RESIDENTIAL SEGREGATION IN BOGOTÁ ACROSS TIME AND SCALES

LISSETTE ALIAGA-LINARES
MARÍA JOSÉ ÁLVAREZ-RIVADULLA[1]

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ABSTRACT:

This project aims at describing socioeconomic residential segregation in Bogotá over time for different spatial scales, comparing spatial and non spatial measurements. Its goals are twofold since it attempts to be both a substantial and a methodological contribution to the study of segregation in this city. Using census and cartography data from 1980s to the present we a) track changes over time, b) compare segregation at different scales (e.g. "localidad", neighborhood, etc.) c) compare spatial and non-spatial segregation indexes, d) identify "hot spots" or very homogeneous areas of the city, e) suggest hypothesis about the processes behind the spatial clustering of population and the changes in that clustering. This is the first draft of an ongoing research project. Results are, therefore, preliminary.

About the Authors

Lissette Aliaga-Linares is a Peruvian sociologist graduated from the Universidad Nacional de San Marcos, Lima (2001). As a Ph.D. Candidate from the Department of Sociology at the University of Texas at Austin, she holds a specialization in demography targeting urbanization and migration areas of research. Aliaga-Linares is a trainee at the UT-Population Research Center and has participated in various Latin American comparative research projects. Her main research focus has been the informal economy, topic that she studies combining qualitative methods with spatial and non-spatial statistical techniques.
Contact information: *Population Research Center, 1800 Main Building, 1st University Station, University of Texas at Austin, Austin TX 78712; phone: 512-471-5514; lissette@prc.utexas.edu*

María José Álvarez-Rivadulla is a Professor of Sociology at the Faculty of Human Sciences, Universidad del Rosario in Bogotá, Colombia. She got her Ph.D. in Sociology at the University of Pittsburgh (2009). Her dissertation was about the cycle of land squatting in Montevideo, Uruguay. She has been an active member of GESU, a Latin American network for the study of residential segregation and neighborhood effects. She is interested in the study of inequalities, especially urban ones, social movements, and research methods.
Contact information: *Escuela de Ciencias Humanas, , Universidad del Rosario; Carrera 6A No. 14-13 Oficina 505 Edificio Santa Fe Bogota, D.C. Colombia; Phone: 571-341-4006, ext 212 ; jose.alvarez72@urosario.edu.co*

INTRODUCTION

The study of residential segregation has relatively recently diffused from the US to Latin America. Theoretical and empirical studies have proliferated since the 1990s (Portes and Roberts 2006; Queiroz and Kaztman 2008; Rodriguez 2001; Rodríguez and Arriagada 2004; Sabatini, Cáceres and Cerda 2001). These studies have focused on socioeconomic segregation rather than on the ethnic categories more common in US studies. But like them, have tried to find the degree to which two or more groups live separately from one another, in different parts of the urban environment (Massey and Denton 1988: 282). Generally, they have found that the Latin American metropolis tends to be very segregated by income and other socioeconomic traits and, moreover, that this trend has increased with time. Besides, those studies that have jumped from describing segregation to using it as an independent variable to explain neighborhood effects, have found perverse effects of living in poorly endowed neighborhoods controlling for other factors such as family and school characteristics.

Since at least the 1950s, Bogotá has shown a pattern of north-south segregation with the richest populations living in its northern part and the poorest in the southern part. Although this might still hold true it remains an empirical question. Already in 1989, a study questions this north south monolithic divide finding pockets of poverty in the north and a middle class moving and expanding the city in its south-west direction (Portes 1989). A recent study, however, reaffirms the north-south class divide (Salas Venegas 2008).

Bogotá has changed enormously in the last part of the XX century. People currently in their seventies, who grew up in a city of approximately 200.000 people, today cope with a city of about 8.000.000 people. Unlike the trend in other major Latin American cities (Portes and Roberts 2006) Bogotá keeps growing. Most migrants come attracted by the opportunities of the big city, but a percentage of them come under no option since they are displaced by the violence in some parts of the countryside.

Bogotanos have not only witnessed a change in their city size, but a sharp change in the pattern of city governance. Since 1988 major are not appointed by the presidents as they were before, but elected. From a city planning based on market principles, Bogotá is today a city in which the state has taken back the planning and implemented model public projects admired elsewhere. The most famous of them is perhaps the *Transmilenio* project, a system of public buses that functions like a metro with bus only lanes and connects the city from north to south. A series of majors from the mid-nineties until today have emphasized public space, public transportation and social policies from the city government. Yet, this trend has been counteracted by others such as the policy of city stratification, formalized in 1994. This policy, implemented for all Colombian cities, aimed at subsidizing the poorest residents. By stratifying the prices of public services based on the built environment of the surrounding houses, the richest strata would pay

more and the poorest would pay less. This policy, however, has had unintended consequences that scholars have just recently started to explore (Uribe 2008). People have assimilated this administrative category as a social one that shapes residential preferences and might be causing segregating patterns.

A small but very interesting group of studies have started to explore Bogotá's segregation patterns. Dureau's (2007) compilation of urban studies in Colombia includes a study of Bogotá's segregation patterns from 1973 until 1993. Salas Venegas (2008) continues this tradition adding very interesting information and analysis about the housing market. Her census analysis also goes until 1993. Two other studies, based on data from the Survey of Quality of Life 2003-2004, analyze more recent trends (Bogotá . Secretaría Distrital de 2007; PNUD-IDH 2008; SDP 2007; Secretaría Distrital de 2007). Because of the representativeness of this survey, the smaller areal unit these two last studies are able to analyze is UPZ, an administrative territorial subdivision for zoning and urban planning purposes, much bigger than the neighborhood. Taking these four studies as antecedents, ours attempts to add in several ways: a) it expands the time span until the most recent census of 2005; b) it calculates spatial segregation indexes for the first time, and c) it compares segregation levels at four different scales: block, census track (similar to neighborhoods in Bogotá), UPZs and localities.

