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The Intra-Urban Dynamic based on Spatial Statistics: A case study of a Brazilian Municipality in 1990s

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Abstract

This paper has two main goals. The first one is to show the main possibilities and limitations of the Brazilian Demographic Census of 2000 for those who work with intra-urban analysis, dealing specially with information access at local, or intra-municipality level, and to promote a method of data analysis that minimizes these limitations. For this, a study case with the Municipality of Santos, located on the coast of São Paulo, was realized, using a procedure of data interpolation, known as kriging. Then, the second goal arises: to analyze the intra-urban dynamic of Santos in the 1990s, a possible application for these procedures.

Introduction

The microdata of the Brazilian Demographic Census of 2000, presented recently, brought some innovations and limitations when compared to the Census of 1991, for those researchers that study the intra-urban dynamic of certain area. The main innovations and limitations of this census are denoted in this paper, as well as suggestions of how to analyze the census tracts in a better way. To help in this work, a study case was realized with the Municipality of Santos, located on the coast of São Paulo.

Santos is the core of the Baixada Santista Metropolitan Area (BSMA), which contains another eight municipalities too. The BSMA is the third Metropolitan Area of the State of São Paulo in terms of number of inhabitants, almost 1.5 million in 2000. Santos had almost 418 thousand in 2000, and 99.5% of them lived on the Island of São Vicente, which contains part of the municipalities of Santos and São Vicente, the first municipalities created on the State of São Paulo (São Vicente in 1532 and Santos in 1545). The insular part of Santos has almost 40 squared kilometers, shared by many hills, the residential place, and the Santos Harbor, the biggest of Latin America in terms of moved tons, 48 millions in 2001.

The Municipality of Santos is now consolidated. In 1980-1991, its population growth rate was 0,1% per year, while in 1991-2000 was reduced to 0.01% per year, almost null, and with migratory balances of -45,290 and -19.782 persons in the same periods, respectively[1]. With these facts, the intra-urban dynamic of this municipality has a growing importance.

[1] Source: Jakob, 2003a.

Jakob (2003a) denoted that the tendencies verified for the BSMA, of spatial "de-concentration" of population, "peripherization", and modification of the kinds of occupation of the places, have an intra-municipality expression. In this way, this expression was analyzed for the Municipality of Santos in this paper.

Methodological Aspects

The "intra-urban" term is used here in the same conception of Villaça, to whom:

"A estrutura do espaço regional é dominada pelo deslocamento das informações da energia, do capital constante e das mercadorias em geral. O espaço intra-urbano, ao contrário, é estruturado pelas condições de deslocamento do ser humano, seja enquanto portador da mercadoria força de trabalho - como no deslocamento casa/trabalho - seja enquanto consumidor - reprodução da força de trabalho, deslocamento casa-compras, casa-lazer, escola, etc." (Villaça, 1998: 20).

"The structure of the regional space is dominated by flows of energy information, constant capital and goods in general. The intra-urban space, in the other way, is structured by the conditions of the human being flows, like work force goods – transfers house/workplace – or consumer – reproduction of work force, transfers house-shopping, house-leisure, school, etc." (Villaça, op.cit.: 20).

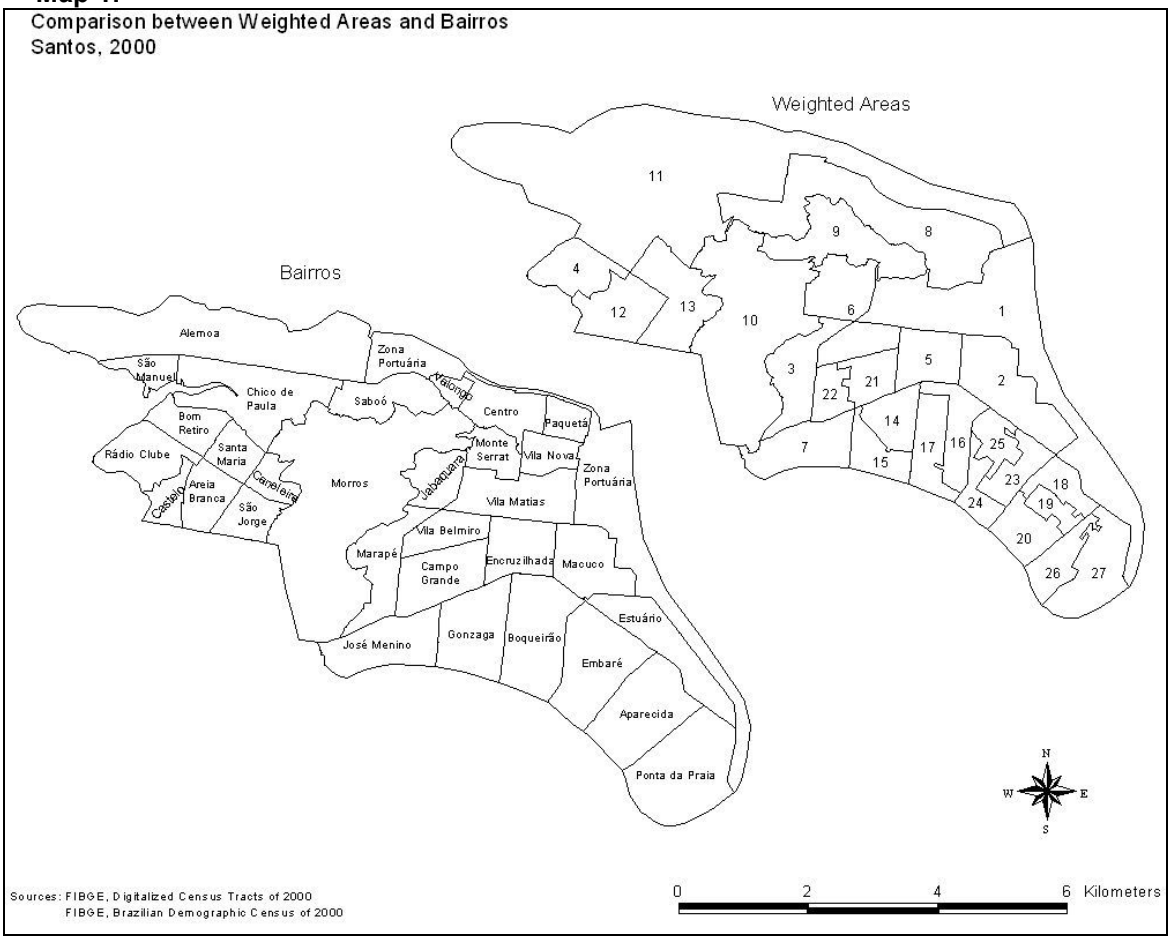
So, the intra-urban space, or place, is not constrained to rigid boundaries, like administrative limits, and can be delimited by boundaries smaller or bigger than municipalities. It was used intra-municipality analysis in this paper in order to show that is possible to find very interesting results from local scale information, with census data only.

The main innovation of the Brazilian Census of 2000, in terms of the sample questionnaire, compared to the 1991 census, is the new variable "Weighted Area". This variable was defined as "*a geographic unit, created by a mutually exclusive aggregation of census tracts, for the application of estimative calibration procedures with the known information for the population as a whole*" (FIBGE, 2002: 12). In terms of the number of households in each weighted area, it can be from 400 to the total of particular households occupied of the municipality.

A total of 484 Brazilian municipalities were classified with more than one weighted area, from 5,507 municipalities in 2000, but only 42 of them had 20 or more weighted areas in 2000. The municipalities of São Paulo and Rio de Janeiro were the big ones in terms of number of these areas, with 456 and 170, respectively. The Municipality of

Santos was classified with 27 weighted areas, that are, generally, subdivisions of its "bairros"[2]. This can be seen in Map 1, which shows the insular – and urban – part of the Municipality of Santos.

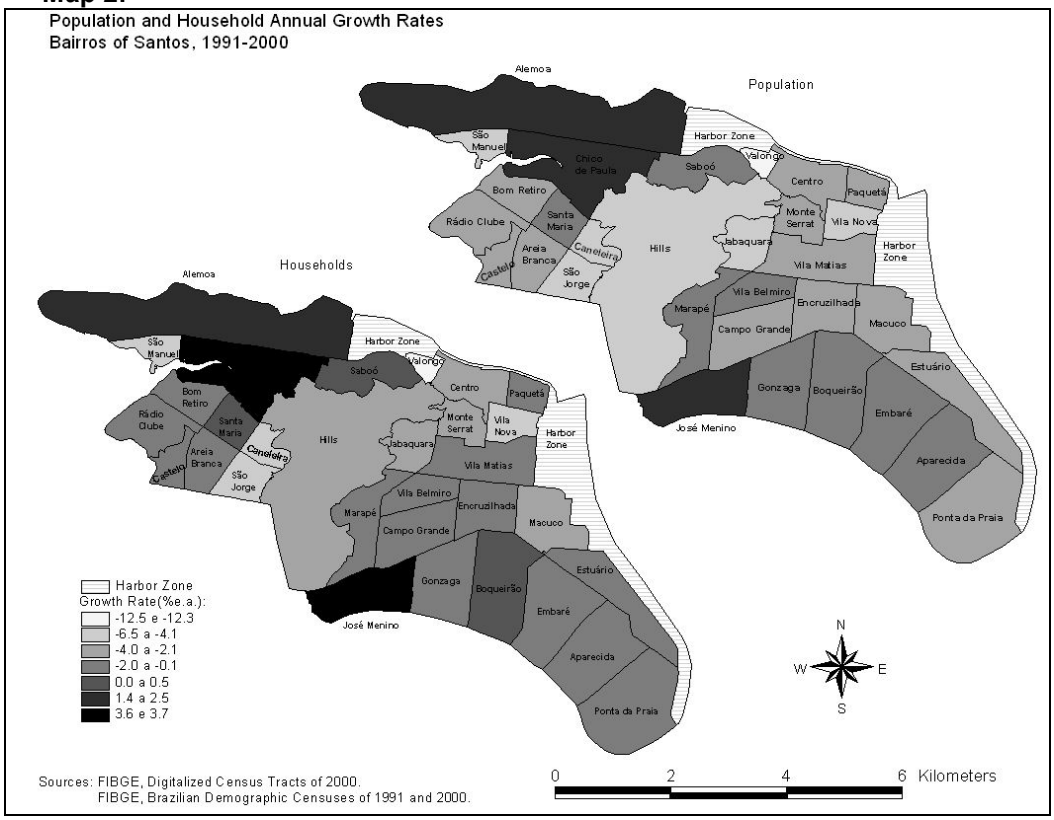
Map 1:



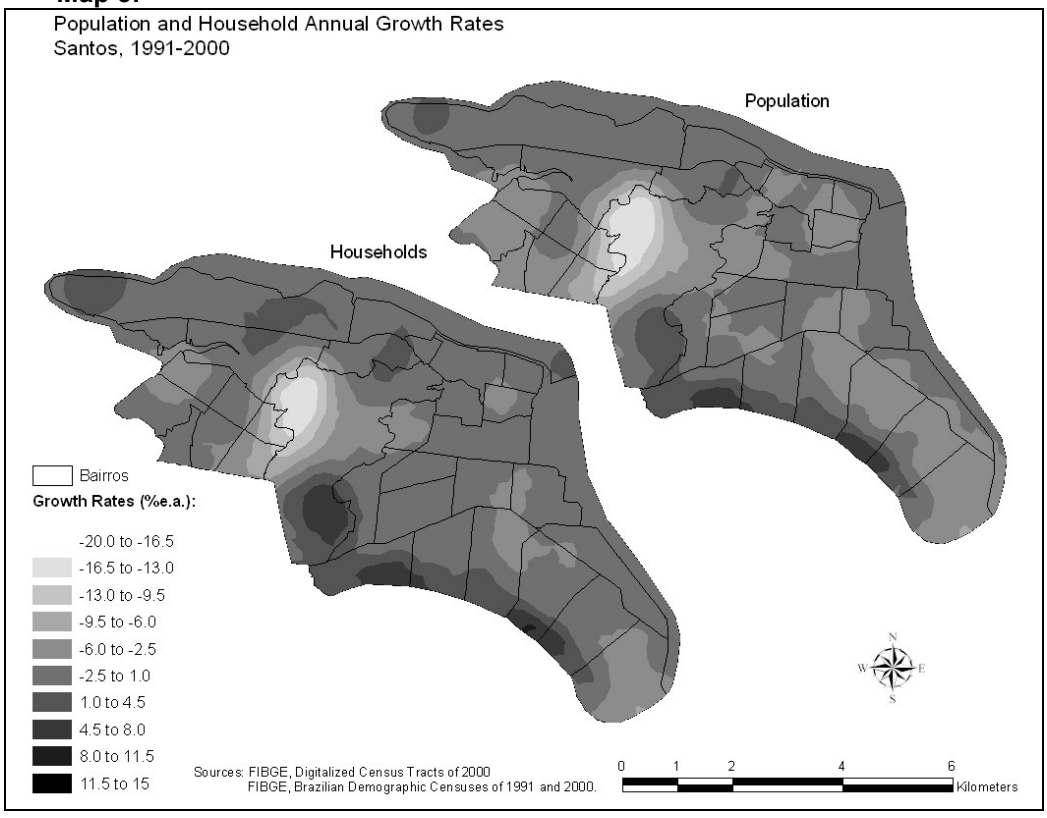
This is a good start to the researcher that wants to have a local view of the municipality of study, but in order to obtain better details, it is necessary to study the census tracts of the area. Map 2 brings the population and household growth rates for the 1990s, at the bairros level. However, it is known that this growth is not homogeneous in the whole bairro, there are points of higher or lower growth inside each bairro, as seen in Map 3, that uses census tracts data from Demographic Censuses of 1991 and 2000.

[2] In Brazil, big municipalities are divided by districts, and each district can be divided by bairros. But small municipalities, in general, are divided just by bairros, without districts. So, the bairro is an administrative boundary smaller than the district, both inside of the municipality.

Map 2:


Population and Household Annual Growth Rates
Bairros of Santos, 1991-2000
Population
Households
Alemoa
São Manuel
Chico de Paula
Harbor Zone
Saboó
Valongo
Centro
Paquetá
Bom Retiro
Rádio Clube
Santa Maria
Areia Branca
Caneleira
Castelo
São Jorge
Hills
Jabaquara
Monte Serrat
Vila Nova
Vila Matias
Vila Belmiro
Encruzilhada
Marapé
Campo Grande
Macuco
Estuário
Gonzaga
Boqueirão
Embaré
Aparecida
Ponta da Praia
José Menino
Harbor Zone
Growth Rate(%e.a.):
-12.5 e -12.3
-6.5 a -4.1
-4.0 a -2.1
-2.0 a -0.1
0.0 a 0.5
1.4 a 2.5
3.6 e 3.7
N
W
E
S
0
2
4
6 Kilometers
Sources: FIBGE, Digitalized Census Tracts of 2000.
FIBGE, Brazilian Demographic Censuses of 1991 and 2000.

Map 3:


Population and Household Annual Growth Rates
Santos, 1991-2000
Population
Households
Bairros
Growth Rates (%e.a.):
-20.0 to -16.5
-16.5 to -13.0
-13.0 to -9.5
-9.5 to -6.0
-6.0 to -2.5
-2.5 to 1.0
1.0 to 4.5
4.5 to 8.0
8.0 to 11.5
11.5 to 15
N
W
E
S
0
1
2
4
6
Kilometers
Sources: FIBGE, Digitalized Census Tracts of 2000
FIBGE, Brazilian Demographic Censuses of 1991 and 2000.

But the variable “census tracts” was removed from the microdata of the 2000 census, was changed by the weighted area, in order to preserve better the secrecy of information. The only one possibility to study census tracts now in Brazil is to obtain a database with aggregated data, no more in microdata format. However, this aggregated data now came with the census tracts shapefile of 2000, for the first time the Brazilian Census Bureau (IBGE) makes the census tracts boundaries available. And through a comparison table, it is possible to recreate the census tracts boundaries for the censuses of 1991 and 1980, per example.

Once created the census tracts boundaries, is easy to create a shapefile of points, in order to make data interpolations. These interpolations, although generating maps with smoothed data, give more expression to the highest spatial concentrations of certain phenomenon, minimizing unexpressive differences of the contiguous data.

Map 3 was created by this technique, using data kriging in order to eliminate the “patchwork effect” that a census tracts map generally looks like. It is clear the better detail of this map in comparison with Map 2. It can be verified that only few census tracts of the bairros are responsible by the growth denoted, located near the coastal strip of the bairros of José Menino and Embaré, mainly.

So, the detail of the analysis grows, comparing to the analyses of bairros or weighted areas. Then, it is necessary a better explain about data kriging.

The data interpolation by kriging

Geographic Information Systems are being used for many years as a method to visualize data, in order to obtain better conclusions. These “conventional” methods of data analysis generally use data like polygons, lines or points to represent geographic characteristics of the study area. The polygons usually represent with areas like municipalities, states or countries. Then, when the GIS software is used to analyze data, the whole polygon usually assumes the same value. This is not true. There are mean values between two polygons, that aren’t seen with these kind of vector analyzes. Sometimes, there are huge differences, and then, the map becomes like a patchwork of colors.

A better method of data analysis is the data interpolation. The mean values are preserved, and the final result is a surface of smooth data, which minimizes the differences between the polygons, and gives more expression to the highest spatial concentrations. Kriging generally is known as the best linear method of data interpolation, with the minor errors and unbiased. It uses the tabular data and its geographic position in order to calculate the interpolations. As a result, a surface map is created from the original points map. The Tobler's First Law of Geography is used, that says that nearest unit analysis are more similar than that more distant ones. So, using mathematical functions, it gives more significant weights to nearer positions of the known point, and the weight becomes less significant when the distance from the point grows, originating new interpolated points based on these linear combination of the data.

Geostatistics includes a wide variety of techniques, like the Inverse Distance Weight (IDW), nearest neighbor analysis and linear and non-linear kriging. It is commonly used to identify and map spatial patterns across a landscape, and can be used to find spatial autocorrelation between data points. For this, the most common function used is the (semi)variogram. The variogram is a mathematical description of the relationship between the variance of pairs of observations (data points) and the distance separating these observations (h). Spatial autocorrelation can then be used to make better estimates for unsampled data points (inference = kriging).

Kriging is based on the idea that you can make inferences regarding a random function Z(x), given data points $Z(x_1)$, $Z(x_2)$, …, $Z(x_n)$. The function $Z(x) = m(x) + \gamma(h) + \varepsilon$ has a constant mean, a spatial correlation, and a residual error. The spatial correlation is given by the variogram:

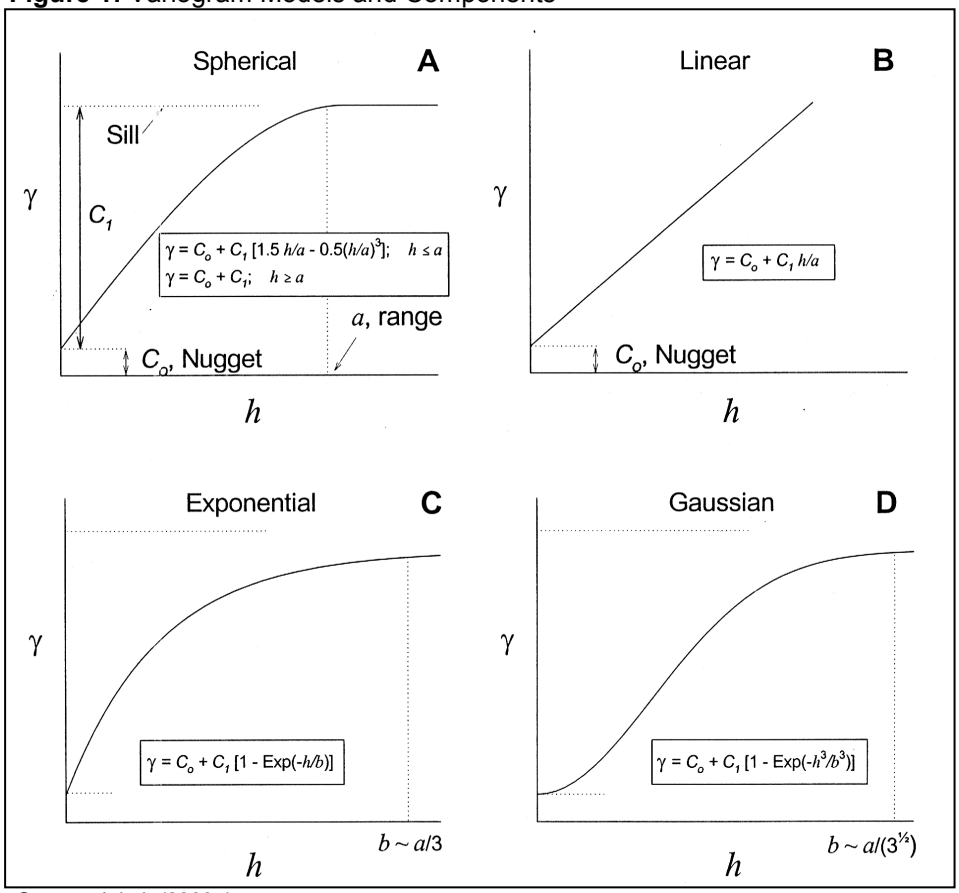
$\gamma(h) = ½ \text{ var } [Z(x) – Z(x+h)] = ½ E [\{Z(x) – Z(x+h)\}^2]$; in practice:

$\gamma(h) = ½ N(h) \Sigma_i [Z(x_i) – Z(x_i+h)]^2$, where N(h) is the total number of pairs of observations separated by a distance h, and the fitted curve minimizes the variance of the errors.

