#75
A CONFIGURATIONAL STUDY OF SOCIOSPATIAL SEGREGATION IN THE METROPOLITAN REGION OF FLORIANOPOLIS, BRAZIL

BRUNA DA CUNHA KRONENBERGER
Universidade Federal de Santa Catarina, UFSC
brunakron@gmail.com

RENATO TIBIRIÇÁ DE SABOYA
Universidade Federal de Santa Catarina, UFSC
rtsaboya@gmail.com

ABSTRACT

Several classical studies of urban phenomena such as socioeconomic inequality and spatial segregation adopt the "concentric circles", or center/periphery model to characterize locations in urban space, according to which distance to CBD is the main determinant of high and low income classes positions. Contrasting to this coarse-grained view of the city, configurational analyses allow us to identify details in the street level, revealing how the urban fabric is connected and what are the roles of each space in several scales concerning both its proximity to all other spaces and its potential to channel flows between other pairs of spaces. In this paper, we examine the relationships between socioeconomic inequality and the position of different socioeconomic strata in Florianopolis' Conurbation Area (FCA). We build a multi-dimensional Socioeconomic Index from the 2010 Brazilian Census data and contrast it with configurational properties of the grid using the Theory of Space Syntax and its main measures (Integration and Choice). Several recurring patterns were identified, both at the global and local levels. Results show that more privileged groups tend to occupy areas that are highly accessible both in terms of Integration and Choice, but areas with the highest values in these measures are occupied by the cohorts immediately below. Despite higher global Choice averages, we found that upper cohorts tend to avoid locating themselves directly on main streets or highways, preferring, instead, a more inwards oriented location in relation to the foreground network. That seems to express a strategy which balances relative isolation – avoiding the negative effects of high intensity traffic such as air and noise pollution – with easy access to the city center. In the local level, grid discontinuities and the prevention of mutual visibility are the strategies utilized (often simultaneously) to separate two contrasting areas that, otherwise, are located near to each other.

KEYWORDS

Socioeconomic Inequality, Sociospatial Segregation, Space Syntax, Urban Configuration, Socioeconomic Index.

1. INTRODUCTION

Brazil's urban development was deeply influenced by the contradictions of the city (Freyre, 2014): the rich and the poor, the dominant class and the popular strata, the lofts and the huts, the gated communities and our indigenous version of the shanty towns, the notorious and infamous "favelas". According to Villaça, "Brazil's biggest problem is not the poverty, but the inequality and injustice associated with it" (Villaça, 2012, p. 44). Understanding Brazil's society

implies comprehending the phenomena of socioeconomic inequality, to the same extent that comprehending Brazil's urban space – ethereal drama stage of class struggle and its contradictions galvanized in concrete – implies comprehending the socio-spatial segregation.

Quite a few theories on the relations between society and urban space – and consequently about socioeconomic inequality and spatial segregation – approach the subject from the classic point of view of concentric circles – or center/suburb. This perspective took shape in the beginning of the 20th century, with the School of Chicago, and it still reverberates in many socio-spatial studies. However, the generalized description of the urban space and the neglect of the socioeconomic relations of society (Harvey, 1980) direct us towards an ideological comprehension of urban phenomena, naturalizing urban injustices like the socio-spatial segregation (Gottdiener, 1997).

To this perspective of social production, we propose adding the study of spatial configuration, that allows us to describe and comprehend the locations within the urban space in a more refined way, revealing in different spatial scales the possibilities – and probabilities – of encounter between different groups in their daily movements. Configurational analyses help us put in evidence systems of permeability and barriers to movement – and, by consequence, proximities and distances – between spatial locations in a much more precise way than the descriptions traditionally adopted by the theoretical models that aim to explain segregation. Therefore, while most studies on spatial segregation consider the urban space in a wide and shallow spectrum, the configurational analysis uncovers more details about it, while considering the way the urban fabric is connected.

Our research aims to understand the relation between socioeconomic inequality and the location of the socioeconomic strata of the population of the Florianopolis' Conurbation Area (FCA), located in the south of Brazil, by investigating the distribution of these strata and their relation with the urban space configuration. In order to do so, we characterized the FCA with a Socioeconomic Index and described its configuration through the theory of Space Syntax and its main categories, Integration and Choice.

1.1 FLORIANÓPOLIS' CONURBATION AREA (FCA): BACKGROUND

Florianópolis' Conurbation Area (FCA), for the purposes of this study, encompasses four municipalities (Florianópolis, the state capital, São José, Palhoça and Biguaçú). It is unique in the Brazilian urban context, with its invaluable natural heritage – highly attractive to tourists, and also physical basis for the production and consumption of its urban space –, the insular condition of a significant part of its territory, and the deep marks in space and local culture brought about by Azorean immigrants.