METHODOLOGY

We use 1985, 1993 and 2005 population censuses, the cartographic census data of 1996 and cadastral data for 1997 and 2007. Censuses were carried out by the *Departamento Administrativo Nacional de Estadística* (DANE, in Spanish acronyms) which is the National Institute of Statistics that produces official population estimates for Colombia since 1951. Census microdata have been digitalized since 1964, yet the last three censuses are the only ones that permit a comparable georeferenciation at local scales.

Interested in socioeconomic segregation, and constrained by the census questions, we selected two household based reference variables: level of education of the household head and whether or not a household is poor, which can be followed in the three available censuses.

Head of the household's education is a basic variable that we divide into 3 categories. The first one includes all head of household with no education or with an incomplete primary education. The second one includes those head of households who completed primary and have a complete or incomplete secondary education. The third category contains all those with some technical, college or university years of education.

The Poverty variable based on Unsatisfied Basic Needs (NBI, in Spanish acronyms) is an official approximation that relies on five aspects of poverty: access to housing, housing quality, access to basic services, economic capacity and access to education. To evaluate access to housing, living in a house with more than three members per room, qualifies for an unsatisfied need. Housing quality needs correspond to a house with inadequate construction materials. The lack of basic services such sewage and drinkable water account for a basic need too. A family in which the

head of household has just primary school, and which have an average of 3 dependents also qualifies as poor. The non-attendance to school of a 6 to 12 years-old child is considered a need in terms of the access to education. A household that have at least 1 basic need unsatisfied is considered poor under this approach. More than 2 unsatisfied needs represent a case of extreme poverty. These indicators are available for each census year. However, for 2005, the aspect of housing quality and access to housing cannot be measured, because those indicators were incorporated in a sample that is not representative at the local/neighborhood level. Our poverty definition, thus, will contain this limitation for that last census period.

For 2005, we also considered some measures of social vulnerability or exclusion in order to explore their association with levels of segregation. We therefore looked at unemployment, youngsters 16-24 years-old that do not study or work, women between 12 to 17 that are mothers or pregnant, and adolescents 12-16 that do not attend school. All selected indicators were calculated for the block level, which enabled different subsequent aggregations.

Besides the census, we used cadastral data to explore segregation by the official division of population in six *strata* for the payment of urban services. In order to calculate the number of household per strata, we relied on the official stratification shapefiles which contain the number of residential lots per strata at the block level in 1997 and 2007. Based on the ratio of households per house of censuses, we computed the number of households per strata living in a specific block. Since precise data on population at the block level is not available for 1997 we calculated the household population based on three projections: a mean year approach based on intercensal period rates, a mean-year approach based on household survey projections and a mean year approach of block level estimated intercensal growth rates. We calculated average population for year 1997 and used a bayes correction of the total count of households for that year.

For georeferenciation purposes, we use 1996 census cartography. Unfortunately, 2005 census cartography is not available[2]. Then, some data attrition may occur particularly for newly expanded areas within peripheral localities such Usme, Ciudad Bolívar and Bosa.

After georeferencing the information, the base population for our analysis in 1985 was 800.339 households; in 1993, 1.236.300; and in 2005 1.622.630 (compared to 927.644[3], 1.255.108, 1.931.372 officially reported respectively).

We estimated segregation indices for two units: the neighborhood and the city level. Our definition of neighborhood is census neighborhoods (census tracks or *sectores*). There are 607 census track neighborhoods.

Based on classic references as well as on recent developments on segregation measurement (Duncan and Duncan 1955; Lee, Reardon, Firebaugh, Farrell, Matthews, and O' Sullivan 2008; Massey, White, and Phua 1996; Reardon, Matthews, O' Sullivan, Firebaugh, Farrell, and

[2] According to DANE officials 2005 census cartography is still under correction and not available to the public.

[3] For the 1985 census year, the number of households equates the number of houses.

Bischoff 2008; Wong 1993; Wong 1996; Wong 1997; Wong 1998; Wong 1999; Wong 2001; Wong 2002a; Wong 2002b; Wong 2003a; Wong 2003b; Wong 2004; Wong, Lasus, and Falk 1999) we calculated both spatial and non spatial segregation indexes. We explored two main dimensions of segregation: evenness and exposure. Table 1 below summarizes these selected measures and their formulas. We chose those measures that have been more used and validated empirically in the literature.