The Figure 1 shows the variogram components, and its main models. The nugget effect (or nugget variance) can be zero or a non-zero value for γ when h = 0. It shows how much short distances are similar or not. A high value indicates expressive variations at short distances. It is produced by various sources of unexplained error (e.g. measurement error), or by significant differences at near positions. The sill is the maximum value of γ of the fitted curve. For large values of h the variogram levels out, indicating that there no longer is any correlation between data points. The sill should be

equal to the variance of the data set. It is important to define de sill in order to analyze the range, the value of h where the sill occurs (or 95% of the value of the sill), the maximum point where there are spatial correlation of the data. And this spatial autocorrelation of some variable is given in known distance units, like meters or miles, and can be a proxy of spatial segregation. With this, is possible to find a value of spatial segregation of certain variable. In general, 30 or more pairs per point are needed to generate a reasonable sample variogram.

Figure 1: Variogram Models and Components



Source: Jakob (2003a)

Other factors to be studied are the anisotropy and the drift. The anisotropy happens when there is a spatial autocorrelation more concentrated in certain direction, and the drift happens when some attributes (like the mean of the values) modifies themselves in a systematic way. There are specific functions to deal with these factors.

Kriging produces the best linear unbiased estimate of an attribute at an unmeasured site. There are many kinds of kriging. The ordinary kriging is used when there is no drift in the data, although it can incorporate also anisotropy analysis; universal

kriging accounts for drift; punctual kriging produces values for non-sampled points; block kriging produces values for areas instead points; and co-kriging uses two or more variables that are correlated between themselves in the estimation of values for one of them. In this paper, the ordinary kriging was used.

Ordinary kriging is a data interpolation method that "*is often associated with the acronym B.L.U.E. for 'best linear unbiased estimator'. Ordinary kriging is 'linear' because its estimates are weighted linear combinations of the available data; it is 'unbiased' since it tries to have the mean residual error equal to '0'; it is 'best' because it aims at minimizing the variance of the errors*" (Isaaks and Srivastava, 1989: 278).

Finally, it can be observed that kriging, although bring very good results (especially for 100 or more points or observations), demands more specialization, dedication and training for the involved people, in order to obtain better, more expressive and, above all, reliable and accurate results[3].

The intra-urban dynamic of Santos

After the creation of interpolated maps, is possible to analyze the mobility of social groups, people and households, and find its spatial concentration which, in this paper, happens inside of the Municipality of Santos.

Linking the population mobility and the expansion of São Paulo Metropolitan Area (SPMA), Cunha (1994) denoted that 90% of the migration inside SPMA was formed by nuclear families, and pointed the main characteristics that would originate the familiar migration, like the familiar life cycle, its socio-economic condition, its size, and its socio-occupational level. Smolka (1994, 1992a, 1992b, 1992c) found a similar result, studying the intra-urban structure of Rio de Janeiro, which pointed as the main responsible factors for the intra-urban mobility the demographical ones (related to the familiar life cycle), the socio-economical ones (related to the labor market insertion), and the environmental and cultural factors, related to the neighborhood adaptability or not, and to the introduction of "new ways of life", like the closed condominiums.

In order to analyze data at census tracts level, we have the limitation imposed by the Brazilian Census Bureau, allowing only data related to age, years of study and

[3] More details about kriging can be obtained in Matheron, 1963; Journel and Huijbregts, 1973; Jakob, 2003a and 2003b, among others.

income of the head of household, as well as household variables, like its type, localization, condition of occupation, number of inhabitants, kinds of water supply, sanitary installation, and trash destination. Since is impossible to make data tabulations at census tracts level in 2000, because the microdata are unavailable, these variables shall be analyzed in an independent way in 2000. For this, interpolated maps of each one of these variables were created for the Municipality of Santos in 1991 and 2000, in order to find and denote the movement of them spatial concentrations in 1990s.

Jakob (2003a) pointed some tendencies of population spatial de-concentration, peripherization, and modification of ways of place occupation inside BSMA. As denoted before, one aim of this paper will be to show that these tendencies have an intra-municipality expression at the core-municipality of the area.

Another goal of this paper, related to the spatial segregation of social groups, would be to verify if the characteristics of the places are being modified along time, due to the appearing of new ways of occupation acting in these places, which could be happening due to urban renovation processes, with valorization of the area and the resultant expulsion of poorer families, or due to the familiar life cycle. With this, families at initial stages of life cycle could be looking for new occupation places, meanwhile those at fragmentation stages would stay on those older and consolidated locals. So, these ways of occupation could implicate on ageing or rejuvenating of certain locals, depending on the type of occupation evolved on this process.

Once denoted these goals, the analysis of census tracts were divided on population and household characteristics.

The population characteristics of census tracts

This topic analyzes some characteristics of the census tracts inhabitants of the Municipality of Santos, like the number of illiterate, the age of the head of household, and his/ her monthly income, in minimum salaries. But before this, it is important to denote some socio-demographical and local characteristics of the area.

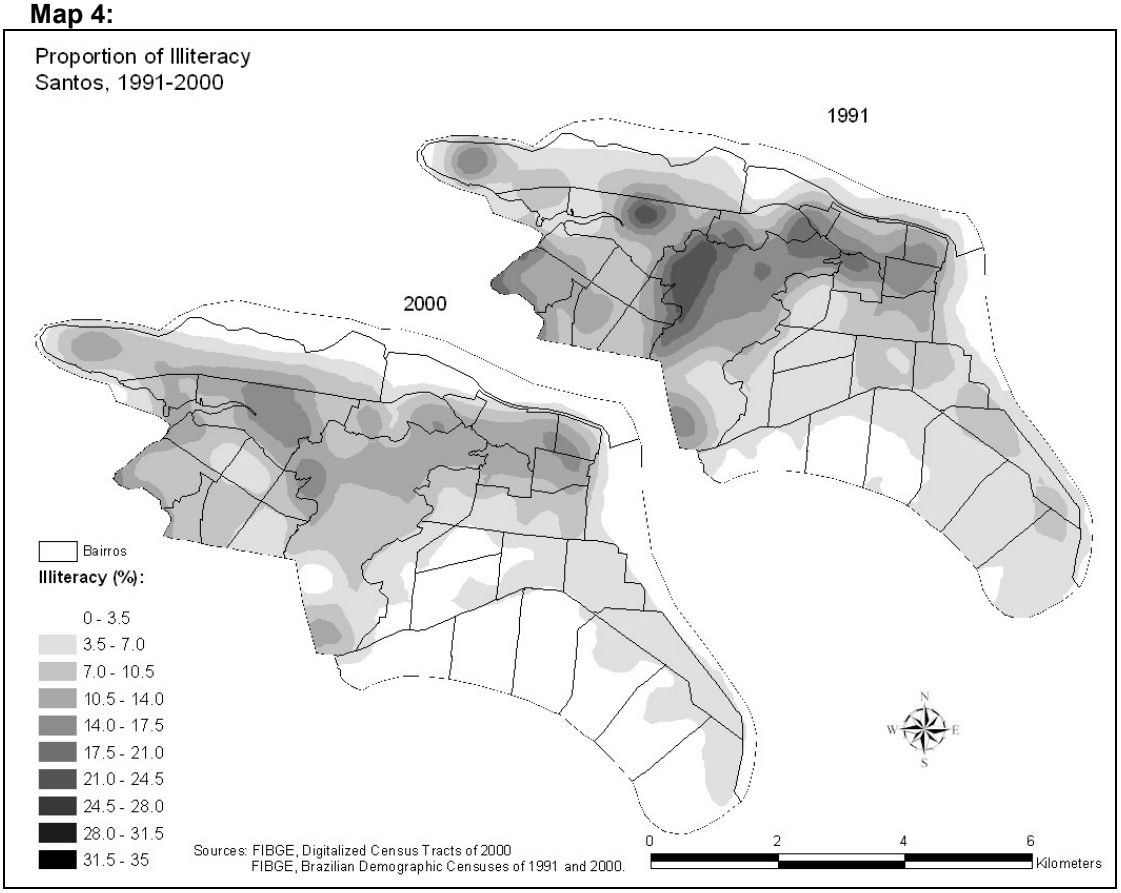
It can be verified in Map 3 that the coastal strip of Santos contains the bairros of José Menino, Gonzaga, Boqueirão, Embaré, Aparecida and Ponta da Praia. The limits of these bairros are two major roads, and the perpendicular limits to the coastal strip are drainage canals, where the water runs from north to south, to the Atlantic Ocean. It is

important to denote also that the limit of Alemoa with São Manuel and Chico de Paula is given by the Via Anchieta, a local highway that ends in Saboó.

This map shows also the space occupied by hills, which constrains the available space for the population. As denoted forward, the bairros at north and west of the hills zone are inhabited by popular or poor families. The bairros of Paquetá, Vila Nova and Centro are the older ones of the island, containing slum tenements and some big antique houses. These bairros are now in stage of deterioration. The bairros located near the seafront are inhabited by wealthy families, and those located between the pointed areas are inhabited by the mean class of Santos. So, the most popular, the most noble and the most antique areas are easily delimited.

Looking initially for the participation of illiterate people in Santos' census tracts, Map 4 shows that they were more spatially concentrated on the region of Chico de Paula, at the slopes of the hills, in Paquetá, Centro, Valongo and Saboó, as well as near the harbor zone (*zona portuária*). We can note also the gradual reduction of the illiteracy in 1990's.

Map 4:



So, it can be verified that the highest participations of illiterate household heads were seen in census tracts of the more antique residential area, containing rooms inhabited, in general, by only one person, as denoted forward. There were also expressive concentrations in tracts near the harbor zone, inhabited mainly by antique harbor workers, easily seen at Estuário and Macuco in 2000, as well as near the hill zone and at the more popular areas, like expected, paying special attention to Chico de Paula, considered the bairro with more recent urban expansion.

