Journal of New Frontiers in Spatial Concepts
KIT Scientific Publishing

ISSN 1868-6648 | Volume 4(2012), 53-59
http://ejournal.uvka.de/spatialconcepts/archives/1536

The spatial specificities of SC and ST population in Kolkata city: approaches, techniques and analysis

Swasti Vardhan Mishra
Indic Knowledge Operations network, E-Mail: swastivardhanmishra@gmail.com

Abstract
The paper aims at achieving two objectives, firstly, to acquaint the researchers in the field of spatial demography with the techniques of residential segregation; pattern of population distribution based on the concept of spatial statistics and secondly, the practical evaluation of the techniques through real life data. The study queries about any residential segregation and pattern of location of the scheduled caste (SC) and the scheduled tribe (ST) population in Kolkata city by concentrating on the measures of Entropy Index (EI), Atkinson's Index, Absolute Centralization Index (ACE) and the Global and Local Spatial Autocorrelation (SA) measures of Moran's I and LISA. The outcome of the study clarifies the fact that caste and race based segregation is being diluted in the wake of Indian urbanization and the spatial clustering tendency of the Concerned Social Group (CSG) is as mild.

Keywords: Residential Segregation, Spatial Autocorrelation, Scheduled Caste, Scheduled Tribe

Manuscript recieved 23 April 2012, revised 25 April 2012, accepted 04 June 2012.

INTRODUCTION

Spatial Demography[1] has gained a recent prominence among the spatial scientists trained in the disciplines of Geography, Economics, Sociology and Demography. Since the last few decades availability of micro data based on individual behavior (for example worldwide Demographic and Health surveys)[2] has somewhat aloof the discipline of Spatial Demography as the individual centric information had nothing to be evaluated,[3] on average and based on spatial implication. The recent vigour for the discipline has again delved life into the same, bringing in more sophisticated and error free spatial statistics. Anthropocentric data has always been spatially integrated, where space is not a variable to be excluded,[4] intentionally, from description, analysis and evaluation. A second point of research-oriented discontentment is with the *Genre of Research*. Recent demographic research is intensively focused on Reproductive Health, Maternal and Child health and Ageing with a hairline slot for population distribution and their pattern. Population Distribution Techniques (PDT) are the most powerful tool, which help largely in generalization and policy framing for specific group of spatial units.

Health data, in a broader class, is spatially integrated and do have spatial underpinnings. PDT helps not only in recognizing any specific pattern of

1 John R. Weeks, Population: An Introduction to Concepts and Issues, California 2008.

2 John R. Weeks, The Role of Spatial Analysis in Demographic Research, in: Michael F. Goodchild/Donald G. Janelle (Ed.), Spatially Integrated Social Science, New York 2004, 381-399.

3 Paul R. Voss/Katherine J. Curtis White/Roger B. Hammer, The (Re-) Emergence of Spatial Demography, in: Working Paper 4. 2004, 1-4.

4 Guy Stuart, Research and Publications: Harvard Kennedy School, *Harvard Kennedy School,* 2004.

distribution but also in chalking out much needed strategic plan.

Residential segregation is a common term applied for clustering of a minority social group in contiguous neighborhoods; for instance, if a minority population of a city is clustered in particular municipal wards, which are spatially contiguous in nature, Residential segregation is said to be existing. Residential segregation and its related concepts like Ghetto, hypersegregation, etc have their roots in Urban Sociology and Urban Ecology domains. It is a theme of much interest among Sociologist, Urban Geographers, Economists and Spatial Demographers.

The following literature zeroes in the distribution and pattern of location of scheduled caste and scheduled tribe population of Kolkata city.[5] At the initial level, two measures of Evenness and one measure of Centralization of Residential segregation have been attempted,[6] which is followed by evaluation of any pattern of distribution of above or below average (i.e., the city average) proportion of the Concerned Social Group (CSG). Massey and Denton (1988), through extensive literature survey and employing clustering technique demarcated five aspects of segregation: (a) Measure of Eveness: measures the differential distribution of CSG; (b) Measure of Exposure: measures the potential contact of CSG with other groups; (c) Measure of Concentration: measures the relative amount of physical space sharing among groups; (d) Measure of Centralization: accounts for the centripetal (towards CBD) or centrifugal (towards fringes) distribution of CSG; (e) Measure of Clustering: accounts for the intensity of disproportionate living of CSG in contiguous areas.