Table No. 1: Selected Segregation Indices

Dimension and Index	Formula	Notation
Dissimilarity *D*	$D = \frac{1}{2}\sum_{i=1}^{n}\left\lvert\frac{X_i}{X} - \frac{Y_i}{Y}\right\rvert$	x_i = minority population in the i^{th} zone x = total minority population y_i = majority population in the i^{th} zone y = total majority population
Multigroup Dissimilarity *D (m)*	$D_{(m)} = \frac{1}{2}\frac{\sum_i\sum_j\lvert N_{ij} - E_{ij}\rvert}{\sum_k NP_j(1-P_j)}$	$E_{ij} = \frac{N_i - N_j}{N}$ Nij: population count of the jth population group in areal unit i Ni: Total population an areal unit i Nj: Total population of group j in the entire study region N: total population in the entire region Pj: Proportion of population in group j
Spatial Multigroup Dissimilarity *SD(m)*	$SD_{(m)} = \frac{1}{2}\frac{\sum_i\sum_j\lvert CN_{ij} - CE_{ij}\rvert}{\sum_k CN * CP_j(1-CP_j)}$	$CN_{ij} = \sum_k d(N_{kj})$ d() : function defining the neighborhood of i $CE_{ij} = \frac{CN_i * CN_j}{CN}$
Multigroup Entropy Index *H (also known as information index)*	$H = \sum_{i=1}^{n}\left[\frac{t_i(E - E_i)}{ET}\right]$	$E = \sum_{m=1}^{M}\pi_m \ln\left(\frac{1}{\pi_m}\right)$ m= 1…M Number of groups j = 1…J Number of Organizational Units π_{jm} = proportion of group m in organizational unit j t_j = population in group j T = Total population
Multigroup Spatial Information Theory $\widetilde{H}$	$\widetilde{H} = 1 - \frac{1}{TE}\int_{p\in R}\tau_p \widetilde{E}_p\, dp$	$E = -\sum_{m-1}^{M}(\pi_m)\log_M(\pi_m)$ τ_p : population density at point p π_m : proportion in group m of total population T : Total population in R
Interaction Index *P*	${}_xP^*{}_y = \sum_{i=1}^{n}[x_i / X]\times[y_i / t_i]$	x_i : numbers of X members y_i : numbers of Y members t_i : the total population of unit i, X: the number of X members within the entire study area.
Spatial Interaction Index ${}_m\widetilde{P}_n^*$	${}_m\widetilde{P}_n^* = \int_{q\in R}\frac{\tau_{qm}}{T_m}\widetilde{\pi}_{qn}\, dq$	τ_{qm} : population density of group m at point q T_m = Total population in m $\widetilde{\pi}_{qn}$: proportion in group n in total environment of point q
Isolation Index	$\sum_{i=1}^{n}[x_i / X]\times[x_i / t_i]$	x_i : numbers of X members t_i : the total population of unit i, X: the number of X members within the entire study area.
Spatial Isolation Index ${}_m\widetilde{P}_m^*$	${}_m\widetilde{P}_m^* = \int_{q\in R}\frac{\tau_{qm}}{T_m}\widetilde{\pi}_{qm}\, dq$	τ_{qm} : population density of group m at point q T_m = Total population in m $\widetilde{\pi}_{qm}$: proportion in group m in total environment of point q

For the evenness dimension, we calculated the D dissimilarity index which is the most widely used in the segregation literature. Depending on the variable, we used the simple version and the multigroup version. While successful in overcoming what the literature has dubbed the "checkerboard problem" there is evidence that the D index is affected by changes in scale (Wong 2004). Yet, its interpretation is so clear (the percentage of the population that would have to transfer their residency across units to equalize the group proportions in the territory) that it is still very attractive. The spatial version controls for spatial proximity and has the same interpretation.

We also used the aspatial and spatial versions of the H entropy index, which has been validated as one of the most consistent segregation measures of evenness (Reardon and Firebaugh 2004; Reardon and O' Sullivan 2004; Reardon et al. 2008). The entropy index refers to the diversity of a specific area. It is interpreted as the difference between the diversity (entropy) of the system and the weighted average diversity of individual units, expressed as a fraction of the total diversity of the system. It is also documented that the spatial version of this index is sensitive to changes in scale (Reardon et al. 2008).

For the exposure dimension, we used the interaction and isolation indexes and their spatial versions. They are conceptually two-group residential measures, and operationally, each reference group can be compared based on pair-wise permutations or one to all comparisons. Interaction refers to the probability that a person from one reference group can interact with a person from another group. Conversely, isolation is interpreted as the probability that a person will interact with his/her same reference group.

We performed a descriptive analysis of the segregation patterns using different indexes and different scales, across years. Spatial computations were possible thanks to the SpatialSeg extension developed for ArcGIS by Steve Graham and David O'Sullivan.[4] We have also used GEODA for spatial autocorrelation measures such as LISA and Moran's I.

[4] See http://cairo.pop.psu.edu/mss/submit.cfm .

FIRST RESULTS

We started this research with four main hypotheses mainly based on research conducted elsewhere. We here restate these hypotheses and present some preliminary results on each.

H1: Socioeconomic residential segregation in Bogotá has decreased at the localidad (bigger aerial unit) level but increased at the neighborhood level (smaller aerial unit).

This is a trend documented for other Latin American cities but that has not been explored in Bogotá (Sabatini, Cáceres and Cerda 2001). The lower spatial units where segregation expresses itself relates to the malignity of segregation, since it tends to be related to harsh pockets of poverty similar to what the literature has called *underclass* in the US (Wilson 1990).

We measured segregation in Bogotá based on three different variables: *poverty*, measured as households with unmet basic needs; *education level of the household head*, which we divided in three levels: low or less than finished elementary school, medium or from finished elementary school to finished secondary education, and superior which meant having entered the university or other form of tertiary education; and, finally, the *official stratification* measure, which divides the population in six strata based on a classification of the urban quality of the block in which people live with the purpose of charging differently for urban services such as water, gas and light.