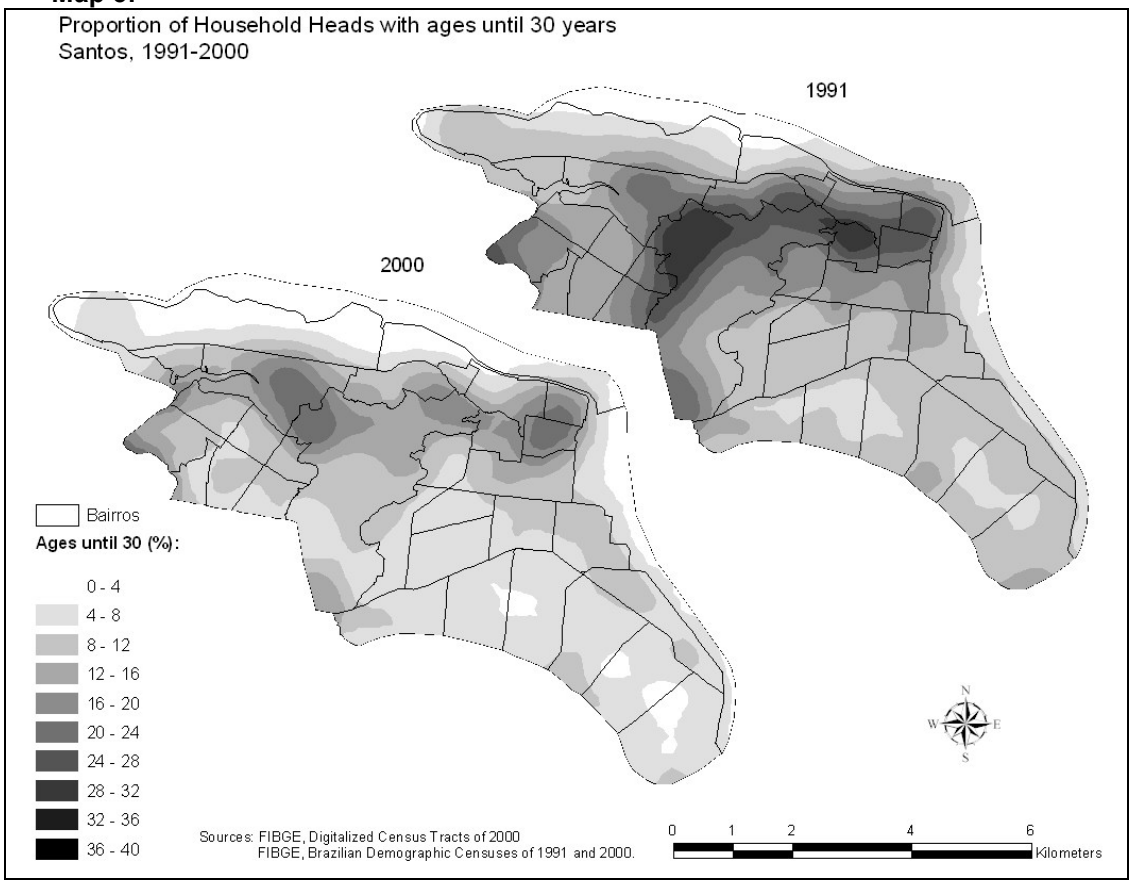
This map shows that an expressive proportion of illiterate heads of family were concentrated on census tracts near the municipality limits of São Vicente (at west) and Cubatão (at northwest), considered more peripherical, as well as in more antique areas. And the important participation of illiterate heads at Paquetá and Vila Nova, traditional bairros, could mean a mixture of wealthy and poor inhabitants, returning to the discussions about the growing difficulty in the division among core and periphery, included at the work of Ribeiro and Lago (1994), Bógus and Wanderley (1992), Rolnik, Somekh and Kowarick (1990), among others.

Studying now the age of the head of household, Cunha (1994) suggested a division which considered that the mean age of the couple of 34 years old would mark the end of the "formation" stage of the family, while the stage of "consolidation" ranged from 35 to 45 years old, and then, from this age, the family would go to the "fragmentation" stage. However, this variable was grouped in decennial categories in the census tracts data of 2000. So, it was decided to de-aggregate a little bit more the suggested division. Then, in this paper, it was adopted the follow division: 10 to 29, 30 to 39, 40 to 69 and 70 or more years old. This new division gives more importance to the youngest and oldest household heads, since they are more important for us, and are showed next.

Map 5 locates where the household heads with ages from 10 to 29 were concentrated. It can be verified that these were located, in general, at the same areas denoted before, with the study of illiteracy. It can be noted also that the participation of young heads was been reduced in the whole municipality. This shows that families at initial stages of life cycle were concentrating at the more peripherical areas of the municipality. The decline of fertility was in part responsible for that reduction, as well as a possible migration of these families to neighbor municipalities of Santos, where the homes were more accessible, denoting a bigger peripherization, in terms of distance of source area. It could represent also a migration to the continental area of Santos, but as

denoted before, the volume of population in this rural zone of Santos was not expressive (only 0.5% of the total population).

Map 5:



Map 6 shows the ageing of the insular (and urban) part of Santos. The families at the stage of fragmentation, as well as those consolidated, arose their participation along time.

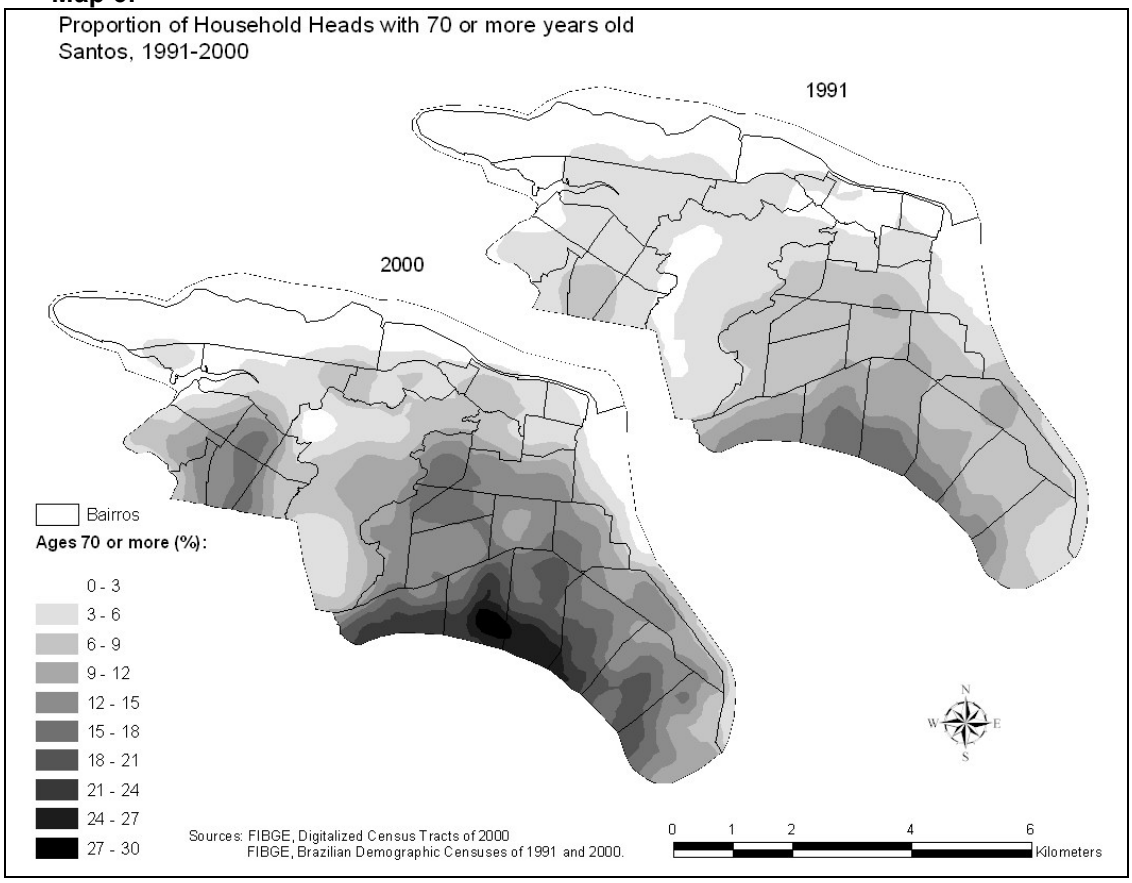
The participation of old household heads was arising mainly at the seafront, especially at Gonzaga, Boqueirão, Embaré and José Menino. So, the old people were occupying, more and more, the places left by the floating population[4] near the seafront. As seen in Jakob (2003a), these tourists were changing their occasional homes in Santos for others at less consolidated, and therefore, more private and calm locals.

The Planning Department of Santos, in an interview given in July, 2000, attested that "*nobody builds more apartment houses for floating people in Santos, the attention is*

[4] "Floating population", in this paper, is the group formed by seasonal or weekend tourists, which owned households in Santos.

given to the elderly, which inhabit households with less rooms, less stairs and not far from the beach". The local government and real state realized already the growing importance of the elderly in the municipality. They represented 5.3% and 7.4% of the total population of Santos in 1991 and 2000, respectively, according to the Demographic Censuses of these years.

Map 6:

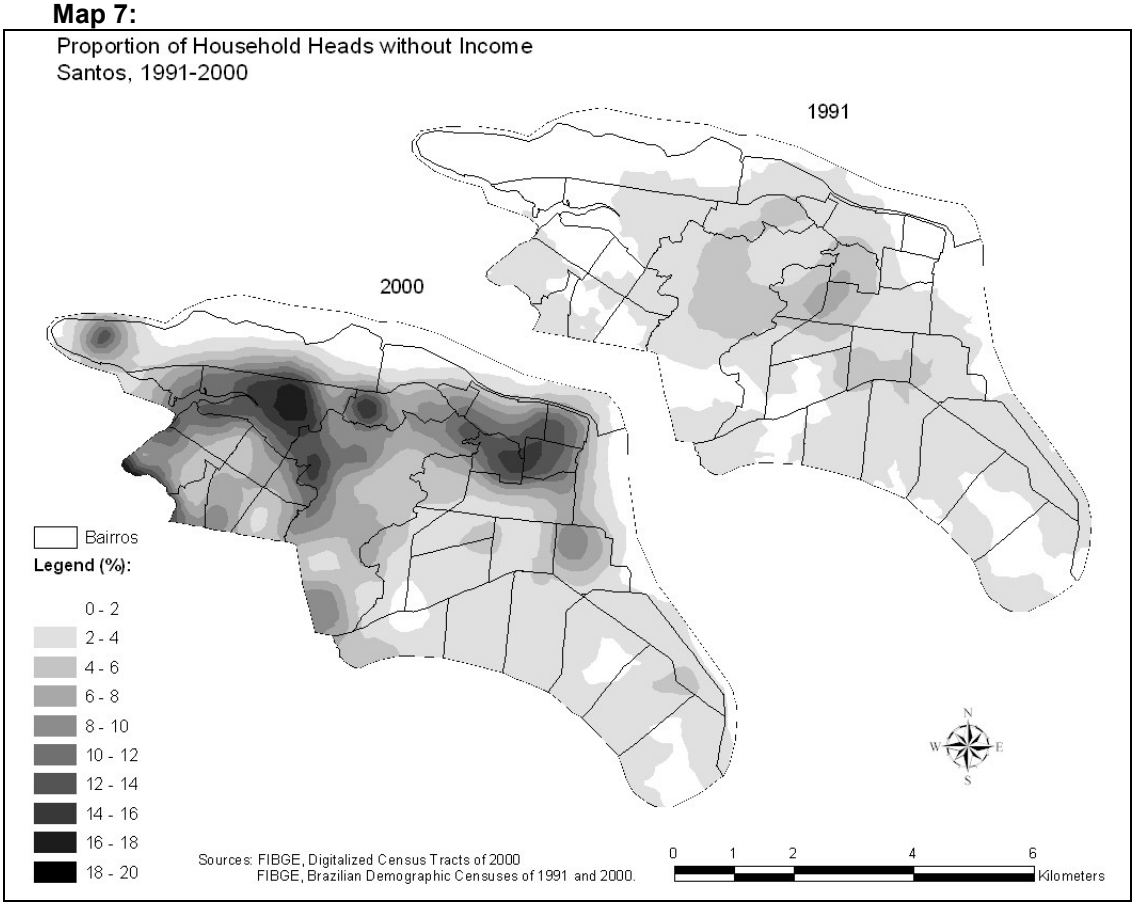


At the most popular area, it was expressive (and growing) the participation of household heads with ages between 40 and 69 years, especially at locals near the popular condominiums located on Castelo and recently, Areia Branca. At the most noble area, the proportion of these household heads was more significant behind the apartment houses located on the seafront.

