in respective enumeration blocks.

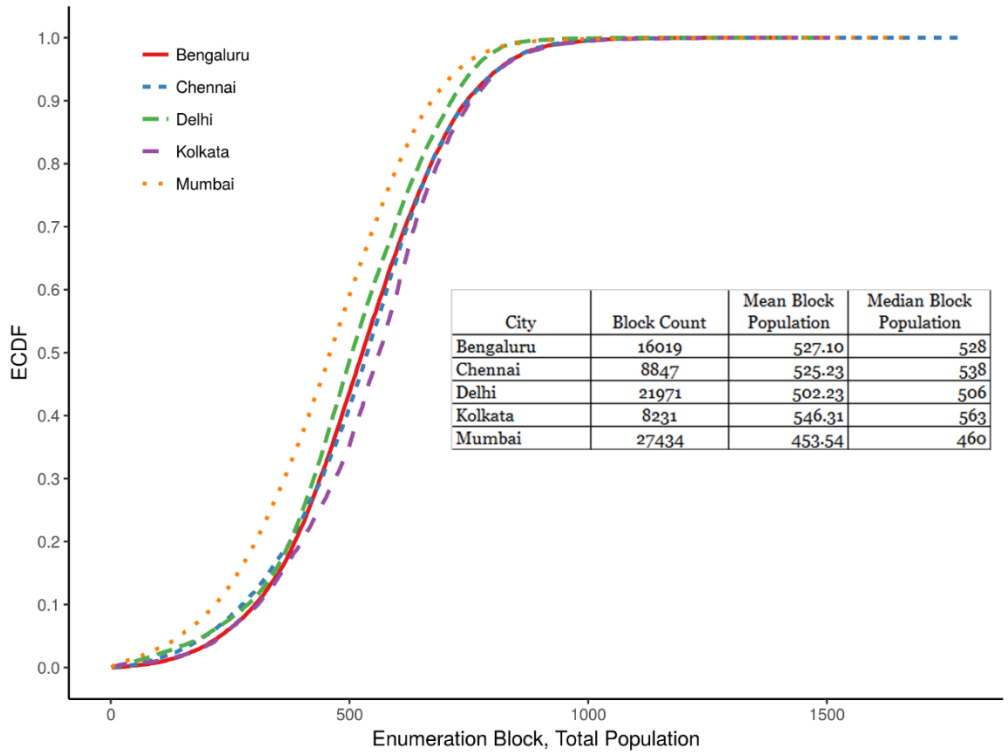
We also use enumeration block maps of Bengaluru (we digitized and geo-registered ~16,00 polygons representing enumeration blocks and sub-blocks in Bengaluru's 198 wards using official ward maps that we obtained from Census of India and merged block level population data) to present the first visual portrait of the extent of caste-based residential segregation in India.[2]

City	Total Population	% SC	%ST	% SC+ST
Bengaluru	8443675	11.37	1.83	13.21
Chennai	4646732	16.78	0.22	17.00
Delhi	11034555	15.76	0.00	15.76
Kolkata	4496694	5.38	0.24	5.62
Mumbai	12442373	6.46	1.04	7.50

Table 1: City population and percentage of SCs and STs (Data from Census of India, 2011). Census numbers under-estimate the number of people belonging to SC and ST groups. This is best illustrated by Delhi where census numbers report no person belonging to the ST group – which evidently does not reflect empirical reality. This discrepancy arises from the fact that Census uses state-specific SC and ST lists to tabulate group populations. Delhi does not have a state-specific ST list. People who belong to ST groups under lists from other states are not enumerated as ST in Delhi. Similar process is followed for enumeration of people belonging to SC groups as well. Thus, for example, only people belonging to groups that are in the Karnataka SC list are counted under SC for the city of Bengaluru. A person belonging to an SC group that is recognized as such outside Karnataka is not enumerated as an SC in Bengaluru.



