

## #117

### SPATIAL CONFIGURATION AND REGIONAL ECONOMY

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#### ABSTRACT

The second most important economic pole in the State of Rio Grande do Sul, Brazil, corresponds to an agglomeration of thirteen cities located in its northeast zone. They are mid-sized cities whose municipalities concentrate seven per cent of the state population and fifteen per cent of the State Gross Product.

In 2013, this group of municipalities, despite not exactly presenting the main characteristics that commonly describe a metropolitan phenomenon, such as large population, commuting and conurbation, was institutionalized as the Metropolitan Region of Serra Gaúcha - MRSRG, when political reasons overcame technical delimitation criteria.

However, the territory in between those cities shows interesting peculiarities which deserve to be examined face to the model of the post-industrial city, spreading over diversified, fragmented, heterogeneous, dense or diffuse zones with different growth dynamics. Relations between accessibility and land use at different scales over MRSRG territory need to be better understood on this contemporary context. The investigation is aided by recent developments of Space Syntax tools, which have been efficient to describe large complex systems.

The present paper brings part of the results of the ongoing exploratory research about spatial configuration and regional structure, which aims to review criteria for delimitation of metropolitan areas in Brazil. It uses a geo-referenced data base which contains over two hundred thousand plots of electric energy supply for the great majority of the activities developed in the region. These locations were correlated to syntactic measures of closeness and betweenness centrality based on the whole axial segments network, in order to investigate land use and occupation patterns representative of a contemporary territoriality in the southern part of the country. Demographic census data were also used to verify correlations between income and location.

The results point out to significant centrality changes when municipalities are globally analyzed; to the existence of industrial activity being developed in rural areas; and to the fact that

residential areas are not only inserted into urban zones but also in the rural territory, although the highest family incomes are more concentrated in the inner city.

## KEYWORDS

urban and regional planning, spatial configuration, space syntax

## 1. INTRODUCTION

In a general sense, the purpose of regional planning actions is to reduce the imbalances between territories at different scales, in order to promote social and economic development, with better labor, housing, health, leisure and culture conditions for the population.

France, England, Italy, Sweden, and other countries where regional planning has a long tradition, present nowadays significant results regarding to industrial and culture decentralization, agriculture modernization and tourism development (Tavares, 1996).

Despite being one of the most important economies in the world, Brazil presents high levels of social and economic inequalities among municipalities, what reveal a lack of effective up to date regional policies (Neto, 2009). In the 60's, they were somehow implemented regarding to the macro-regions of the country, much more based on fiscal incentives for industrial development poles than focused on the municipalities possibilities and sustainability.

In the last decades, the regional issue, in Brazil, has been directed mostly to the metropolitan problem, which is strongly marked by the fact that there are strictly three government levels in the country: the municipal, the state and the federal. The regions themselves do not have institutional power, what makes integrated planning actions a difficult task.

However, it is argued, there is an emerging necessity of Brazilian communities to belong to some kind of institutional association, what results in political initiatives to create metropolitan regions. In fact, there are nearly 70 metropolitan regions in the whole country and most of them were delimited with basis in unclear criteria. Excessive number of municipalities, overlapping delimitation, unjustified inclusion and exclusion of cities are the components of a conceptual distortion and misunderstanding about the metropolitan phenomenon.

Naturally, the first step on any possible regional delimitation approach of the territory is to be conscious of the environmental, social and economic issues, which extrapolate the municipal scale, and that are obviously related to the state and federal context.

In fact, regional delimitation, is not a simple process, mainly when it deals with the complexity of urban dynamics. Some authors use to say that delimitation happens to be discriminatory, in a certain way (ABRANTES et al, 2010). Actually, it is very difficult to draw a line separating a diversified territory with a fragmented and heterogeneous occupation, formed by dense or diffuse zones with different growth dynamics, from an exclusive rural one.

However, in some way this is necessary to be done, in order to be put in evidence where the strongest dependence relations between parts and the whole happen to be. This is the case of Metropolitan Region of Serra Gaúcha - MRSG, which is here taken for a deeper investigation. It was recently instituted, by the State of Rio Grande do Sul Government, based exclusively in the notion that the agglomeration of municipalities was important for the State because of its intense industrial activity. Other important aspects were not taken into consideration like population density, urban occupation continuity and commuting which indicates a metropolitan dynamics (Ugalde et al, 2015). The ongoing exploratory research, intends to introduce the spatial variable as an element to be considered on the delimitation of metropolitan agglomerations.

So far, parts, on traditional approaches, are taken as surface units such as demographic census sectors, districts or neighborhoods, which do not allow a deeper spatial analysis. Space syntax, combined with GIS tools, offers an interesting methodology supported by a consistent theory for morphological analysis based on space disaggregation and differentiation, which has been efficient for urban and regional structures identification.

This paper aims to present the results of the mentioned research, regarding to three of its main goals: to identify the global spatial structure of RMSG from the emergence of patterns of accessibility, centrality and distribution of important economic activities; to verify the degree of dependence of each municipal spatial structure from the global regional structure and to analyze the possibilities of urban expansion face to natural conditioning, particularly regarding to topography. Main industrial location will be examined and correlated with accessibility patterns, because of its importance in the regional economy and to contribute for a discussion about the rural / urban dichotomy in the studied territory.

## 2. BRAZILIAN INSTITUTIONAL CRITERIA FOR THE DELIMITATION OF METROPOLITAN AREAS AND URBAN AGGLOMERATION

The first Brazilian metropolitan regions were institutionalized based on studies developed by the official statistics and geography institute (IBGE), in 1969, aiming to conceptualize the metropolis, metropolitan areas and metropolitan regions as well as to stipulate delimitation criteria, which resulted in three categories: demographic, structural and integration.

Regarding to the demographic criteria, the central city should not have less than 400,000 inhabitants, according to 1970 Census. Its population density should be more than 500 inhabitants / km<sup>2</sup> and satellite cities' should not be lower than 60 inhabitants / km<sup>2</sup>. There also should be a variation of at least 45% on municipal population from 1950 to 1960.

Structural criteria, regarded to economic aspects and commuting, required that 10 % of the population of each municipality should be working in industries or number of commuters not to be less than 20% of the dormitory cities population. Besides that, the regional Industrial Gross Product should be three times higher than the Agricultural Gross Product, considering the group of municipalities within the region.

The integration criteria states that at least 10% of each municipal population should take two-way daily trips, either to the central city or to the other ones, besides the number of phone calls to the central city, which should be over 80 per terminal.

One of the first metropolitan regions delimited in the country was the Metropolitan Region of Porto Alegre, in 1967, when 14 municipalities fulfilled those requirements plus the ones regarding to urban occupation continuity and functionality, that is, some infrastructures, facilities and services were offered only in some cities. Meanwhile, other rules were approved regarding to the inclusion of municipalities in pre-existing regions, which will not be mentioned here due to the article extension limits.

In 1988, the Federal Constitution designated the states to create and regulate metropolitan regions but didn't include any criteria for their delimitation. The lack of rationality on many state administrations led, for example, to the zoning of the whole territory of the State of Santa Catarina into metropolitan regions.

More recently and in order to avoid these distortions, a federal law, called "Metropolis Statute" introduced new concepts based on influence regions of cities. However they are not very clear and directly applicable in complex territorial situations.

The Metropolitan Region Serra Gaúcha fulfills partially the criteria mentioned before. The main city of the region is Caxias do Sul with a population of approximately 470,000 inhabitants. However its population density is not higher than 286 inhabitants / km<sup>2</sup> whereas only six out of the thirteen municipalities have densities over 60 inhabitants / km<sup>2</sup> (Figure 1).