Emphasizing now the monthly mean income of the head of household, it can be verified that the heads without any income were concentrated only in some locals in 1991. However, in 2000 these heads had an important participation at the popular areas, especially at Chico de Paula and Areia Branca, as well as near Paquetá and Vila Nova,

reflecting the decline of the participation of the occupied economically active population at the industries and civil construction of Santos, denoted by Jakob (2003a), as well as the number of people looking for jobs, from 2,900 in 1980 to 12 thousand in 1991. This map shows that this number in 2000 shall be bigger than in 1991.

Map 7:

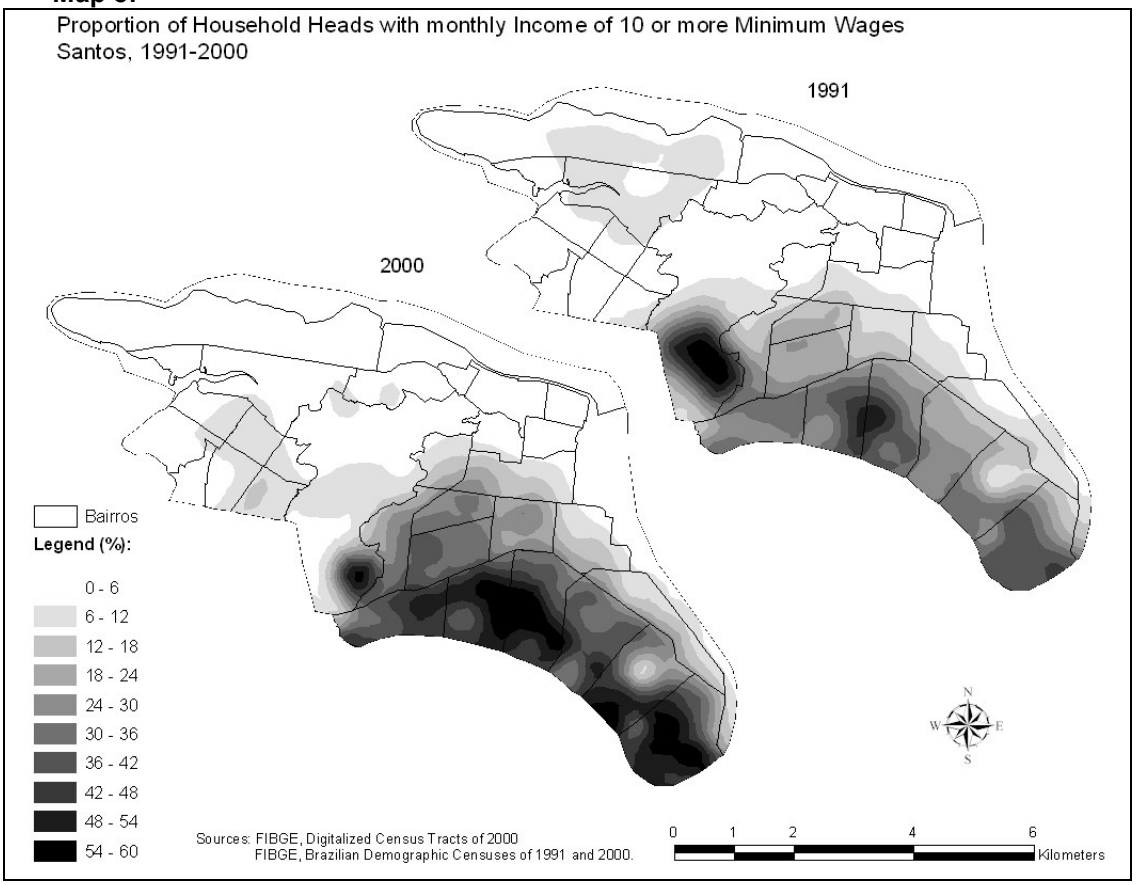


Dealing now with the other extreme of the income distribution of the household heads, with monthly mean incomes of 10 or more minimum salaries, Map 8 shows where they were concentrated until 2000. It is verified that in 1990s there was a big concentration of this heads at the noble area of Santos, seafront, Gonzaga, Boqueirão and Ponta da Praia, but also at the hill of Santa Terezinha, near José Menino, in a luxurious condominium of houses.

This map shows also that the wealthy people of Santos were located just behind the line of apartment houses of seafront, the place of residence of the floating population. And them concentration was growing in 1990s. This rise of the concentration place of the elite near the seafront can represent either a more expressive flow of household heads

with more than 10 minimum salaries to that place, or the “expulsion” of poor families from that place.

Map 8:



Analyzing with more detail the relation “population-households”, Map 9 brings the index of home density, interpolated by census tracts[5].

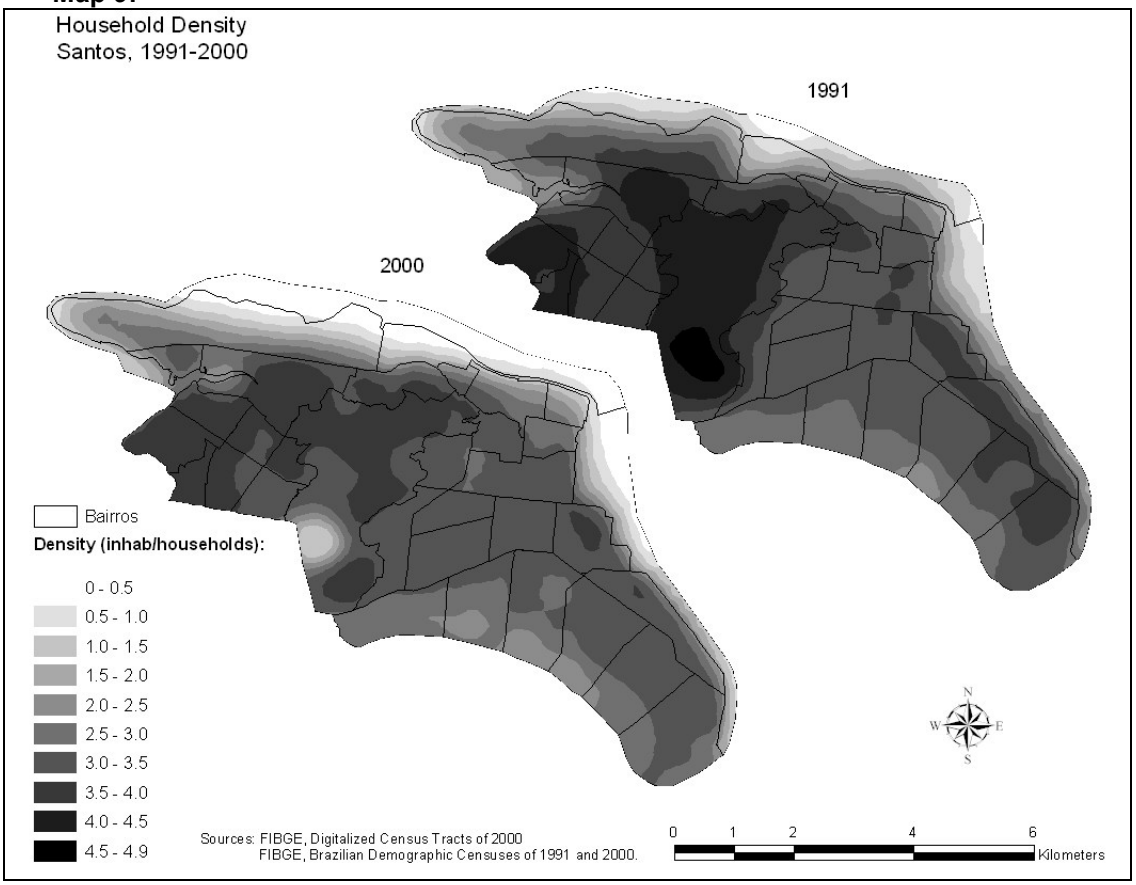
This map shows the different kinds of occupation of the area. Along the 1990s, as expected, there were more people living on homes of popular areas, and less inhabitants near the seafront. This lower density was more evident at Embaré in 1991, and at Gonzaga and Boqueirão, more recently. These areas concentrated the higher proportions of elderly in 1990s, as seen in Map 6. So, we can deduce that these locals concentrated a higher participation of elderly living alone.

Another possibility to explain this lower density at seafront, besides the familiar life cycle with a higher proportion of fragmented families, could be the higher participation of

[5] This index refers to the number of inhabitants over the number of households, representing a mean number of inhabitants by household.

occasional residences. But, according to the Demographic Census of 1991 and 2000, the number of these households was reduced at the period (from 21,600 to 20,816). A more real possibility would be the rise of vacant residences (from 13 thousand to 17 thousand), combined to the rise of closed residences (from 730 to 1,090), that could produce this lower index in 2000, especially at seafront.

Map 9:



This rise of vacant and closed homes could mean a higher “desertion” of households by the floating people, which would be looking for new vacation places, as denoted before. The most probable is that this was happening in a joint way with the rise of the elderly at these places, confirming the hypothesis that the elderly and the retired people are occupying the places left by the floating people.

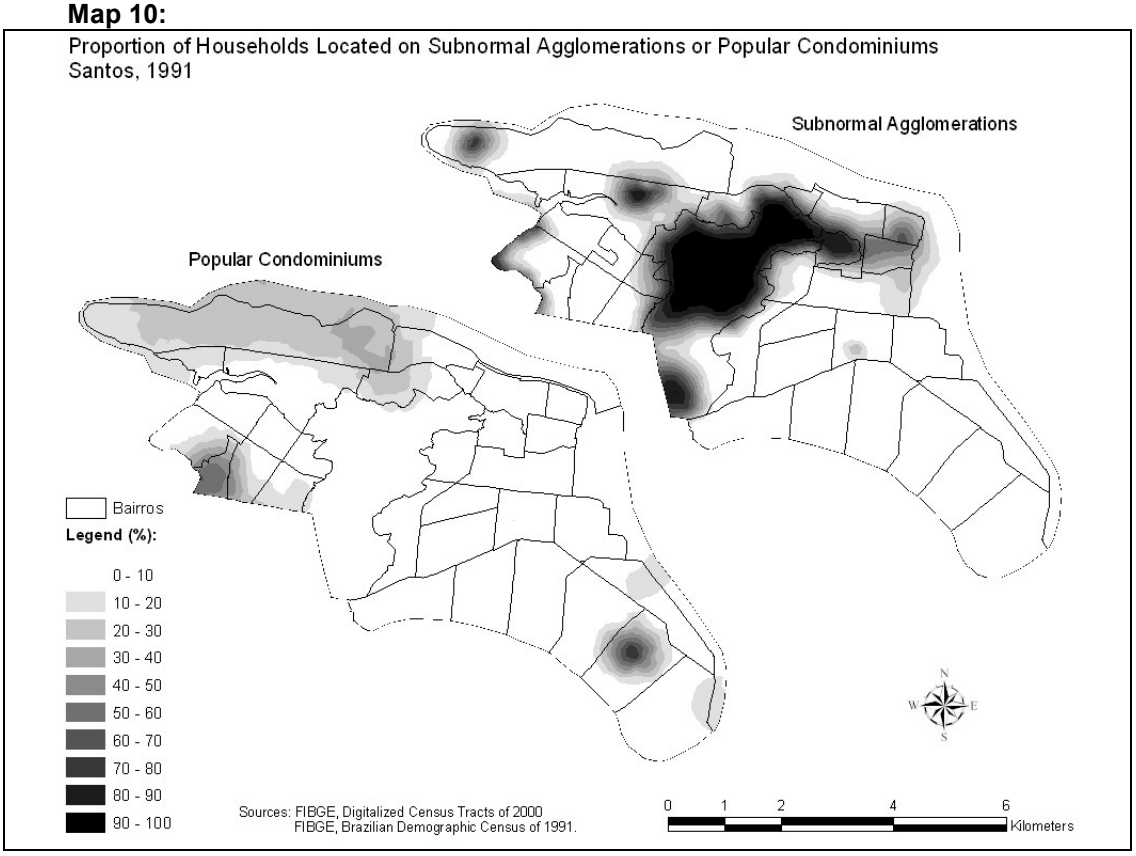
The next item aims to analyze with more detail the characteristics of the households at the census tracts level in Santos, in 1991 and 2000, in order to evaluate the residential conditions of the population.