City	Ward Count	Mean Ward Population	Median Ward Population
Bengaluru	198	42644.82	39551
Chennai	155	29978.92	23595
Delhi	289	38181.85	41723
Kolkata	141	31891.45	29566
Mumbai	97	128271.89	80583



City	Block Count	Mean Block Population	Median Block Population
Bengaluru	16019	527.10	528
Chennai	8847	525.23	538
Delhi	21971	502.23	506
Kolkata	8231	546.31	563
Mumbai	27434	453.54	460

Figure 3: Cumulative density plots of population at ward and block levels. Data from Census 2011. These plots provide the basis (or lack thereof) for comparisons across the five metro cities in India. The top panel shows the density plot at the ward level. Ward sizes are comparable across cities except Mumbai that has much larger wards. The block sizes (bottom panel) are comparable across all cities.

2.1 Measuring Segregation

We use a simple dissimilarity index and the standard Gini index to measure residential segregation. Both indices measure degree of 'evenness' of a given geographical unit. The dissimilarity index measures how population shares of different social groups are different from the larger spatial aggregate. In our case, we ask how blocks in the ward are different from the ward itself. We also study how blocks are different from the city as a whole. To benchmark our block-level results with earlier ward-level results, and illustrate the extent of intra-ward segregation, we also present results for how wards in the city are different from city as a whole. Both the indices vary from 0 to 1, with 0 indicating complete integration; and 1, complete segregation.

We compute a simple Dissimilarity Index (D) at city and ward levels. We compute two different dissimilarity indices at the city-level, and one at the ward-level. At the city-level, we ask how the caste composition of a ward or a block is different from the city as a whole. To understand intra-ward heterogeneity, we also compute the dissimilarity index at the ward level – an indicator of how the blocks within a ward are different from ward as a whole. We use a simple index defined by:

$$D = 0.5 \sum_{i=1}^{N} \left| \frac{s_i}{\mathbf{S}} - \frac{r_i}{\mathbf{R}} \right|$$

where s_i=SC+ST population in ith block/ward

S= Total SC+ST population in ward/ city

r_i= Rest of the population rth block/ward

R= Rest of the population in ward/ city

We also compute a simple Gini index as an index of segregation for each of the five cities that we study.

Gini index (G) of a city is calculated using:

$$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |s_i - s_j|}{2n \sum_{i=1}^{n} s_i}$$

where s_i and s_j are SC-ST populations in ward (or block) i and j respectively.

3. Results

Table 2 presents the three different dissimilarity indices that we compute in the paper. The first column reports the dissimilarity index computed at the ward-city level, and represents the benchmark result – for example, these numbers are consistent with numbers reported by Vithayathil & Singh (2012). As discussed, this index is a measure of how wards within a city are different in their caste composition from the city as a whole. The second column reports the dissimilarity index comptued at the block-city level – a measure of how the caste composition of blocks in a city are different from city as a whole. A comparison between these two columns illustrates how ignoring intra-ward segregation amounts to neglect of a significant portion of segregation in a city. The last two columns present a direct measure of intra-ward segregation. For each ward, we computed how the blocks within the ward are different from the ward as a whole in terms of caste composition. The table reports the median ward-block dissimilarity index for each city as well as a mean (ward population weighted). As seen from the table, for a typical ward, the dissimilarity index computed at ward-block level is greater than the one computed at ward-city level – and thus showing how wards are heterogenous and segregated.

In Figure 4, each of the six panels (corresponding to the five individual cities studied in this paper, and one corresponding to combinded data from all the five cities) show two different SC-ST population Lorenz curves – one computed at the ward-level, and other computed at the block-level. For each of the five cities, the ward-level Lorenz curve lies unambiguously, and wholly inside the block-level Lorenz curve. The degree of intra-ward heterogeneity is seen from the difference in Gini coefficients at block and ward levels. The Gini coefficients reported here are a measure of segregation at ward and block levels. This figure clearly illustrates why treating ward as a homogenous entity is empirically fraught. For example, in Bengaluru, there is a 30% difference between segregation measured at block and ward levels as mesaured by the Gini index.

Figure 5 illustrates how there is no systematic relationship between ward size and the dissimilarity index. The first panel in the figure combines wards from all five cities that we study in this paper. This figure provides evidence for intra-ward heterogeneity across ward sizes. Figure 6 illustrates the extent of intra-ward heterogeneity. For each of the five cities, as well as for the combined dataset, we present the distribution of the block-ward dissimilarity index.