Initially, the main foci of development were concentrated in small localities around the Island of Santa Catarina, in which fishing and subsistence agriculture were the main economic activities. Travels were made almost exclusively by the sea, with few and far between terrestrial paths sinuously connecting the "freguesias", as these localities were known (Reis, 2012). From 1970 onwards, with the construction of BR-101 and BR-282 federal highways, the four municipalities experienced an intensification of their urban fabrics intertwining, marked, among other things, by the concentration of state investments in the insular (and richer) portion (Sugai, 2015).

According to Sugai (2015), these investments were directed to those portions of the Island in which the upper classes had direct interests. This way, a "structuring and interconnection axis was formed between the residential areas of the elites and the neighborhoods where they intended to expand their residential and summer areas" (Sugai, 2015, p.148). In spite of these actions to improve accessibility, nowadays FCA's grid is among the most segregated in the world (Medeiros, 2013), not only as a consequence of its environmental conditions but also because of historical, cultural and political aspects.

Figure 1 - Conurbation of Florianópolis and its main geographical and urban landmarks.

2. DATASETS AND METHODS

The method of the research articulates two specific objectives: the characterization of the socioeconomic reality of the FCA by a Socioeconomic Index, and the characterization of the FCA's urban configuration through Spatial Syntax Theory. From the output of these descriptions, we compare the location of socioeconomic strata of the population with its configurational characteristics.

The Socioeconomic Index draws from the work of Jannuzzi (2001) and Genovez (2002), and uses data from IBGE's Demographic Census Research (2010), which means that the territorial unit adopted is the Census tract, totalizing 1216 sectors in the FCA. It pursues some desirable key features, such as reliability, comprehensiveness, intelligibility, data gathering feasibility, updating periodicity, and spatial resolution.

The dimensions upon which the index was built are: Income, Education, Housing, Infrastructure and Surroundings. Each of these dimensions was described through one or more variables, as shown in Table 1, according to its availability in IBGE's Census and preliminary analyses about redundancies. The weight of each dimension was determined through the AHP method, building on the experience and input of the authors and a team of experts working in the master plan of one of the cities of the FCA.

Socioeconomic Index	
Dimensions and Variables	**Weight**
Income	**0.482**
Household average income	
Percentage of individuals earning less than US$560.00 (monthly)	
Literacy	0.146
Percentage of literate heads of households	
Housing	**0.198**
Number of bathrooms per residents	
Infrastructure	**0.111**
Percentage of residents with own bathroom or access to public sewer system	
Percentage of residents with access to public garbage collection	
Percentage of residents with access to public electricity system	
Neighborhood	**0.063**
Percentage of residents with access to public street lighting	
Percentage of residents in paved streets	
Percentage of residents in areas free of sewer exposure	
Percentage of residents in areas free of waste accumulation	

Table 1 - Dimensions, weights and variables of the Socioeconomic Index.

Thus, five socioeconomic cohorts were classified (A, B, C, D and E), with cohort A referring to better socioeconomic conditions, that is, higher household average income, percentage of individuals earning less than US$ 560.00 monthly near to zero, higher percentage of literate heads of households, houses with better infrastructure conditions and neighborhood with urban facilities and services. On the other hand, cohort E represents the opposite conditions to those of cohort A.

The configurational characterization of the FCA's urban space was made through an angular analysis of segments consisting in global Integration (Rn), local Integration (R1200m, roughly equivalent to a 15 – minute walk), global Choice (Rn) and local Choice (R1200m). After obtaining the configurational and socioeconomic information on the FCA, the data were exported to a geoprocessing software (QGIS), allowing the superposition of the information, and the visual and statistical analyses to be presented below.

3. RESULTS

3.1 PRELIMINARY OBSERVATIONS

The distribution of the socioeconomic cohorts throughout the conurbated area shows that the highest strata is predominantly located in Florianópolis, especially in its insular portion. We can also confirm the concentration of cohort A along the direction that Sugai (2015) called the "privileged access routes of the upper classes", extending from south of BR-282, along Av. Beira-Mar Norte, and heading north to Jurerê and to the east towards Lagoa da Conceição (Fig. 1).