Using different segregation indexes, both spatial and non spatial ones, and different scales we got some interesting results. First, if we look at the residential segregation of poor households, focusing on the Spatial D index (D* on figure 1), we see relative stability in the moderate levels of residential segregation for all scales. Although segregation of poor households is greater at the smaller block or census track levels than at the bigger locality level, the increasing malignity hypothesis does not hold. Besides, levels of segregation are moderate (from 0.20 to 0.34 depending on the year and the scale). Besides, looking at the Interaction Indexes, we see that the chances of a poor household to live closer to a non poor household have increased in Bogotá at all scales. The big mixing jump seems to have happened in between 1985 and 1993.

Figure 1: Segregation of Poor Households in Bogotá (1985, 1993, 2005), Different Areal Units.

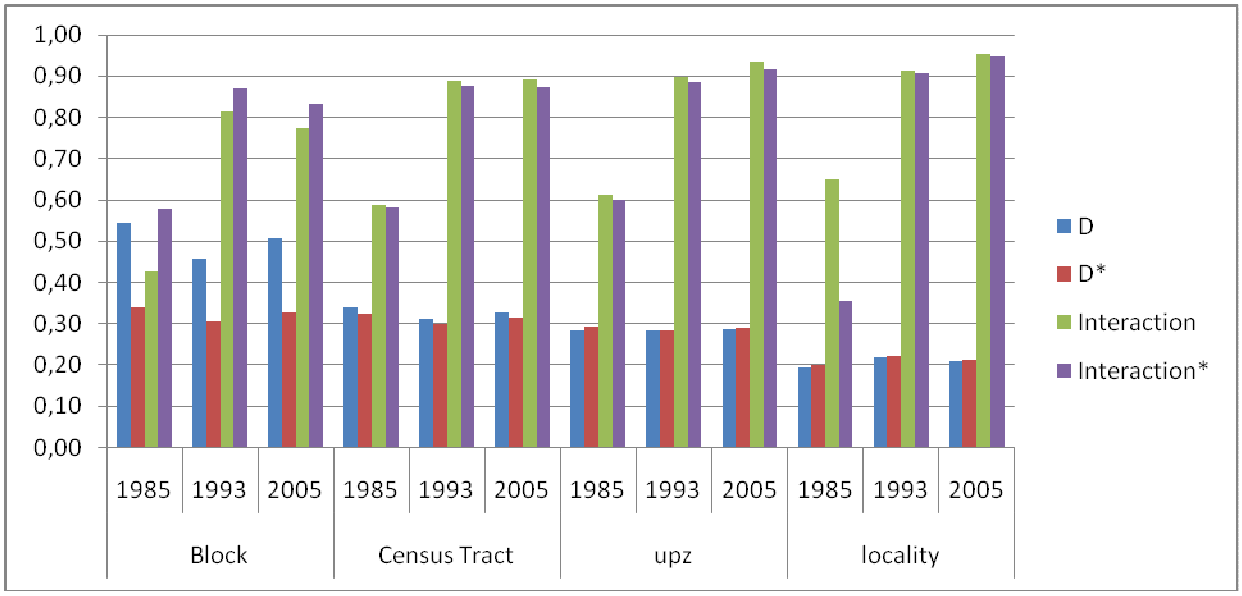
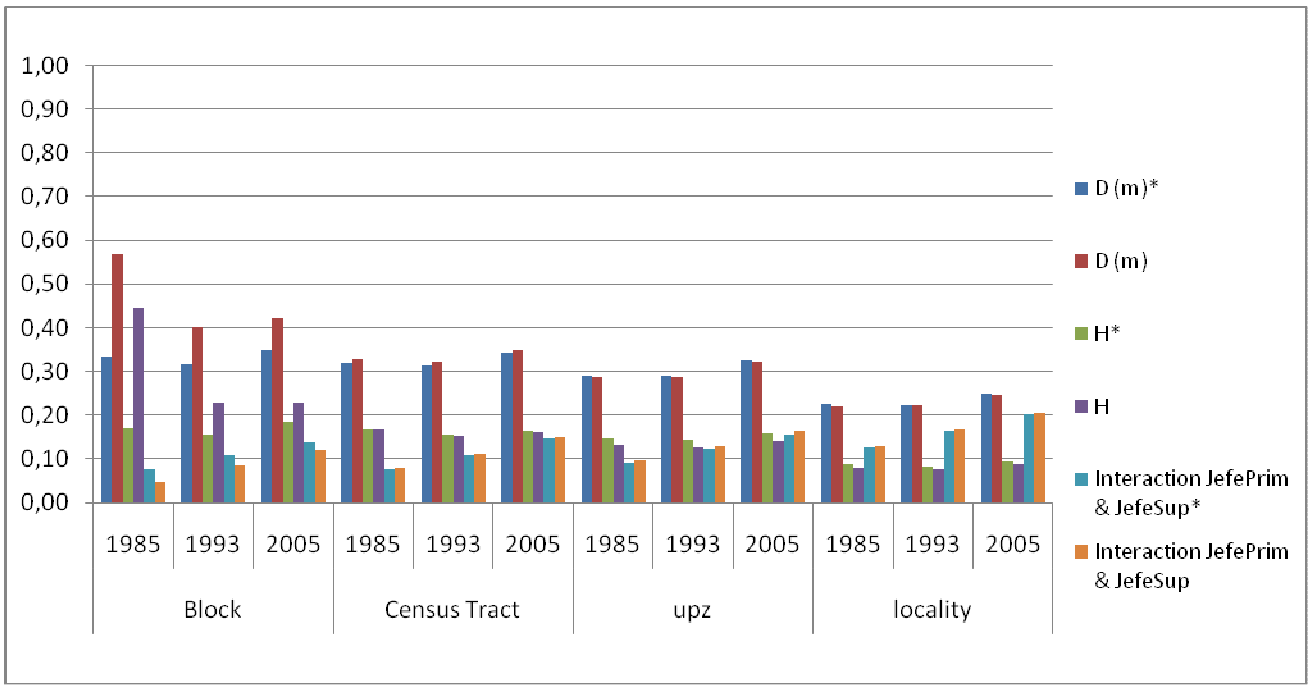