Figure 7 juxtaposes kernel density plots for fractionalization index computed at block and ward levels for each of the five cities (the first panel combines blocks and wards from all five cities). Even when wards are diverse (higher fractionalization), the blocks are homogenous (lower fractionalization). The fractionalization index is usefully interpreted as the probability that two randomly selected people (here, from either a ward or a block) belong to different social groups (here either SC-ST or OTH).

City	D (Ward-City)	D (Block-City)	Median D (Block-Ward)	Pop. Wtd. Mean D (Block-Ward)
Bengaluru	0.23	0.51	0.46	0.46
Chennai	0.33	0.62	0.56	0.53
Delhi	0.33	0.60	0.54	0.54
Kolkata	0.37	0.71	0.67	0.67
Mumbai	0.21	0.59	0.59	0.57

Table 2: Patterns of Segregation: Dissimilarity Index. See main text for computational details.

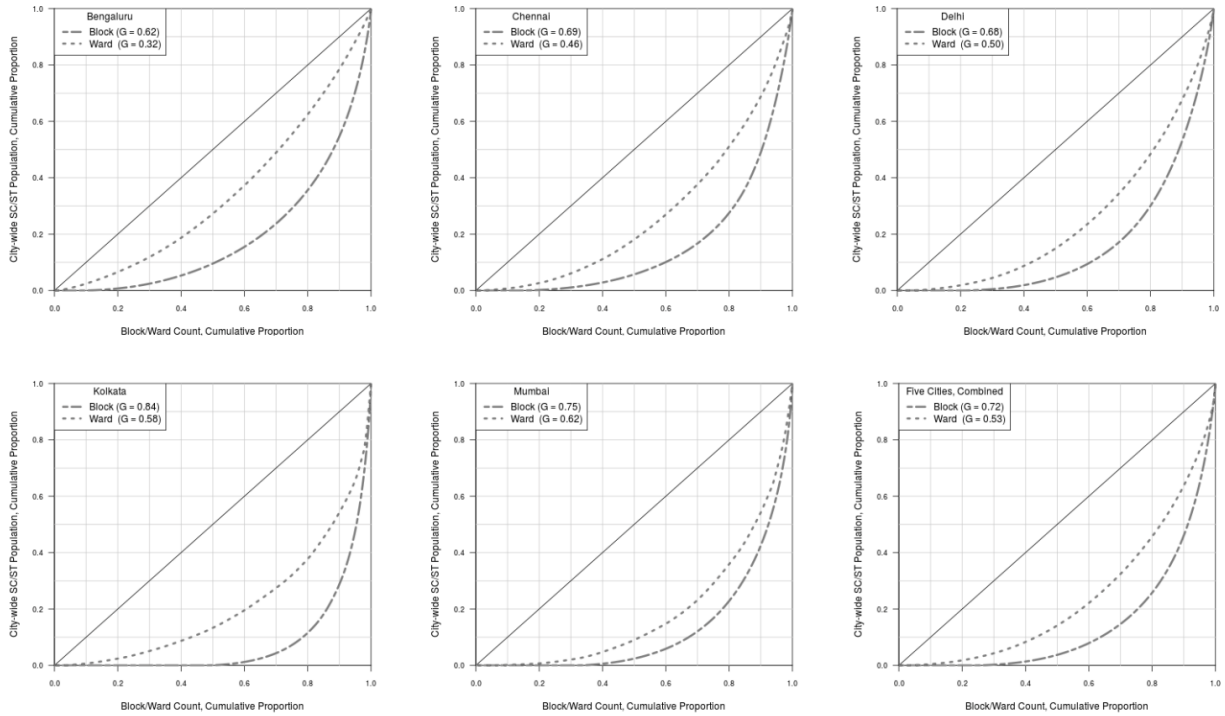


Figure 4: Block and Ward Segregation: Lorenz curves.