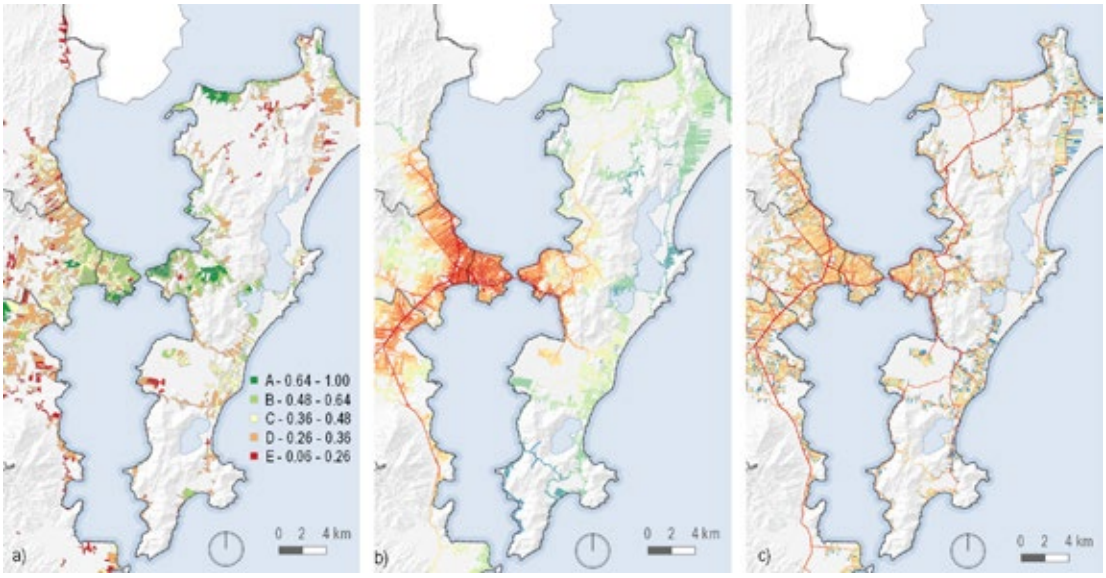

Figure 2 - a) Socioeconomic Index; b) Global Integration; c) Global Choice.

Reciprocally, sectors with worse socioeconomic conditions are primarily located in the peripheries of the conurbation, particularly in the mainland and in the northeast and south / southeast of the Island. The situation of Biguaçu, the poorest of the municipalities, is especially problematic, with almost all of its sectors belonging the two lowest socioeconomic cohorts ("D" and "E"). On the other hand, it is also possible to see some of these strata located in central areas, although in a significantly smaller number.

Configurationally, we see a more intensified grid at the insular and continental peninsulas in the central portion of the system, where the most integrated segments are located. Outside of this Integration core, there is a rather dispersed grid pretty much everywhere else, resulting in several disconnected neighborhoods in the periphery. This is a consequence of three main factors: the extremely complex and varied environmental conditions, the previous rural subdivision, and the substitution of a protourban structure based on naval flows by another based on a rather precarious road system (Reis, 2012). In the mainland, however, this situation is somewhat less severe.

An examination of the global Choice values (Fig. 2c) shows that the foreground network of this central core is formed by rings that structure more local areas but, beyond them, it is constituted mainly by expressways that divide, more than integrate, the urban tissue. Because of a near tree-like structure, several of them are, for practical purposes, the only connections available between important localities. In the mainland, however, there are a greater number of situations in which the foreground is in close proximity to the background, creating areas in which it is easy to access the former from the latter, and also affording a greater variety of possible paths.

3.2 SOCIOSPATIAL ANALYSIS: GLOBAL RADIUS

3.2.1 GLOBAL PATTERN #1: PRIVILEGED CLASSES IN MORE INTEGRATED STREETS

The overlay of the Socioeconomic Index and Global Integration shows a general proximity of sectors in better socioeconomic conditions to more integrated routes. This is the case for the most part, although some of them are located outside of the Integration core, such as "Jurerê" in the north, "Lagoa da Conceição" in the east, and "Pedra Branca" in the West (see Fig. 1 and Fig. 2a). Of these, only the latter is not directly related to an environmental amenity (beach and lagoon for the first two, respectively).

Figure 3 confirms this trend and shows that there is a little drop in global Integration values for the "E" cohort, with highest values in the "A" and "B" ranges (Fig. 3a). Figures 3c and 3d show in more detail the locations of "A" class in comparison to the "E" class, also confirming that the higher cohorts are located in more integrated areas. This suggests that privileged classes tend to occupy areas of the city that are nearer, on average, to the system as a whole, revealing a desire (and capacity) to take possession of the best areas in terms of accessibility (at least as inferred from a configurational and angular point of view). At the same time however, they seem to avoid the most integrated streets of all, probably because of the nuisance supposedly associated with higher number of people and liveliness of these spaces, preferring slightly less (yet still highly) integrated ones.