The residential characteristics of the census tracts

The goal of this item is to verify the evolution of the residential conditions of the population at the census tracts level in Santos, and try to show that the worst conditions were located at the hills and the periphery of the municipality, clearly confirming vectors which leave the boundaries of the municipality.

Firstly, in order to know where the higher concentrations of households in subnormal agglomerations and in popular condominiums were located, Map 10 is showed for 1991[6].

Map 10:



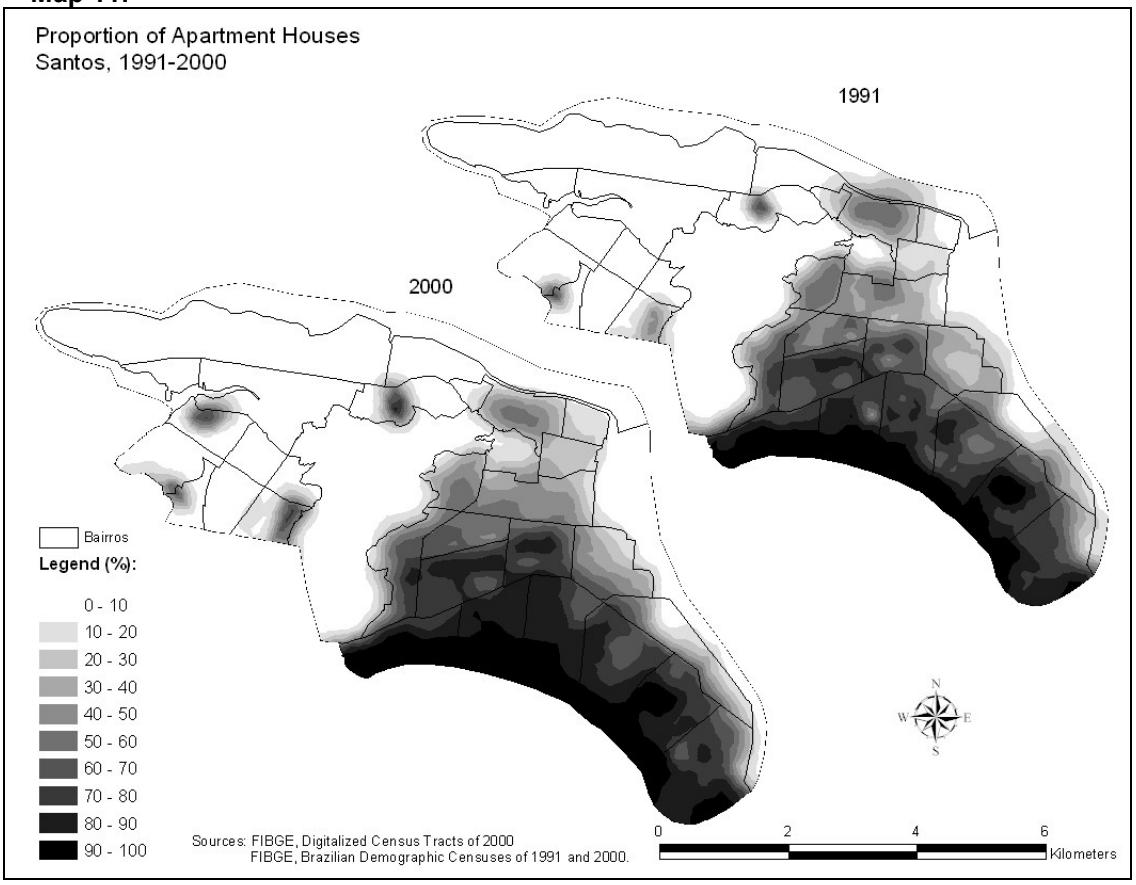
Map 10 shows that the subnormal agglomerations were more concentrated at the hills, as expected, also in Chico de Paula, in some places near the limits with Cubatão (at

[6] Unfortunately, is not possible to obtain a similar map for 2000, since this information is not present in the census tracts data in 2000.

northwest) and São Vicente (west), and between Paquetá and Vila Nova. It was showed, in these more antique bairros, a mixture of wealthy and poor inhabitants.

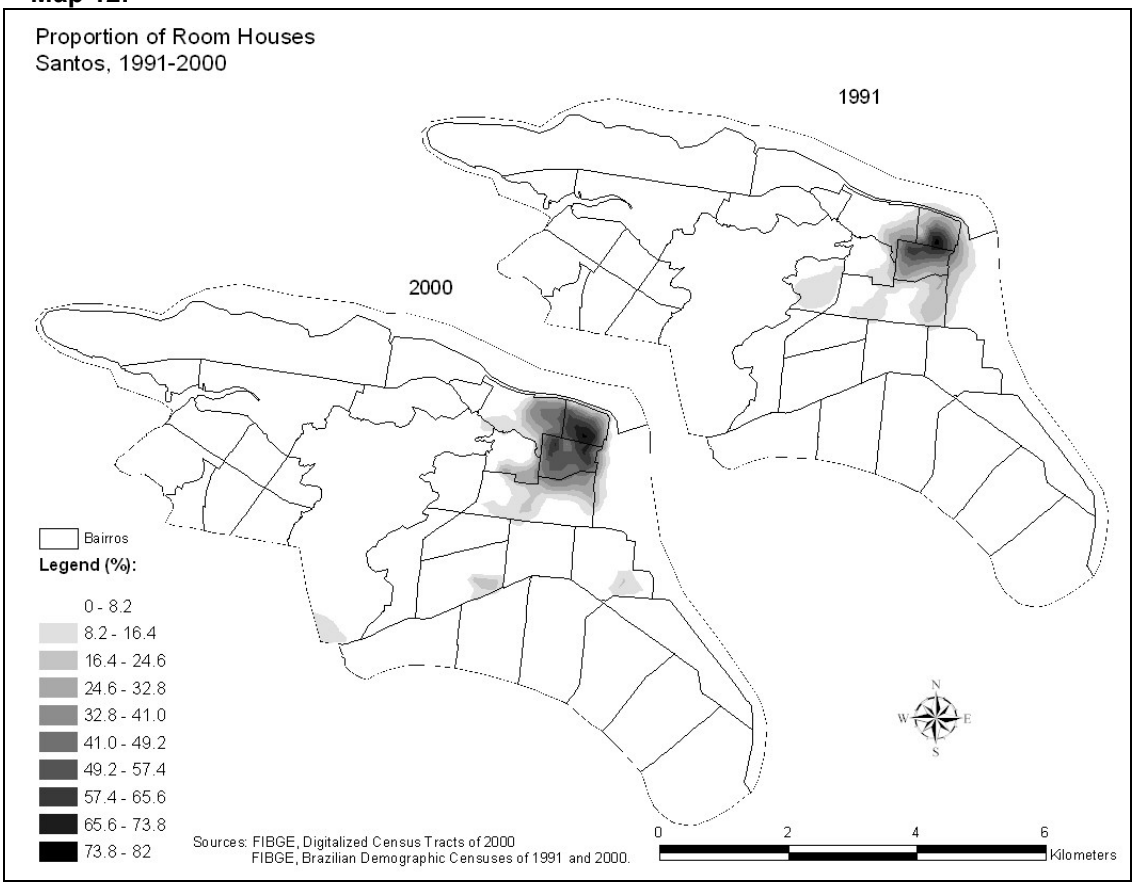
Focusing now the popular condominiums, these were more concentrated in Alemoa, Aparecida and Castelo. In this last one, a big popular condominium is located, which is always important, since it creates optional spaces of occupation for poorer population.

Map 11:



Maps 11 and 12 are the result of the interpolation of the variable ”type of household”. They clearly show the existence of a differential spatial concentration in terms of this variable. While the concentration of apartment houses was more expressive at the seafront, besides the presence of some isolated places (Map 11), the spatial concentration of households like rooms (room houses) was more significant in Paquetá, Vila Nova and Centro, the most antique area of the island (Map 12). The higher concentration of houses was verified at the hills, at west part of the island, and near the harbor zone, places which correspond to the white area of these two maps.

Map 12:

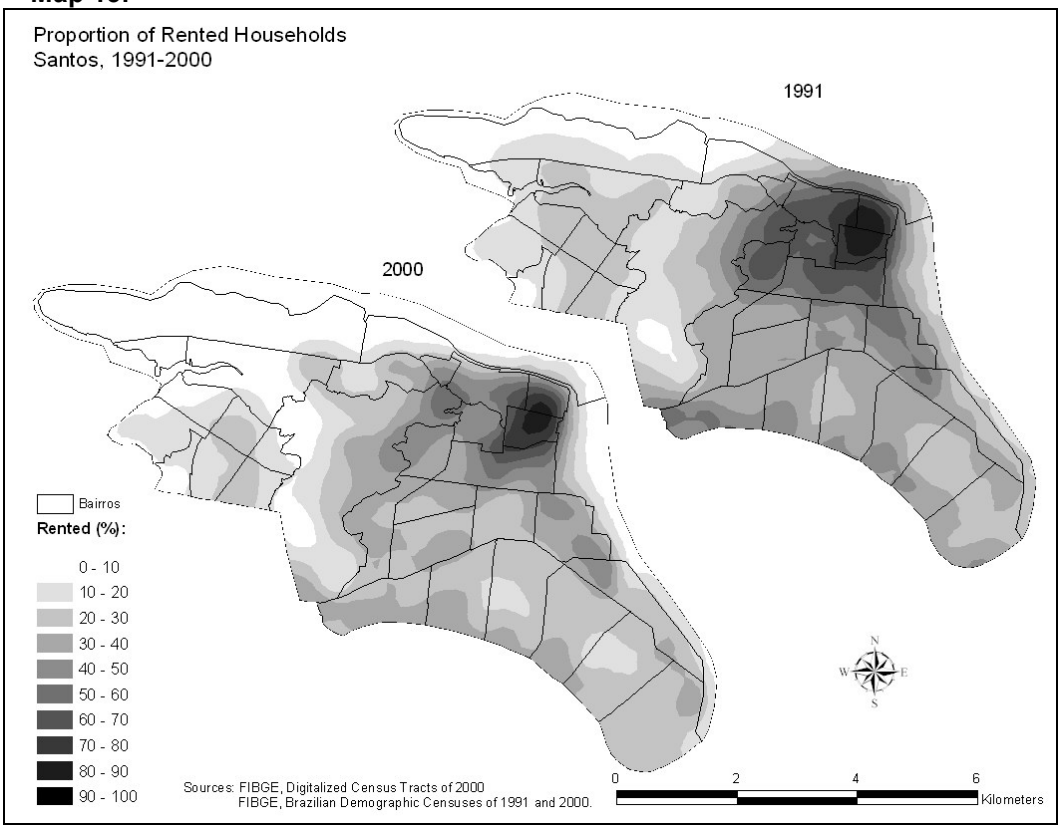


It can be verified, from these maps, that this different spatial concentrations of types of household didn't modifies themselves in a significant way along the 1990s, and also the confirmation of the limits between the popular, the noble and the antique areas. The condition of occupation of the households also pointed to the referred division, which can be observed from Maps 13 and 14.