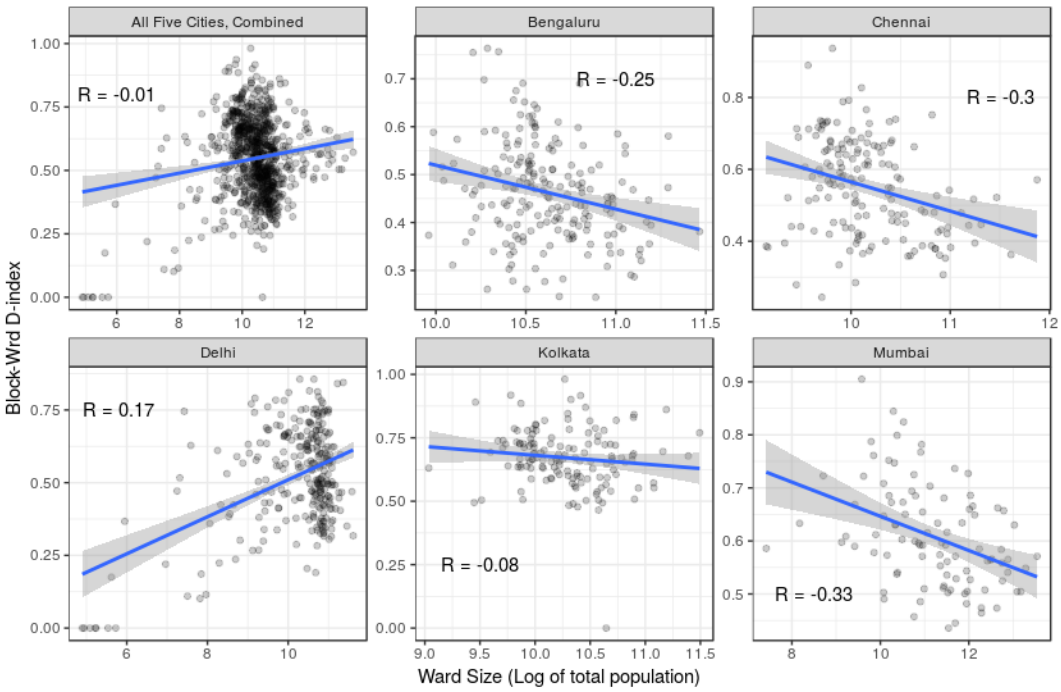


Figure 5: Relationship between ward-size and block-ward dissimilarity index.