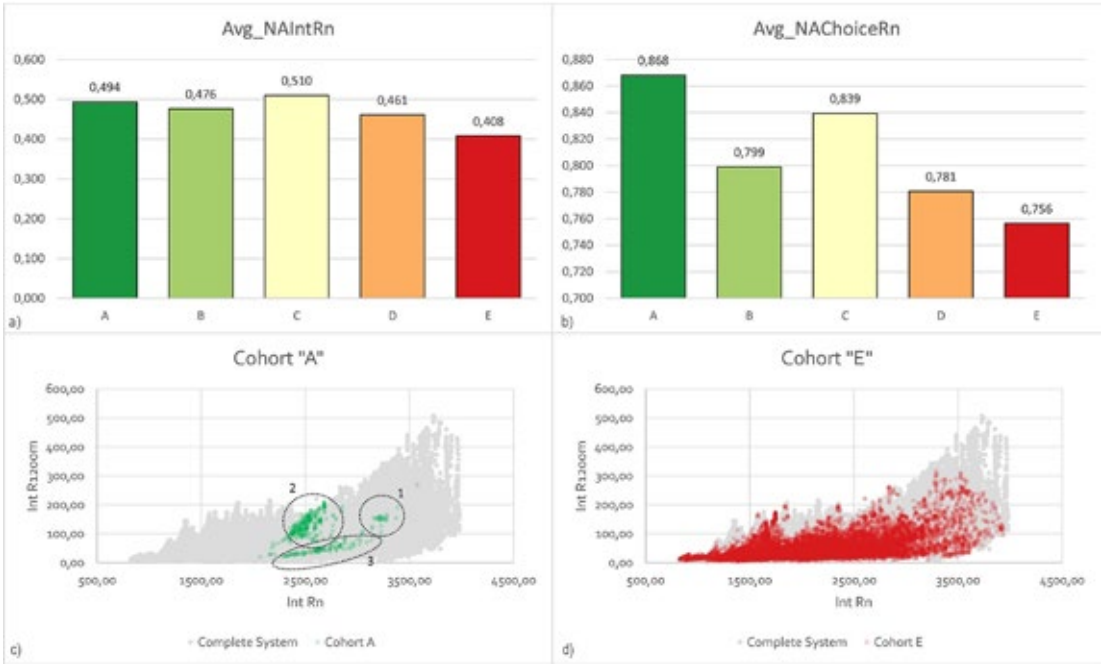

Figure 3 - a) averages of the normalized global Integration for socioeconomic cohorts; b) averages of the normalized global Choice for socioeconomic cohorts; c) scattergram for cohort "A" (non-normalized measures); d) scattergram for cohort "E" (non-normalized measures).

Figure 3c shows that this average is achieved by a combination of medium-high global Integration values and a relatively narrow range, especially if compared to the "E" cohort. It also shows three distinct clusters: the first (1) is Beiramar Norte, an area along the sea with high global and medium-high local Integration. The second (2) corresponds to planned neighborhoods in medium global Integration and medium-high Local Integration (Jurerê, Pedra Branca and Jardim Anchieta). They represent newer developments that avoided the more central areas but still display a grid-like structure, although the connections to the immediate surrounding tend to be sparse. The third (3) cluster comprises, for the most part, neighborhoods associated with environmental amenities (Praia Brava, Canto da Lagoa da Conceição and Cacupe). One

important exception, in that it is not close to an important environmental amenity, is Bosque das Mansões, in the central portion of São José. All of them are poorly connected on a local level, presenting closed communities' characteristics (or actually being one, as is the case of Bosque das Mansões) and tree-like internal structures, while varying more freely on global Integration values.

By the same token, it is clear that the vast majority of "E" sectors (in red) are located in the more segregated, peripheral and disconnected areas, as can be seen by a visual comparison of Figures 2a and 2b. Although there are spots from the "E" cohort in areas with good integration, this is clearly an exception and not the rule, probably originated by a combination of irregular occupations and the necessity to be close to jobs and other facilities. The numerical analyses provided in Figures 3a and 3b confirm this finding, albeit Fig. 3d shows that the range of locations for the "E" cohort is much larger and nearly encompasses the full range of Global Integration. The image leaves no doubt, however, that there is a significantly higher concentration of locations in the medium and lower ranges.

3.2.2 GLOBAL PATTERN #2: NON-RESIDENTIAL ACTIVITIES IN INTERMEDIARY COHORTS

As expected, there is some coincidence between Integration and the density of nonresidential activities and Jobs (Fig. 2b and Figs. 4b and 4c). The scattergram in Figure 5 shows, however, that higher densities of nonresidential activities are almost never found in the extreme ranges of the socioeconomic index, concentrating very clearly at around 0.5 – 0.6.