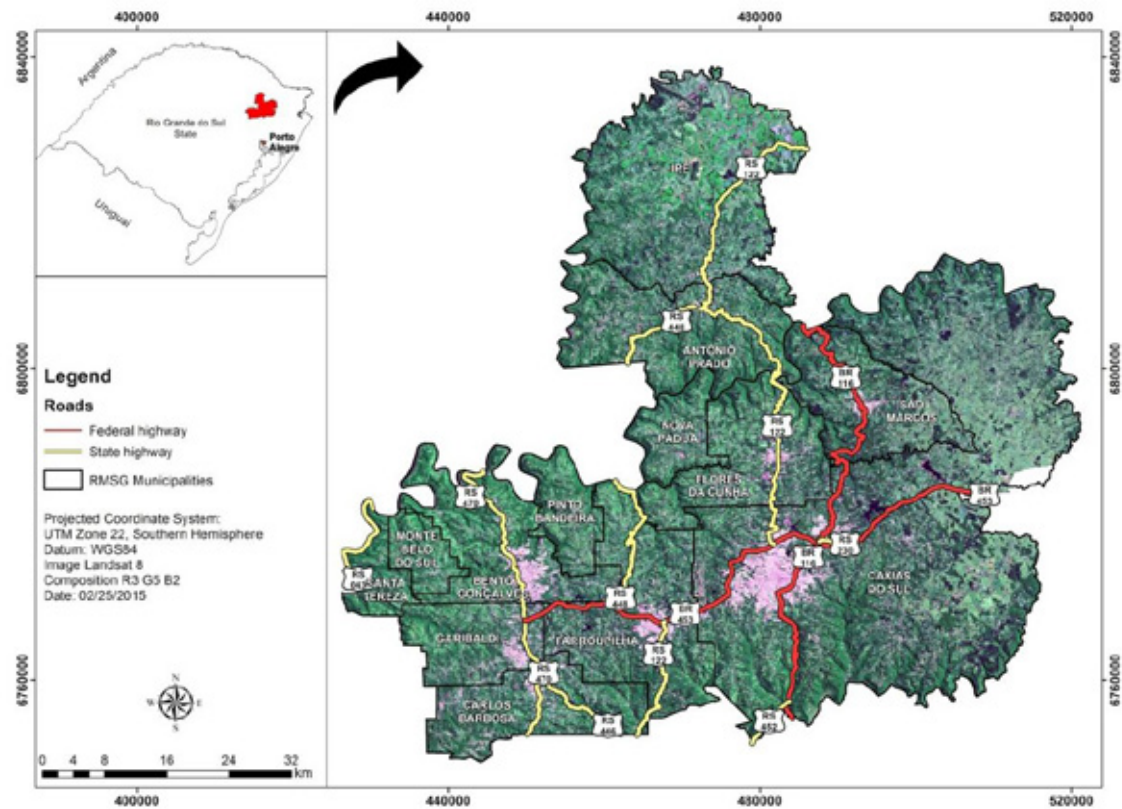


Figure 1 - Satellite image of MRSG with the federal and state highway network. Source: Produced by Geographer Vagner Mengue.

Table 1 shows the percentage of the Economic Active Population working on factories what reinforces the industrial character of this region, in such a way that the industrial Gross Product is 17 times higher than the agricultural value. Therefore, it seems that there is no doubt about the economic profile of those municipalities. However an important criterion was not attended. The amount of commuting trips for work and educational purposes, except for Carlos Barbosa, Flores da Cunha and Garibaldi, remains below 10% of their total population, according to the demographic census of 2010. Later in this article, an spatial analysis regarding to conurbation, which is, together with commuting, fundamental for a metropolitan region delimitation will be done.

MUNICIPALITY	EAP (habitants)	EAP on industry	%
ANTÔNIO PRADO	13,906	4,337	31
BENTO GONÇALVES	91,432	37,089	41
CARLOS BARBOSA	26,406	12,504	47
CAXIAS DO SUL	354,737	153,465	43
FARROUPILHA	55,969	25,720	46
FLORES DA CUNHA	24,224	9,411	39
GARIBALDI	27,865	11,741	42
IPÊ	6,216	1,558	25
MONTE BELO DO SUL	2,654	381	14
NOVA PÁDUA	3,058	412	13
PINTO BANDEIRA	0	0	00
SANTA TEREZA	1,989	251	13
SÃO MARCOS	17,977	7,839	44
<b>TOTAL</b>	<b>626,433</b>	<b>264,708</b>	<b>42</b>

Table 1 - Economic Active Population on industrial activity in MRSB (Source: IBGE).

### 3. THE RURAL-URBAN DICHOTOMY AND “O NOVO RURAL” IN BRAZIL

The previous paper about the mentioned ongoing research brought a brief review about the basic characteristics of metropolitan areas in a context of globalized economy as well as the importance and possibilities of regional delimitations (Ugalde et al, op cit.). The metropolis was described as the model of fragmented, heterogeneous and diffuse post-industrial city spread over a territory that gradually loses its characteristics of a typical rural environment.

Caiado and Santos (2003) verified that the main feature of the socio-spatial transformations is the conurbation growth together with a weight reduction of agriculture activities on employment and income of the families living in rural areas in the State of São Paulo, Brazil. The structuring and expansion of real state market, organized in different stages of the merchant capital reproduction (land subdivision, construction, incorporation, financing and sale) intensified verticalisation with residential and corporate buildings, as well as the implantation of medium-class private gated communities on peripheral neighborhoods without infrastructures. Slums appearance on almost all small cities regardless their size became the expression of a contradictory urbanization pattern, resulting from the urbanization of the capital and to the capital.

Not only urban areas have changed their features. Regarding to rural areas, agriculture and cattle raising achieved higher levels of technology, demanding less manual work and higher

levels of instruction in the rural labor market. However there are still traditional agriculture areas where low technology practices are still adopted. The fact is that they are not able to describe and explain the demographic and labor market dynamics anymore. According to the authors, other rural activities, not related to agriculture, are emerging from the increasing urbanization process of the rural territory such as: accommodation and hospitality, tourism, leisure, environment preservation, floriculture, crafts, and others.

Tourism in rural environment comprises spa resorts, defined as *places devoted to enhancing overall well-being through a variety of professional services that encourage the renewal of mind, body and spirit*, rural convention centers, training places for executives, ecological tourism, adventure tourism, business tourism and others. This economic sector increases territory valorization, through environmental, historical and cultural protection. Family small enterprises can offer products to specific groups of consumers that, for being small, do not stimulate big companies to be in the business.

Blakely and Bradshaw (1985) emphasize that, despite all these changes, rural policies are still focused basically on rural population segregation including transportation, housing, education and health improvement. Planners and authorities are not conscious yet about the new necessities of rural zones, related to a post-industrial society. One of these necessities is, for example, a sustainable zoning for a more diversified land use based on environmental protection.

In the next sections, considerations about rural territory of MRSG will be made regarding to industrial activities.

#### 4. THE COURSE OF THE RESEARCH

The previous paper brought to discussion the syntactic analysis of five municipalities belonging to MRSG: Caxias do Sul, Farroupilha, Bento Gonçalves, Garibaldi and Carlos Barbosa (Ugalde et al, op.cit.). The global space integration of the agglomeration was analyzed aided by Depthmap (Varoudis, 2012) and ArcGIS software. After processing the global integration of each municipality up to the limits of their boundaries, it was possible to observe changes on closeness centralities when each one of these parts were put together as a whole.

Afterwards, a considerable set of land use data was obtained to overlay the configuration, allowing an overview of possible relationships between syntactic measures and basic urban activities related to commerce and services, industry and housing. For that purpose, approximately 52,000 geo-referenced water consumption measure points were provided by the State Sanitation Company (CORSAN-RS). The number of units linked to each point also permitted a preliminary analysis of activity densities.

For the present analysis, approximately 232,000 geo-referenced electric energy consumption measure points were provided by RGE, the electric energy supplier for the region. Each point is categorized according to the National Classification of Economic Activity, what makes possible to relate activity locations with syntactic variables. This set of data represents an advantage compared to water consumption measure points because activities located in rural areas might not need a public water supply, but they are totally dependent from electricity.