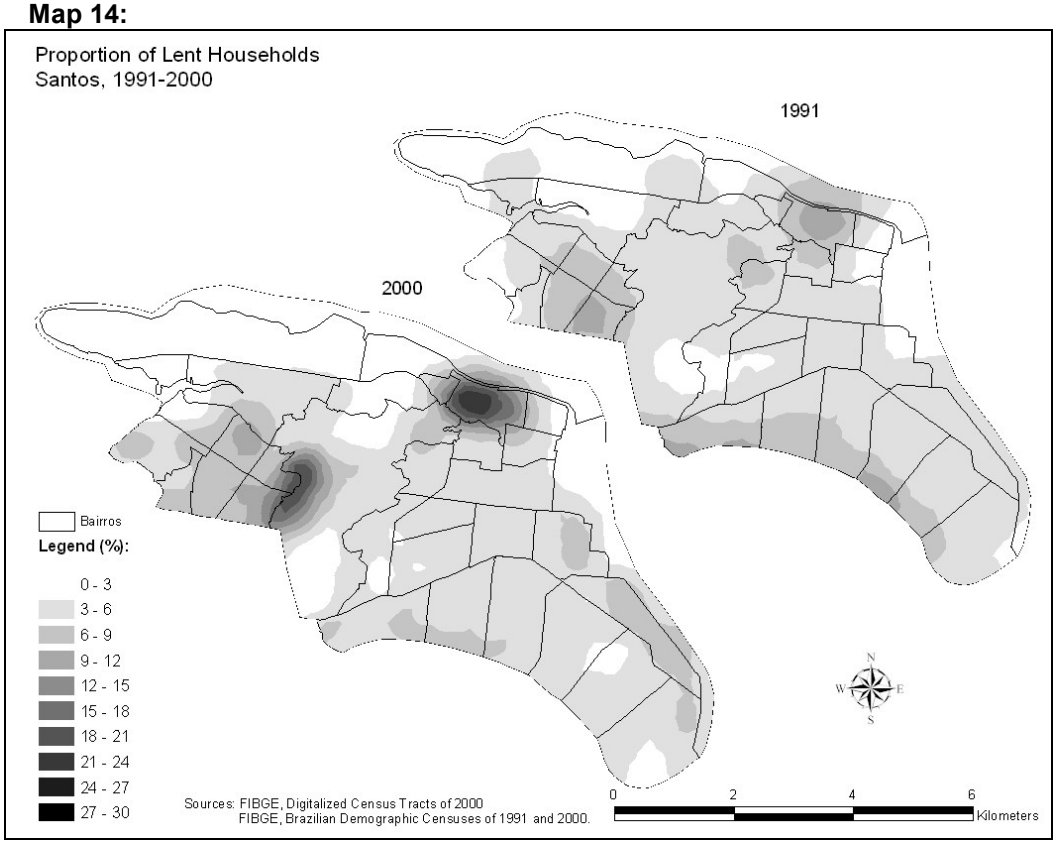
Since the higher concentration of own households was located on the white part of Maps 13 and 14, it can be noted that the localization was more expressive in the popular area, but was also significant in the noble area. And the participation of rented households was located at Paquetá, Vila Nova and Centro (Map 13).

The condition of occupation of the property brings a reflection about its kinds of occupation. In the popular area, or the periphery, the own property is more accessible to poorer population, and the auto-construction is more significant. Moreover, the person usually thinks that owns the land, but sometimes is not.

Map 13:


Proportion of Rented Households
Santos, 1991-2000
1991
2000
Bairros
Rented (%):
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
Sources: FIBGE, Digitalized Census Tracts of 2000
FIBGE, Brazilian Demographic Censuses of 1991 and 2000.
0 2 4 6
Kilometers

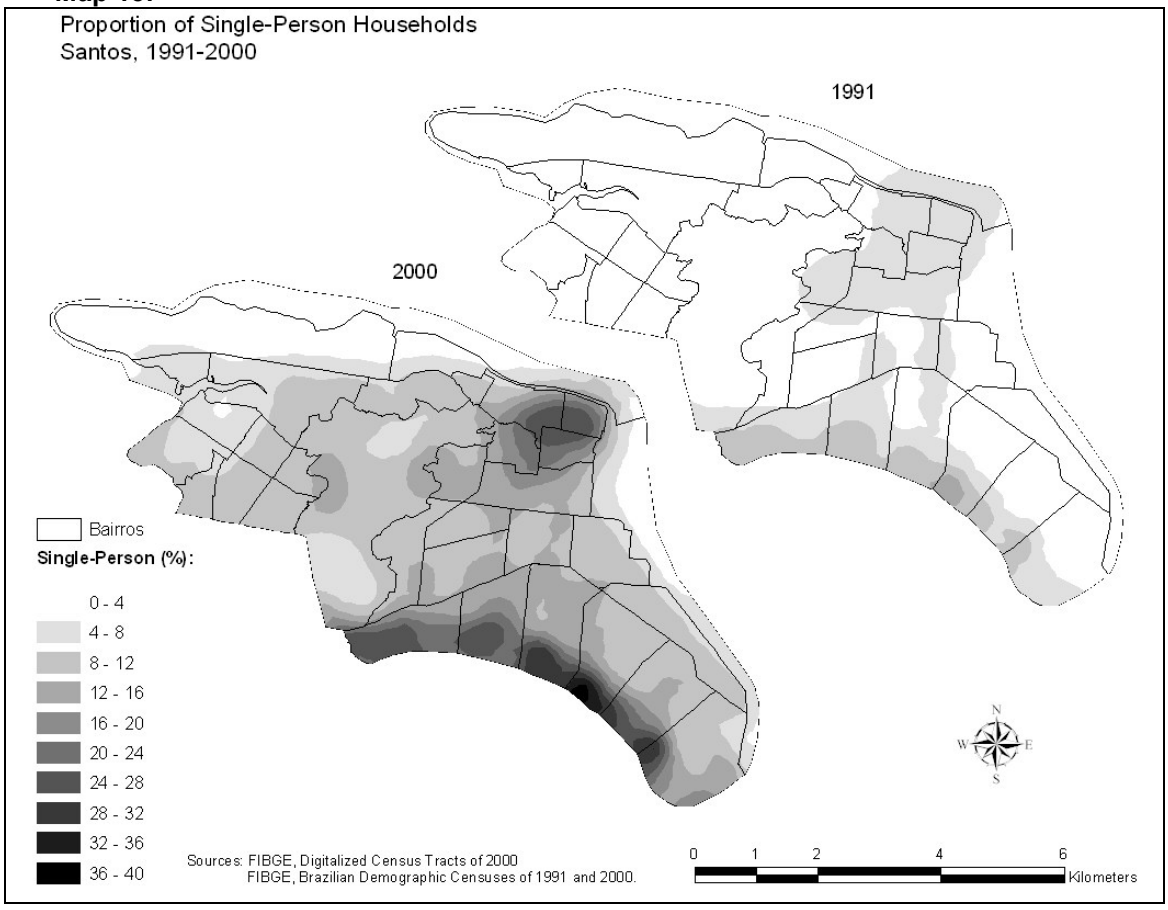
Map 14:


Proportion of Lent Households
Santos, 1991-2000
1991
2000
Bairros
Legend (%):
0 - 3
3 - 6
6 - 9
9 - 12
12 - 15
15 - 18
18 - 21
21 - 24
24 - 27
27 - 30
Sources: FIBGE, Digitalized Census Tracts of 2000
FIBGE, Brazilian Demographic Censuses of 1991 and 2000.
0 2 4 6
Kilometers

When the property is rented, its occupation is done by persons with a better financial situation, which can maintain the rental cost, or live in rooms at the antique area, as seen in Map 13. The households of the most antique area were, in general, rooms, rented by only one person, as noted forward. However, in the noble area, the wealthy inhabitants had conditions to buy the properties.

The households with the condition of occupation “lent” (Map 14) were located more and more near Centro and at the slopes of the hills, in São Jorge and Caneleira. It also can be verified that, in 1991, there was a participation of this kind of occupation at the seafront, highly reduced in 2000, in favor of some areas near the harbor zone, like Estuário and Macuco. These data, combined to the expressive decline of the growth rates of the vacant and occasional residences in Santos in 1990s, showed the higher demand for households, especially those located near the seafront.

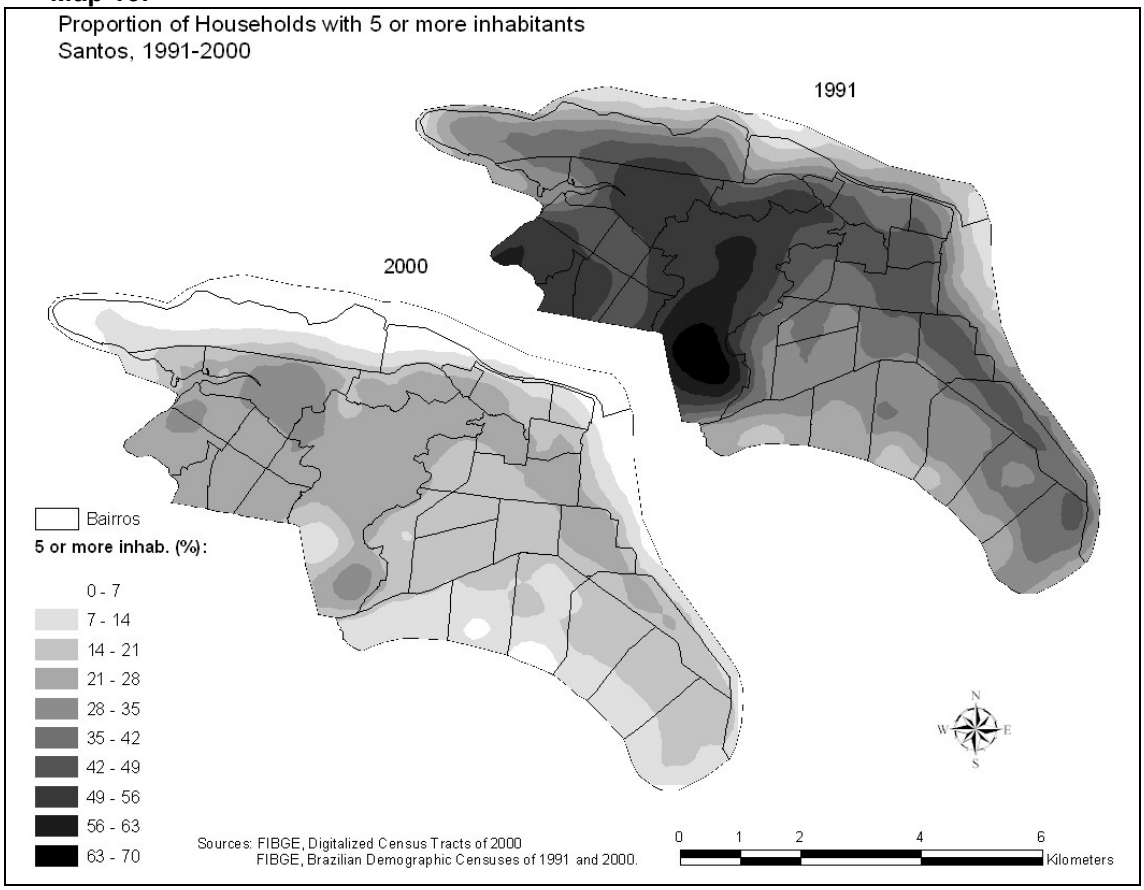
Map 15:



Focusing now the number of inhabitants of the household, were created the Maps 15 and 16. Analyzing the households with only one inhabitant (Map 15), it can be noted that they were more expressively located at the seafront, as well as in areas near Paquetá, more recently. And this spatial concentration rose in 1990s.

The higher concentration of single-person households in 2000 at the seafront represented the higher participation of elderly and retired people in these areas, living alone, as seen before. It could also represent a higher participation of occasional residences, with the owners leaving some house keepers to live on and take care of their seasonal properties. However, this hypothesis seems improbable, since the number of these households was reduced in 1990s, with a negative annual growth rate. Perhaps, the most probable is that the participation of households with a higher number of inhabitants was been reduced in these census tracts, which would rise the proportion of households with one inhabitant.

Map 16:



With respect of the significant participation of households with one inhabitant in Centro, Vila Nova and Paquetá, especially in 2000, these areas were also those with a higher proportion of lent households, rooms and subnormal agglomerates.

It can be verified, from Map 16, that there was a reduction in the proportion of families with 5 or more inhabitants in 1990s, which raised the participation of families with less members. The concentration places were the same ones, near the harbor zone, the slopes of the hills, and in Chico de Paula, a more recent expansion area, near Via Anchieta (the highway), but with expressive reductions of their participation.

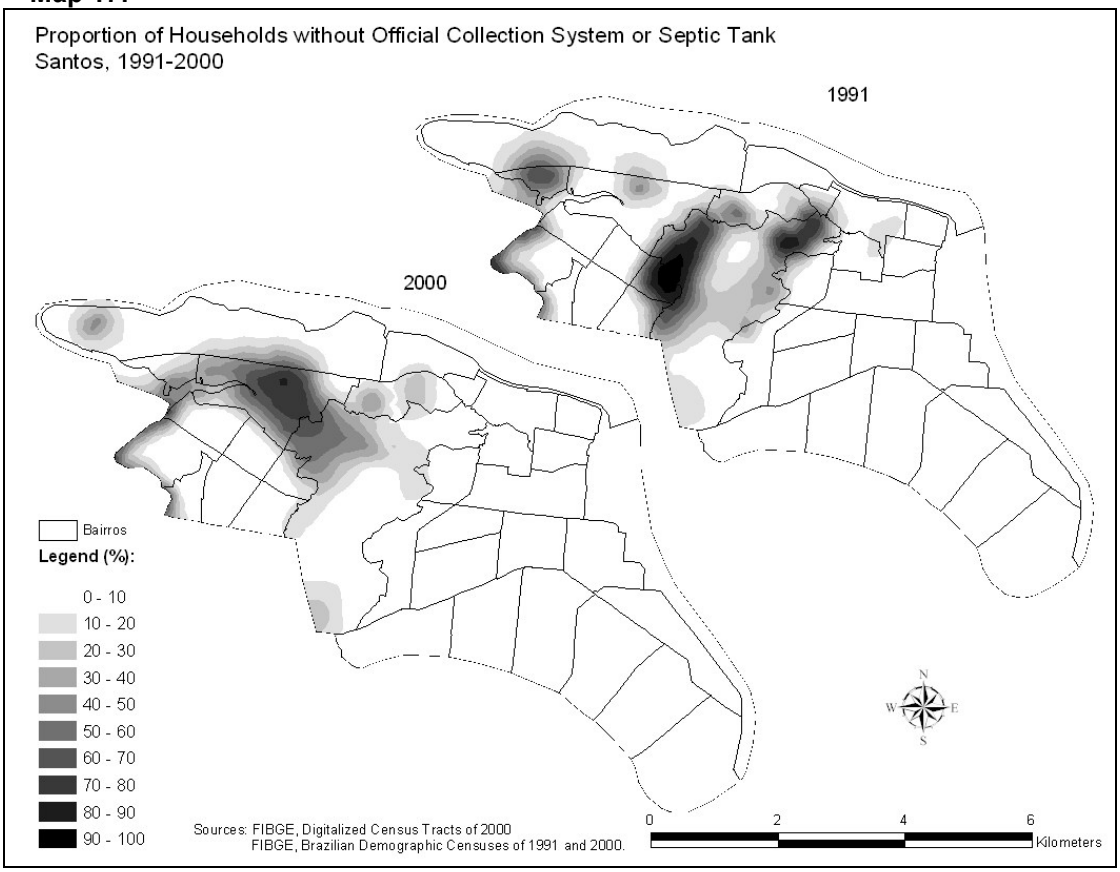
This map reproduces in part the general trends of decline of fertility, which happened mainly in the big urban agglomerates in Brazil, and to have an influence on the size of the families, and reproduces also, in a huge part, a possible modification of the households' profile, with the reduction of the size of the families. This reduction of families' size could have occurred either as consequence of their fragmentation, or the big families was been replaced by smaller families, denoting a possible movement of bigger families to outside the municipality, in a search for more adequate places to their financial condition.

With respect to the sanitary installation, which can help to detect more recent occupation areas (expansion areas), it can be seen, from Map 17, that the participation of households without official collection system or septic tank was more concentrated in Chico de Paula, in 2000, as well as in a place between the Casqueiro river and Vila Industrial, at the limits of Santos and Cubatão. So, these areas could be considered as expansion areas, located on the periphery of the municipality.

Analyzing now the water supply and garbage destination, the 2000 data shows a general distribution system of almost 100% for the whole municipality, as well as with respect to the garbage destination. The few areas without these public services in 1991 were located at the slopes of the hills.

So, with respect to households, the maps explained before confirmed the division of areas, as nobles, popular and antiques. The noble areas had a high concentration of apartment houses, in general owns, with until four inhabitants, and near the seafront, the family size was smaller, showing that this place was concentrating families at fragmentation stages, with high participation of the elderly.

Map 17:



In the most popular areas, a higher concentration of houses, owned, and nuclear families was observed. In the most recent expansion places, verified from Map 17, there was, in general, a higher proportion of owned houses with more inhabitants. There was also an expressive participation of families at consolidation stages, or consolidated already. However, in the most antique places, it was observed a higher proportion of rooms used as household, with a single person and, in general, rented. This characteristic can be observed also in other municipalities. So, this is not a specificity of Santos.

It can be observed also, from the presented maps, that there was a mobility of the spatial concentration of these variables. However, in the same direction which was occurring, what denotes the configuration of an expansion vector, which goes outside the municipality limits.

Final Considerations

The presented maps showed clearly the tendency of socio-spatial segregation of population. The areas located until two kilometers from the seafront, in general the noble ones, occupied by wealthy and older household heads, and with more proportion of apartment houses, in general owns. It was important also the participation of single-person households, especially near the coast of Boqueirão and Embaré, and the participation of nuclear families, with until four members, on the other points of the seafront.

Embaré was a singular area in comparison with the other locals of the seafront, with high proportions of old household heads and single-person households, but with less income, as well as less participation of own households. So, its way of occupation was different from the rest of seafront bairros.

The census tracts located at west of the hill zone, until a distance of three or four kilometers of it, and also that located until one kilometer of the harbor zone, the coastal strip at north, northeast and east of the island, were the most popular areas, with more participation of own houses, more inhabitants, high levels of illiteracy, youngest household heads (with less than 50 years), poorer ones, and with lower levels of public services, although with expressive improvements in 2000.

The tracts situated near Centro (the old center of Santos), at northeast, an area with older occupation, denoted the higher concentrations of rooms, “lent”, rented and single-person households, although had concentrated in 1991 bigger families, significant levels of illiteracy, household heads with ages until 40 or 50 years, without income or monthly incomes until one minimum wage.

So, these three areas were observed in the municipality of Santos, a noble one and two more popular, with limits well defined. Between them, a space occupied by the mean class, inhabited by household heads with monthly incomes between 5 and 10 minimum wages, ages between 40 and 69 years (consolidated families, and families in the stage of fragmentation), nuclear families and, in general, own apartment houses.

It was observed also, in this paper, the relation core-periphery, with the periphery been defined as a more popular area; the deterioration of the old center and the appearing of new centers, as the located on Gonzaga; the “verticalization” of households; the spatial movement of social groups; and the spatial segregation, in terms of spatial concentration of social groups. All of these socio-spatial processes are present in the intra-urban analysis denoted by Villaça (1998).

So, the core-municipality consolidates itself as a more developed municipality, with more complex urban functions than its neighbors, and the socio-spatial processes which occurred in it are gradually moved to its nearest neighbors, and so on, explaining the urban expansion of the metropolitan area.

This analysis shows how the processes are complex and have its expressions well located, which are more explained by mean of a municipality analysis. So, in order to understand better the processes involved in a regional analysis, usually an intra-urban analysis is necessary, because it can detect the causes of these broader processes, as well as to help on the simplification of their complexity.

This paper denoted also that important intra-urban analysis can be done without the presentation of any table, only by means of maps of interpolated variables. As important as the analysis of the intra-urban dynamic was the presentation of this new methodology of analysis, based on the spatial concentration of certain population and household attributes. The kriging technique shows itself well adequate to the proposed goals, since in the 1991-2000 period of time, with a range of only nine years, important movements of spatial concentrations were seen in practically all of the created maps.

Given the space limitation of a scientific article, it was preferred not to broach more specific details about the creation of these maps, the presentation of the variograms which were used to create the interpolations, the treatment of the census data, detection of anisotropies, calculation of model parameters, etc. But these steps can be more studied by means of a more detailed search on the literature. It was preferred, in this paper, to emphasize more the analysis which can be done by mean of these spatial statistics techniques, through a study case.

Finally, I hope that this paper can be used as inspiration in order that other researchers use their study area data with the same goals, what could originate new applications for these presented techniques, and also turn possible the change of information about this matter.

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