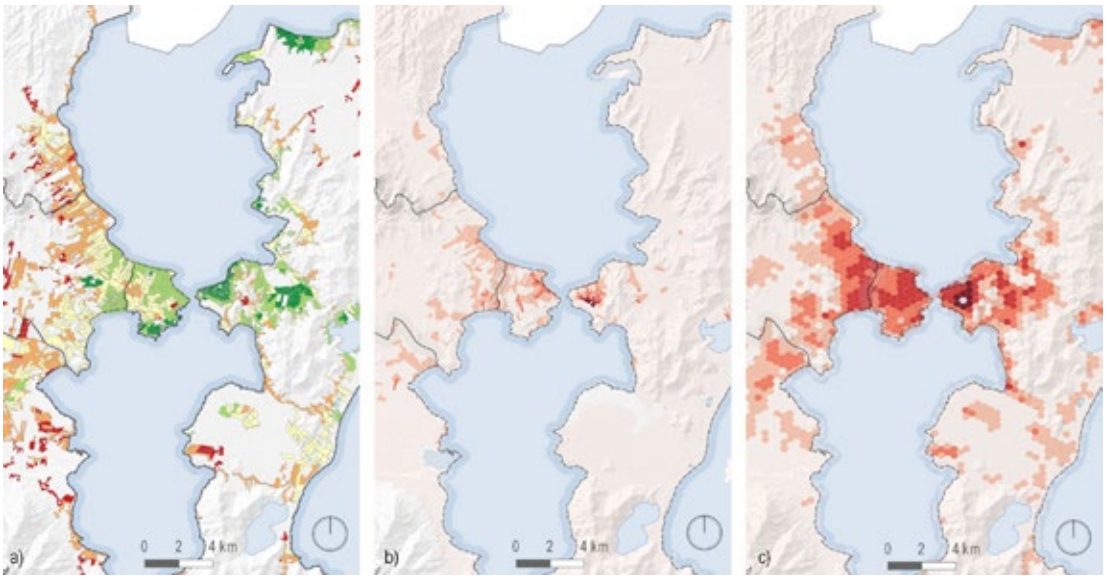

Figure 4 - a) Socioeconomic Index; b) Non-residential density (units per hectare); c) Quantities of jobs.

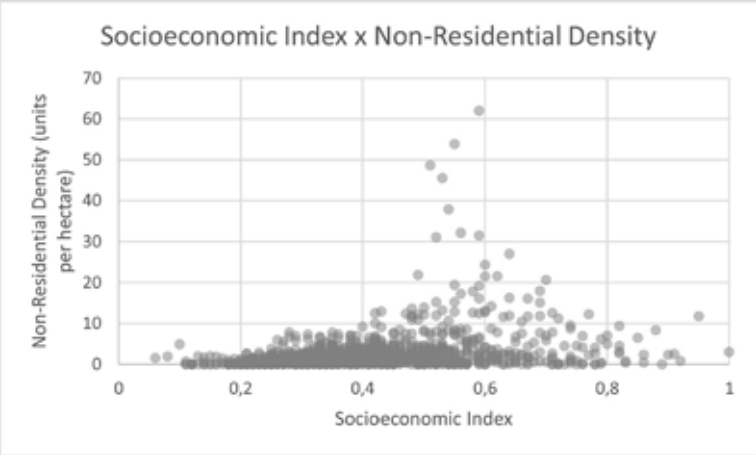

Figure 5 - Non-Residential Density and Socioeconomic Index.

From this point, the density of nonresidential activities decrease in both directions. We suggest that this corroborates the avoidance of most integrated lines by the highest cohort, as mentioned earlier. Nonresidential activities are, after all, a source of liveliness, sounds, transit, smells and other inconveniences. Furthermore, this social group is highly mobile and willing to trade some accessibility (nearness) by a quieter surrounding. This, coupled with the next pattern relating to global Choice, guarantees that it will have near optimal locations within the urban system.

In summary, then, we have a situation in which there is a high dependency between the four municipalities and this central area, with especially bad conditions in the "E" cohort case, which is located at the more distant regions of the conurbation. These regions are extremely poorly served by nonresidential activities – not only retail but also important facilities such as bus terminals, hospitals and governmental departments, among others. Consequently, socioeconomic deprivation is made even worse by this combination of locational aspects, especially when we consider their need to access these activities in places far from home and their dependence on a poor public transportation system.

3.2.3 GLOBAL PATTERN #3: PRIVILEGED CLASSES NEAR HIGH CHOICE STREETS – BUT NOT TOO NEAR

Differences in Choice between better and worse off classes are even more pronounced than those of Integration (Fig. 3b). On average, the choice values of the "A" range are much higher, suggesting that they locate themselves in areas at or near streets high in through movement, although, again, the higher values are in the "B" cohort. This proximity, however, does not mean direct contact; in several areas, what happens is that the "A" cohort is near high Choice roads but slightly removed from them. This affords easy access to the road (and, consequently, to the CBD), while at the same time avoids the nuisance brought about by the intense traffic.