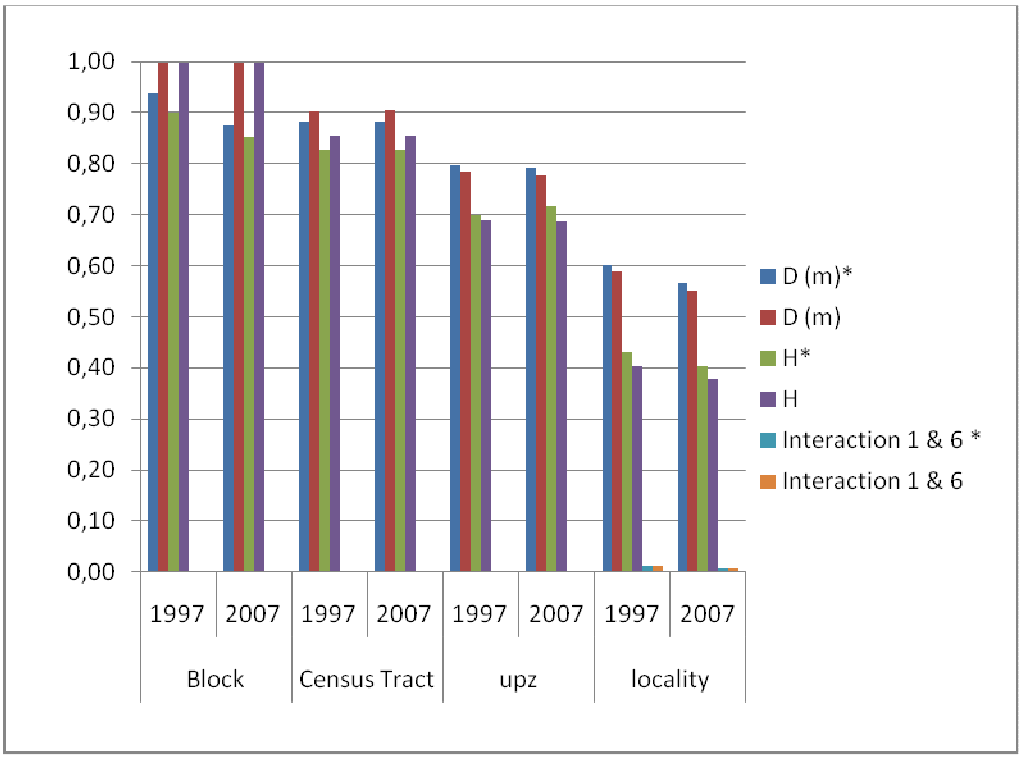
Figure 2. Segregation by years of education of household head in Bogotá (1985, 1993, 2005), Different Areal Units.



Levels of segregation by education of household heads are also moderate. A little more than 30% of the households would have to switch their census track of residency in order to reach a more even distribution of education across Bogotá. Levels are higher at the block level and lower at

the bigger locality level. Considering the Spatial D multigroup index or the Spatial Entropy (H) index, segregation has been relatively stable throughout the years. There is no support for the increasing malignity of segregation hypothesis either. Yet, when we look at the two extreme groups, those with very little education and those that have reached some tertiary education, the panorama becomes more disheartening. The chances of a poorly educated household head to live close to a highly educated comrade are low, even at the locality level. Poorly educated and highly educated household heads live apart in Bogotá.

Figure 3. Segregation by Official Stratification Measure, Bogotá (1985, 1993, 2005), Different Areal Units.



Segregation by the official stratification measure is high. Saying that it becomes almost complete at the block level is trivial for those who know how the municipal government stratification system works. Since a household's stratum is generally assigned considering the urban quality of its block, it comes as no surprise that segregation at the block level is complete. Yet, what is indeed surprising is the fact that localities are very much segregated by stratum. Almost 60% of household would have to move localities for segregation by stratum to disappear in Bogotá. Households from stratum one and six do not share blocks, census tracks our upz. They almost do not share localities. These facts become worrying if we consider that Bogotá

residents use the words stratum and class interchangeably. Meanings associated to living in stratum 1 or 5 go far beyond paying more or less for urban services. For *bogotanos*, people do not just live in strata three, they *are* strata three.

In general, although socioeconomic segregation tends to be higher the smaller the areal unit we consider, there is no evidence of an increasing malignity of segregation getting higher at the smaller areal units with time.

H2: For some areas of the city, spatial measures of segregation will be higher than the non spatial ones.

When the spatial measures of segregation are higher than the usual non-spatial measures, the problem of segregation is greater than what D accounts for. When spatial measures are higher, the probability of being in touch with different-others is lower, given that spatial measures consider not only population in a certain area but also population in adjacent areas.