Presently, the axial map of the whole region, composed by 13 municipalities, is complete. It consists of approximately 93,000 axial lines and 142,000 segments. The necessary operation for the analysis were processed by Depthmap X in combination with ArcGIS, and QGIS integrated to Space Syntax Tool Kit (Gil et al, 2015)

##### 4.1 THE GEOMORPHOLOGICAL ANALYSIS

The course of the research firstly leads to a natural environment analysis because it becomes necessary to evidence the main characteristics of the MRSG site, specially regarding to geomorphologic aspects.

Regarding to the geomorphological characteristics, the study area is inserted in the Geomorphological Region of the Planalto das Araucárias, belonging to the Geological Survey of Paraná (RADAM, 1986). The Geomorphological Region of the Planalto das Araucárias is characterized by relief forms carved in acidic and basic volcanic rocks of the Serra Geral Formation (CPRM, 1998; IBGE, 1986).

According to Pinheiro (2000), the geomorphological unit of Serra Geral, in turn, is subdivided into two compartments, Aparados da Serra and Área Serrana (in which the study area is inserted). The Área Serrana is characterized by forms of relief marked by deep and intense dissection with marked structural control, occurrence of structural grooves of various orientations and fluvial channels adapted to them. The main drainage axes refer to the Caí, Turvo and especially the Taquari-Antas rivers.

In this context, MRSG presents variants, from fairly rugged relief areas, mainly in the central and southern portions of the study area, where the Caí and Taquari-Antas rivers are located, where edges and strands of great slope can be observed, to areas with smoother relief, in the northern portion.

Figure 2 shows how environmentally conditioned the territory of MRSG is, specially by Antas River, which practically divide the territory in two parts: municipalities of Ipê and Antônio Prado, located in the northern part and the rest of them in the southern part. High slopes, specially along the main water courses also constraint urban occupation.



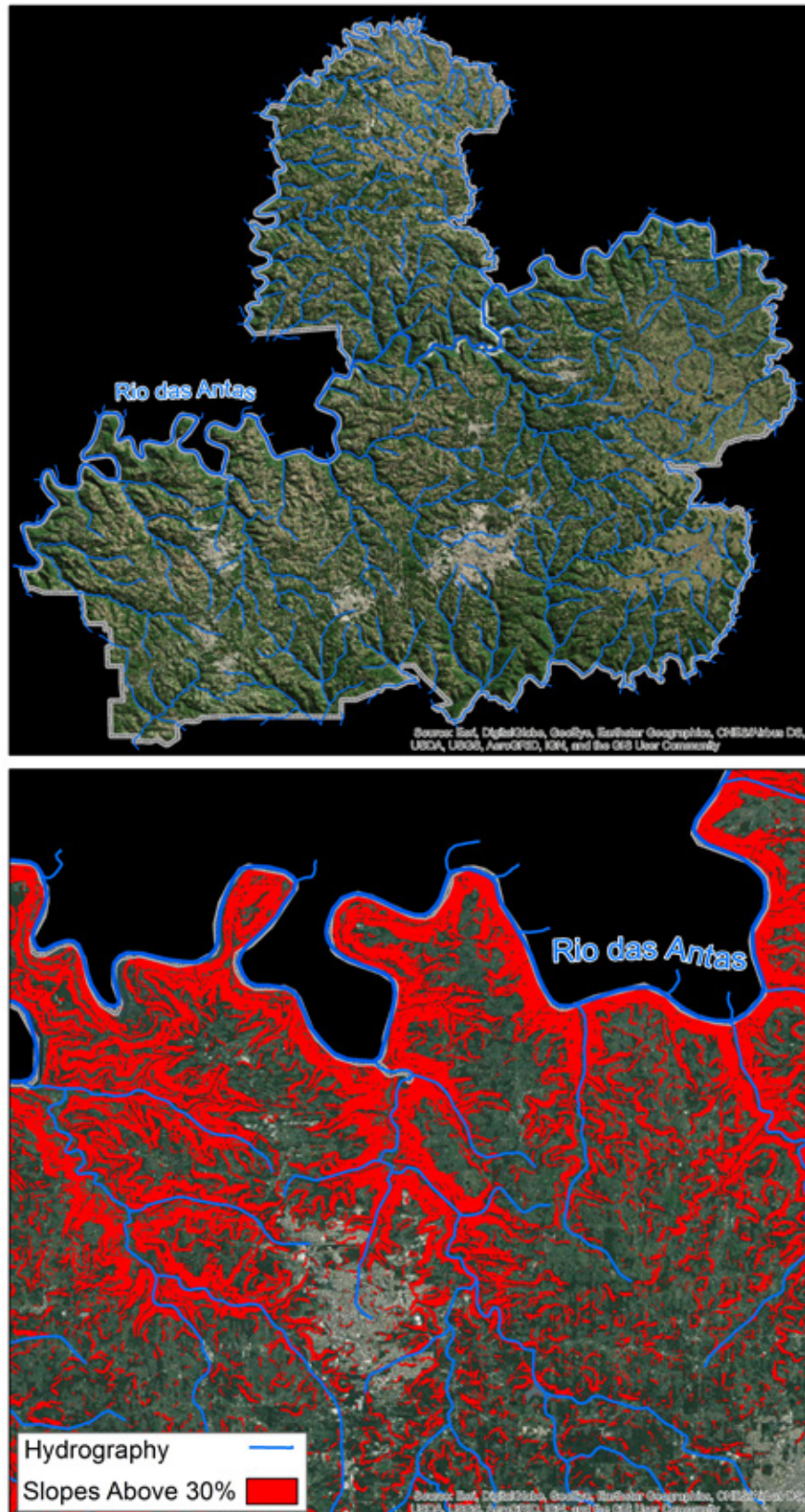


Figure 2 - The image in the left shows the superficial drainage natural system (in light green) with Rio das Antas (in blue). The image in the right position shows the layer of slopes above 30% (in red). Source: Produced by Geographer Vagner Mengue with information from IBGE processed by software ArcGIS.



#### 4.2 THE CONURBATION ANALYSIS

A significant feature of the metropolis is the urbanization crossing administrative borders on the territory. Measuring conurbation is not a simple task. The continuity of the territory occupation is different according to the scale of observation. Two hundred meters is an international parameter as being the maximum distance between buildings, but what density of these buffers can be taken as a continuity of occupation. Figure 3 shows the circles with a 100 m radius delimiting 200 m from one spot to another, in two different scales of observation: 1/100.000 and 1/10.000