Conversely, "D" and "E" cohorts frequently occupy areas immediately adjacent to high global Choice segments. This pattern may be found in several locations, such as State Highway SC-401 (Fig. 6-1), that connects the CBD to the beaches in the North; District of Rio Vermelho, in the Northeast (Fig. 6-2); in most of the extent of Federal Highway BR-101 (Fig. 6-3) and Federal Expressway BR-282 (Fig. 6-4); and State Highway SC-405 (Fig. 6-5). This is the case, however, only when the road has the characteristics of an expressway, but not when it has environmental and sightseeing qualities such as in Beiramar Norte. This pattern also seems to be somewhat weakened by the conjunction with global Integration, since in areas where this measure is high we see more of cohort "C" and less of cohort "E" along the highway (compare the south portion of BR-101 to its central segments, for instance).

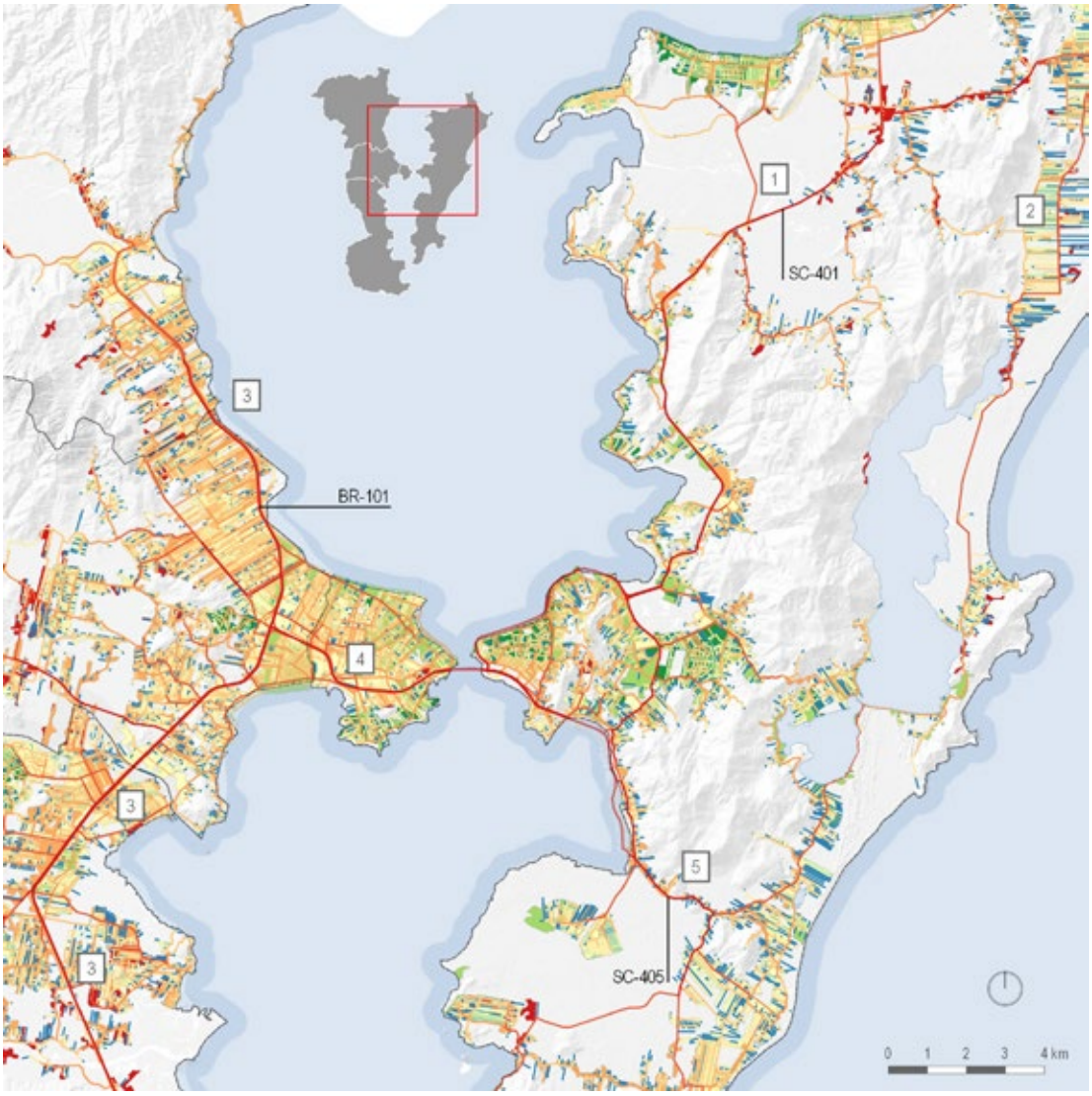

Figure 6 - Cohorts "D" and "E" at high global Choice highways: 1) State Highway SC-401; 2) Rio Vermelho; 3) Federal Highway BR-101; 4) State Highway SC-405.