The pattern of distribution of CSG is evaluated on theoretical grounds of Spatial Autocorrelation (SA), employing Global and Local statistics, Moran's I and LISA,[7] respectively. Spatial autocorrelation exists when an observation of a variable is in spatial relation with other observations of the same variable. The observations must have spatial character and could be represented on space. For example, in the following study the variable is the Scheduled caste and the Scheduled tribe population (CSG) and the observations are the Average Deviate Value (ADV)[8] of CSG located on space i.e., in different municipal wards of the city. Now, CSG being the variable, if the High ADV lies contiguously to the High ADV or the Low ADV lies in contiguity to Low ADV then positive spatial autocorrelation exists (fig. 1 (a) and 1 (b)). On the other hand, if Low ADV lies in contiguity to the High ADV negative spatial autocorrelation exists (fig. 1 (c)).

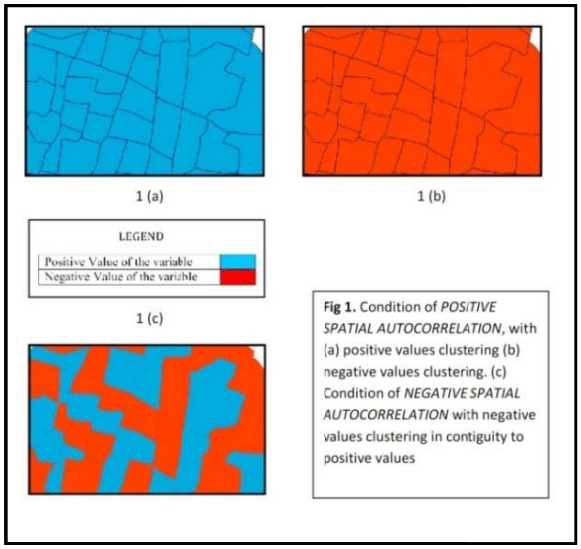

Figure 1. Identifying Positive and Negative Spatial Autocorrelation

Spatial Autocorrelation can be further classified, based on the desired outcome, into Global and Local statistics – when a single value is produced to denote the level of spatial autocorrelation, it is called a Global measure (Moran's I) and when a set of outcomes are produced (generally, in the form of cluster map and significance map), we call it a Local measure. Local measures are the decomposed form of Global measure, which goes beyond the average value (Moran's I) to highlight the individual clusters of Hot spots, i.e., the individual unit's contribution towards the average value.

Local Indicators of Spatial Association (LISA) being a decomposed form of the Global measure is easily represented on maps and helps in drawing value differences with respect to the average value of the Global measure.

[5] Veronique Dupont, Socio-spatial differentiation and residential segregation in Delhi: a question of scale?, in: Geoforum 35. 2004, 157-175.

[6] Douglas S. Massey/Nancy A. Denton, The Dimensions of Residential Segregation, in: Social Forces 67. 1988, 281-315.

[7] Luc Anselin, Local Indicators of Spatial Association- LISA, in: Geographical Analysis 27, no. 2. 1995, 93-115.

[8] Author has coined the term to show how much individual unit's specific value differs from that of the city average, which in other sense also helps in demarcating low and high ADV units.

	$EI = \sum_{i=1}^{141} \left[\frac{t_i(E-E_i)}{ET} \right]$
CONCEPT	**E = entropy score of the city** $E = P \log (1/P)$ E_i = entropy score of the municipal wards $E_i = p_i \log (1/p_i)$

Figure 2. Formula and related concept of Entropy Index.