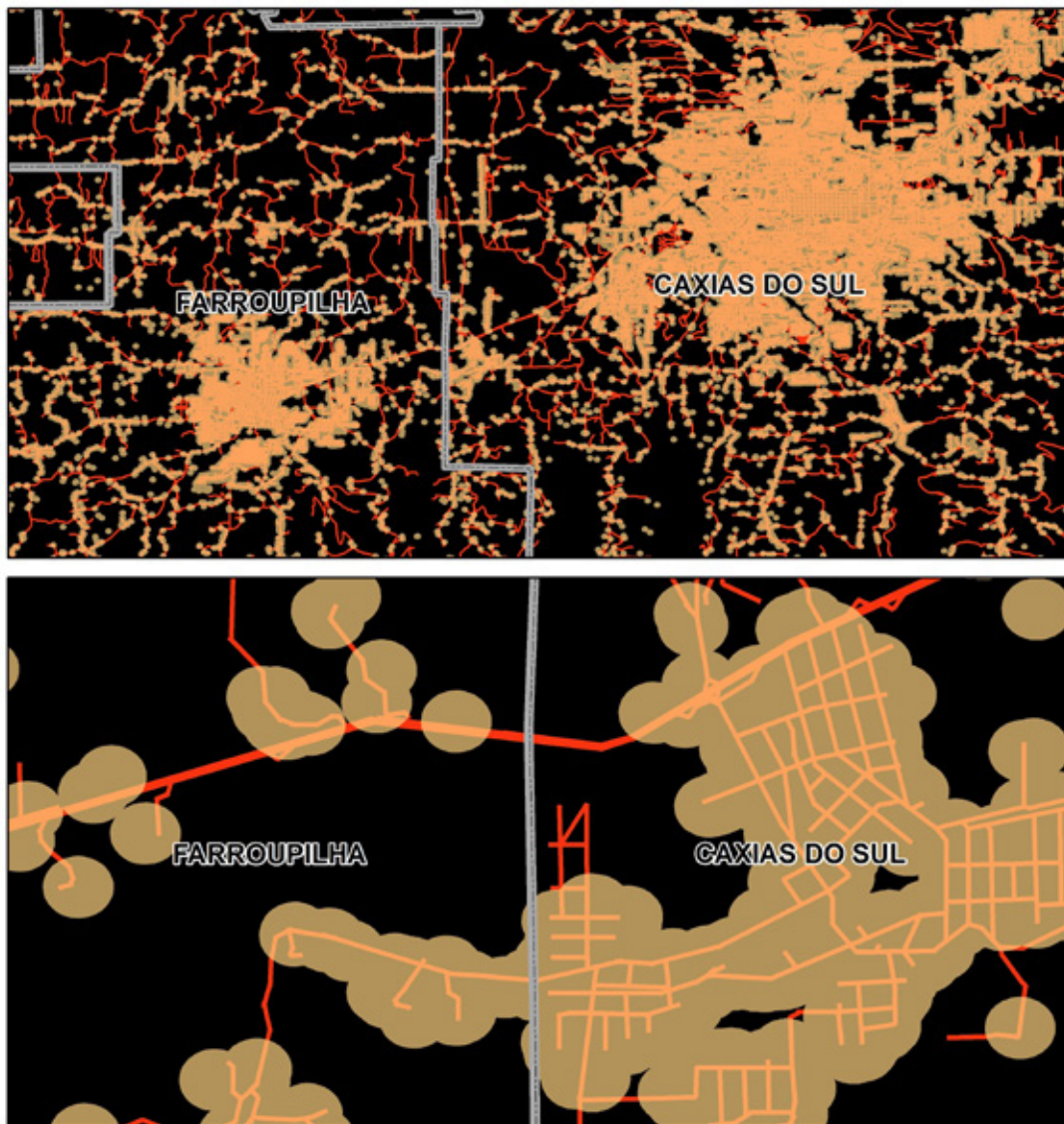


Figure 3 - A 100 m buffer centered in each electric energy consumption measure point, processed and observed in ArcGIS, in scales 1/100,000 (left) and 1/10,000 (right). Zoom to Caxias do Sul / Farroupilha border (white vertical line). Source: Produced by Geographer Vagner Mengue with information from RGE processed by software ArcGIS.

Another aspect to be considered is that, according to legislation, the question to be answered is if there is conurbation among municipalities. Therefore, municipality is the spatial unit formally considered. Although this question is not properly adequate to the complexity of the spatial phenomenon, the density of occupation along borders was examined. Legislation establishes that state government should regulate land subdivision projects located inside a 500 m buffer

along municipality borders. This distance was then taken for the evaluation. The result is illustrated on figure 4. Actually, there are conurbation zones and, consequently only parts of

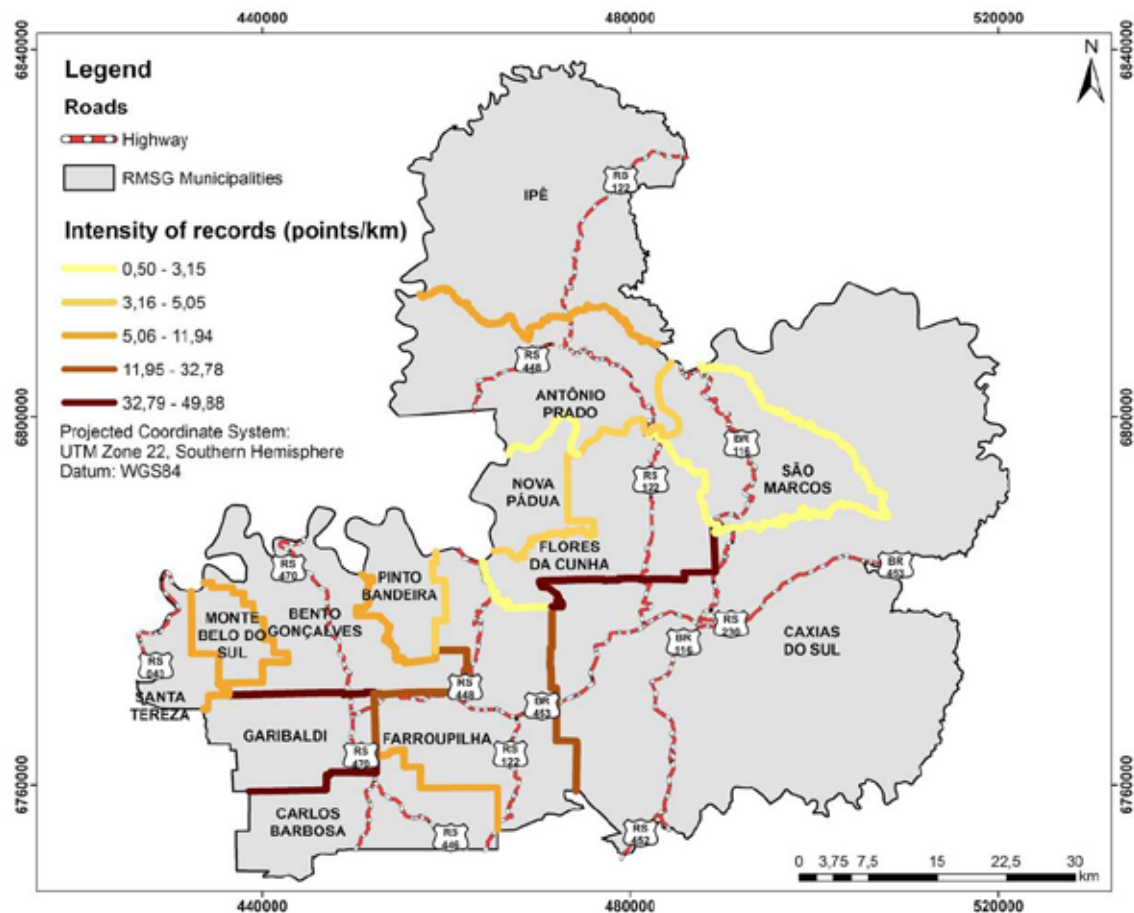


Figure 4 - Municipal borders and intensity of territory occupation per linear kilometer. Source: Produced by Geographer Vagner Mengue with information from IBGE processed by software ArcGIS.

the borders can be considered to be linking two or more municipal urbanization processes. The main borders are among Carlos Barbosa, Garibaldi, Bento Gonçalves, Farroupilha and Flores da Cunha.

Regarding to other possibilities of measuring potential conurbation under the syntactic point-of-view, there should be remembered the studies proceeded by RIGATTI (2009), and RIGATTI and UGALDE (2007). Those contents are still being discussed in order to subsidize the final research report.

#### 4.3 THE SYNTACTIC ANALYSIS

The part-whole problem is brought to discussion in the research project because its main purpose is to identify a spatial structure of the MRSRG and to observe if it is strong enough to justify the institutionalization of a regional entity of thirteen municipalities. For this approach, space disaggregation is essential to be done so that the complexity of spatial relations can be captured. Therefore the axial map, composed by approximately 93,000 lines, represent the road and street regional accessibility grid.

The degree of dependence from each "municipal part" to the "regional whole" can be evaluated by closeness centrality and betweenness centrality, which correspond, in Space Syntax, to integration and choice measures.

Figura 5 shows global integration ( $R_n$ ) of MRS<sub>G</sub>. The color gradient, from red to dark blue, indicates the rank of integration values from the more integrated axial lines to the more segregated ones. Thus, on one hand, we can observe a high concentration of integrated lines relatively close to the central part of the configuration, practically corresponding to the cities of Caxias do Sul and Farroupilha. Certainly, this happens not only because that is the zone of the least topological distances from each line to all the other ones, but mainly because a large quantity of long and highly connected lines are located there. Accessibility is largely privileged, what reflects on high densities of population and activities related to commerce and services.