This combination of high (but not highest) integration and choice may be regarded as a more accurate description of what Sugai (2015) loosely called "the privileged access route of the upper classes". It affords the higher socioeconomic classes two kinds of locational advantages: they remain, on average, closer to the rest of the system and – more importantly, judging by the greater differences – closer but not directly adjacent to the streets that carry out important connections in the grid and are on the paths between other locations. This, in turn, is linked to higher presence of commercial activities and microeconomic vitality (Hillier, 2009). At the same time, however, they are able to avoid the negative externalities associated with these factors.

It is remarkable that a purely configurational measure is able to capture this phenomenon so clearly. It shows the power of public investments in transforming the material structure of the city, especially when we compare the original path of the colonial era with the much more straightened contemporary route. Angular minimization seems to have been an active and significant force in this transformation throughout the decades.

3.3 SOCIOSPATIAL ANALYSIS: LOCAL RADIUS

3.3.1 LOCAL PATTERN#1: LOWER COHORTS IN STREETS WITH LOW CHOICE AND INTEGRATION VALUES

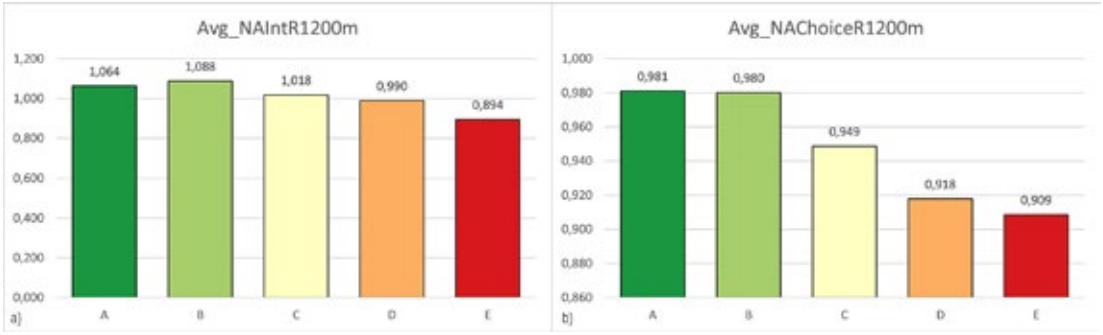

Figure 7 - Averages of Normalized Local (R1200m) a) Integration and b) Choice for socioeconomic cohorts.

This pattern closely mirrors that of their global counterparts, albeit probably for different reasons. While in the global case the low values of cohorts "D" and "E" are related to the low prices of locations distant from the more integrated areas, in the local scale this is not necessarily the case, since there is no obvious reason to assume that locally integrated streets have higher land values than segregated ones. It was not possible to unequivocally identify the cause of this phenomenon, but it is probably due to the tree-like structure prevalent in most of the peripheral areas, coupled with the segregation and low Choice that, almost by definition, characterize areas in the outer portions of any syntactic system. It seems, however, that planned neighborhoods for the upper classes sometimes manage to circumvent this tree-like structure and achieve quasi-grids street systems.

Highly locally integrated areas tend to afford better conditions to the development of local centralities (Hillier 1999; 2009), social contact and better use of the facilities in their surroundings – considering that the radius of 1200m is roughly equivalent to a 15 minute walk. Underprivileged population living in locally segregated areas have these possibilities undermined, adding once more spatial disadvantage to their already difficult situation.

3.3.2 LOCAL PATTERN #2: SEGREGATION BY GRID DISCONTINUITY

The most common pattern in the local scale is segregation by grid discontinuity between adjacent areas with contrasting socioeconomic conditions. There are several examples where misalignments between streets separate areas that are otherwise very near to each other. Such is the case, for instance, of the deprived areas in Morro da Cruz, in the central area of Florianópolis and relatively near to Beiramar Norte (Fig. 8a); Pedra Branca e Frei Damião, in the mainland (Fig. 8c); and "Bosque das Mansões", a gated community (Fig. 8e). Figures 8b, 8d and 8f highlight the shortest paths between the contrasting areas depicted in the images on the left. It becomes clear that any possibility of interaction in errands and other daily patterns of movement is severely restricted in such situations.

In fact, there is reason to believe that this grid-generated segregation may have important implications in the emergence (or lack thereof) of neighborhood ties among adjacent areas. Not only the flow of pedestrians is impaired, but also of vehicles. What is more, even the routes of public transport systems have to make excessive turns in order to cover a reasonable area. As a result, the copresence (and its possible ramifications, like interaction, familiarity, collaboration, weak and strong ties, etc.) among people from different classes and backgrounds is also minimized.