	$ACE = \sum_{i=1}^{141} (C_{(i-1)} K_i) - \sum_{i=1}^{141} (C_i K_{(i-1)})$
CONCEPT	This measure is based on the cumulative value of proportion of area and cumulative value of proportion of CSG population. It has been calculated separately for SC and ST population.

Figure 3. Formula and related concept of Absolute Centralization Index.

Following paragraphs are divided into data and methodology part, description part and concluding views.

	$ATKINSON'S\ INDEX = 1-\left(\frac{P}{1-P}\right)\left[\sum_{i=1}^{141}\left[\frac{(1-p_i)^{1-b} p_i^{b} t_i}{X}\right]\right]^{\frac{1}{1-b}}$
CONCEPT	The shape parameter is a normative concept. More the lower distribution contributes (here wards having BA distribution) the value is below 0.5 and more the upper distribution contributes (here wards having AA distribution) the value is above 0.5. Value 0.5 denotes equal contribution of AA and BA distribution b= 0.40/0.30/0.20/0.10

Figure 4. Formula and related concept of tkinson's Index.

DATA AND METHODOLOGY

The data has been obtained from the Office of the Census Commissioner of India pertaining to census 2001. The spatial data i.e., the area and distance from the CBD is calculated with the help of a GIS application. The methodology applied in arriving at conclusions is facile and available through any length of segregation literature.

The formula for three measures of Residential segregation is structured in figure 2, 3,4 & 5.[9] [10] [11]

In calculating ACE, the distance of the respective wards from CBD is calculated as a distance of centroid of different wards from the centroid of the CBD ward. This technique of estimation is not error free but it is surely the best possible alternative for the same. In the previously mentioned measure, the wards are arranged according to their distance from the CBD before calculating the cumulative of proportion of CSG population and area. The main motive behind including two measures of Eveness (Entropy Index and Atkinson's Index) is the curiosity to dig out any possible differences when both the CSG are combined to measure (EI) and when both of them are independently evaluated for segregation (Atkinson's Index).

Spatial Autocorrelation measures have been performed through open source spatial statistics software *GeoDa*[12] published for the same purpose by Luc Anselin (Arizona State University's GeoDa center).[13] It is not feasible to illustrate both the measures in detail for the lack of space and their vast availability across the online domain. The value of Moran's I ranges between -1 to 1, where 0 signifies no association, -1 signifies severe negative spatial autocorrelation and 1 signifies very strong positive spatial autocorrelation.

In the following study, SA is framed for analyzing the pattern of distribution of those municipal wards where the proportion of SC and ST population is better or worse than the city average. The Average Deviate Value wards are identified with the help of a simple formula:

$$ADV = \frac{p_i}{P}$$

The value over 1 connotes a situation of CSG proportion in the respective ward above the city average (High ADV), value of 1 denotes equal proportion and value below 1 signifies comparatively lower CSG proportion (Low ADV).

[9] Jacob S. Seigel/David A. Swanson, The Methods and Materials of Demography, London 2004.

[10] Sean F. Reardon/David O'Sullivan, Measures of Spatial Segregation, in: Sociological Methodology 34, no. 1. 2004, 121-162.

[11] Leah Platt Bouston, Residential Segregation in American cities, in: Nancy Brooks/Kiran Donaghy/Gerrit Jan Knaap (Ed.), The Oxford Handbook of Urban Economics and Planning, New York 2011, 318-339.

[12] http://geodacenter.asu.edu/software/downloads.

[13] Luc Anselin, Review of Cluster Analysis Software, North American Association of Central Cancer Registries 2004.

KEYS TO THE FORMULAE
t_i = total population of the municipal wards
x_i = CSG population of the municipal wards
p_i = ratio of x_i to t_i
a_i = area of the municipal ward
T = total population of the city
X = CSG population of the city
P = ratio of X to T
A = area of the city (sum of all a_i)
b = shape parameter
C = cumulative ratio of x_i to X
K = cumulative ratio of a_i to A

Figure 5. Keys to the Residential Segregation formulae.