On the other hand, there are zones of high segregation, not only for being near the edge of the configuration, but mainly for being parts poorly connected to the whole. That's the case of Antônio Prado and Ipê, which are practically separated from the rest of the municipalities because of Antas River.

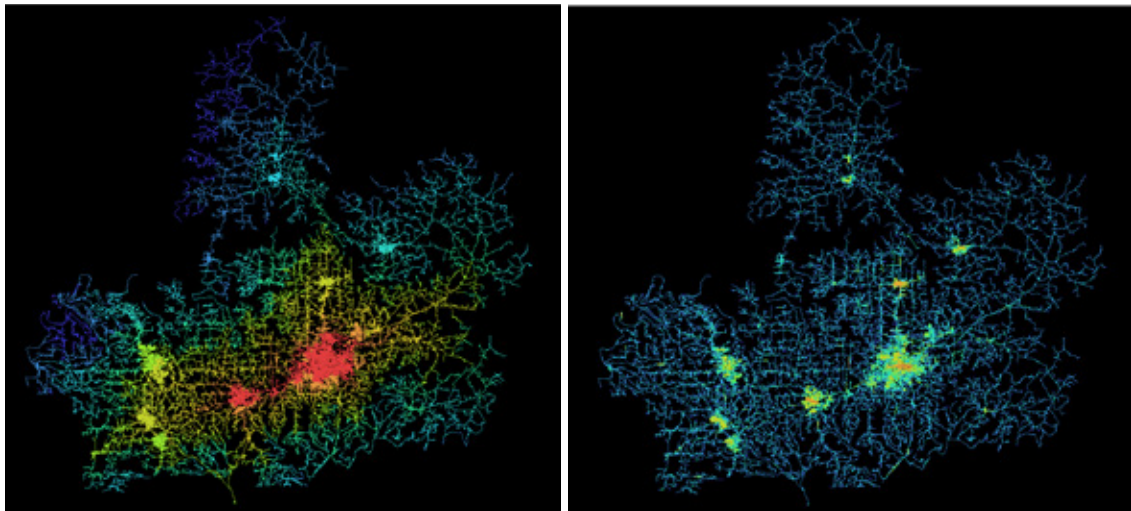


Figure 5 - Global integration ( $R_n$ ) of MRS<sub>G</sub> (in the left) and Local integration ( $R_3$ ) processed by Depthmap.

The global integration visual analysis based on Depthmap output evidences a difficulty as far as the representative colors get more distant from the red color. It becomes more difficult to distinguish the differences among global integration values. Local integration ( $r_3$ ) was tested as an option to identify more localized centralities. In fact, they emerge as shown in Figure 5. However, the algorithm measures the importance of each line up to 3 direction changes or 3 depth steps. Therefore there is a surface limitation within the global configuration and it does not reveal properly the global integration gradient in those parts of the whole which are more distant from the center.

In order to better visualize the global integration nuances, a simple method is created for the purpose of this investigation: after running the algorithm for global integration on QGIS, the group of values of each municipality are selected in order to be processed individually. Because the axial map is geo-referenced, it is possible not only to better visualize global integration variation but also to compare the change of centralities when the municipality is embedded in the regional configuration. Figure 6 shows the result.



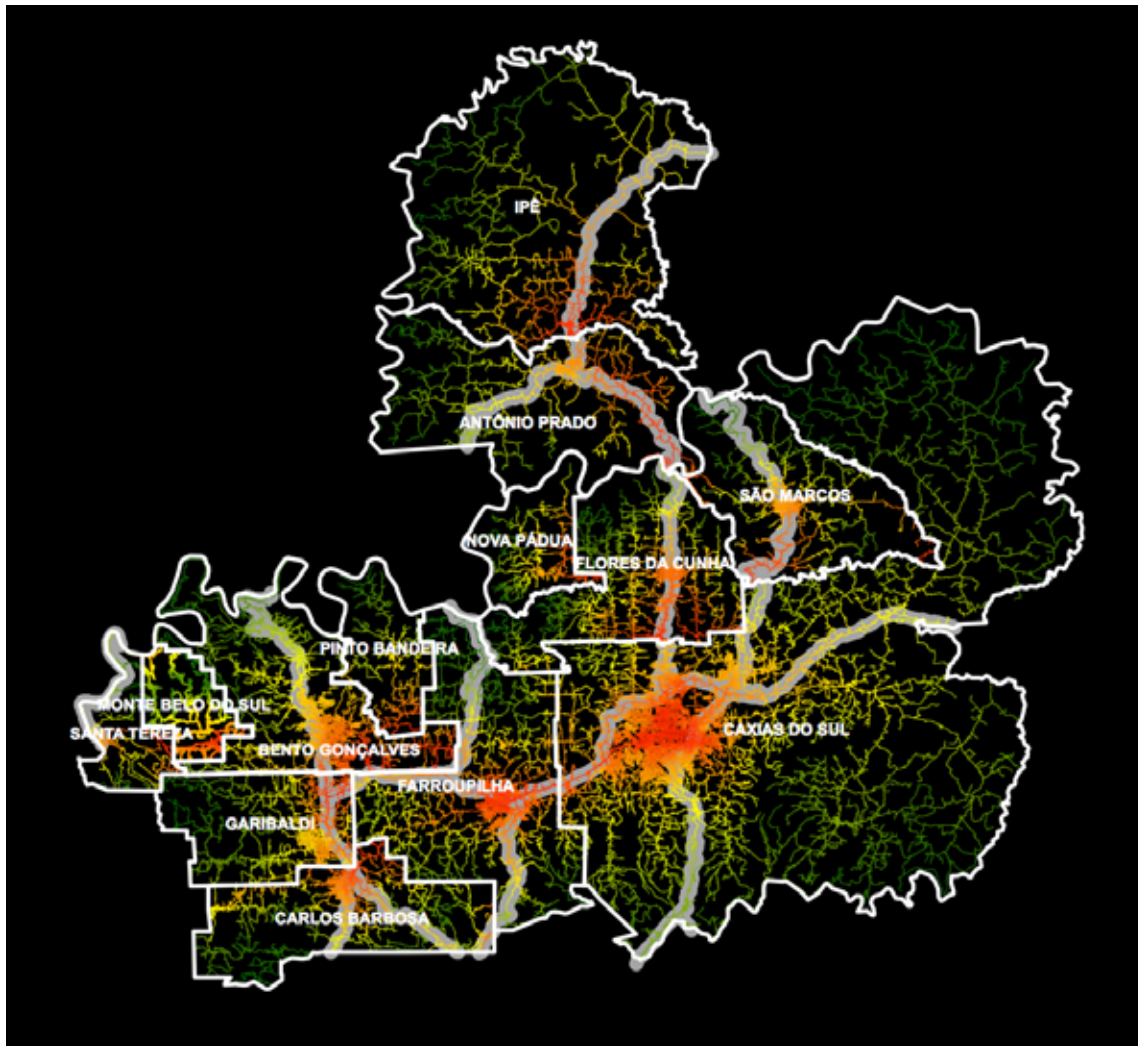


Figure 6 - Global integration (Rn) of each municipality joined together in the same MRSG axial map. Federal and State highway network is highlighted in light grey. Source: Assembled by Architect Cláudio Ugalde. Data processed by Space Syntax Tool Kit for QGIS.

On one hand, the more integrated lines in each municipality tend to be closer to the federal and state highways which, in most cases, are the straightest connection between cities. The least direction changes decreases topologic distances and those spaces become the preferred locations for attraction. In Figure 07, some examples of this increasing tendency can be verified.