Figure 8 - a) Beiramar Norte and Morro da Cruz; b) shortest path for (a); c) Pedra Branca and Frei Damião; d) shortest path for (c); Bosque das Mansões; f) shortest path for (e);

Sometimes, but not always, this pattern emerges as a result (at least partially) of topographic conditions. This has the effect of making the disconnectedness more "natural" and, at the same time, hide one community from the other. That is the case in Morro da Cruz and Bosque das Mansões, above, but not of Pedra Branca and Frei Damião. These last two communities, despite having similar values of global Integration, have quite different local Integration. Pedra Branca has a central avenue (Av. Pedra Branca) that crosses its full extent[1] and structures its grid, and is highly integrated in the local scale. It has a tendency be the seed of a local centrality that, nonetheless, will not be a viable option to the inhabitants of Frei Damião. Apparently, due to the absence of a hill separating both communities, a wall has been built between them to ensure that not even mutual visibility is possible, as can be seen in Fig. 8d. Another wall was built along the interface to the other deprived community in the west. The location and extent of the walls leave no doubt as to what contacts they are trying to prevent.

1 The yellow area to the east of the green portion is also part of Pedra Branca. The classification in the "C" cohort is most likely due to its more recent development and the imprecisions, at this scale, of census tracts.

In the case of Beiramar Norte and Morro da Cruz, despite being in the central area of the Island, they have vastly different values of global Integration. The proximity between them was not able to overcome the effects of the highly disconnected and tortuous grid that characterizes the deprived community. Perhaps more worryingly, the local Integration is very low as well, obstructing the emergence of strong spaces for the gathering of its inhabitants and the maintenance of commercial and communal activities.

Figure 9 - a) Normalized global Integration; b) Normalized global Choice; c) Normalized local (R1200m) Integration; d) Normalized local (R1200m) Choice.

4. CONCLUSIONS

The investigation of the spatial distribution of socioeconomic cohorts as described by syntactic measures of grid configuration showed that the classical approach of concentric circles is not a sufficiently accurate model. We found, instead, that the upper socioeconomic ranges seek not only locations near the CDB but also more remote one that, nevertheless, have direct and easy access to the CBD through high Choice streets or highways. This does not mean, as the study revealed, that these cohorts place themselves directly at these streets. Rather, they have a tendency to (self) segregate, mildly isolating themselves from the foreground network while guaranteeing easy access to it. On the other hand, we found that the lower socioeconomic ranges were far more frequently located directly along these routes, at least when they have the characteristics of expressways.

At the local level, when contrasting socioeconomic sectors are close to each other, topography and the road system are often used to disconnect them from each other and thereby decrease the likelihood of casual encounters and copresence in daily activities and movements. The suppression of mutual visibility also appeared as a pattern in these cases, achieved either by topography conditions or by the deliberate construction of walls separating the areas.

The consequence of this scenario of socioeconomic inequality and sociospatial segregation is the likely reduction of contacts with people from different social and urban backgrounds, with the ensuing effect of reduced coexistence and opportunities to exercise tolerance, empathy and negotiation in situations that involve unfamiliar characteristics and social values. Moreover, the

segregation at the global scale restrain the access of the most deprived groups to institutional and community facilities, as well as to jobs and retail. This brings an extra burden on an already underprivileged group, imposing higher commuting times and costs, diminishing their available free time and restricting their capacity to pursue leisure and social activities.

REFERENCES

Freyre, G. (2014). Sobrados e Mucambos. 1. ed. São Paulo: Global Editora.

Genovez, P. (2002). Território e desigualdade: análise espacial intraurbana no estudo da dinâmica de exclusão/inclusão social no espaço urbano em São José dos Campos. Instituto de Pesquisa Espaciais (INPE), São José dos Campos.

Gottdiener, M. (1997). A produção social do espaço urbano. Sao Paulo: EDUSP.

Hillier, B. (1999). Centrality as a process: accounting for attraction inequalities in deformed grids. Urban Design International, 4(3&4), 107–127.

Hillier, B. (2009). Spatial Sustainability in Cities: organic patterns and sustainable forms. In Proceedings of the 7th International Space Syntax Symposium. Stockholm.

Jannuzzi, P. de M. (2001). Indicadores sociais no Brasil: conceitos, fontes de dados e aplicações para formulação e avaliação de políticas públicas, elaboração de estudos socioeconômicos. Campinas, SP: Alínea Editora.

Medeiros, V. (2013). Urbis brasiliae: o labirinto das cidades brasileiras. Brasília, DF: Editora UnB.

Reis, A. F. (2012). Ilha de Santa Catarina: permanências e transformações. Florianópolis, SC: Editora UFSC.

Sugai, M. I. (2015). Segregação silenciosa: investimentos públicos e dinâmica socioespacial na área conurbada de Florianópolis (1970-2000). Florianópolis: Editora UFSC.

Villaça, F. (2012). Reflexões sobre as cidades brasileiras. São Paulo, SP: Studio Nobel.