Each measure of Moran's I and Lisa is accompanied with a scatterplot, LISA cluster map and significance map, where the significance is kept at α= 0.05 level.[14] Besides, a multivariate analysis is attempted between SC and ST population. The SA measure between the two identifies any spatial conformity i.e.,[15] possibility of high proportion of SC population lying at the same spatial unit as high proportion of ST population or vice versa. The cluster maps also display Spatial Outliers (SO), symbolizing a pattern common to Negative Autocorrelation. A spatial unit of a certain value lying in the vicinity of spatial units, having value opposite to it, is a spatial outlier.

The interpretation will be presented through a well-structured format, in which individual measure is explained first followed by a combined interpretation taking into view all the measures.

DISCUSSION

Even distribution of a population subgroup across spatial units is a normative consideration. The two measures of evenness i.e., Entropy Index and Atkinson's Index have been attempted to emphasize that the significance of caste has decreased with Indian urbanization.[16] With this idea of caste, tribes can be roughly merged without ambiguity. The following generalization has not been sought after through a comprehensive and exhaustive time series model, nevertheless, the present study do stress upon the same. Entropy Index, calculated for CSG as a whole, shows a slight deviation from the situation of absolute even distribution with a value of 0.195. SC and ST groups have roughly equal distribution across all the municipal wards of Kolkata city, implying a situation of no segregation in relative terms. The evenness quotient for both the CSG, calculated separately, is more intriguing. Atkinson's Index is performed with four shape parameters[17] [18], highlighting the normative component of the measure and its judicious use.

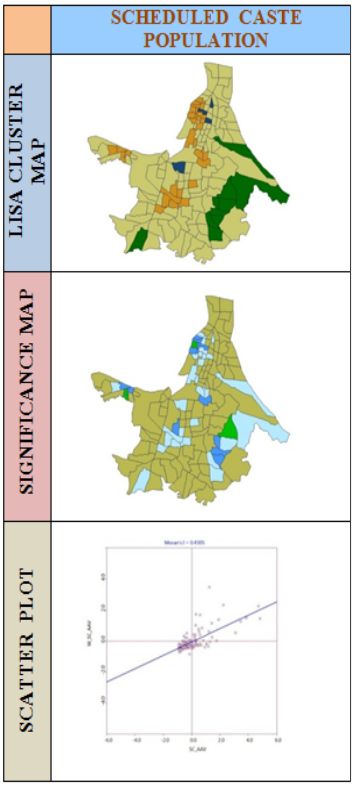

Figure 6. LISA Cluster Map, Significance Map and Scatter Plot for **Scheduled Caste** Population

[14] Peter A. Rogerson, Statistical Methods for Geography: A Student's Guide, New Delhi 2001.

[15] Rick Grannis, Segregation Indices and their Functional Inputs, in: Sociological Methodology 32, no. 1. 2002, 69-84. The author talked of spatial proximity to justify location of minority units with respect to majority units, but in this paper the two CSG are two kind of minority social and cultural group.

[16] Chandra Bhan Prasad, New order, in: Himal Southasian April. 2010.

[17] John Iceland/Daniel H. Weinberg/Erika Steinmetz, Racial and Ethnic Residential Segregation in the United States: 1980-2000, Washington 2002.

[18] Holger Schlor/Wolfgang Fischer/Jurgen-Friedrich Hake, Social Welfare, Income, Consumption, Energy, and the Inequality Aversion of society – A case study from Germany, in: Nicholas Tsounis (Ed.), International Conference on Applied Economics, Perugia 2011, 567-577.

The value of *b* is kept between 0.4 and 0.1 (below 0.5) as the no. of wards having above city average CSG population is less; 42 for SC and 48 for ST population. The value for the index increases as the shape parameter value goes down, the only exception being the SC population as the shape parameter is tuned from 0.2 to 0.1.