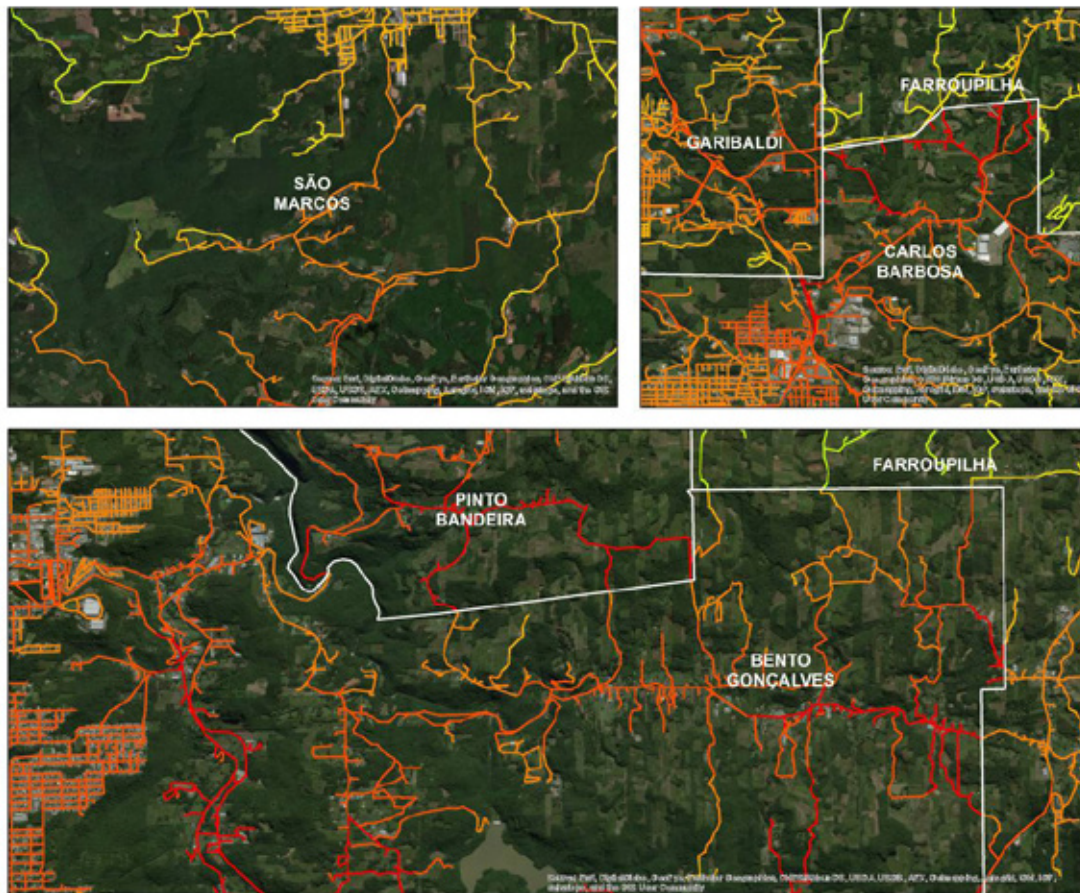


Figure 7 - Centrality gradual change from urban cores to more peripheral areas in São Marcos, Carlos Barbosa and Bento Gonçalves. Source: Shape files shown on Figure 6 overlaying satellite image.

Some smaller urban concentrations, like Pinto Bandeira and Nova Pádua, which are not directly accessible by those highways, tend to be polarised by larger concentrations as Bento Gonçalves and Flores da Cunha, respectively.

Another contribution to the discussion about how each municipality is configurationally affected by the global regional system, was based in a comparison between global integration of each municipality with their global integration when embedded in the regional whole. Figures 8 and 9 illustrates four characteristics of centrality change in Garibaldi, Caxias do Sul, Ipê and Monte Belo do Sul.



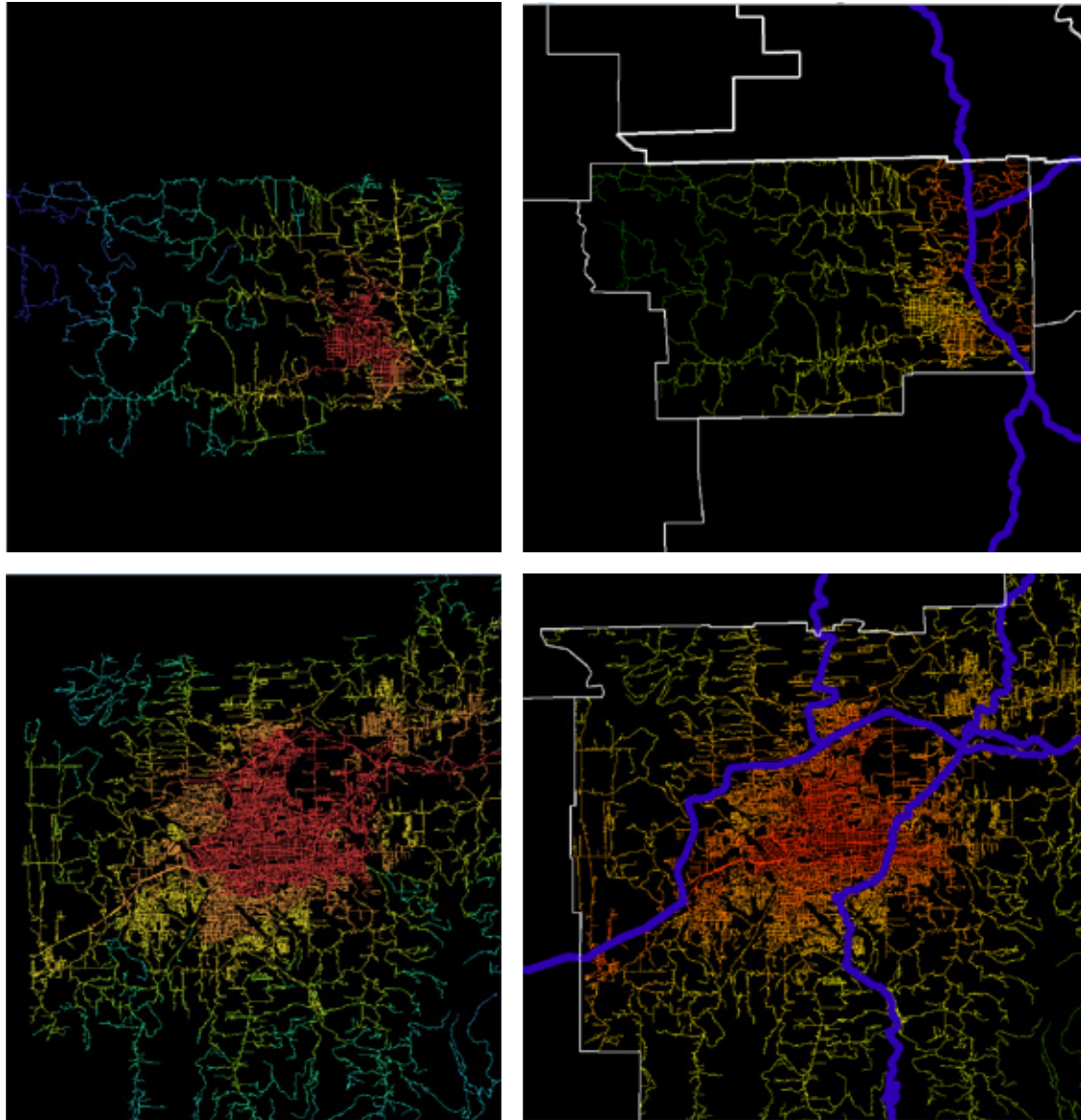


Figure 8—Global integration (Rn) of Garibaldi and Caxias do Sul in two different contexts. On the left side, integration up to the borders of the municipality. On the right side, municipality embedded on the global regional system. Source: Assembled by Architect Cláudio Ugalde. Data processed by Space Syntax Tool Kit for QGIS.