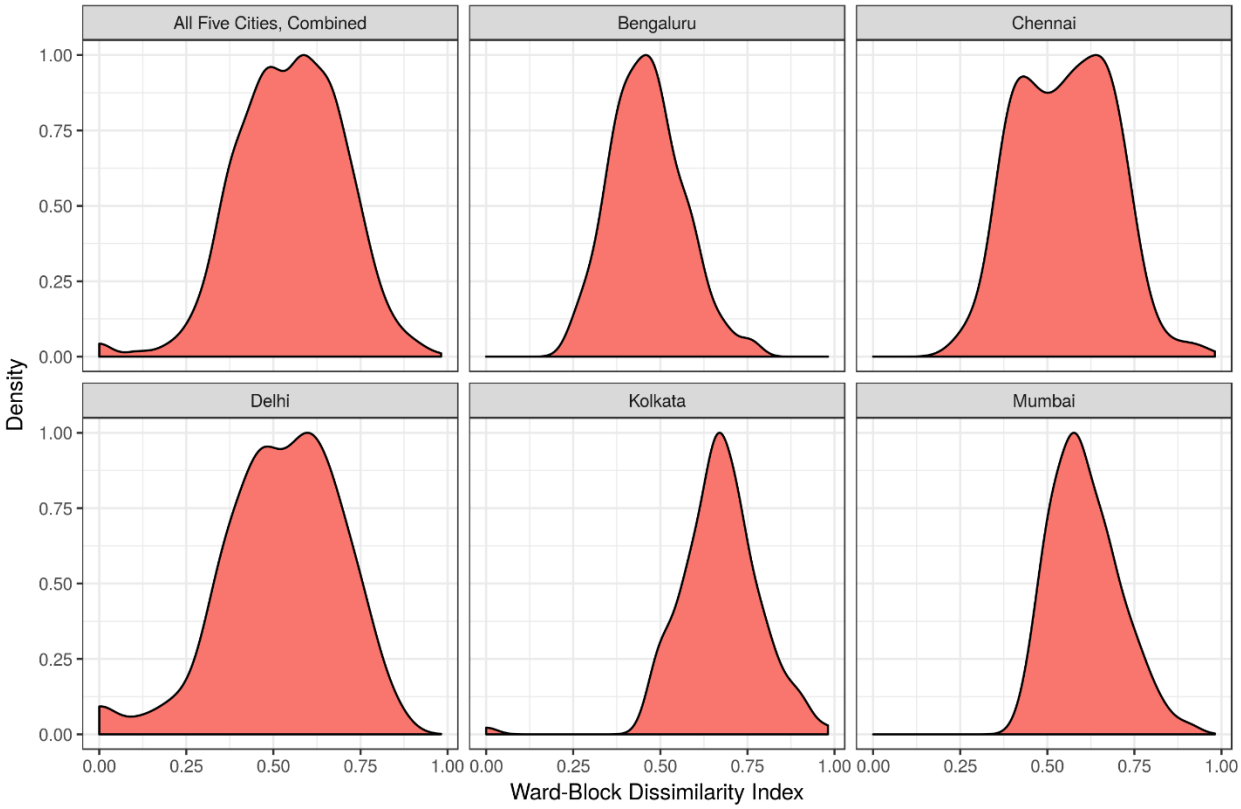


Figure 6: Kernal density plots of ward-block dissimilartiy index

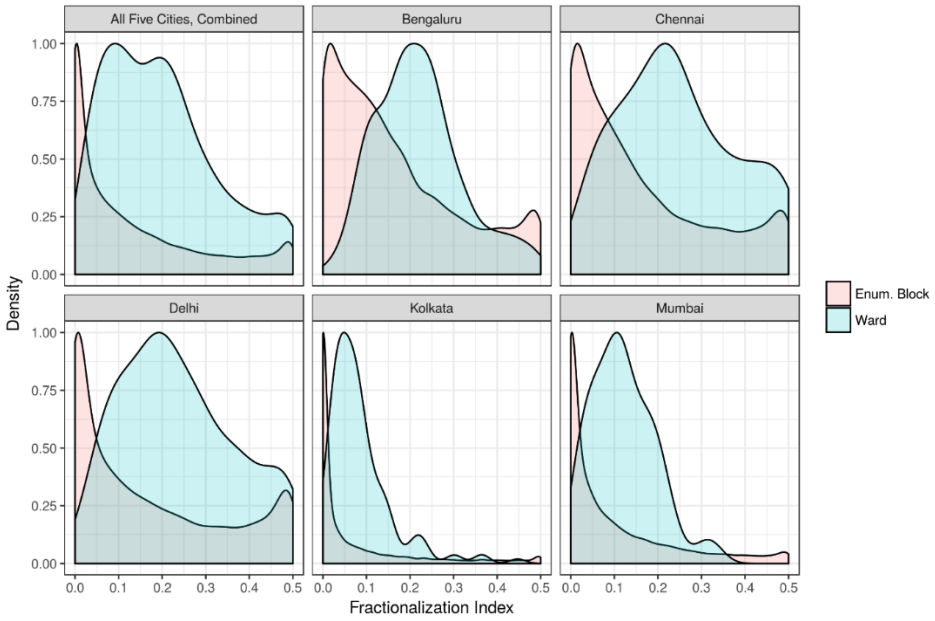


Figure 7 Ward diversity and Block Homegeneity

4. Visualizing Quantitative Segregation Results: The Case of Bengaluru

We illustrate the quantitative results from the section spatially using Bengaluru as our case study. Considered as the IT hub of India, Bengaluru (also known as Bangalore) is a great example of changes which economic liberalisation can bring about in the form and fabric of a city. In 2011 the number of foreign investment projects in the city was eighth highest in the world (Fingar, 2013). Bengaluru was founded in the 1537 by Kempegowda, a local chieftain. At the time of Kempegowda, the city was divided into several *petes* – each one for different trades and profession – which was similar to any other traditional Indian city. Nagarthpete was for textile and gold traders, Ganigarapete was for *Ganigas* – the oil pressing caste, Cubbonpete- was for people of the Devanga community who were the weavers of traditional silk sarees, Kumbarapete for potters, Upparapete was for the members of the *Uppara* caste, Thigalarapete was for *Thigalas* and so on (Nair, 2005). After the British captured the city in 1791, the documents show that the city was divided and organised along caste lines (Buchanan 1807).