The Atkinson's Index for ST population increases from 0.025 to 0.90 to 0.25 to 0.53, accentuating the point that as the influence of wards having Below Average CSG population is inflated (by reducing the value of b), the index increases. The values for SC population, at the previously mentioned level of *b* are 0.005, 0.007, 0.008 and 0.006. Following from the values at hand, it can be interpreted that in spite of maximum credibility given to BA wards (*b*=0. 1), the Index value does not show a noticeable mark. There exists close to zero segregation for both CSG, however ST population does show a feeble natured segregation (unevenness).

In Human Geography, concepts of urban fringe, spatial distance and demographic gravitation is overwhelmingly followed, which are of fundamental importance for the exposition of Residential segregation in general and measure of centralization in particular. Absolute Centralization Index (ACE) is a measure of intensity of CSG to live away from or close to the central core of the city (CBD). The measure considers the distance from the CBD and the proportion of total area for each ward. From the study it is found that the SC population tends to live evenly throughout the cityscape, with a value of 0.028. This group does not seem to be spatially marginalized or spatially dear, for its value lies close to zero. The ST population of the city illumines its peripheral location with an ACE value at -0.597. The value is seriously considerable for detecting the probable causes of such a spatially marginal character of the CSG. Innumerable literature on the condition of tribes in India along a long span of time has highlighted their marginal nature; their location in the peripheral and hostile terrain. Drawing from the same notion, it can be deduced that the marginal character of ST population in Kolkata is attributable to their failure in merging themselves with the mainstream population.

Contrary to this well-grounded view, is the view of counterurbanisation, which asserts relocation of population from urban core to fringe; for straying from the grime and congestion of the city. Kolkata city has certainly a ring of posh localities around its urban core like Jadavpur, Kankurgachi, Phoolbagan, Jodhpur Park and others, which work as *Relief Magnets*;[19] to stay away from the city chaos. It is imperative to take a field visit and get accurate justification for such a level of segregation. The lack of resource and time prevented me from taking this effort, which prompts one of the most severe drawbacks of a research; nevertheless, the possibility for such an initiative will be binding on me.

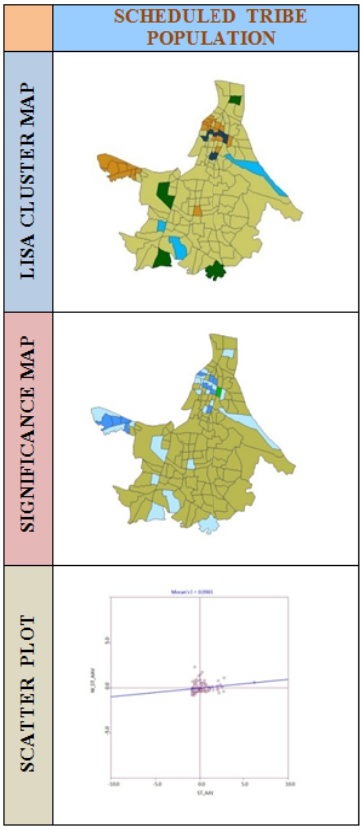

Figure 7. Showing the LISA Cluster Map, Significance Map and Scatter Plot for **Scheduled Tribe** Population

Tobler's First law of Geography is at the core of Spatial Autocorrelation statistics.[20] The law divulges that "everything is related to everything else, but near things are more related than distant things".[21]

[19] Author has coined the term, keeping in mind the local perspective.

[20] Harvey J. Miller, Tobler's First Law and Spatial Analysis, in: Annals of the Association of American Geographers 94, no. 2. 2004, 284–289.

[21] W. Tobler, A computer movie simulating urban growth in the Detroit region, in: Economic Geography 46, no. 2. 1970, 234-240.