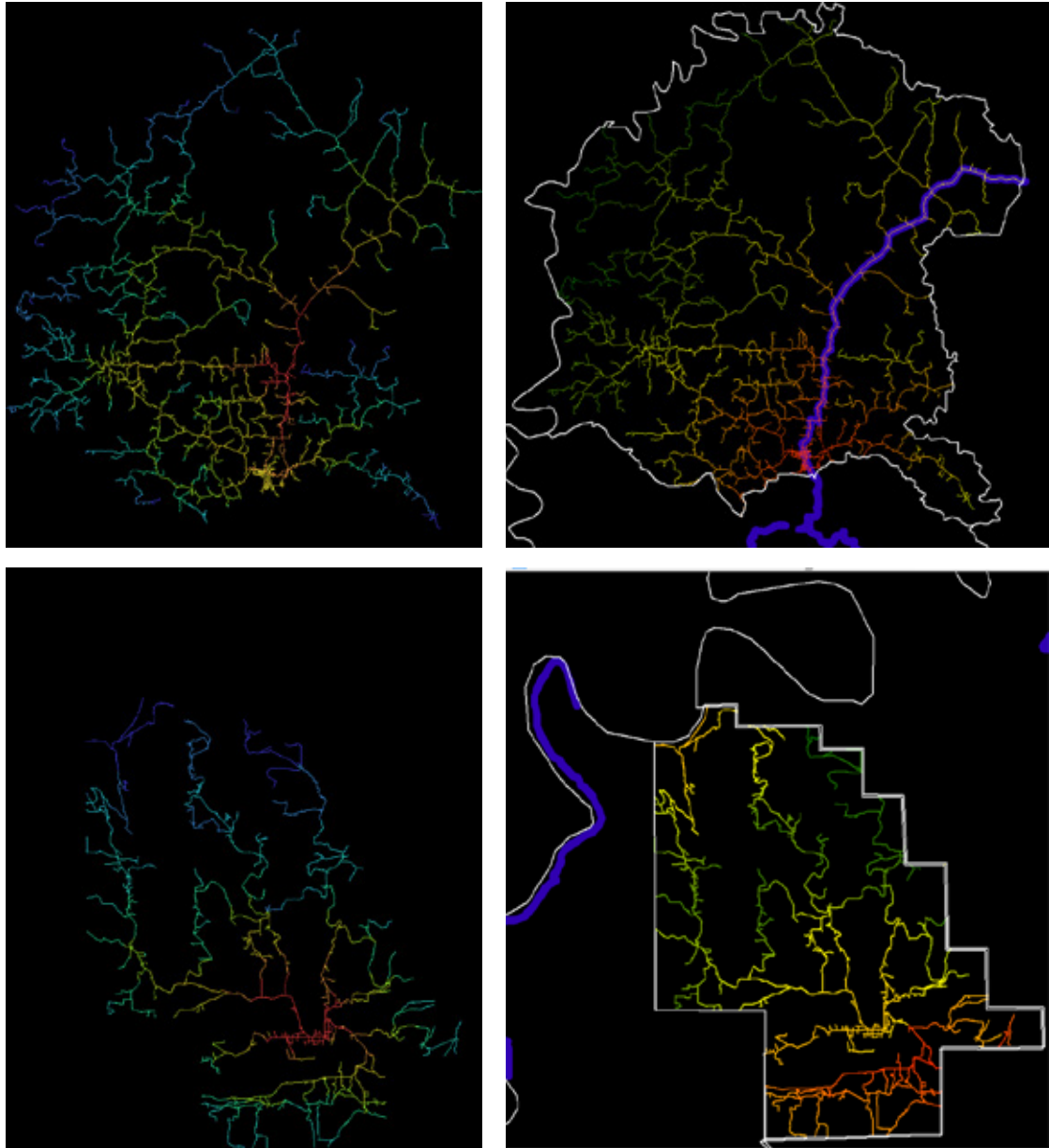


Figure 9 – Global integration ( $R_n$ ) of Ipê and Monte Belo do Sul in two different contexts. On the left side, integration up to the borders of the municipality. On the right side, municipality embedded on the global regional system. Source: Assembled by Architect Cláudio Ugalde. Data processed by Space Syntax Tool Kit for QGIS.

The urban concentration of Garibaldi, the city itself, is in fact, the most integrated area of the municipality and is located relatively close to RS 122 and BR 453. This is very clear. However, there is a group of lines which are more integrated than the ones in historical center, influenced by an even more topological proximity to the rest of the system, what is propitiated by the highways. Thus, there is a centrality change process in course in so far as the urban expansion connects to them.

The city of Caxias do Sul is in fact the most integrated one, not only in the regional configuration but also when centrality is measured up to the limits of its own territory. Besides some reasons pointed out before but also for being intersected by BR 116 and BR 453. The first one, built in 1941, attracted urban expansion to the east, regarding specially to industrial location and the second one, built in 1972, have supported mostly logistic and large size commerce.

Another interesting situation comes up with the case of Ipê, where the original urban core acquire importance at the regional scale. In the individual analysis, centrality is located a little further north, where, in fact, the level of occupation and activitiy is very low. On the contrary, Monte Belo shows a significant centrallity displacement from the historical urban core to a paralell road, which is the shortest route to Banto Gonçalves, where different land uses are consolidating.

Space Syntax presents another important measure, significantly correlated with through movement: choice. The measure highlights the most used spaces which tend to be least angle paths taken on journeys between each pair of segments in the spatial configuration (Hillier 2010).

Based on the reasonable idea that easy through movement within the city-region is an strategic element for development, the choice network was identified in order to examine how present it is in the territory of each municipality.

According to Jiang (2009), a quantity follows a power law when the probability or frequency of its value varies inversely as a power of that value. This is what happens regarding to the potential quantity of through movement in a spatial configuration. Based on previous investigations (Newman, 2005), he argues that majority of traffic, approximately 80% occurs in the top 20% of streets and the top 1% of streets account for more than 20% of traffic. Least angle choice has been powerful on expressing this phenomenon.

In Figure 10(a), 5% of the highest choice values is represented. Practically the whole highway system was captured, what reinforces the tendency of the mentioned municipal centralities change.