When the British settled in Bengaluru, they chose not to have any connections with the existing city and started a new military settlement – Cantonment in 1809 far from the existing settlement. The population of the Cantonment mainly consisted of Europeans and Tamil speakers who were part of the Madras regiment. It took more than a century for these two different cities to merge. Even today, the difference between these two parts of the city is quite felt in terms of culture, language and landscape.

During World War II and after independence various public-sector industries were started in Bengaluru that resulted in migration from other parts of India. Noel Gist (1958) in his study of Bengaluru notes that there were some neighbourhoods in the city where a large number of families belonging to depressed classes (Scheduled Castes) lived. He also notes that areas of highest occupancy by depressed castes were on or near the city's outskirts. Members of Brahmin caste showed similar tendencies of segregated residence. Brahmins were concentrated in the

western part of the city. The areas occupied heavily by Brahmins and other high caste Hindus were attractive residential districts, among the most sought after as the city grew. Muslims were highly segregated and lived in highly congested neighbourhoods. Majority of the Christians lived in Cantonment, and among them Anglo-Indians lived separately. (Gist, 1957) concludes that spatial isolation of various communities reflected their social isolation, too.

Economic liberalisation brought about profound changes in the economy of the city. During the 1990s, Bengaluru was a preferred location for many Information technology (IT) related industries and Bengaluru emerged as a globally integrated centre of high-technology research and production (Dittrich 2007). This boom in economy created enormous employment opportunities and allied service sector grew at a faster pace. As a result, Bengaluru became one of the fastest growing cities in India in terms of population and geographical area. Bengaluru urban district's population grew at a whopping rate of 46.68 per cent over the past decade (2001-2011) as compared to 7.65 per cent growth of Chennai and 4.2 per cent growth rate of Mumbai (Bose 2013). This has changed the demography and geography of the city. The socio-cultural dynamics and the urban settlement patterns have had a momentous change (Dittrich 2007).

We use EB level maps of Census 2011 to study the intra-ward level residential segregation in Bengaluru. Figure 8 illustrates the spatial variation of SC-ST population in Bengaluru. As we can notice, there are many neighborhoods (EBs) with no SC-ST population and neighborhoods with substantial SC-ST population denoting high segregation. This is pattern is same across older neighborhoods and the localities which were developed in the post-globalization era. Figure 9 zooms in on a particular portion of Figure-8 to better illustrate intra-ward variation in SC+ST populations. The map shows that there is no considerable difference between old neighborhoods and the new neighborhoods which developed in the globalized era. Globalization has benefitted very few communities (Upadhya & Vasavi, 2012), and this is very much evident in the spatial organization around the epicenter of software boom in Electronic city.