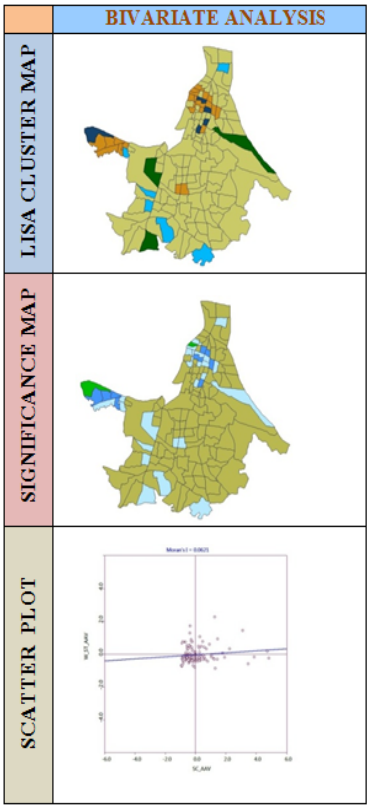

Figure 8. Showing the LISA Cluster Map, Significance Map and Scatter Plot for **Bivariate Analysis** between Scheduled Caste and Scheduled Tribe Population

Spatial Autocorrelation, Global and Local, has been performed for the proportion of CSG in every ward, above or below the city proportion.

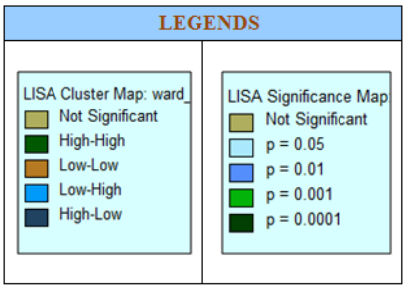

Figure 9. Showing the Legends for interpreting LISA Cluster map and LISA Significance map.

The LISA cluster map, significant map and Moran's I, shows an engrossing view of spatial association. It is more marked for the SC population; being testified by the value of Moran's I (0.4305 for SC population and 0.0965 for ST population). The significance of these associations, obviously, is well pronounced for SC population with 3 units showing significance at α= 0.001 level, which in the case of ST population is a single unit.

Spatial autocorrelation is more numerous for low ADV units (low value lying in contiguity to low) in contrast to the units with high ADV. For SC population an extensive cluster of high value spatial autocorrelation is observed in the eastern fringe of the city, otherwise the pattern of high values, in both the cases, is dispersed. In contrast, units with low value present a more clustered association in both the cases. The spatial outliers or negative autocorrelation is also found to be present for both the CSG, where units of high values residing in proximity to low values is a common feature but low values lying in contiguity to higher values is a distinctive feature of the ST population.

The bivariate association between the SC and ST population is more weaker with a value of Moran's I= 0.0621, implying a weaker correlation between the location of SC and ST population and here also high value units are meager in contrast to low value units and units with negative spatial autocorrelation. The association in any of the cases is not strong enough to conform to the view of Tobler. Presence of outnumbered non-significant units show the discontinuity of any spatial conformity, a weaker demographic gravitation within a group and possibility of any economic, other social and psychological motives behind the location of CSG.

CONCLUSION

Residential segregation, a universal phenomenon, is a massive concern when it is in tune with low-income social group. The milieu of such groups influences and get influenced so immense, as to create chaos in city governance. Handling of Residential Segregation, embedded in social structure, must be the prerogatives of the Local governance and should be maneuvered gently and through efficient Urban Planning.

Population of Kolkata city has decreased for the first time in census history from 4.57 million to 4.48 million,[22] which creates an opportunity for more comprehensive study. The scope of the study will look for any specification in the explosion of population outwards and how strong it is reflected in its segregation scenario.

[22] Census Commisioner of India, Provisional Population Totals Paper 1 of 2011: West Bengal, Office of the Registrar General and Census Commissioner of India 2011.

It is desired that the present study has influenced the thought process of researchers and motivated them to delve deeper into the domain of population distribution. The concept of local measures of segregation in addition to complex measures of other aspects of Residential segregation, are the field of much interest and should be explored.

The measure of Spatial Auocorrelation, having a wider range of application, is a successfully trod path in spatial science. This technique can be successfully applied to concepts of Health Demography in spatial context. Recent research and development in the same has brought sophistication and chances of immense possibilities.

Social research must internalize the dimension of space and should adhere to its rightful application at the time of investigation and analysis.