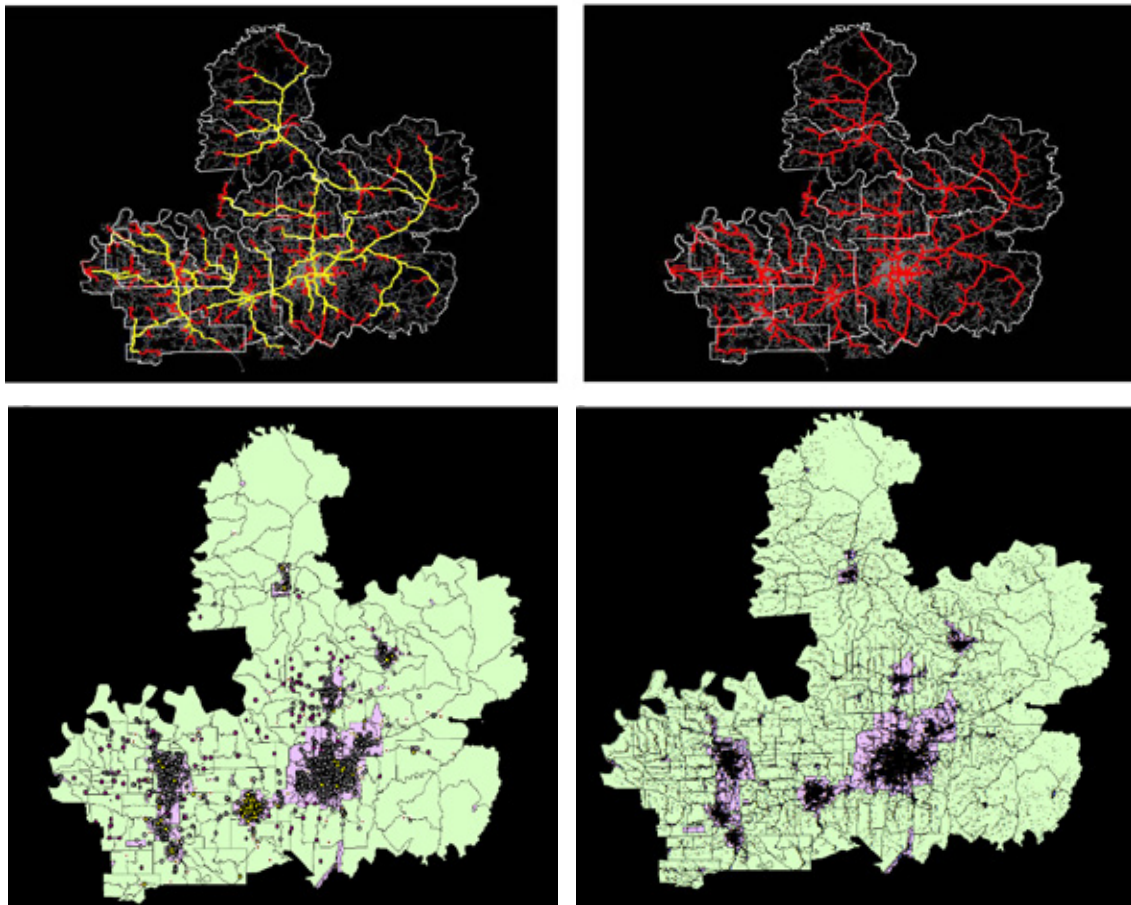


Figure 10 – (a) Choice network in MRSG axial map (in yellow 5% of highest values and 10% in red). Source: Depthmap output from segment map processing. (b) Rural and urban MRSG territories occupation (in the left) and main industries highlighted (in the right). Image produced by Geographer Vagner Mengue with information from RGE processed by software ArcGIS.

Table 2 shows the number of segments of the choice network (10 % of the highest values) belonging to each municipality. The purpose of this statistics is to observe how connected each municipality is to the mobility regional network, potentially used for the transportation of passengers and products. On one hand, it calls attention that Monte Belo do Sul, with a small urban core, has a number of choice network segments / km<sup>2</sup> as expressive as Bento Gonçalves, while Caxias do Sul has a much lower quantity per square kilometer of its territory. Of course, these means have to do with the municipal surface, but the difference is the choice mean value of the segments. Thus, the routes inside Caxias do Sul are much more potentially used than the ones in Monte Belo. Any way, the distribution of choice lines over the territory should be investigated in order that the relationship among municipalities regarding to large scale movement can be better evaluated.

MUNICÍPIO	Surface (km <sup>2</sup> )	Number of Segments	Segments / Km <sup>2</sup>	Choice Mean Value
ANTÔNIO PRADO	347.3	687	1.98	627,991,754.60
BENTO GONÇALVES	273.9	1562	5.7	352,004,617.18
CARLOS BARBOSA	229.8	569	2.48	173,412,998.98
CAXIAS DO SUL	16.1	4780	2.9	540,080,776.23
FARROUPILHA	361.4	1569	4.34	814,045,498.20
FLORES DA CUNHA	272.4	944	3.47	841,155,902.74
GARIBALDI	1.8	653	3.89	572,090,696.10
IPÊ	598.8	894	1.49	216,969,416.55
MONTE BELO DO SUL	69.5	359	5.16	155,048,763.43
NOVA PÁDUA	103.2	225	2.18	183,241,257.19
PINTO BANDEIRA	105	244	2.32	158,706,681.95
SANTA TEREZA	73.9	226	3.06	153,604,749.28
SÃO MARCOS	256	713	2.78	224,235,531.69

Table 2 – Number of choice network segments (10% of the highest values) belonging to each municipality per square kilometer.

#### 4.4 THE LAND USE ANALYSIS

The land use data base available has geo-referenced information about approximately 232,000 geo-referenced electric energy consumption measure points provided by an electric energy company responsible for the service. The basic land use categories were partially analyzed by Ugalde et al (2015) for a group of 5 municipalities in MRSB. For the present paper, the whole metropolitan region is examined regarding to the industrial use divided in the 5 most important categories for the regional economy: leather, machines and equipment, metallurgy, furniture, textile and wine. Besides these products being sold all over, specially the wine, textile and furniture industries frequently also sell their products in showrooms located near by the factories, what attracts tourists and bring jobs to rural areas.

Figure 10 (b) shows the location of the whole set of dots, where an immense quantity of activities in rural zones can be observed. However when the selected categories are highlighted, it becomes clear that, except for the wine industry, according to Table 3, the majority of the dots still overlay the urban areas, what indicates that main industrial activity in the region is either dependent of urban accessibility and urbanization patterns or regulations are still stricted regarding to industrial activity. The wine industry, very representative of the regional economy, seems to be under two circumstances: a necessary location near the cultivation areas and the opportunity of bringing tourists to an interesting rural landscape. However, hospitality and accommodation for tourists are still very related to urban areas.



Industrial Sector	Wine		Furniture		Metallurgy		Textile		Equipment		Leather		Hospitality	
Total of establishments	157		216		926		424		983		97		73	
	urb an	rur al	urb an	rur al	urb an	rur al	urb an	rur al	urb an	rur al	urb an	rur al	urb an	rur al
Number of establishments	58	99	172	44	874	52	420	4	902	81	90	7	65	8
%	36.9	63.1	79.6	20.4	94.4	5.6	99.1	0.9	91.8	8.2	92.8	7.2	89.0	11.0
Included in a 100m buffer along choice network (20%)	100		115		467		254		498		56		56	

Table 3 – Establishments of the industrial sector according to urban / rural zoning and to choice network buffering.

A 100 m buffer was set along the 20% top values of choice network in order to observe how dependent were those economic activities from a large scale movement grid. Expressive percentages regarding to wineries (100/157) and accommodation (56/73) tend to be located along choice network what suggests a stronger relation between the sector with consumers and suppliers from distant parts of the region besides a more local demand.

## 5.FINAL CONSIDERATIONS

Some issues of the exploratory research were brought to discussion in the present paper. Presently, activity locations analysis cannot be operated with basis on homogeneous territorial units. Complexity resulting from relations, flows, dynamics, competition requires other models to be captured in different territory scales. In a network urbanism perspective, space disaggregated units associated to precise location of activities can lead to the identification of patterns of accessibility, centrality, movement and land use among others. This approach was here attempted to better know the city-region of Serra Gaúcha and how spatially dependent each of its parts depends upon the whole.

If global integration would be taken as a parameter, Figure 5 suggests that the municipalities of Ipê, Antônio Prado, São Marcos, Nova Pádua, Pinto Bandeira, Monte Belo do Sul and Santa Teresa should not be part of the delimitation. However when large scale movement (Choice 10%) network is visualized, the smaller cities appear to be more dependent from the rest of region, meaning that they are more directly connected to the other municipalities, although not so intensively.

The intensity of connections among municipalities presupposes a potential conurbation, once the syntactic model deals with accessibility networks, but not directly with real occupation along them. Densities tend to increase in more accessible public spaces overtime and that is the case of an agglomeration with a great degree of discontinuity of occupation in territories in between yet.

Despite this discontinuity, the territory of MRSRG is visibly dotted not only with an immense number of residences and agricultural infrastructure, but also with general retail (318), administrative and public functions (213), sports and leisure activities (85), services (19), specialized retail (15) among others. On the continuity of the research, correlations will be tested between configuration local and global properties with other activities different from industrial ones. Regarding to these ones, it was seen, they are still well correlated to the urban accessibility pattern, predominantly the traditional regular grid.

The main purpose of delimiting metropolitan regions is the governance of public functions which cannot be managed by municipalities in an independent way, such as commuting, natural environment resources and infrastructures going beyond municipal borders. Some of these functions are not so clearly present in Metropolitan Region of Serra Gaúcha. However, for being still an incipient conurbation process, could be taken as an important fact to create a technical and political environment towards innovation on planning and governance initiatives.

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