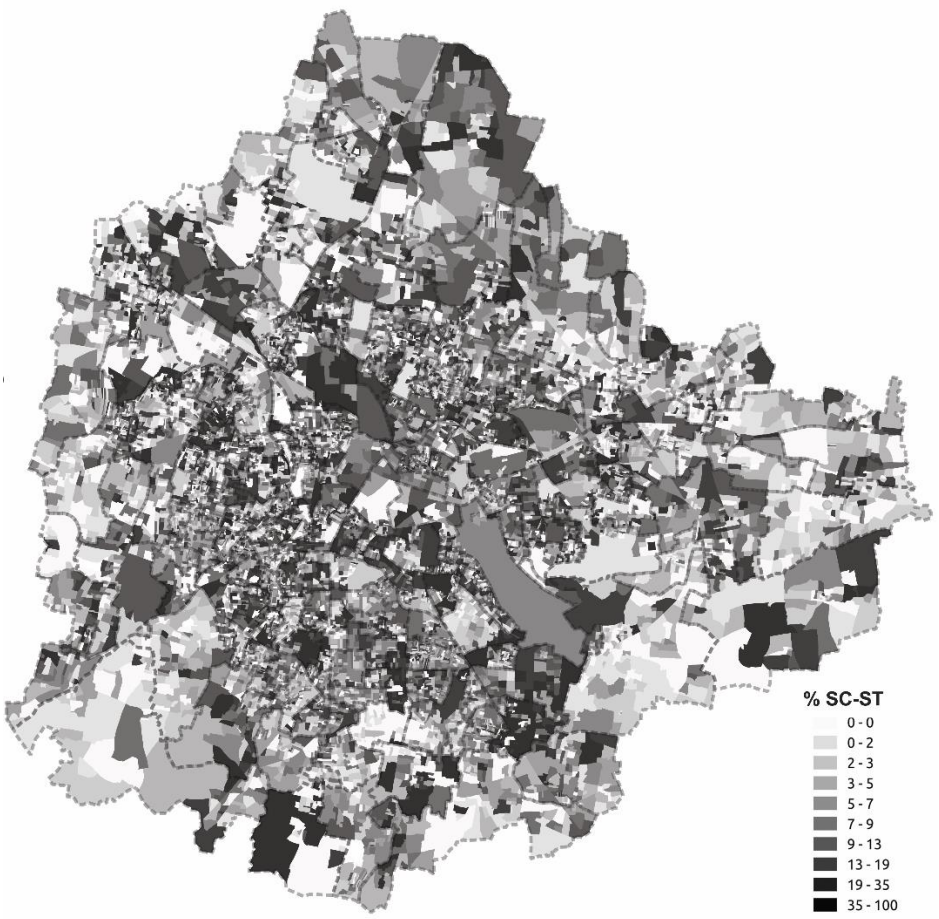


Figure 8 Bengaluru enumeration block level SC+ST population variation. The population numbers, ward boundaries, and block boundaries are all from Census of India (2011). Ward boundaries in dotted. Also cf. Figure-11

Figure 9: Variation of SC+ST population within wards in Bengaluru. This figure zooms in on a particular portion of Figure-10 to better illustrate intra-ward variation in SC+ST populations. As we can notice, within a ward, there can be blocks with no SC+ST population and blocks with substantial SC+ST population. This illustrates how neighborhoods within ward are highly segregated and studies on segregation at ward level amounts to neglect of a significant portion of segregation in a city.

5. Conclusion

We presented the first ever neighbourhood-scale segregation patterns in India's major urban centres, and in the case of Bengaluru, the first visual map of neighbourhood-scale segregation of space by caste. Our analysis provides the first ever systematic neighborhood-scale evidence for urban segregation in India – in a discourse dominated by anecdotal accounts of ethnic space making in urban India. Our analysis immediately point to severe data limitations that has constrained scholarship, policy, and praxis surrounding urbanization. The results of this paper make a strong case for future census data to be released at a geo-tagged enumeration block resolution. The project team collectively spent over 90 fulltime person days to digitize and geo-reference block level data – effectively replicating digital data that the Census of India does not make public. If an analog version is made public, there is no reason why a digital version should not also be made public. Currently, the Census of India releases enumeration block level data for only basic population numbers that does not permit characterizing segregation based on other socio-economic axes or characterize the uneven availability of public goods in different neighbourhoods. By developing a visual portrait of segregation for Bengaluru, this paper has demonstrated that enumeration block data must become the bedrock for any policy and praxis focused on building inclusive urban spaces.

While our analysis provides the most detailed portrait to date of spatial segregation in urban India, our snapshot provides little insights into the causal pathways that can explain the linkages between urbanization and ethnic space making. For example, how has globalization shaped urban space making in contemporary India? While, we can speculate on the connections between globalization and segregation using the visual portrait from Bengaluru – arguably, India's most global city – cross-section data used in this paper cannot provide definitive answers. Another significant limitation of the portrait we have presented here, beyond the lack of longitudinal data, is that we have not been able to control for non-ethnic characteristics of the neighborhoods. For example, we do not know if the pattern of social segregation of space that we have presented here holds across economic classes since enumeration block level data on neighborhood amenities such as education is not available in public domain. Data limitations also prevent us from studying residential segregation along religious lines.

Data limitations notwithstanding, our results pose a significant challenge to one of the bedrock normative promises of urbanization in India – the dilution of caste boundaries Indian cities (at least the cities presented in the paper, and there is no reason to believe the results will be very different in other urban centres) remain highly segregated along caste lines. Thus, studying patterns of urban segregation offers an important window to understanding the robust perseverance of caste structures in contemporary India.

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[1] Appendix 1, Table A-12 of the Census Abstract, 2011.

[2] The Census of India does not make available digital files for census enumeration blocks. *Cf.* concluding section of this paper for our arguments about why future census operations must make geo-coded enumeration block data available in digital format.

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