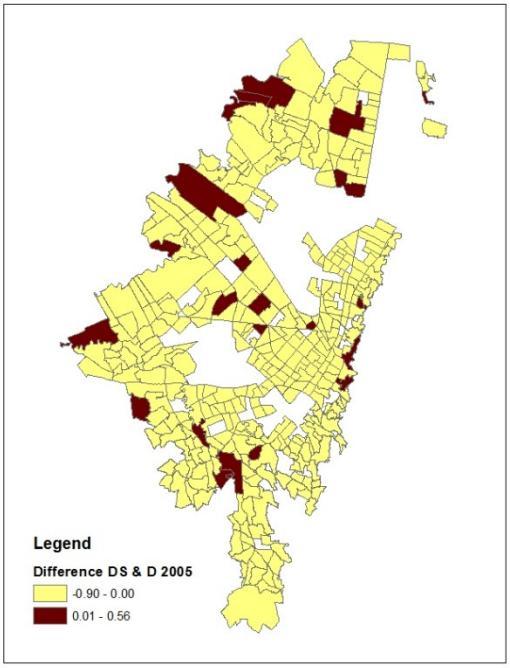
Based on very stimulating research conducted mainly in the US but also in Lima for example about segregation based on spatially weighted indexes as well as on the devastating criticism to non spatially weighted indexes when you are interested in spatial phenomena such as segregation, we calculated spatial and non spatial indexes for the city of Bogotá, for different areal units, as well as for each of its census tracks (in progress).

Figures 1 to 3 show differences in spatial and non spatial measures for the entire city, at different scales. What we see is that spatial segregation estimations are generally lower than non spatial ones. Thus, previous works that used only the D index or other non spatial ones had overestimated segregation in Bogotá. Using spatial indexes we see a more integrated city, yet still with moderate or high levels of segregation depending on the variable we consider.

Yet, the hypothesis refers not to the whole city but to its different areas. Figure 4 shows the difference between the D spatial index and the simple D index for poverty in 2005 for 393 of the about 600 census tracks of the city.

Figure 4:

Difference between Spatial and Non Spatial D Index
for poverty (NBI). Bogotá, 2005, 393 census tracks.



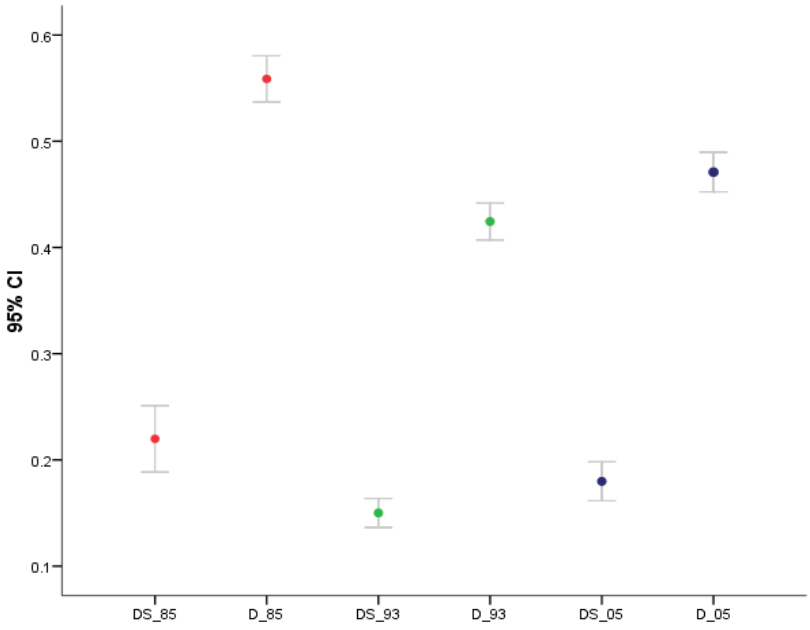
Contrary to what we originally thought, in general spatial indexes of segregation are lower also for the different census tracks (similar to neighborhoods in Bogotá). Only for some isolated and sparkled neighborhoods are non spatial indexes underestimating segregation. In sum, and at least when we look at poverty as measured by basic needs, the probability of a poor household to live by with a non poor one is higher than what we thought. Table 2 offers complementary evidence for this finding, for different indexes and three census years. For all cases, average spatial indexes across census tracks are lower than average non spatial ones.

Table 2: Descriptive statistics of spatial and non spatial segregation indexes. Bogotá (1985, 1993, 2005), 626 census tracks (in progress).

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
HS_85	254	-1.67	1.00	0.08	0.31
H_85	254	0.01	1.00	0.35	0.19
DS_85	341	0.00	4.30	0.22	0.28
D_85	341	0.02	1.00	0.56	0.20
ES_P85	342	0.00	2.07	0.60	0.32
E_P85	342	0.00	0.86	0.44	0.21
ES_NP85	342	0.00	1.38	0.30	0.22
E_NP85	342	0.00	0.71	0.22	0.15
IS_P85	342	0.00	7.18	0.42	0.47
I_P85	342	0.00	1.00	0.55	0.21
IS_NP85	342	0.00	1.41	0.67	0.28
I_NP85	342	0.00	1.00	0.77	0.17
HS_93	301	-0.81	1.00	0.03	0.23
H_93	301	0.00	1.00	0.17	0.12
DS_93	399	0.01	1.38	0.16	0.14
D_93	399	0.00	1.00	0.43	0.17
ES_P93	400	0.00	2.07	0.88	0.27
E_P93	400	0.00	1.00	0.81	0.18
ES_NP93	400	0.00	0.99	0.10	0.15
E_NP93	400	0.00	0.94	0.09	0.13
IS_P93	400	0.00	1.49	0.13	0.19
I_P93	400	0.00	1.00	0.18	0.18
IS_NP93	400	0.04	1.48	0.90	0.19
I_NP93	400	0.06	1.00	0.91	0.13
HS_05	299	-2.04	1.00	0.06	0.31
H_05	299	0.01	0.85	0.19	0.15
DS_05	393	0.00	1.04	0.19	0.17
D_05	393	0.00	1.03	0.46	0.17
ES_P05	394	0.00	3.01	0.92	0.34
E_P05	394	0.00	0.99	0.85	0.22
ES_NP05	394	0.00	1.13	0.06	0.13
E_NP05	394	0.00	0.96	0.05	0.11
IS_P05	394	0.00	1.40	0.09	0.19
I_P05	394	0.00	1.01	0.14	0.19
IS_NP05	394	0.00	3.26	0.95	0.28
I_NP05	393	0.00	1.00	0.95	0.12

Finally, looking at average indexes of segregation by neighborhood or census tracks shows something more than the considerable and unexpected difference between spatial and nonspatial segregation indexes. It also makes a city trend clearer.

Figure 5: Average Neighborhoods' (census tracks') Poverty Segregation Indexes, Bogotá 1985-2005



The average segregation indexes by census tracks shown in figure 5 do not only support the systematic difference between spatial and non spatial indexes. It also shows a time trend in the level of segregation that was present but more invisible in the city estimations and graphs. Socioeconomic segregation in Bogotá seems to have decreased during the period 1985-93 and increased, although without returning to its previous levels, during the 1993-2005 period.

H3: Residential segregation will be higher when calculating indexes based on other measures of socioeconomic stratification rather than solely the urban environment.

As figures 1 to 3 show, the opposite is true. Segregation by the official stratification measure is much higher than segregation by the other variables at all areal units and for all years.

H4: Displaced populations tend to concentrate in the already poorest and most segregated areas of the city.

This hypothesis was also based on the ideas about the reduction of the scale of segregation in Latin America and its increasing malignity in terms of "ghettoization". We presumed that immigrants displaced by violence were reinforcing this ghettoization process by finding residence in the poorest and most segregated areas of the city. Again, we were wrong. Although there are concentrations of displaced migrants in the city as other works document, it is not a general trend. We explored this hypothesis using correlations of segregation and poverty in 1985 with the percentage of migrants for displacement in the census track according to the 2005 census. We also explored the relationship of poverty and segregation with other indicators of vulnerability in order to identify hot spots in the city.

Table 3 Bivariate correlations. Segregation measures in 1985 and Vulnerability indicators in 2005. Bogotá, Census Tracks.

	% adolescent pregnancy, 2005		% unemployed, 2005		% youngsters that do not study or work, 2005		% school dropouts 2005		% displaced population, 2005
DS 1985	0.199	**	0.012		0.057		-0.191	**	-0.084
HS 1985	0.005		0.123	*	0.042		0.048		-0.002
Isolation S 1985	0.485	**	0.222	**	0.380	**	0.435	**	-0.026
Exposure S 1985	-0.485	**	-0.276	**	-0.474	**	-0.464	**	-0.086
% poverty in 1985	0.597	**	0.354	**	0.592	**	0.589	**	-0.002

** correlation is significant at the 0.01 level (two tailed)

* correlation is significant at the 0.05 level (two tailed)

As shown in table 3 neither segregation measures nor poverty seem to be correlated with the percentage of displaced people coming to live to a particular census track. Yet, both poverty and segregation appear to be connected with other vulnerability indicators such as adolescent pregnancy or the percentage of young people that do not either work or study. From all the segregation measures, the ones that seem to be more systematically related with risk indicators are isolation and exposure. Given that these two indicators of interaction depend on the size of the studied groups, poor and noon poor in this case, it becomes even more important to control for poverty to see if segregation has an independent effect on vulnerability indicators. Table 4 shows regression results.

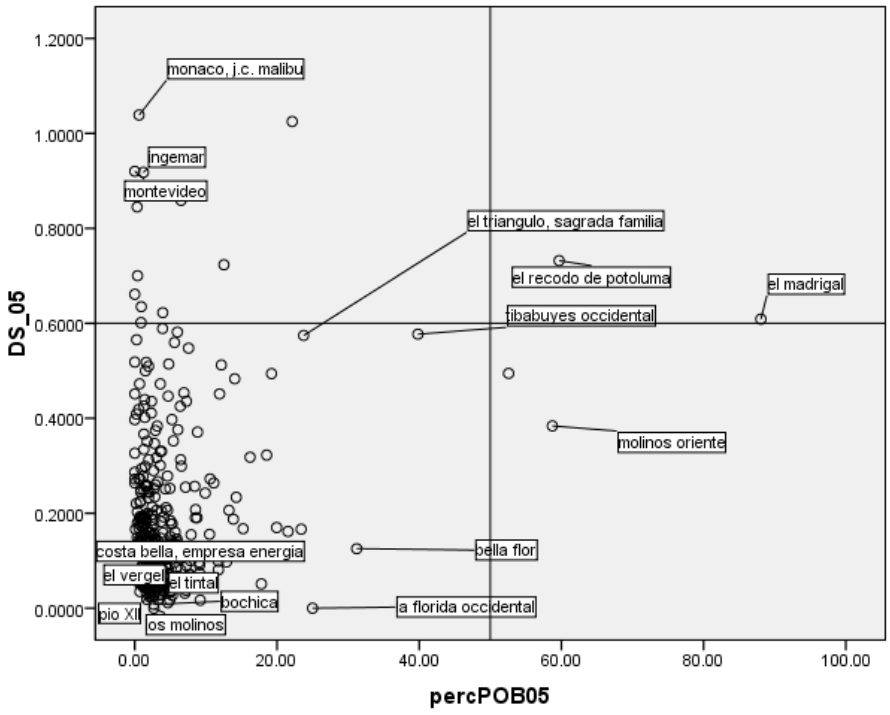
Table 4 Linear Regression Estimates for Several Neighborhood Vulnerability Indicators.

	% adolescent pregnancy, 2005	% unemployed, 2005	% youngsters that do not study or work, 2005	% school dropouts 2005	% displaced population, 2005
% poverty in 1985	0.011 **	0.061 **	0.121 **	0.118 **	0.002 *
Isolation (spatial index) in 1985	0.215 **	0.563	1.107 **	1.835 **	-0.075
Constant	0.028	8.465 **	2.324 **	3.708 **	0.500 **
R	0.520 **	0.154 **	0.457 **	0.463 **	0.014
N	291	340	339	340	341

According to these preliminary regression results, segregation appears to have an independent effect on most of the chosen vulnerability indicators even after controlling for poverty. Poor and segregated neighborhoods in 1985 are worst twenty years after than poor neighborhoods that are not segregated. This causal effect of segregation on vulnerability justifies the need to keep doing research on its characteristics, causes and consequences. It also signals different types of neighborhoods, of which the worst off are those that are poor *and* segregated at the same time.

Figure 6 shows a scatter plot of census tracks in Bogotá in 2005, by their poverty and segregation levels. Most neighborhoods are clustered in the lower left quadrant. Although most would change their position if we changed the scale of the axis, they show that at low levels of neighborhood poverty there is great variation in the segregation of poor households within those neighborhoods. Thinking of a typology, those in the lower left quadrant would be integrated neighborhoods without major problems. Those in the upper left quadrant, with low poverty and high segregation have the challenge of mixing. In turn, those in the lower right corner are poor neighborhoods that are not segregated. They provide opportunities for social mix. The most problematic ones are those in the upper right corner since they are poor and segregated. They are the ones regression results showed to be very associated with vulnerability indicators. Although more in depth research is needed to affirm such a thing, they are theoretically closer to the ghetto ideal type.

Figure 6 Scatter of Census Tracks, Bogotá 2005 by Percentage Poor households and Spatial D Segregation Index of Poor Households versus non Poor Ones.



We can observe this same correlation geographically, searching for those spots in the city where poverty or vulnerability and segregation coexist, making problems worst.

Figure 7 Bivariate Local Moran I for Adolescent Pregnancy and Segregation of Poverty (spatial D), Bogotá 2005.

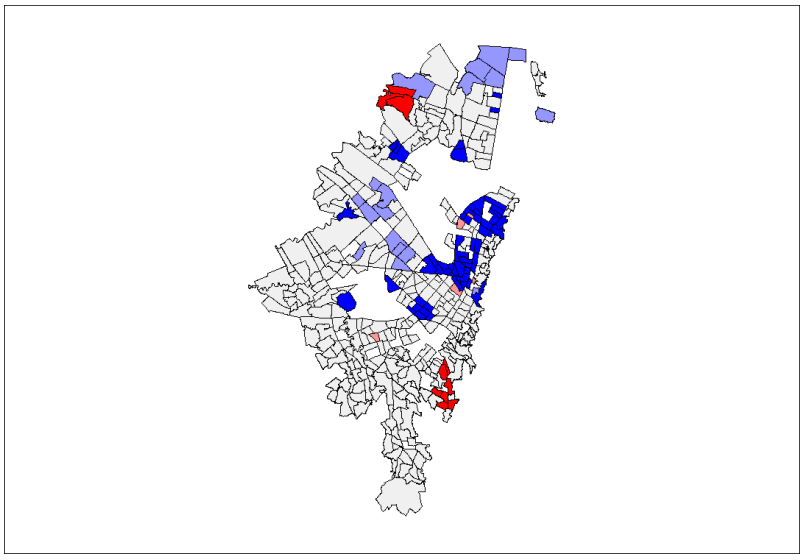


Figure 7 shows the LISA preliminary results for adolescent pregnancy and poverty segregation. It signals some hot spots, in red, with high rates of adolescent pregnancy and high levels of poverty segregation. Curiously, a group of them is in the north of the city, not in the traditionally stigmatized south. They correspond to three neighborhoods in the locality of Suba, a locality of striking contrasts. Blue census tracks have lower values of both variables. These neighborhoods are clustered in the north, close to the mountains, but the north is far bigger than these "unproblematic" neighborhoods.

CONCLUSIONS

We have presented preliminary results from our ongoing research on the patterns and changes of socioeconomic residential segregation in Bogotá. Most of our findings have puzzled us in interesting ways. Perhaps the most puzzling of all is the fact that blocks and neighborhoods (census tracks) are more heterogeneous than we had originally thought in terms of poverty and household head education. The fact that spatial segregation indexes are lower than non spatial ones points to that direction.

If further research confirms this conclusion, we may find that Bogotá is not suffering from the malignity of segregation (increasing homogeneity at smaller areal units such as blocks) that has been detected in other Latin American cities.

Another interesting finding is the fact that while segregation seems to have decreased in Bogotá during the period 1985-1993, it appears to have increased in the period 1993-2005. This invites to a study of the possible causes of these processes. Certainly, a careful study of city policies at different points in time and their spatial impact is one of the possible ways to start solving this puzzle.

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